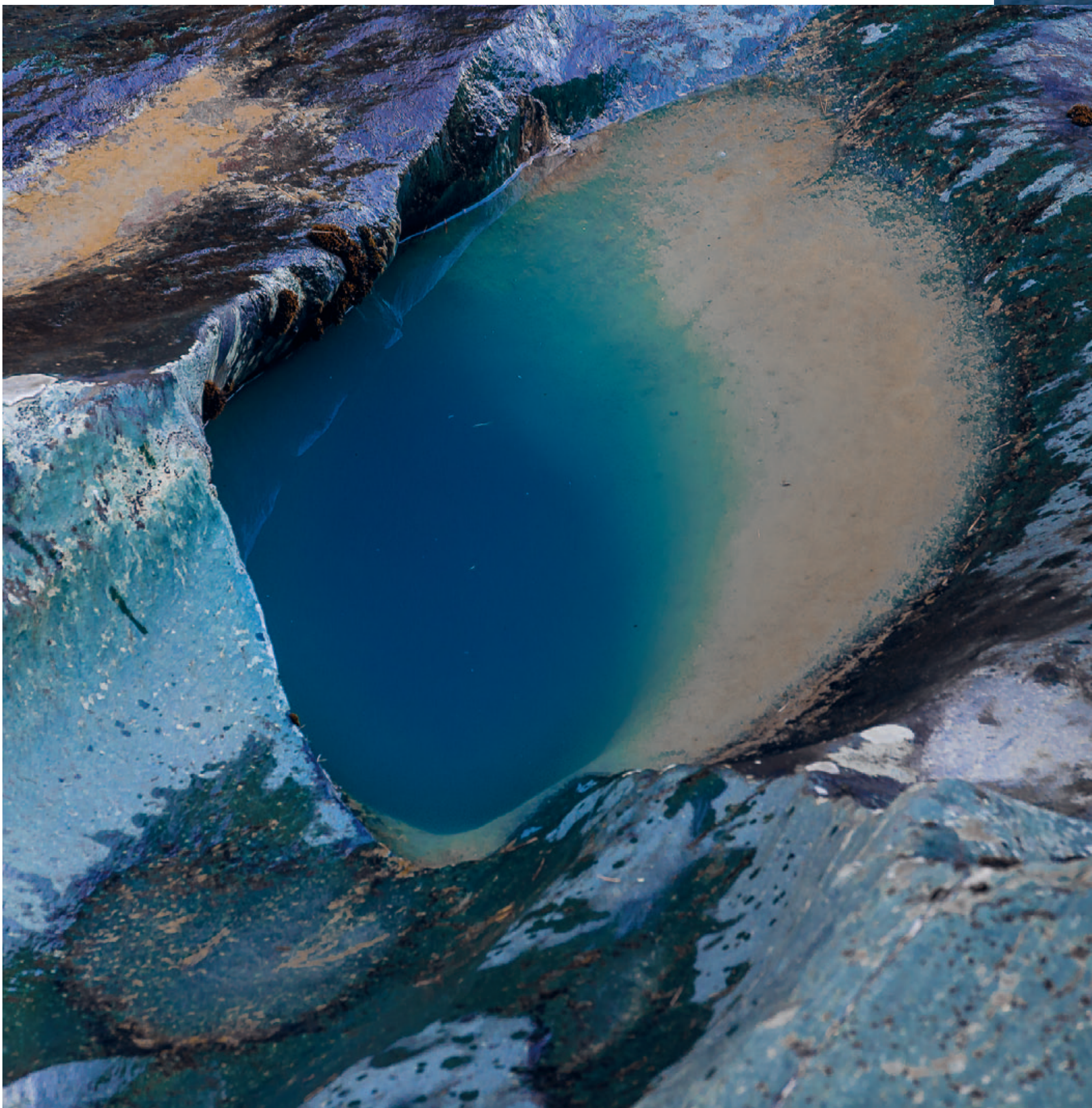
Conference Volume

6th Symposium for Research in Protected Areas

2 – 3 NOVEMBER 2017 – FACULTY OF NATURAL SCIENCES, UNIVERSITY OF SALZBURG



SUPPORTED BY THE FEDERAL GOVERNMENT AND THE EUROPEAN UNION

BUNDESMINISTERIUM FÜR NACHHALTIGKEIT UND TOURISMUS

LE 14-20
Entwicklung für den Ländlichen Raum

The European Agricultural Fund for Rural Development: Europe investing in rural areas

Nationalpark Hohe Tauern

NATIONAL PARKS AUSTRIA

Our natural heritage.

6th Symposium
for Research in Protected Areas

2 to 3 November 2017, Faculty of Natural Sciences, University of Salzburg, Austria

Conference Volume

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An application example for modeling grazing intensity: National Park Hohe Tauern

Susanne Aigner & Gregory Egger

Abstract

In the years 2014 to 2016 a determination of the grazing intensity in the National Park Hohe Tauern in Carinthia, Tyrol and Salzburg (Austria) took place. Basis was the land use model called 'Grass pre' (see presentation of G. EGGER). The work was focused on the following questions:

1. Which areas in the National Park are grazed?
2. How high is the grazing intensity?
3. Which measures are required?
4. How was the development of the grazing intensity in the last 20 years?

Keywords

National Park Hohe Tauern, grazing intensity, land use, alpine pasture, modeling vegetation.

Introduction

From 2014 to 2016 a repetition of the survey about the uses of alpine pastures in the National Park Hohe Tauern of Carinthia, Tyrol and Salzburg was performed. The survey focussed on the following questions:

- Where do the animals graze in the National Park? What are priorial uses of alpine pastures in the core zone and in the peripheral zone of the National Park?
- How are the cows, goats, sheep and horses distributed on the individual alpine pastures and throughout the National Park?
- Which potential yields are for each alpine pasture and in the National Park achievable?
- What percentage of the potential yield is being used and how high is the density of animal populations on the individual alpine pastures, or rather in the National Park?
- How has the uses of the alpine pastures changed in the last 20 years (since the last survey)
- How does the surface balance of the current grazing intensity look like?

Methods

The potentrial yields for each alpine pasture and in the National Park, as well as the grazing intensity have been modeled. The program used for the calculation of the yields is called 'Evalution model of alpine pastures'. The calculation of the grazing intensity is been done with the model 'Grass Pre'. The methods of these two models will be presented in Gregory Egger's speech 'Modeling grazing intensity of grassland'.

Results

Area distribution of the National Park Hohe Tauern

The Hohe Tauern National Park covers parts of the three provinces Salzburg, Carinthia and Tyrol. The biggest part with around 80 500 ha is located in the federal state of Salzburg. Its emphasis is dairy farming. Especially the long through valleys in the western part of the National Park and the valley called 'Seidlwinktal' are characterized by dairy farming. Eastern Tyrol has the second biggest proportion of the National Park Hohe Tauern with about 61 100 ha. Here the main focus is in the pasturing of young cattles. Additionaly, there are a few big alpine pastures for dairy farming, for example in Dorftal or in Innergschlöss. Carinthia has the smallest area size of the Natinal Park with around 32 700 ha. Nontheless, the core zone of the National Park in Carinthia is only a bit smaller than the core zone in Eastern Tyrol. In Carinthia the pasturing of young cattles is predominated. Dairy cows are only moved to alpine pastures sporadically.

National Park	Carinthia		Tyrol		Salzburg	
	Total area (ha)	Pasture area (ha)	Total area (ha)	Pasture area (ha) (ha)	Total area (ha)	Pasture area (ha)
Peripheral zone	11 320	6 507	26 414	16 523	26 782	10 200
Core zone	32 674	13 838	34 712	7 080	53 780	13 882
Total area	43 994	20 345	61 127	23 603	80 562	24 082

Table 1: Surface balance of the National Park Hohe Tauern. Here, pasture areas are defined as alpine pastures after the map called 'Hofkarte' and by informations of land managers. Areas without share of forage areas are included too.

Carinthia has the biggest share on grazed area in the entire National Park Hohe Tauern. All in all, 46 % of the area of the National Park are alpine pastures. In Eastern Tyrol it is 39 % and in Salzburg 30 % of the protected areas.

However, when considering only the core zone, a different picture emerges. Only 20 % of the core zone in Eastern Tyrol are within alpine pastures and only 8 % of the core zone are actually grazed. In Salzburg 26 % of the core zone is used as alpine pastures and 13 % of the core zone are actually grazed. In Carinthia, however, the share of alpine pastures are with 42 % much higher. But indeed only a small part of it is grazed (13 % of the areas).

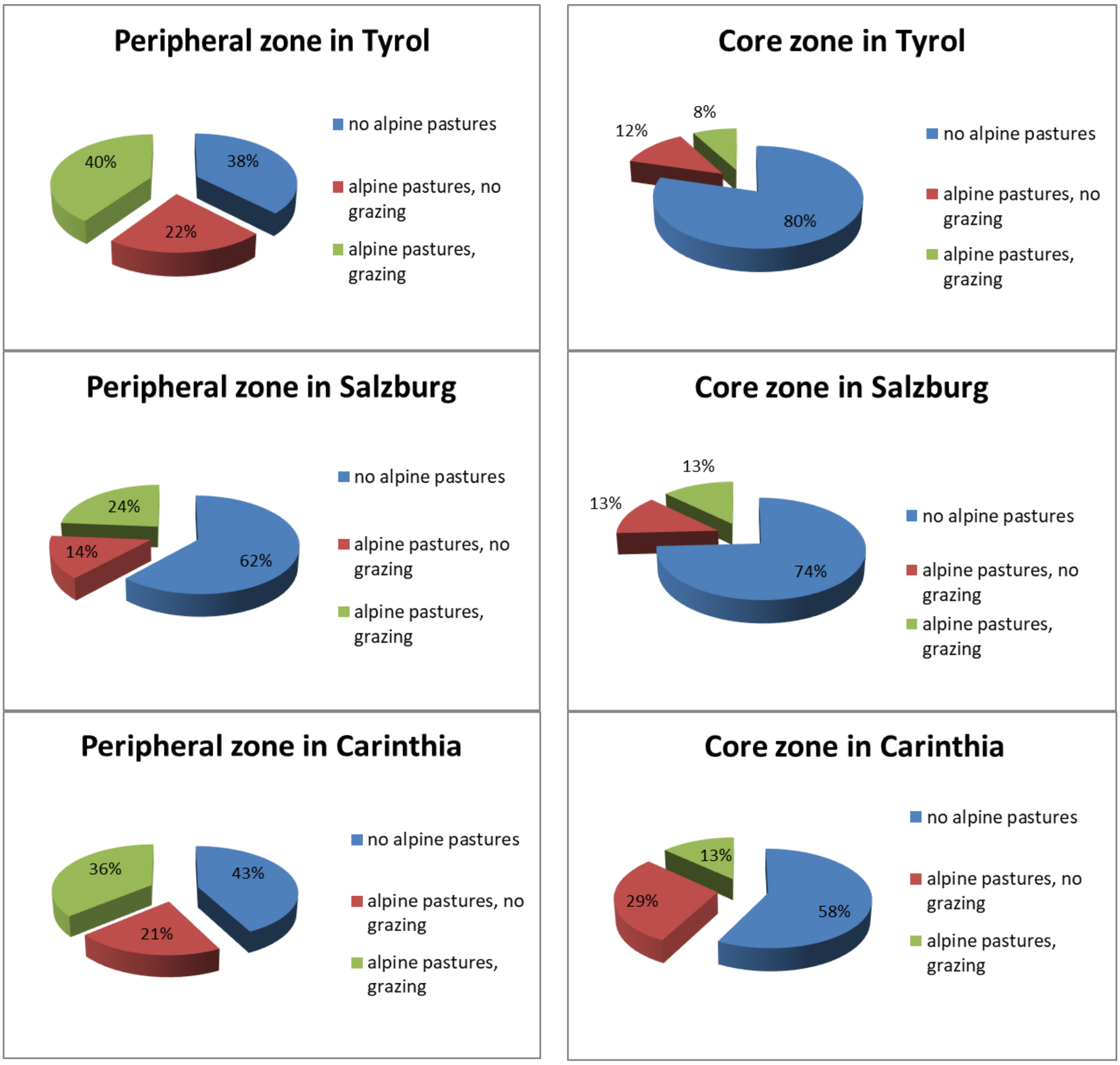

Figure 1: Distribution of the uses of alpine pastures in the National Park Hohe Tauern. Legend: 'No alpine pastures' are defined as areas outside of the external borders marked in the map called 'Hofkarte' of after informations of land managers as not grazed. 'No grazing' is defined as areas within the identified pasture areas and which could be accessable for animals (inside of the map 'Hofkarte') but have been currently not grazed. These are either areas without grazing suitability (e.g. densly dwarf shrubs, very steep slopes) or the uplift is too small so the areas could not be grazed by the animals. 'Grazing' is defined as areas which are extensively grazed (>0,01 GVE/ha).

Comparison of the numbers of moving animals to mountain pastures

All in all, 14 166 livestock units (=GVE) are grazing in the alpine pastures of the National Park Hohe Tauern in summer. This number can be split in 20 100 sheep and goats (that is 16 % of the sheep and goats which live on alpine pastures throughout Austria), 12 400 young cattles and horses, as well as 1 700 dairy cows.

With almost 7 000 livestock units, the main focus of alpine pasture use is located in Salzburg's share of the National Park Hohe Tauern. Additionally, Salzburg's part of the National Park also has the largest share of dairy cows (1 200 dairy cows). Whereas in Eastern Tyrol are still a few big milking alpine pastures located, there are hardly any in Carinthia. Here only 37 dairy cows are being milked on alpine pastures. The number of sheep at alpine pastures plays an important role in all three parts of the National Park.

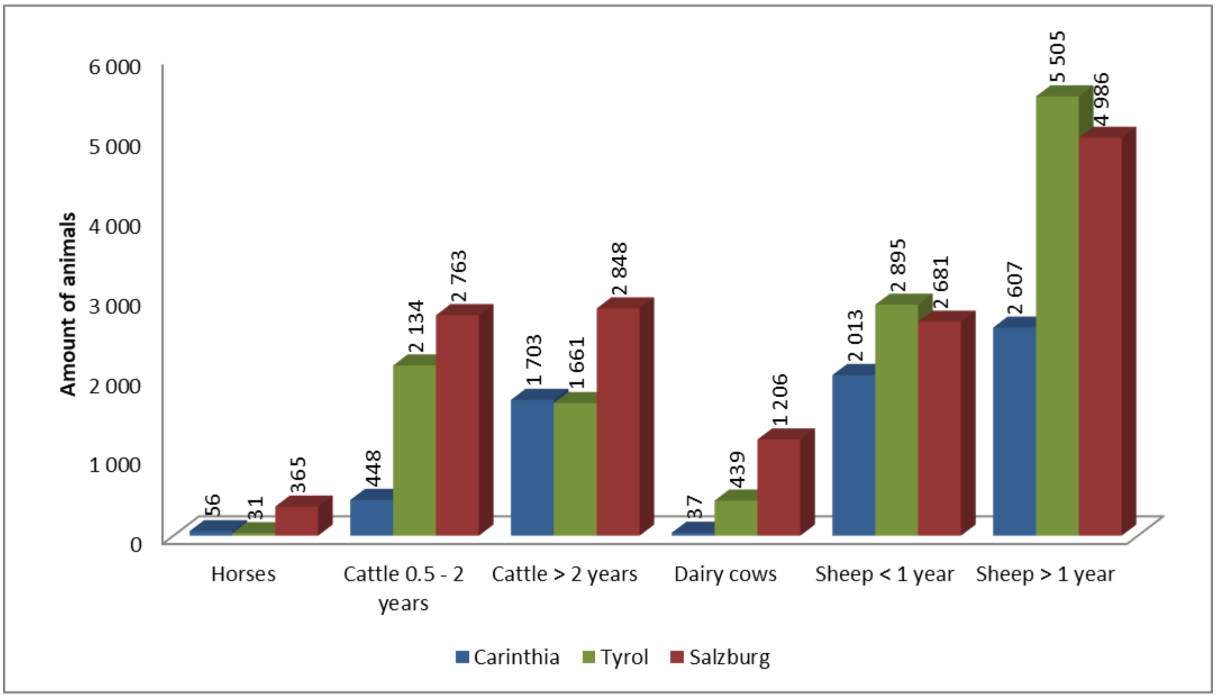

Figure 2: Amount of moving animals to alpine pastures in the National Park Hohe Tauern separated by federal states and livestock categories.

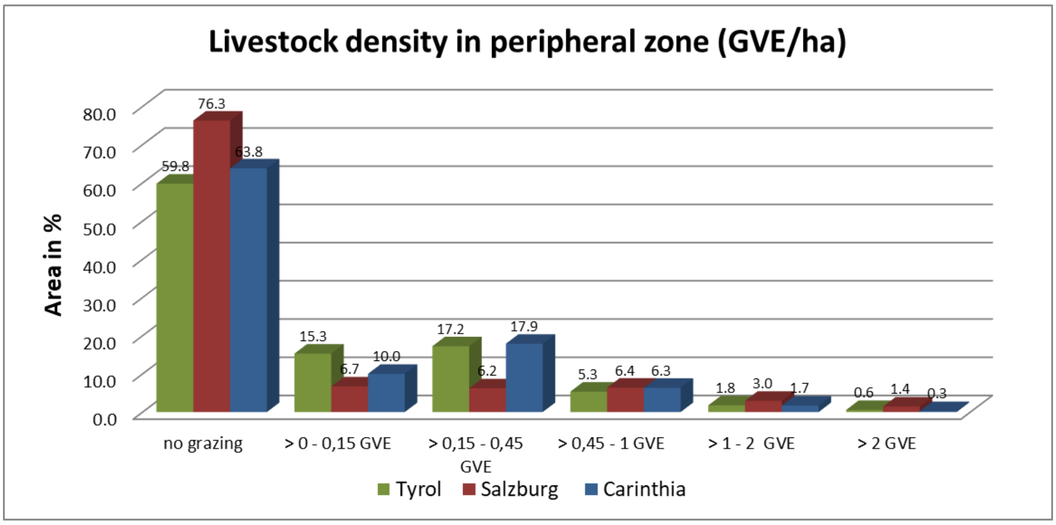

Figure 3: Livestock density in peripheral zone seperated by federal states.

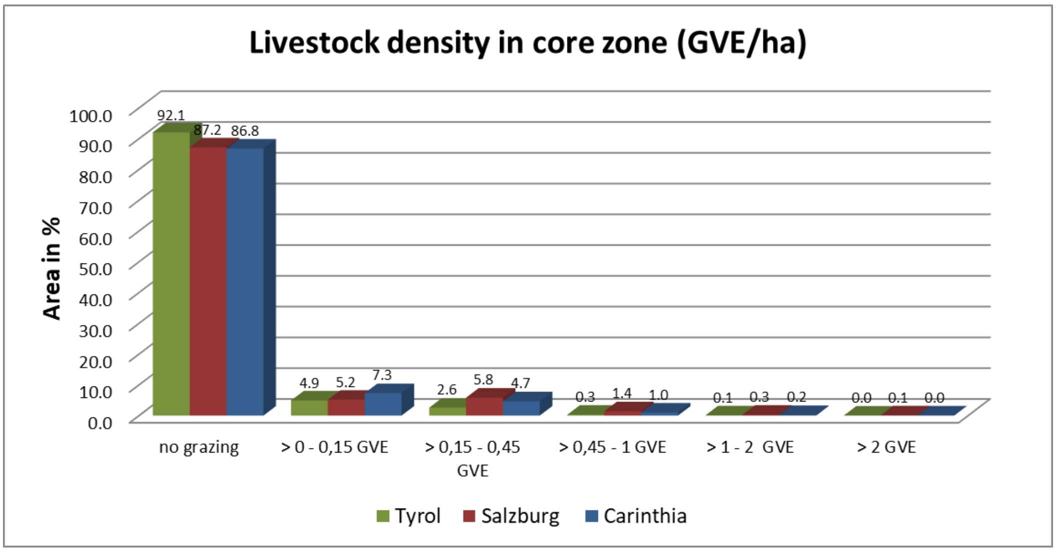

Figure 4: Livestock density in core zone seperated by federal states.

Comparison of the uses of alpine pastures

The density of animal populations (in GVE per ha) is on most alpine pastures, in the core zone as well as in the exterior area, under 0.45 GVE per ha. A densly animal population which is above 1 GVE/ha can be found only on individual areas. Those are usually located on lower elevated, profitable rich pastures in the range of alpine huts or they are very small alpine pastures which got grazed more intensively. That has the effect that the share of areas with densly animal populations are dramtically higher in the exterior areas than in the core zones. In the core zones fast-growing rich pastures are rare and areas with a densly animal population are in all three parts of the National Parks similar low and can be found in most cases only on the edges.

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Rain, cost or publicity – what determines variation in visitor numbers to the Swiss National Park?

Pia Anderwald, Andrea Millhäusler, Matthias Haeni, Rudolf M. Haller

Keywords

economic success, weather, modeling visitation, slab sensors

Summary

Visitor numbers are often used as a measure for the economic success of protected areas, but are influenced by a variety of parameters such as season, weather, social/institutional factors, publicity and the cost of visiting the wider region. The Swiss National Park celebrated its centenary in 2014 with correspondingly high media coverage, enabling the application of a before-during-after design in modeling visitor counts over eight years. Our results suggest that the economic situation was the most important predictor of visitation rates after accounting for month and temperature.

Introduction

Visitor numbers to national parks can fluctuate according to a variety of factors such as the wider economic situation, natural disasters, or simply weather conditions. We investigated visitation rates to the Swiss National Park (SNP) over an 8-year period between 2008 and 2015. This period included the opening of a new visitor centre in 2008, the centenary celebrations of the park in 2014 with high media coverage, and the depreciation in value of the Euro against the Swiss Franc. We hypothesized that visitor numbers would be influenced by an interaction of variables relating to the European economy, weather conditions, social and institutional factors, and publicity around special events.

Methods

Visitors to the SNP were counted using pressure-sensitive mats buried below footpaths (slab sensors; Eco Counter; http://www.eco-compteur.com/en/products/rangeslabs) at narrow parts of trails where hikers were forced to walk in single file. Daily counts from 5 permanently installed systems on different hiking trails distributed throughout the park were used as an index of visitation. These daily summaries were used as the response variable in a GLM with month (June – October; the hiking season), holiday, weekend (both coded as yes/no), average daily air temperature, total daily precipitation, average monthly exchange rate between the Euro and Swiss Franc, and total number of media articles published about the SNP per month as explanatory variables. A second model additionally included all first order interaction terms between these parameters.

Results

In the first model without interactions, the most important variable determining visitor numbers to the SNP was month, with highest visitation recorded during September and lowest in June. The second most important variable was the exchange rate, where visitor numbers increased with increasing value of the Euro against the Swiss Franc. As expected, visitor counts were also higher during the holiday season than outside school holidays, increased with increasing temperature and decreased with increasing precipitation. Monthly media coverage only had a weak positive effect on visitation rates.

In the second model with first order interactions included, the interaction between month and temperature was the most important predictor of visitation rate: higher temperatures particularly in October resulted in higher visitor numbers, while there was a weaker effect between July and September. While visitation rate was higher at weekends during September and October (highest on September weekends), it was lower at weekends than during weekdays in July and August. The increase in visitor numbers with increasing value of the Euro against the Swiss Franc was strongest during July and weakest in October. A strong Euro also led to a weaker positive response in visitation to temperature, and a weaker negative response to precipitation. The negative effect of precipitation was strong at low to intermediate temperatures, but weak at high to very high temperatures. Finally, visitor numbers showed a weaker negative response to increasing precipitation with increasing media coverage of the SNP.

Discussion

The strong seasonal effect on visitation rate in the model without interactions can be explained by visitors' expectations of the SNP: one of the main highlights is the red deer rut in September, which is when most visitors are recorded. Particular expectations such as the red deer rut or special events associated with high media coverage (the centenary celebrations in 2014) also lead to visitor numbers being less sensitive to weather conditions (no effect of temperature in September, and decreasing sensitivity to precipitation during months of high media coverage). However, the most important predictor of visitor numbers to the SNP when corrected for seasonal effects was the exchange rate between the Euro and Swiss Franc. The area around the SNP represents an expensive tourist destination, and while a weak Euro against the Swiss Franc makes holidays in the region more expensive for visitors from abroad, it also makes similar offers abroad cheaper for visitors from Switzerland. While particularly high media coverage around a special event such as the centenary celebrations can thus decrease hikers' sensitivity to weather conditions, it cannot compensate for the negative effects of an adverse economic situation in Europe on visitor numbers to the park.

References

Further details can be found in the following publication:

MILLHÄUSLER A, ANDERWALD P, HAENI M & HALLER RM (2016) Publicity, economics and weather – changes in visitor numbers to a European National Park over 8 years. Journal of Outdoor Recreation and Tourism 16: 50-57.

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Palaeoecological Research in the Triglav National Park (Slovenia)

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Keywords

palaeoecology, geochemistry, sedimentology, palynology, vegetation history and human impact on the environment, long-term environmental changes, Lake Bohinj, Triglav National Park, Slovenia

Summary

The aim of multidisciplinary palaeoecological research in the Triglav National Park is to investigate long-term environmental changes to better understand past, present and future changes of the environment. Previous research in the area focused on multidisciplinary studies of Lateglacial sediment of Lake Bled and the reconstruction of the climatic fluctuations and vegetation history between ca. 20.000–10.000 cal. BP (Andrič et al. 2009). These results suggest that terrestrial and aquatic ecosystems at Lake Bled were very dynamic and sensitive to Late-glacial climatic fluctuations. They responded to changes of temperature, precipitation and hydrological conditions. Thin layers of microscopic volcanic ash deriving from Italian and Icelandic volcanos were also discovered (Lane et al. 2011). In Europe study sites with volcanic ash from both, northern and southern Europe are very rare, therefore Lake Bled is a missing link connecting both areas. It helps us to tie together regional stratigraphy into a broader, continental-scale Late Quaternary European tephrostratigraphic framework.

In addition to studies of Lateglacial environment, palynological research at Pokljuka plateau (Šijec peat bog) focused on vegetation changes and human impact on the environment in the last few centuries (Andrič et al. 2010). In the 15th century AD Šijec was surrounded by mixed forest (*Fagus, Abies, Picea, Quercus*) and agricultural fields and pastures, but by the beginning of the 19th century AD the landscape had become more open, with very intensive agricultural land-use and grazing. The forest composition also changed: beech (*Fagus*) and fir (*Abies*) declined because of intensive grazing and ironworks (forest clearance and charcoal production). In the second half of the 19th and at the beginning of the 20th century AD, forest recovered, but farming activities continued and, as a result of the forestry policy, spruce (*Picea*) prevailed. After AD 1945 agricultural economy declined and mixed forests, which today cover more than 70% of land, started to expand.

The results of previous research in the Julian Alps indicate that Late Quaternary environment was very sensitive to climatic fluctuations and human impact (farming and metallurgical activities in the last few centuries). However, to date no detailed study of the entire Holocene sequence when both, climatic fluctuations and human impact, were important, was carried out.

Current research in the Triglav National Park aims to close this gap. It is being carried out by an international multidisciplinary team (Slovenian–French cooperation) of geologists, chemists and paleaoecologists, who collected two 12 m deep sedimentary cores in both Lakes Bled and Bohinj (in 2012, Fig. 1, Fig. 2). Selected Triglav mountain lakes were also cored (2014 and 2015, Fig.3). Studies of fossil plant/animal remains (e.g. pollen), sedimentological and geochemical composition of lake sediments and radiocarbon dating are being used to reconstruct the vegetation composition, earthquake chronicle, climatic fluctuations and the impact/adaptation of people on the environment.

The research in the area of Lake Bohinj focuses on changes of the vegetation, farming and metallurgical activities, soil erosion, climatic fluctuations, floods and earthquakes in the last 6600 yrs cal. BP. Sedimentological and geochemical results namely suggest that the area was affected by a very strong earthquake (6617±94 yrs cal. BP), which reworked previously deposited sediment (Rapuc et al., in review). In addition to 29 deposits, which can be related to earthquakes, there is also evidence of sedimentation rate changes, which are linked to human activity in the watershed. The results of palynological research e.g. suggest that in the Neolithic the lake was surrounded by mixed beech-spruce-fir forests (*Fagus, Picea, Abies*), with weak traces of human impact (agriculture and grazing), whereas in the Bronze Age human impact (especially grazing) on the environment increased. Very intensive clearance of beech forest, which can be associated with metallurgic activities of local population (Mohorič 1969; Horvat 2006; Ogrin 2006), is dated to the Iron Age (ca. 2700 cal. BP), when sedimentation rate in the basin increased. Human impact on the environment continued also in younger archaeological and historical time periods.

Figure 1: Coring at Lake Bled (2012), photo M. Zaplatil

Figure 2:. Lake Bohinj core, description of sediment. Photo M. Andrič

Figure. 3: Coring at Lake Ledvica (2014), Photo M. Andrič

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Protected areas' landscapes as resources for human health and well-being – case studies from Austria

Arne Arnberger, Brigitte Allex, Renate Eder, Hans-Peter Hutter, Peter Wallner, Nicole Bauer, Johann G. Zaller, Thomas Frank

Abstract

Natural and historic cultural landscapes of protected areas may positively influence the health of protected area visitors. Today's western societies are faced with a growing incidence of poor health because of mental stress and sedentary lifestyles. Natural and semi-natural landscapes are increasingly seen as restorative settings, compensating for these negative psycho-physiological effects. However, the restorative potential of different landscape types of protected areas seems to be rather unexplored. This presentation gives an overview about recent Austrian research activities on restorative effects of a stay in mountainous protected areas.

Keywords

attention restoration, biosphere reserves, mountain meadows, perceived restorativeness, stress reduction

Introduction

Natural and cultural landscapes of protected areas harbour not only a high biodiversity, they attract tourists and even may positively influence the health of protected area visitors. Today's western societies are faced with a growing incidence of poor health because of mental stress and sedentary lifestyles. Natural landscapes are increasingly seen as restorative settings, compensating for negative psycho-physiological effects on humans (ARNBERGER & EDER 2015; EDER et al. 2016; HARTIG et al. 1997, 2003; KAPLAN & KAPLAN 1989; ULRICH et al. 1991). However, the health potential of natural and semi-natural landscapes of protected areas seems to be rather unexplored, in particular for mountainous landscapes (ARNBERGER & WÖRAN 2012; EDER et al. 2015). In addition, possible linkages between cultural ecosystem services such as landscape beauty, human health and well-being benefits, and actual or perceived biodiversity have rarely been investigated (ARNBERGER et al., in press; LOVELL et al. 2014).

So far, health effects of mountainous landscapes of protected areas are rather unused for sustainable health-related offers. Consequently, the ecosystem services they provide cannot be fully considered in political decisions and public health measures as well as in nature conservation policies and measures. If protected landscapes are specifically effective in providing restorative effects, then such benefits can be used for regional development by exploiting the natural-cultural capital for new health-related (commercial) offers in a sustainable way.

This presentation gives an overview on recent Austrian research activities of an interdisciplinary team which investigates the restorative effects of a stay in mountainous protected areas. This presentation is part of the session on 'Protected areas' landscapes as resources for human health and well-being'. The following research questions guided these studies:
Do mountainous landscapes of protected areas provide positive effects on human health and well-being?
Do various landscape types have different effects on attention restoration, stress relief and well-being?

Methods

<u>Study areas</u>

This presentation focusses on two Austrian study areas. The Großes Walsertal UNESCO Biosphere Reserve in the west of Austria, and the Wienerwald UNESCO Biosphere Reserve in the east of Austria. In both study areas, the effects of different landscape types on human health and well-being were analyzed (Table 1). While the study in the Großes Walsertal compared perceived health benefits of managed and unmanaged meadows, the Wienerwald study compared perceived health benefits of forests, meadows and vineyards. The projects were financed by the Earth-System-Science-Progamme and the Man and the Biosphere-Programme of the Austrian Academy of Sciences.

Data collection

In both studies, a dependent sample of participants was used, visiting the study sites in a standardised manner. Each survey day started at the same time with the arrival to the study site. When participants arrived at the study sites, a 25-minute (Großes Walsertal Biosphere Reserve) or 45-minute (Wienerwald Biosphere Reserve) on-site session by sitting or walking and watching the landscape scenery followed. Directly after the visit participants had to fill in several survey forms, dealing among others with perceived restorative quality of landscape types (PRS, HARTIG et al. 1997). Participants were also asked whether they have the perception that a stay in the landscape type has restored their attention, reduced their stress level, and changed their psychological well-being (Table 1). Participants were recruited on a voluntary basis.

Study areas	**Großes Walsertal Biosphere Reserve**	**Wienerwald Biosphere Reserve**
Study goal	Comparing perceived health benefits of managed and unmanaged meadows	Comparing perceived health benefits of different landscape types
Sample	N = 22; 55% females; Mean age=27, ranging from 22 to 36 years	N = 44; 55% females, Mean age =32.5, ranging from 20 to 75 years
Methods	On-site questionnaires	On-site questionnaires
Topics	Attention restoration, stress reduction, changes in psychological well-being, perceived restorativeness	Attention restoration, stress reduction, changes in psychological well-being, perceived restorativeness

Table 1: Description of study goals and methods

Results

Both studies showed that study participants perceived natural and semi-natural landscapes as restorative settings, providing health benefits to them. Participants reported reduced stress levels, higher well-being and increased attention restoration after the stay. The studies also found differences but also commonalities between the landscapes types in perceptions for health benefits.

In the Wienerwald study, the meadow proofed to be the best restorative environment for participants in terms of subjective recreational effects, perceived reduction of stress and perceived restoration of attention, followed by the visit of a forest. In the Walsertal study, no differences between managed and unmanaged meadows were found for perceived effects on attention restoration, stress relief and well-being.

Discussion and conclusion

Although restoration research has shown that natural environments achieve higher outcomes concerning the improvement of the psychological and physiological state of humans than built environments, little is known about the health benefits of natural and semi-natural mountainous landscapes of protected areas. This study explored potentials of protected landscapes for human health and well-being. We found that meadows, regardless of managed or unmanaged types, are seen as very restorative places which are providing many health benefits. European mountain biosphere reserves typically include cultural and natural landscapes, among these are extensively managed and unmanaged meadows. If further studies confirm these findings on perceived health benefits of mountain meadow types, such benefits could be used for health-related offers for tourists, thereby preserving valuable landscapes (EDER et al. 2015).

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Collaboration between researchers and protected area managers - Empirical insights

Isabelle Arpin, Arnaud Cosson, Clémence Mazard, Gaëlle Ronsin, Thomas Scheurer

Abstract

We will present the results of a series of quantitative and qualitative studies recently conducted in France and at the alpine scale about the collaborations between researchers and protected area (PA) managers. We will analyse the characteristics and factors of these collaborations and tease out three collaborative models that coexist in PAs and entail specific difficulties and benefits.

Keywords

Collaboration, researchers, managers, protected areas, quantitative and qualitative surveys, France, Alps

Introduction

Collaborations between researchers and PA managers are increasingly encouraged by research and management institutions and have become commonplace (see PARKER et al., 2010). However, they have so far been little studied. This situation called for obtaining an overview of these collaborations, in order to characterize them, identify their main factors, and tease out distinct collaborative models.

Methods: three complementary surveys

Over the last three years, we carried out a series of quantitative and qualitative surveys in France and the Alpine space to explore and analyse the collaborations between researchers and protected area managers.

One of these surveys focused on scientific councils that have been established in several Alpine countries, notably France and to a less extent Switzerland, and are one specific way of gathering together scientists from several disciplinary and institutional backgrounds and managers (for a description of this survey, see ARPIN et al., 2016).

Another survey was carried out by the French Foundation for Research on Biodiversity and included two steps, the first one quantitative and the second one qualitative. The quantitative part was based on two national questionnaires which were sent by email to scientists working in PAs and to PA managers, in the spring of 2016. Its goal was to obtain an overview of the research carried out in PAs and of the collaborations involved from 2010 to 2015. We received usable responses from 116 managers and 185 researchers. Results were analysed through R. The qualitative part consisted of semi-directed interviews conducted in the spring of 2017 with 9 self-constituted pairs of managers and researchers who collaborate. These interviews aimed to collect empirical material about specific cases of collaboration rather than general opinions about collaboration. We first chose one member of the pairs among the respondents to the questionnaires and asked him/her to designate one researcher or manager with whom s/he collaborates. We chose the first member of the pairs so as to diversify the collaboration situations in terms of types of PAs, age of the collaboration, degree of satisfaction of the respondents. The interviews were conducted with the manager and with the researcher separately, so as to collect their respective viewpoints about their collaboration. The interviews were analysed using qualitative data analysis software (MaxQDA).

Finally, an empirical survey was conducted concerning a specific programme involving managers and researchers, the 'Alpages sentinelles' programme. This programme aims to document and improve the adaptation of alpine grazing systems to climate change. It was born in the Ecrins national park and has gradually been extended to other French alpine protected areas and will be soon extended in the Italian Alps. The survey consists of some twenty semi-directed interviews with participants in the programme, notably researchers from various disciplines and protected area managers.

Results

Overview of collaboration in protected areas

Collaboration appears first of all as a professional resource, most respondents expecting that it will enable them to do their own job better. For instance, a majority of researchers (notably from life sciences) indicate that their main reason to collaborate is that PAs are a privileged research field and that their main expectation is to obtain support for their research. They see the PA regulations and the poor quality of data collected by managers as major sources of difficulties.

Overall, collaborations are deemed to be rather or very satisfactory by a large majority of respondents. However, dissatisfied respondents are three times more numerous in the managers' group than in the researchers' group. Collaboration usually concerns some steps of research projects and not others. We suggest to position researches on a collaboration gradient rather than distinguish between collaborative and non-collaborative researches.

Factors of collaboration

Structural factors

The lack of financial and human resources, and the scientific rewards system based on peer-reviewed publication are considered to be key constraints by many respondents in both professional groups. There is a significant link between the effort invested in research and the research activity when this effort becomes important (> 30 person-days/year).

Institutional factors

Acknowledgment of the importance of research and collaboration in PAs by research and nature management institutions at all institutional levels is considered to be a major step for improving collaboration. Researchers observe a positive evolution toward a better recognition of the importance of collaborating with operational actors in general. Another institutional factor concerns the visibility of PAs for researchers, which varies a lot according to their status, location, age, and activity. Creating a scientific council can be a means of gaining more visibility but is never sufficient and requires a genuine involvement to be effective.

Individual factors

Trust is a main factor for collaboration (e.g. HARRIS & LYON, 2013), as collaboration entails risks for both partners. Trust requires time to be established and remains fragile. It is enhanced by the proximity of training and career paths, previous knowledge of partners, and by the formalization of collaborative arrangements, especially at the beginning and at turning points of the collaboration.

Collaborative models

Three collaborative models can be distinguished, based on the type of collaboration: 1) a science-centred model, where most steps of researches are led by researchers and collaboration is mainly oriented towards the production of scientific knowledge; 2) a management-centred model where most steps are led by managers and collaboration mainly aims to improve PAs management ; 3) a hybrid model, where most steps are jointly carried out and collaboration aims to produce scientific knowledge and to contribute to the PAs management. These models coexist in all types of PAs. Managers and researchers can be satisfied in all of them and none of them guarantees a high level of satisfaction, even if the hybrid model is generally considered ideal. Some difficulties of collaboration are common to all models, whereas others are specific to some.

Elements of discussion

Data suggest that differences in the degree of satisfaction between researchers and respondents might come from the fact that researchers draw more for their work from the collaboration than the managers. Moreover, the managers' comments show that they sometimes experience collaboration as unbalanced and feel subordinate to researchers, even though this subordination is attenuated by their mastery of the field and depends on individual variables, such as stage of career, age, gender, and reputation.

Despite the emphasis commonly put on the hybrid model, the science-centred and the management-centred models should not be overlooked as they appear to be very present and able to respond to specific needs and expectations.

Recommendations

Some recommendations are common to all collaborative models, e.g. :

- Pool research efforts and resources from several PAs, as a minimum effort is necessary to be effective and to enable inter-PAs partnerships;
- favour encounters between researchers and managers, through different and complementary means and with moments of conviviality to attenuate power effects: creation of scientific councils, provided conditions are met to make them effective (see Arpin et al., 2016), participation in federative structures such as LTSER sites and in joint research programmes, organization of mutual visits in labs and PAs, etc. Structures such as LTSER sites are particularly effective to achieve long term collaboration.
- Familiarize managers to the researchers' work and vice-versa, in initial training and through training sessions;
- Encourage researchers and managers to explicit the collaborative model of their joint research projects so as to anticipate potential difficulties;
- Recruitment of managers trained in human and social sciences in order to increase collaboration in this domain.

Other recommendations are particularly important for each collaborative model, e.g.:

– Science-centred model:
    - explicit the PAs regulations. The elaboration of an 'ethic charter of research in PAs' could be a way of avoiding tensions;
    - Improve the quality of data collection and analysis in PAs;
    - Systematic information provided by researchers to managers about the researches carried out in the PA.
– Management-centred and hybrid models:
    - Encourage/help researchers to publish their research in peer-reviewed journals;
    - Encourage institutions to acknowledge the researchers' commitment to PAs in professional careers.

Future steps

Results will be presented and discussed in Salzburg and Montpellier in November 2017. Reactions to these presentations and participants' suggestions will help refine the results and analysis.

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Where do endemics reside? Endemic beetles in the Gesäuse National Park (Austria) and their relevance for nature conservation

Sandra Aurenhammer, Christian Komposch, Daniel Kreiner

Abstract

The Gesäuse National Park is one of the most important hot spots for endemics throughout the Eastern Alps. The aim of the current study is to present the first species inventory of the endemic beetle fauna of this alpine area. Results from fieldwork as well as historical sources provide the database for this survey. The latest fieldwork investigations were carried out during 25 days in the vegetation period of 2015 and 2016 using 370 pitfall traps at 74 sample sites, hand collecting, beating of vegetation, sweep netting and sieving.

In total 2,827 individuals and 478 beetle species were documented. Among these 5 endemics and 19 subendemics of Austria were recorded within the range of the Gesäuse National Park. Due to their distribution pattern we expect another 15 (sub)endemic species to occur in the study area. Most of the (sub)endemics are stenotopic and stenoecious, being bound to Alpine meadows or screes. The records concentrate on the subalpine and alpine zone. The occurrence at locations with special microclimatic conditions indicates a preference for cold-stenothermic biotopes.

Grazing in Alpine meadows as well as climate warming are considered the main threats for most endemic beetle species. The long term protection of habitats throughout the Gesäuse National Park and the continuation of research will be the main requirement for the protection of its endemic beetle fauna.

Keywords

endemics, insects, Arthropoda, Coleoptera, *Oreina elongata styriaca*, climate change, protected area, FFH-directive, Gesäuse National Park, Ennstal Alps, Austria, Eastern Alps

Introduction

Located on the fringe of the last glacial maximum during the Würm ice age, the North-eastern Calcareous Alps are known for their richness in endemic species. The Gesäuse National Park is part of the 'Ennstaler Alpen' and counts as one of the most important hot spots for endemics throughout the Eastern Alps.

Scientific documentation reaches back to the end of the 19th century, where the first zoological specimens were collected in the abbey of Admont. Of major importance for scientific research on the national park's beetle fauna was the comprehensive work of Herbert FRANZ (1974). Over the years, numerous coleopterologists dedicated their private research activities to this region and studies were commissioned by the Gesäuse National Park since its foundation in 2002 (e.g. NEUHÄUSER-HAPPE 1993, ADLBAUER 2010, PAILL 2012, WAGNER et al. 2016, AURENHAMMER et al. 2017). In 2009, PAILL & KAHLEN gave the first profound coleopterological overview over Austria's endemic beetle fauna within the nationwide endemics catalogue (RABITSCH & ESSL 2009). In the following study, surveys of the national park's endemic invertebrate fauna were carried out by the ÖKOTEAM – Institute for Animal Ecology and Landscape Planning (ÖKOTEAM 2009, KOMPOSCH & PAILL 2012).

Today for many beetle families the available data is, however, still limited to historical sources. The present study is part of a comprehensive survey about the invertebrate endemic fauna of the Gesäuse National Park. This project aims to present an endemic species inventory, reveal new insights in the distribution of beetle endemics within the national park and seeks to produce results for use in the practice of nature conservation.

Study area, Material and Methods

The project area comprises the Gesäuse National Park (Ennstaler Alpen, Northern Calcareous Alps, Styria) with its nearest surroundings and reaches from the colline zone (480 m a.s.l.) up to the alpine zone (2369 m a.s.l.). Due to preceding projects, two altitudinal belts were predominantly investigated: forests between 600 and 700 m and alpine meadows between 2000 and 2200 m. Furthermore, historical records of endemic beetles were extracted from FRANZ (1974). Concerning historical data, records from adjacent localities were also included (e.g. Admont, Kaiserau, Haller Mauern, Hieflau). The majority of records are, however, located within the recent borders of the national park.

The collected material of the current zoological investigation originates from recent field studies as well as from preceding surveys by the ÖKOTEAM. The latest fieldwork was carried out within 25 days in the vegetation period of 2015 and 2016 and included the following methods: pitfall traps (370 traps at 74 sites, mainly in cold-stenothermic habitats), hand collecting (during daytime and at night, mainly in the subalpine zone under stones), beating of vegetation and sweep netting (mainly shrubs and hydrophilous tall herb communities) and sieving (leaf litter in beech and ravine forests and dwarf shrub heaths). Beetles were collected and transferred into ethyl acetate. Records from carabids, staphylinids and scydmaenids were treated separately and appear in separate papers.

Concerning the range-status of endemic species we use the following terminology and definitions: a = endemic of Austria, b = subendemic of Austria sensu stricto (75 % of the distribution area lies within the borders of Austria), c = subendemic of Austria sensu lato (25–75 % of the distribution area lies in Austria), d = endemic of the Eastern Alps, e = endemic of the Alps, f = arcto alpine species.

Species inventory

Overall a total of 478 beetle species were documented from the investigation area; this comprises 2875 individuals, 1579 datasets and 260 sample sites. The full list of species will be published on another occasion. We recorded a total of 24 (sub)endemic beetle species that occur within the range of the Gesäuse National Park. The percentage of endemics amounts to 5.3 % of the species inventory.

family	species	cur.	end.	habitat	EU code
Aphodiidae	*Neagolius montivagus* (Erichson, 1848)	x	b	Calcareous (sub)alpine meadows (calcareous grasslands)	6170
Byrrhidae	*Byrrhus picipes* Duftschmid, 1825		e	Alpine meadows and dolines	6170
	Simplocaria acuminata Erichson, 1847 (Fig. 1)	x	f	Beech forests, shrubs and dwarf shrubs	4070*
Cantharidae	*Malthodes subductus* Kiesenwetter, 1863	x	d	Shrubs *(Pinus mugo)* and calcareous screes	4070*
Chrysomelidae	*Cryptocephalus albolineatus* Suffrian, 1847		e	(Sub)alpine dwarf shrub heaths	4060
	Chrysolina lichenis ahena (Germar, 1824)		a	(Sub)alpine meadows and rocky heaths	6170
	Oreina elongata styriaca (Franz, 1949) (Fig. 1)	x	a	(Sub)alpine tall herb communities (with shrubs of *Alnus viridis*)	6430
	Oreina frigida (Weise, 1883)		e	Alpine dwarf shrub heaths	4060
	Psylliodes subaenea styriaca Heikertinger, 1921	x	b	Calcareous screes	8120
Curculionidae	*Brachiodontus alpinus* (Hampe, 1867) (Fig. 1)	x	b	(Sub)alpine screes and snow pockets	8120
	Dichotrachelus vulpinus Gredler, 1857 (Fig. 1)	x	e	Calcareous alpine screes, dolines and snow pockets	8120
	Leiosoma cyanopterum Redtenbacher, 1849		d	Beech forests	6430
	Oreorrhynchaeus alpicola Otto, 1894		a	Calcareous (sub)alpine screes	8120
	Otiorhynchus auricomus Germar, 1824	x	e	Dwarf shrub heaths	4060
	Otiorhynchus chalceus Stierlin, 1861		d	Calcareous alpine screes and erosion gullies	8120
	Otiorhynchus costipennis Rosenhauer, 1856	x	d	(Sub)alpine meadows, snow pockets and rocky heaths	6170
	Otiorhynchus globulus Gredler, 1866		d	Alpine dwarf shrubs and shrubs	4060
	Otiorhynchus nocturnus Reitter, 1913		b	Calcareous rocky heaths and screes	6170
	Otiorhynchus picitarsis Rosenhauer, 1856		a	Rocky heaths and rock faces	6170
	Otiorhynchus pigrans Stierlin, 1861 (Fig. 1)	x	b	Rocky heaths and screes, alluvions	6170
	Rhinomias austriacus (Reitter, 1894)	x	b	Beech and mixed beech forests	9130
	Thamiocolus paravilis Dieckmann, 1973		d	Calcareous (sub)alpine meadows (calcareous grasslands)	6170
	Tropiphorus styriacus Bedel, 1883	x	a	Tall herb communities and (sub)alpine meadows	6170
	Tylotus chrysops (Herbst, 1797) (Fig. 1)	x	d	(Sub)alpine tall herb communities	6430

Table 1: List of (sub)endemic beetle species in the Gesäuse National Park stating the currency of records (cur.): x = recent record; emdemism status (end.): a = endemic of Austria, b = subendemic of Austria s. str. (75 % of the areal in Austria), d = endemic of the Eastern Alps, e = endemic of the Alps, f = arcto alpine species; habitat association and attribution to one main appropriate FFH habitat type (EU code): 4060 - Alpine and Boreal heaths, 4070* - * Bushes with *Pinus mugo* and *Rhododendron hirsutum* (Mugo-Rhododendretum hirsuti), 6170 - Alpine and subalpine calcareous grasslands, 6430 - Hydrophilic tall herb fringe communities of plains and of the montane to alpine levels, 8120 - Calcareous and calcshist screes of the montane to alpine levels (Thlaspietea rotundifolii).

Currently 5 endemic and 19 subendemic beetle species are known to occur in the Gesäuse National Park (Table 1). In total 451 individuals were registered, whereby 36 % of the records stem from historical sources (FRANZ 1974). During the recent field studies 13 (sub)endemic species could be detected. Regarding their distribution patterns, another 15 (sub)endemic beetle species are likely to occur in the Gesäuse National Park. Weevils and leaf beetles dominate the endemic species inventory.

Respecting their range, 5 species are considered as endemics and 6 species as subendemics of Austria. The other species are endemic to the Eastern Alps or show a broader distribution (Fig. 1).

Figure 1: (Sub)endemics of Austria occurring in the Gesäuse National Park: *Tylotus chrysops* (top left), *Otiorhynchus pigrans* (centre left), *Brachiodontus alpinus* (bottom left), *Oreina elongata styriaca* (top right), *Dichotrachelus vulpinus* (centre right), *Simplocaria acuminata* (bottom right) | Photos: S. Aurenhammer/ÖKOTEAM.

Distribution and ecology of endemics

Endemic and subendemic species are found in all altitudinal zones of the Gesäuse National Park. The records of species and datasets concentrate, however, in the subalpine and alpine zone. Endemics of Austria (category a) were only recorded at an altitude above 1000 m (Fig. 2). From a nature conservation perspective high level habitats are therefore of great value.

Subalpine and alpine meadows, dwarf shrub heaths and shrubs (*Alnus viridis*, *Rhododendron hirsutum*, *Pinus mugo*), screes and snow pockets as well as hydrophilic tall herb communities are numbered among the main habitats of endemic beetles in the national park (Fig. 3). Their occurrence at locations with special microclimatic conditions indicates a preference for cold-stenothermic biotopes.

The majority of the (sub)endemic species are considered stenotopic and stenoecious, being bound to specific habitats, structures and environmental conditions. This is the case for many terricolous species as well as for species living in the low herb layer that hide underneath stones during the day time and become active at night. These include the strict Austria-endemics *Chrysolina lichenis ahena* (Chrysomelidae) and *Tropiphorus styriacus* (Curculionidae). Species living in (dwarf) shrubs are often bound to its leaf litter.

The endemic species inventory includes phytophagous specialists, there mainly under weevils and leaf beetles like *Brachiodontus alpinus* or *Oreina elongata styriaca*.

Endemics as character species of FFH habitat types

According to current definitions, the protection and conservation status of FFH habitat types is also related to their fauna (e.g. LANDESAMT FÜR UMWELTSCHUTZ SACHSEN-ANHALT 2002). Stenotopic beetle species are valuable character species for FFH habitat types. A good state must therefore be related to the presence of endemic beetle species as well as the completeness of its community of beetle species. The major habitats where endemics occur in the national park can be assigned to 6 FFH habitat types (Table 1).

Alpine and subalpine calcareous grasslands are the most significant habitats for endemic beetles in the national park. Second, are calcareous and calcshist screes of the montane to alpine levels (Thlaspietea rotundifolii). Apart from their structural preference for alpine rocky grassland and scree, several species are highly calciphilic and occur only on limy soils. This applies to the weevils *Otiorhynchus chalceus*, *O. nocturnus* and *Dichotrachelus vulpinus*.

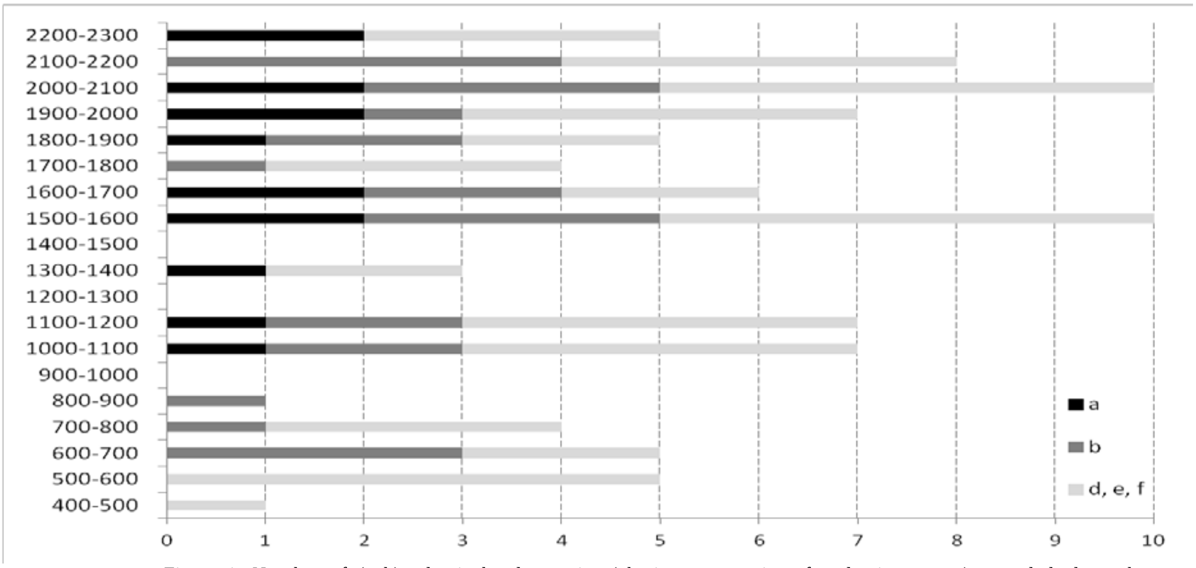

Figure 1: Number of (sub)endemic beetle species (abszissa: categories of endemism-status) recorded along the altitudinal gradient (ordinate: metres a.s.l.): a = endemic of Austria, b = subendemic of Austria s. str. (75 % of the areal in Austria), c = subendemic of Austria s. l. (25-75 % of the areal in Austria), d = endemic of the Eastern Alps, e = endemic of the Alps, f = arcto alpine species. Gaps of records at single altitudinal belts result from a varying sampling intensity.

Figure 3: Endemics habitats in the Gesäuse National Park: Snow pockets in the Tellersack (top left); hydrophilous tall herb communities at the Untere Koderalm (bottom left); rocky alpine meadows at the Unterlugauer (top right); various FFH-habitat types in the high altitudes, viewing the Sulzkarhund with Rotofen from the Hochtor/Tellersack (bottom right). | Photos: Ch. Komposch & S. Aurenhammer/ÖKOTEAM.

The 'flagship-endemic' Oreina elongata styriaca

The alpine leaf beetle *Oreina elongata* occurs in isolated populations across the Alps and Apennines. So far 7 allopatric subspecies have been described. Recent genetic analyses on its phylogeography suggest *Oreina elongata* however to be a species complex with 5 species showing a strong genetic differentiation long before the last glacial maximum (BORER et al. 2010).

The Styrian alpine leaf beetle *(Oreina elongata styriaca)* (Fig. 1) is endemic to Austria. It was so far only found in some places in the Northern and Central Alps of eastern Carinthia and Styria (PAILL & KAHLEN 2009). The Gesäuse National Park comprises one-eighth of its worldwide distribution. Like its sister species, *O. elongata styriaca* is adapted to high altitudes (1500-2000 m).

Interestingly, both historical and recent records only stem from three adjacent localities in the national park: Stadlalm, Koderalm and Sulzkaralm. These alpine pastures feature hydrophilic tall herb communities with *Adenostyles* spp., which is known to be the species host. The distribution of *O. elongata styriaca* apparently not only depends on the occurrence of its host plants, as the beetle is capable of flight and both *Adenostyles* species are widely distributed throughout the national park. It might rather be microclimatic conditions that help to explain the species' disjointed distribution pattern. We assume a habitat preference for cold stenothermic and hydrophilic tall herb communities with shrubs of *Alnus viridis*, which are only found at few sites in the national park (Fig. 3).

Nature conservation aspects

The need for action is great, as is the time pressure due to habitat destruction, climate warming and the loss of experts (KOMPOSCH 2010).

Threats

As many endemic beetle species inhabit alpine meadows, grazing is considered one of the main threats in the subalpine and alpine zone. Climate warming also has negative effects on endemics habitats, as it promotes the shrinking and, in the long run, even the loss of the alpine zone.

The situation appears dramatic in the Northern Calcareous Alps with their comparably lower peaks: scientific modelling predicts a loss of the alpine zone up to 80–90 % (DIRNBÖCK et al. 2011). A raised temperature will result in a structural change of open grassland into heath land and forest which makes these habitats unsuitable for praticolous species. Forestry is considered the main threat for endemics of the deciduous forest in the Gesäuse. The past large-scale conversion of primary beech and ravine forests in spruce forest had a major effect on today's forest habitats and is still being practised in the woodlands outside the borders of the national park.

Management measures

As management measures we propose to exclude habitats with endemic beetle species and coenoses from grazing. We further suggest the specific preservation of hydrophilic tall herb communities that grow on alpine pastures and the reconversion of spruce forests into natural forest communities. The expansion of the road network is considered as counterproductive, as it promotes the negative impact of forestry and dispersal of alien species and synanthropic species. A proper Red List of endangered (endemic) species in the Gesäuse National Park according to the IUCN categories as well as the inclusion of endemics in the federal conservation law ('Artenschutzverordnung des Landes Steiermark') would be of paramount importance for the handling of conservation issues. The long term protection of habitats through the Gesäuse National Park and the continuation of research (Fig. 4) will, however, be the main requirement for the protection of its endemic fauna.

Figure 4: Further research is urgently needed! | Photo: Ch. Komposch/ÖKOTEAM, 2.8.2016

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MIT UNTERSTÜTZUNG DES LANDES STEIERMARK UND DER EUROPÄISCHEN UNION

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The evolution of debris mantling glaciers in the Stelvio Park (Italian Alps) over the time window 2003-2012 from high resolution remote-sensing data

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Abstract

Debris cover is a key parameter influencing glacier energy budget, and over the last decades, its expansion on mountain glaciers worldwide has been reported. Nevertheless, works dealing with the detection and mapping of quite continuous supraglacial debris and deep analyses aimed at identifying the temporal and spatial trends affecting glacier debris cover are still limited. In this study, we present a high-resolution detection and mapping of debris mantling glaciers in the Ortles-Cevedale Group in Stelvio National Park, Italy, based on high resolution aerial and UAV orthophotos.

Keywords

Glacier, debris cover, Stelvio Park, remote-sensing.

Introduction

One of the most evident effects of the ongoing climate change, and in particular of the global air temperature warming, is the intense area decrease of glaciers observed worldwide (IPCC 2013). Moreover, the glacier surface undergoes important physical changes, which have significant effects on high-elevation landscapes (Oerlemans 2009): in particular, several authors have reported the areal expansion of supraglacial debris cover over the last decades in the major mountain ranges, including the Alps (Kellerer-Pirklbauer 2008). Glacier darkening is favored by the increased availability of debris in the area surrounding glaciers (Reid et al., 2012). High-resolution mapping and analysis of the spatial and temporal evolution of supraglacial debris are complicated, but its knowledge of is relevant for the glacier mass and energy budgets and evolution (Diolaiuti et al. 2009). In fact, on the one hand fine and sparse debris is one of the main forcing factors of supraglacial albedo, increasing the ice melt rates (Azzoni et al. 2016). On the other hand, if supraglacial debris thickness is higher than a threshold value it may reduce ice melt rates (Mattson & Gardner, 1989). Different techniques, such as semi-automatic approaches based on medium-resolution remote sensing data, were developed to assess the occurrence and distribution of continuous supraglacial debris covers, however, the accuracy of these methods decreases analyzing small ice bodies such as the largest part of Alpine glaciers.

In this work, we propose a method to map and describe the supraglacial debris cover on glaciers in the Ortles-Cevedale Group through multi-temporal and high-resolution remote sensing data (aerial and UAV color orthophotos). These methods permitted us to analyze the evolution of supraglacial debris over the last decade, thus offering a novel approach to describe climatic-triggered surface processes affecting the evolution of high mountain environments. The focus of this research is the Lombardy Sector of the Stelvio Park, which includes the 51 glaciers, covering ca. 29.27 km^2 (Smiraglia et al. 2015). These glaciers have significantly retreated over the past decades, losing about 40% of their area between 1954 and 2007.

Materials and Methods

We analyzed aerial color orthophotos (0.5 m resolution) acquired in 2003, 2007 and 2012. Glacier outlines were already available (Smiraglia et al. 2015). The evaluation of supraglacial debris cover was performed by means of a supervised classification using the software ArcMap. In particular, we used the maximum likelihood classification to discriminate four different classes and form a signature file: debris, ice, snow, and shadow. Shadows were removed from subsequent analysis because it is not possible to investigate efficiently the surface below them.

We create different signature file for each orthophoto to avoid some classification problems caused by the different illumination conditions and we used a different classification scheme in relation to the two different lithologies outcropping in this area (micaschist and carbonates). To assess the accuracy of the supervised classification, we defined separate sets of random points and we manually checked the conformity between the values predicted by the supervised classification (i.e. debris, ice, snow, and shadow) and the ones observed in the orthophotos.

Results and Discussion

The analysis of the 2003, 2007 and 2012 orthophotos permit us to describe the characteristics of the debris cover for each year. In particular in 2003 debris covered 16.7% of the total glacier area, in 2007 22.5%, whereas in 2012 debris covered 30.1% of the total glacier area. These data highlighted a clear increase in debris cover on glaciers located in the Ortles-Cevedale Group in only 10 years (Tab.1).

	2003	2007	2012
TOTAL DEBRIS- COVERED AREA (km^2)	5.28	6.59	8.15
AREA OF ALL GLACIERS (km^2)	31.58	29.24	27.08
DEBRIS COVER (%)	16.72	22.54	30.10

Table 1: Surface features of all the glaciers located in the Ortles-Cevedale Group in the time frame 2003-2012.

On the Forni Glacier ablation tongue, where we extended our analysis also to 2014 and 2015, the debris cover was 26.7% in 2003, 32.4% in 2007, 51.1% in 2012, 48.2% in 2014, and 48.1% in 2015.

The accuracy of these data are confirmed by the error assessment: the overall precision of this supervised classification resulted in 0.87, but the precision of debris classification (the ability of the classification to detect the differences between debris and other surfaces) was higher, up to 0.95.

Debris does not homogeneously cover the glacier surfaces: in fact, some sectors of glaciers are totally covered (the medial or lateral moraine ridges) and it is more common on small glaciers, compared to the large ones. In particular, on glaciers with a surface smaller than 0.10 km^2, the debris cover is 70.9%; conversely, the largest ones exhibit a debris cover of about 17% of their entire surface. We can explain the larger debris cover on the smallest ice bodies considering their geomorphological settings; in fact, these glaciers are predominantly located in small cirques or in narrow valleys, often at the foot of steep rock walls where the debris availability is large. Moreover, their dynamics are limited and the rate of debris transport along the glacier is very low. Conversely, the larger glaciers are characterized by wide accumulation basins, where the presence of debris is scarce and the dynamics of the ice allows carrying debris towards the glacier snout.

Moreover, the large increase in debris cover can be mainly related to the slowing-down of glacier flows occurred in the last decade that prevents the transport of supraglacial debris along the glacier tongue and the discharge of material in the proglacial area. In summary, we detected:

1. a general widening of medial moraine ridges and debris cover in the frontal area
2. the formation of new lateral supraglacial moraine ridges caused by the higher availability of debris from surrounding steep rock walls
3. the development of new debris cones, caused by the emergence of englacial debris.

Conclusion

The analysis of high resolution remote sensing data permitted to detect an appreciable increase in area of debris cover on glaciers in the Ortles-Cevedale Group between 2003 and 2012. In fact, in this period the glacier area covered by rock debris went from 16.7% of the total in 2003, to 22.5% in 2007, to 30.1% in 2012. Debris was found not homogeneously covering the glacier surfaces: in fact, some sectors of glaciers were totally covered (the medial or lateral moraine ridges) and it was found to be more common on small glaciers, compared to the large one.

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Park objectives in transformation: What are parks for and why do we want them?

Norman Backhaus & Olivier Graefe

Keywords

Relational values, *eudaimonia*, conservation, stewardship, park

Summary

Rather than presenting results from finished or ongoing research, in this essay we try to raise questions and open up a discussion on the objectives and rationale of parks for nature protection. They are increasingly embedded in market-based neoliberal conservation that coincides with the proclamation of the Anthropocene. The conception of this new era, in which we have supposedly lived since at least fifty years (and depending on its definition possibly much longer, cf. LEWIS & MASLIN 2015), challenges the notion of a nature-culture binary bi-polarity and therefore also the concept of a wilderness (to be) set apart from human influence. In the following we want to raise the double question 'What are parks for?' and 'Why do we want them?'.

Figure 1: Intrinsic, instrumental or relational values, what should be protected? © Norman Backhaus

What are parks for?

The amount and acreage of protected areas worldwide is increasing steadily since more than hundred years. According to the Aichi biodiversity target no. 11 by 2020 17 percent of the terrestrial and 10 percent of the marine area shall be protected (UNEP-WCMC & IUCN 2016). The reasons that are formulated for the creation of protected areas (e.g. national parks) revolve around 'biodiversity' and 'wilderness' that should be conserved, or 'sustainable development' that parks should make possible. Moreover, it is debated whether nature should be protected for human's sake (instrumental value) or for nature's sake (intrinsic value) (CHAN et al. 2016). Indeed, at the core of park rationales is the avoidance of negative impact to the natural environment a defining characteristic of the Anthropocene (cf. HOLMES 2015).

Therefore, if we ask 'what is a park for?", the answer seems evident to the above presented question about the purpose of a park. However, the core of park rationales and the framings of nature and conservation have changed according to MACE (2014) from 'nature for itself' (until the 1960/70s) to 'nature despite people' (until the 1990s) to 'nature for people' (at the beginning of the 2000s) and 'people and nature' (since 2010). At the same time market-based strategies became central to conservation (ADAMS 2017), expressed in the mainstreaming of Ecosystem Services (KELLER 2017), the funding of conservation by (oil) extracting companies (HACKETT 2015), or in the recent negotiations on the attempt to establish new national parks in Switzerland. There, environmental protection implicitly (but rarely explicitly) hovers in the background of protection rationales, while economic development, preserving cultural identity and keeping political freedom are in the forefront of discussions (Michel & Backhaus submitted). Hence, at the same time as in the conservation discourse people and nature are connected with an 'and', the role of parks becomes more unclear. Consequently, the segregation paradigm, in which nature is set apart from culture or humans is moving towards an integration (or post-integration) paradigm (ARPIN & COSSON 2015) that is heavily debated. Organizations such as Nature-needs-half (natureneedshalf.org 08.08.2017) that opt for setting aside half of the earth's surface in order to preserve biodiversity are a strong example for the segregation paradigm. Others (e.g. BÜSCHER et al. 2016) criticize this notion not only for its lacking practicability but for its injustice to people. We can conclude that the answer for our first question has become more difficult to answer in recent years.

Why do we want parks?

The second question is connected to the first and consequently as difficult to answer. Living in the Anthropocene where the (Western) culture-nature dichotomy becomes at least blurry if not illusionary, we must provocatively ask ourselves if and how a segregative approach to nature protection makes sense and if not, what the alternatives could be. By questioning reasons for nature protection we want to raise the awareness to the meaning nature conservation could bear and the forms it consequently take. CHAN et al. (2016) propose to concentrate on relational values instead of intrinsic and instrumental values of nature conservation, which they deem as problematic and not productive in the long run. They moreover state that *eudaimonia* – the feeling of wellbeing – is an important aspect of conservation. It can best be grasped by a concept of relational values that stress the dynamic affinity between natural objects or concepts and people and that goes beyond instrumental values. Hence, the armchair wilderness lover's attitude – or more up to date the person's buying a down jacket that is designed to survive Arctic winters for the daily commute in Middle Europe – towards nature should be regarded as viable reason for having nature protected. It amounts to the concept of stewardship that CHAN et al. often mention with which these relations are put into practice of conservation. Relational values also include neo-liberal attributions, since economic valuations are also based on relations with natural resources, objects or attributes. The question is how they contribute to whose wellbeing and whether their tradability is infringing on someone else's relations that are not based on neo-liberal thinking. Moreover, it can be asked what kind of nature is produced through these processes of economic valuation and nature's increasing commodification.

Focusing on relational values that only in certain cases can be expressed in numbers or currency for the establishment and management of parks can be demanding since different and competing values cannot be counted up. Whose values of nature do prevail, for what reasons with what consequences on the biophysical materiality are questions we intend to put forward for debate.

Conclusion

The questions we asked in this essay cannot be answered easily. However, since concrete park projects – but not nature conservation per se – are increasingly facing opposition at least in European contexts but not only there, the question 'why do we want parks?' is becoming even more crucial than before. CHAN et al. (2016) propose to consequently focus on relational values and the notion of *eudaimonia* or wellbeing for the establishment and management of conservation. This way people's different attitudes towards nature and its conservation and lastly the creation of a (national) park will be better acknowledged than with an approach that exclusively focuses on the protection of biodiversity. However, the accumulation of different and sometimes contrasting and competing (relational) values may lead to a stalemate. The addressing of these values and potential controversies in park research need not only to be continued but emphasized. This way potential new forms of conservation or different parks may be found and tested.

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Parks as an instrument for sustainable regional development A study in the intersection of tourism research, cultural studies and aesthetics

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Keywords

Sustainable development, landscape aesthetics, concepts of nature, area planning

Summary

Natural parks are multidimensional and multifunctional structures. They generally do have an exemplary status with regard to a sustainable organization of the human / nature relationship: as a space for the protection of nature and landscape as well as for cultural heritage and identities, recreation, education, research and regional development they allow for concrete experiences in these different domains. However, at the same time, they can be regarded as experimental arrangements to fathom the manifold constellations of human perception and behaviour in the triangle of men, landscape and nature.

Especially controversies about the creation of new parks tend to trigger general discussions on regional identity and development issues and lead to their politicization. Hence, it is of special importance for any new creation of natural parks to find out how this politicization can be fruitful in the process of negotiating the different claims, interests and necessities of men, landscape, and nature and to identify suitable concepts and strategies to establish parks as a medium to discuss ideas of sustainability. To lead these discussions successfully, it is essential to clarify and respect the diverse underlying ideas of 'landscape' or 'nature' with their different semantic and aesthetic layers and to embed them in their actual cultural contexts.

Concepts of nature and landscape can be seen as a projection area for the creation of individual and collective identities. As a consequence, they influence visions concerning the organisation of public domains including measurements to protect and use the natural environment as well as cultural heritages. In this respect natural parks – as dispositifs to structure space – always reflect specific ideas of how human society should be organised and look like. They are, therefore, suitable to question and negotiate underlying norms and values. Usually, the heterogeneity of ideas and interests of the involved actors becomes visible in the course of such negotiating processes.

In the light of these considerations I will present the actual research project 'Parks as an instrument for sustainable regional development. A study in the intersection of tourism research, cultural studies and aesthetics.' The project combines humanities, social, and cultural sciences in the fields of research, public discourse and political as well as cultural mediation. On the basis of a comparative analysis of existing approaches to realise different forms of protection areas (natural parks, national parks, biosphere reserves) the project aims at the development of a new understanding of parks as a dispositif to mediate discourses of sustainability. Furthermore, the research project is part of an actual effort to establish the new transnational natural park Rätikon. In this framework, the project aims at the documentation and analysis of the implementation process and should at the same time contribute to its success. We hope to generate new insights in the processes of park developments especially in mountain areas as well as a methodical approach for transdisciplinary park research.

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Changes in Alpine grassland of Gran Paradiso National Park (Italy): first results from CO_2 fluxes monitoring programme.

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Abstract

The alpine grassland of Gran Paradiso National Park (Italy) resulted from centuries of human activities that created high biodiversity semi-natural areas below the timberline. The progressive abandonment of management practices as well as climate change lead to variations in species diversity. In order to apply active management actions for maintaining such ecosystem, a long-term monitoring programme started in 2016 in selected sites of the Park, aimed to: 1) evaluate the effects of a well managed grazing system on animal and plant biodiversity; 2) compare the evolution of managed and non-managed areas, the latter obtained by excluding a portion of the meadows from grazing. Together with CO_2 fluxes, monitoring includes also plant community, invertebrates, soil properties. We present the first results of spatial and temporal variability of CO_2 fluxes from grasslands in relation to air temperature, radiance and soil properties.

Keywords

alpine grassland; Gran Paradiso National Park, CO2 fluxes; Ecopotential

Introduction and Research questions

The Gran Paradiso National Park (GPNP), in the western Italian Alps, is the oldest National Park in Italy. It shows significant high-altitude environments, and hosts the original surviving population of Alpine ibex (Capra ibex).

The open areas of GPNP result from centuries of human activities that determined a lowering of the treeline ecotone, creating peculiar semi-natural areas below the timberline, characterized by high biodiversity values.

The progressive abandonment of mowing and grazing from high-elevation mountain areas is modifying species composition and richness (TASSER & TAPPEINER 2002) that can affect its forage value for mountain wild herbivores (PAROLO et al. 2011). Moreover, fragmentation due to increase of woodlands may negatively influence the interchange of grassland species (BERLIN et al. 2000). Abandonment of traditional land management may also affect nitrogen plant concentration and mineralization (ZELLER et al. 2000), soil organic carbon fraction (GUIDI et al. 2014) and the net ecosystem CO_2 and CH_4 exchange (WOHLFAHRT et al. 2008; IMER et al. 2013).

Climate change is another risk factor for mountain grassland, leading to an upward shift of alpine plant species, with consequent community composition changes and local extinctions (WALTHER et al. 2005, DIRNBÖCK et al. 2003). In addition, increasing temperatures can lead to higher evapotranspiration rates (ABTEW & MELESSE 2012), with direct consequences on soil moisture and vegetation structure. The decline of soil water availability induces an increasing reduction of nutrient uptake and carbon assimilation with a consequent slowdown in plant growth (DALY et al. 2004). The reduction in snow cover alters the frequency of soil frost events and the dynamics of freeze-thaw cycles. This could influence a range of ecosystem properties, including rates of nutrient cycling and, hence, CO_2 (MERBOLD et al., 2013). Water and carbon fluxes between soil, vegetation and atmosphere are only partially known for mountain grasslands, also owing to the complex geological matrix, to the wide variations in soil depth and sub-soil characteristics, and to the unknown response of the fluxes to extreme impact events and climate variability. Particularly, net CO_2 flux from grassland varies largely in time scale (short and long-term) in response to many factors, such as meteorological drivers, changes in the ecosystem structure (including natural and anthropogenic disturbances like changes in land use and management) or physiological response to climate. All these modifications can seriously affect both traditional landscape and herbivores demographic parameters, in turn limiting the possibility of sustainable tourism, associated with the presence of populations of wild ungulates and pristine grassland conditions.

In the framework of the H2020 ECOPOTENTIAL project (www.ecopotential-project.eu), that focuses its activities on a targeted set of internationally recognized Protected Areas, we would like to evaluate the effects of anthropogenic and climate pressures in managed and non managed grasslands on animal and plant biodiversity.

In particular, a long-term monitoring program started in 2016 in selected sites of GPNP aimed to: 1) evaluate the effects of a well-managed grazing system on animal and plant biodiversity; 2) compare the evolution of managed and non-managed areas, the latter obtained by excluding a portion of the meadows from grazing.
In order to investigate short-term adjustment of the grasslands' CO_2 fluxes to climate variability and anthropogenic disturbances, long-term observations and monitoring have to be performed.

Research area and methods

GPNP is about 70,000 ha in size and it includes 5 main valleys. Three of these valleys, running North to South, originate from the northern slope of the Gran Paradiso massif (Aosta region), while two East-West oriented valleys originate from the southern slope (Piedmont region).

The selected sites are Noaschetta (In Piedmont) and Nivolet (in Aosta Region) valleys (Fig. 1). In Noaschetta, an extensive cattle pasture is the only local activity, together with high transit of hikers along trails. Acidophilus grassland of mountain and low subalpine level dominate the natural landscape, colonized by shrubs and trees in the last years. Here we selected two areas, Piangirot and Piansengio. In each of these areas, we selected an 'exclusion plot' where grazing activity is prevented (Fig. 2).

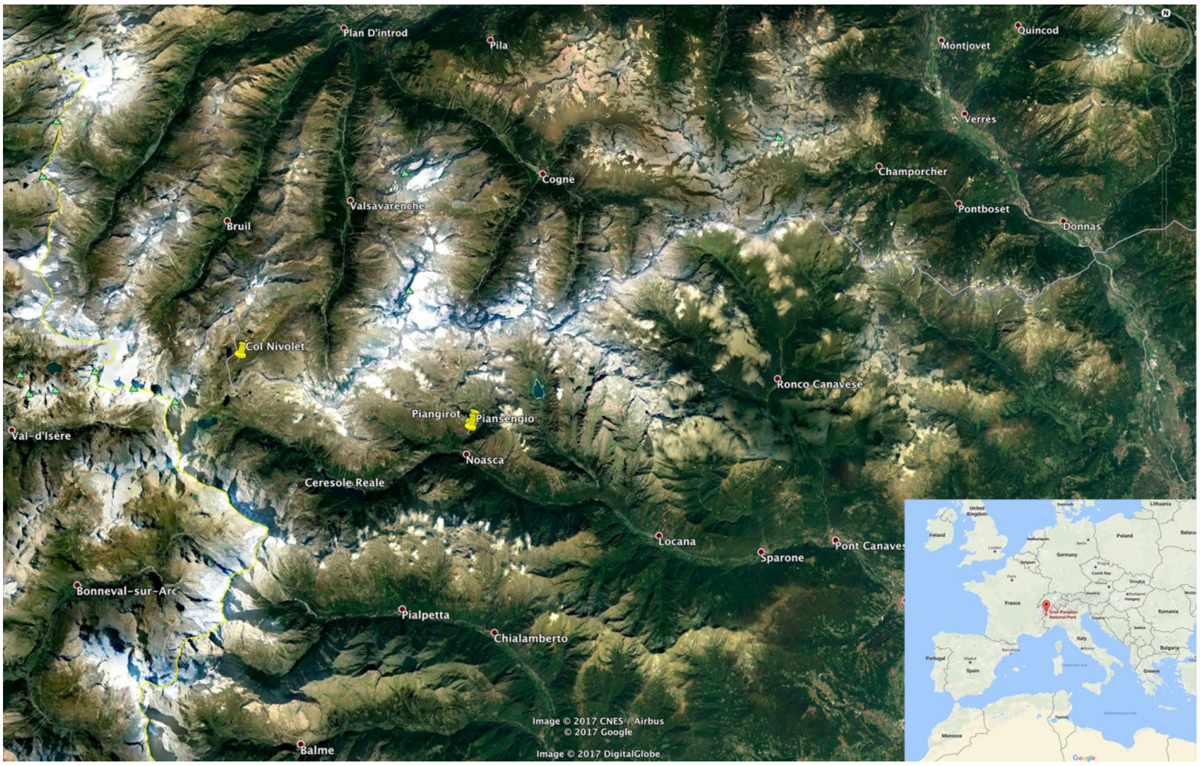

Figure 1: Gran Paradiso National Park.

Col Nivolet is a highly-protected, closed hydrological basin between about 2500 and 2700 meters asl. This area, covered with snow from November to June, is characterized by a complex environment of alpine pastures, oligotrophic lakes, peat bogs, rock outcrops and meandering streams. Here, we selected 4 plots on the main rock outcrops and environment: gneiss, carbonate, glacial deposit and alluvial soil.

Methods

The monitoring program includes plant community, invertebrates, soil properties and CO_2 fluxes .CO_2 fluxes are measured using the accumulation chamber method, composed by an automatic transparent accumulation chamber, diameter 215 mm, height 315 mm (Fig. 3), and equipped with 1) a CO_2 NDIR-sensor (LI-COR LI820), with the range 0-2% vol. and resolution 1 ppm; 2) Power supply unit, including a 14.4V, 4.5 Ah battery, and managed by a handheld computer (PDA) that allows geo-referencing and post processing of acquired data. We also measure soil temperature, soil electrical conductivity, soil relative humidity with a soil probe inserted for about 10 cm into the soil) as well as air pressure, Air temperature and radiance. In each selected area, we perform several CO_2 fluxes measurements with the transparent chamber (light condition) and in dark condition (with the chamber obscured). Soil samples were collected in order to analyze pH, conductivity, inorganic and organic carbon, total nitrogen.

Figure 2: Noaschetta Valley, GPNP: Grazing exclusion plot. Photo credits: Mariasilvia Giamberini.

Figure 3: Nivolet plain, GPNP: Flux chamber in use. Photo credits: Mariasilvia Giamberini.

Results and future perspectives

In summer 2016, CO_2 fluxes were measured in August in Piangirot and Piansengio sites. The net fluxes were about – 0.5 mol m-2 die-1 and in dark condition CO_2 fluxes were about +0.6 mol m-2 die-1. The pH of the soils collected in Noaschetta ranges from 4.1 to 5.8 with a conductivity ranging from 11 to 438 µS25°C/cm. The content of inorganic carbon of soils is under the detection limit, reflecting the absence of carbonate rocks in the catchment.
In summer 2017, several field measurements of CO_2 fluxes, radiance, temperature and humidity of soils are carried out in Noaschetta and in Col Nivolet in order to better describe temporal and spatial variability of CO_2 fluxes for alpine grassland in natural and well-managed grazing. Measures are planned to continue in the next 10 years at least.

Data collected will be elaborated with statistical analysis methods in order to correlate them with radiance, air and soil temperature, soil humidity, soil conductivity, vegetation cover and soil type.

Once a more complete data set will be acquired in the next years, we aim to provide a model that relates the grassland management practices to the state of the ecosystem, focusing on the effects of grazing on biodiversity, soil biogeochemistry and carbon cycle.

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The management of wild reindeer (*Rangifer tarandus*) in Hardangervidda National Park, Norway

Tessa Bargmann & Ole R. Vetaas

Keywords

hunting, climate, tourism

Summary

Hardangervidda is the largest mountain plateau in northern Europe, and is home to the largest wild reindeer (*Rangifer tarandus*) population on the european continent. Wild reindeer are often considered keystone species of the circumpolar region, because they influence ecosystem processes such as nutrient cycling and primary production (e.g. OLOFSSON et al, 2004). The reindeer population on the Hardangervidda plateau is important for its ecological value, and for its economical and recreational value for hunters, hikers and landowners (BJERKETVEDT et al, 2014). A loss of this herd would have a negative impact not only for the ecosystem, but also for the people that depend on it for their livelihood. The protection of the largest population of wild reindeer in Europe was one of the main reasons to designate Hardangervidda National Park. Hardangervidda's wild reindeer population has had frequent and extreme fluctuations in harvest numbers over the last six decades because data on herd size is unreliable, there is a lack of data on recruitment and other life stage characteristics, and because there is a high variation in hunting success (BJERKETVEDT et al, 2014; STRAND et al, 2004). Thus, more reliable population data is sorely needed.

There are a number of factors that are known to affect reindeer populations. For example, human infrastructure has been shown to affect reindeer migration and movement corridors (PANZACCHI et al, 2013). Population fluctuations of reindeer are also affected by climatic variation; Snow quantity and quality is one of the most important natural factors determining winter grazing of wild reindeer, as it affects both access to and quantity of lichens, which are their main food source in the winter (ODLAND et al, 2014; SKOGLAND, 1978). As reindeer depend greatly on lichens as a food source in the winter, the estimation of lichen biomass is an important factor in the study of reindeer populations. An appropriate grazing regime and management by people has the potential to maintain reindeer grazing grounds. However, in order to inform the management of reindeer migration, more reliable information must be gathered on the distribution of lichen biomass which provides superior winter grazing areas for wild reindeer. It is of the utmost importance not only that mapping efforts are improved, but also the ability to predict changes in lichen cover, and determine what changes have already occurred. A recently developed lichen biomass estimator may be helpful in assisting with this type of monitoring (FALLDORF et al, 2014).

Wild reindeer are also highly dependent on good summer pastures to be able to feed their calves, but also to fatten up before the long winter. This is particularly important in an environment where winters are relatively long, and calving occurs in late May, where there is often still snow cover (REIMERS, 2002; REIMERS et al, 1983). Changes in vegetation and availability of summer grazing areas therefore have a great potential to affect the reindeer population. Such changes are particularly likely in the face of climate change, and therefore warrant further investigation. A warming climate can also increase the prevalence of disease and insect harassment, which reindeer suffer from increasingly in the summer. Ordinarily, reindeer seek refuge on snow patches to avoid insects on warm and windless days. However, reductions in snow patches are likely to restrict this insect avoidance behavior. As the reindeer population on Hardangervidda is at the southern end of its range, it is to be expected that these problems are more likely to be exacerbated when compared with northern populations.

The combination of human and natural factors affecting reindeer movements and survival in this vulnerable population pose many interesting questions related to the future of wild reindeer management. As a part of the ECOPOTENTIAL project (http://www.ecopotential-project.eu/), we aim to quantify and map the availability of summer and winter grazing pastures for wild reindeer on Hardangervidda over time, using satellite imagery and data gathered in the field. We ask why reindeer are absent from summer grazing pastures they have consistently used in the past, and whether tourism has had an influence on this change. The reduction in the presence of snow patches in the summer may also play a role in the locations that the animals choose in the summer months. We also try to explain what climatic factors are most important in controlling fluctuations in this population over time. Human factors certainly play a role in population control. Particularly because, in the absence of predators, the population is managed by hunting, an activity that attracts tourism in addition to what is already present in the park through other outdoor activities. However, as tourism and hunting are integral parts of the park management, and the reindeer population is more or less confined to its present range by roads and other human infrastructure, climate variables ultimately have the potential to be the determining factors for the control of the population.

We tested growing degree-days, various temperature and snow cover variables for their effect on fluctuations in the reindeer population over the last two decades. Our preliminary findings suggest that colder temperatures tend to have a positive effect on the reindeer population. Colder winter temperatures are beneficial, possibly due to a reduction in the incidence of icing i.e. melting of the snow and subsequent freezing, which makes the snow pack impenetrable by reindeer. The Hardangervidda wild reindeer population is at the southern end of its range, and as such, this finding has particular consequences under future climate change, and may require a re-thinking of the management of reindeer migration. For example, the Hardangervidda herd should have the possibility to migrate northwards. However, this is a problem in the light of the recent findings of Chronic Wasting Disease, as there are plans to cull the population just north of Hardangervidda quite extensively, and mixing of these populations is not currently desirable (NORWEGIAN INSTITUTE FOR NATURE RESEARCH, 2017). Out of those considered, the only other variable that may be informative in predicting the population is the number of growing degree-days. The data suggests that fewer growing degree-days have a positive effect on the population. This relationship is not significant at any reasonable level, however, though these results may motivate further investigation. Nevertheless, this relationship may be particularly critical for reindeer because of the already short growing season, and the fact that they calve relatively early compared with other ungulates. Warming has also been shown to reduce the variability in plant phenology, which in turn, has been shown to result in a decline in calf production (POST et al, 2008).

These findings have the potential to be used to predict changes and to inform the management of this important reindeer population, and need to be considered particularly in conjunction with the effects of anthropogenic factors which control their seasonal movements in Hardangervidda National Park.

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Conservation of the yellow-bellied toad in Gesäuse National Park: collecting baseline data

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Abstract

The threatened yellow-bellied toad (*Bombina variegata*) was first recorded in Gesäuse National Park in 2004. To gain further information about its status, a mark-recapture study was conducted in 2016. Small populations were found on several disjunct sites, mainly located at altitudes between 1100-1300 m above sea level. Total population size was estimated as about 60 individuals. Relatively high body length and body mass as well as high survival rates indicate old and isolated populations. Body condition was positively correlated with altitude. Since suitable breeding ponds, which mainly occur on pastures, are rare, conservation and creation of habitats as well as regular monitoring and collaboration with forestry workers may be vital management tasks in the future.

Keywords

Amphibia, mark-recapture, population size, reproduction, biometry, body condition

Introduction

Due to habitat loss, the yellow-bellied toad (*Bombina variegata*) is regarded as vulnerable on the Austrian red list (GOLLMANN 2007) and is listed in Appendix II and IV of the Habitats Directive. Although the German trivial name 'Bergunke' refers to its occurrence in mountainous regions, this species is predominantly found at altitudes between 200 m and 800 m above sea level (CABELA et al. 2001). Doubtlessly, higher altitudes are challenging for toads because of a shortened activity period. The rocky Gesäuse National Park (Styria, Austria) extends from 490 m to 2369 m above sea level. It is the youngest National Park in Austria, established in 2002, and also part of a Natura 2000 area. There, *Bombina variegata* was first detected in 2004. Since preservation of biodiversity and protection of rare species are one of the main goals of the National Park and, additionally, Natura 2000 areas are focusing on species of the Habitats Directive, gaining more information about the threatened amphibian in this area is vital. In addition to updating distribution records, the focus of the current investigation was to assess population structure, reproduction, habitats and body condition of the toads.

Methods

From May to September 2016, a mark-recapture study was conducted. All sites were visited four to six times. The toads were captured, their ventral patterns were photographed for individual registration and biometrical measurements (snout-vent length, body mass) were taken. Water bodies were described regarding several parameters (e.g. size, depth, water temperature, vegetation). Additionally, comparative studies in nearby areas and in the Kalkalpen National Park were carried out. Population size was estimated using the Peterson-Lincoln method modified by Chapman (AMSTRUP et al. 2005). The body condition of each toad was calculated with the Scaled Mass Index (PEIG & GREEN 2009).

Results

In the Gesäuse National Park a total of 53 individuals of yellow-bellied toads was captured (BAUMGARTNER 2017). The population size was estimated to be 60 individuals, distributed over several disjunct sites. Local populations were mostly small, consisting of less than ten toads (Fig.1). Contrarily, a comparatively high number of toads (>40) was counted in external areas next to the western part of the National Park, which are used for forestry and logging and are located at lower altitudes. Toads showed high site fidelity: more than half of the captured toads (n = 31) were recaptured at least one more time.

Bombina variegata was found in various water bodies, located mainly on pastures. Ponds, formed by trampling of the cattle, wallows of the red deer, road ditches, wheel ruts and even drinking troughs were used. Despite the relatively high availability of ponds at higher altitudes, toads were predominantly found at 1100-1300 m above sea level.

Only one juvenile toad was captured, which suggests low reproductive success in the previous year. Limited evidence of reproduction was obtained in 2016: in five water bodies spawn or tadpoles were recorded, in two of them larvae actually reached metamorphosis.

Pictures of the toads' ventral patterns taken in 2010 (WERBA 2011) enabled their recognition in 2016. More than half of those toads were recaptured in 2016 (17 of 33 individuals); since they had already been adult in 2010, their minimum age was 9 years.

On average, snout-vent length and body mass of toads were lowest in external areas nearby the National Park and highest in areas 1100 m above sea level. Body condition, which is considered to be an indicator for the energy capital and, by extension, for an animal's health (Peig & Green 2009), was positively correlated with altitude ($r = 0{,}208$; $t(127) = 2{,}3975$, $p = 0{,}018$) (Fig.2).

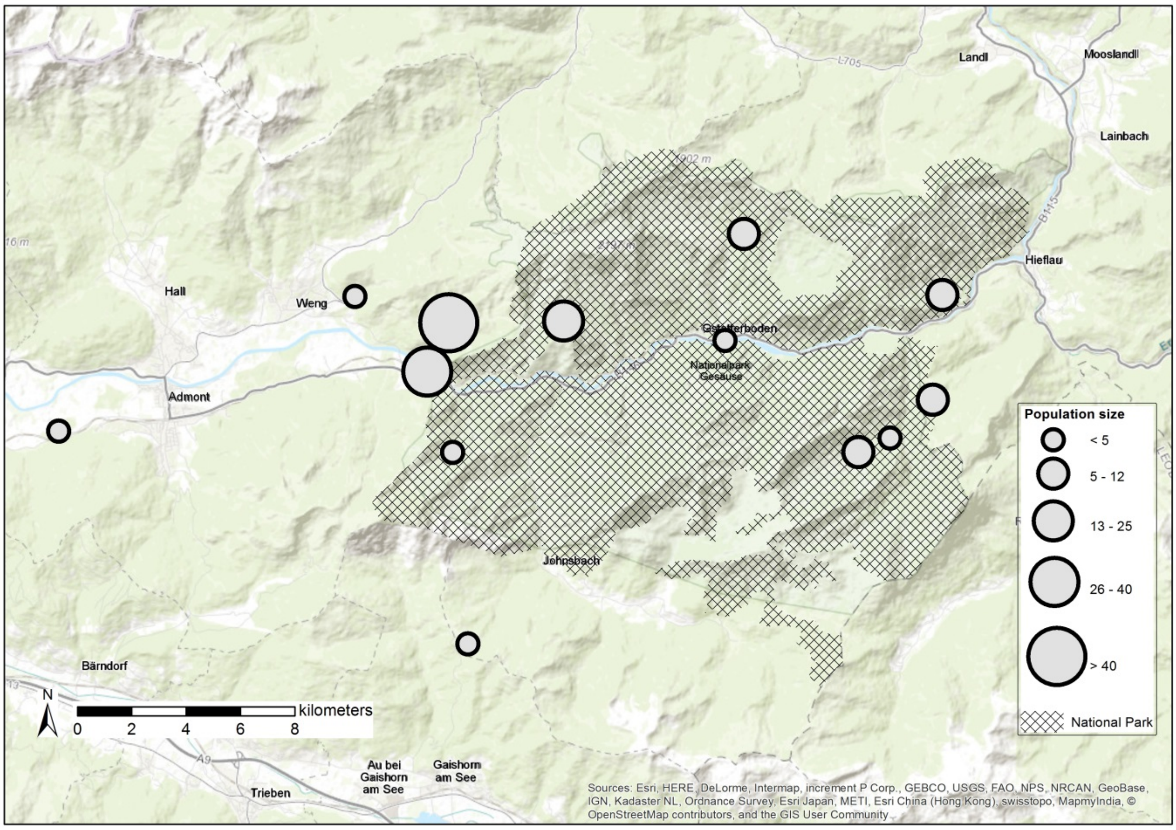

Figure 1: Estimated population size by using the Peterson-Lincoln method in the Gesäuse National Park and areas nearby (© M. Baumgartner)

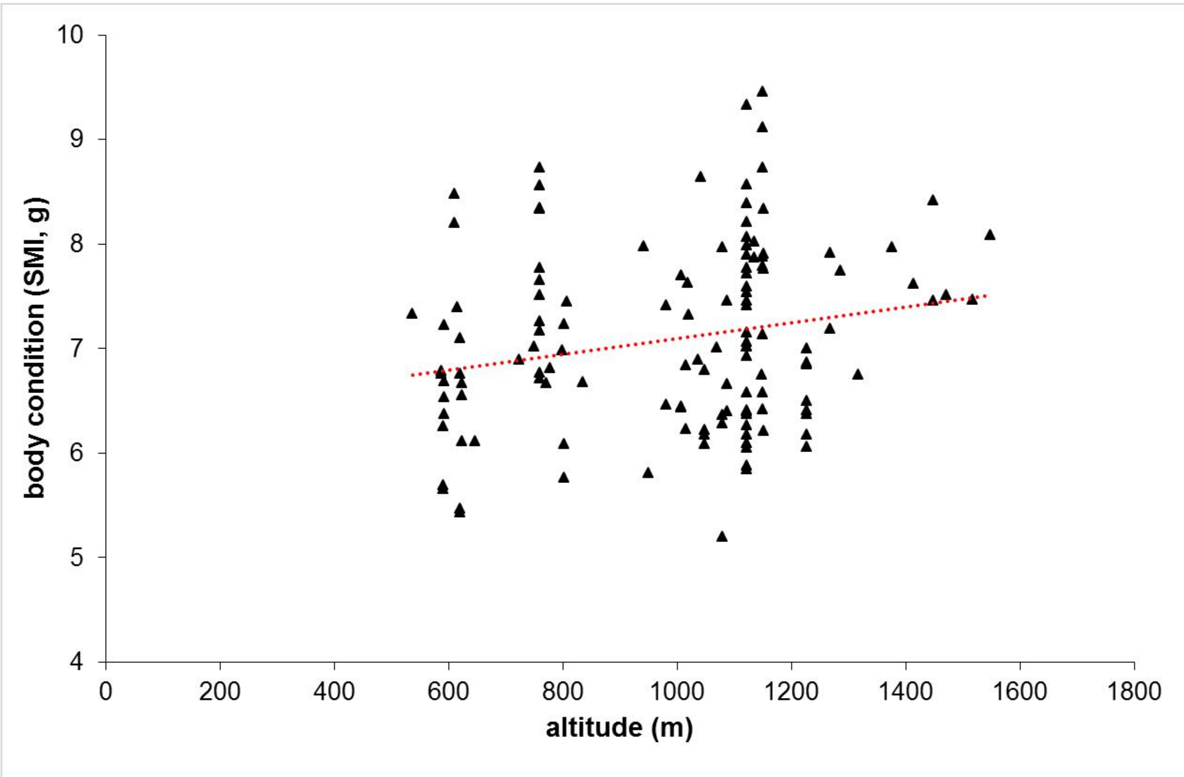

Figure 2: Correlation of body condition (Scaled mass index calculated for a reference length of 45,1 mm SVL) with altitude. Toads from all investigated sites (Gesäuse National Park, external areas and Kalkalpen National Park) are included (n = 129) (© M. Baumgartner)

Discussion

The small number of individuals of *Bombina variegata* and the low reproductive success in Gesäuse National Park presumably relate to several factors. First, the National Park is located close to the Central Alps, which probably are a natural distribution boundary. Additionally, this area is characterized by steep and rough cliffs. Possibly suitable breeding habitats for the species are thus rare especially at lower altitudes. The colder climate conditions at higher altitudes lead to a shortened activity period of the toads. Second, flatter areas with ponds only occur above 1000 m. They are often used as pastures; cattle and big game are important for creating and renewing temporary pools. These animals, however, can represent a threat to the toads if trampling and wallowing happen too often. Furthermore, the alpine newt (*Ichthyosaura alpestris*), which often occurs in the same waters as the yellow-bellied toad, is considered to be a predator especially of spawn and tadpoles.

The total number of individuals in the National Park is probably underestimated by our mark-recapture analysis. Fast colonization of newly formed habitats (e.g. drinking troughs for cattle) suggests that, beside the philopatric toads, also mobile individuals ('floaters') live in the National Park. The high recapture rates refer to high and partly longstanding site fidelity of the toads but may also be the consequence of isolation. Far distances between the populations may make it difficult for toads to switch between sites.

The small number of juveniles as well as the large sizes of adults in the National Park suggest a high average age of the toads. Many amphibians tend to get older at higher altitudes and latitudes (HEMELAAR 1988, SMIRINA 1994). The high body condition at higher altitudes suggests that these habitats provide more favourable growth conditions. Higher body condition, however, may also be connected to the shortened activity period and the lower reproductive participation of the toads at higher altitudes.

Conclusion

In the Gesäuse National Park, populations of *Bombina variegata* are highly endangered. Hence, conservation and management tasks should secure and improve their situation by saving and providing appropriate habitats, which are mainly located on the pastures. Conservation and creation of spawning ponds as well as regular monitoring are crucial. As this species can benefit from secondary habitats originating from human disturbances, e.g. roadside ditches or wheel ruts (GOLLMANN & GOLLMANN 2012), it seems to be of particular importance to raise awareness of this species and to spread knowledge about its preferred habitats among local people in order to preserve newly formed water bodies. Therefore, collaboration with people working in forestry and agriculture is vital.

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Threats of Climate Change to Single-Island Endemic Species in Protected Areas

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Abstract

The Island of La Palma (Canary Islands, Spain) is protected as a whole (La Palma World Biosphere Reserve) and within this frame in parts as a national park (Caldera de Taburiente) and additionally through sites of special conservation status, and Natura 2000 sites. The island hosts a large number of archipelago endemic (AE) plant species and also single-island endemic (SIE) plants. These species even contribute substantially to local species richness, biomass and functioning of ecosystems, and they cannot be replaced through species from other regions. In consequence, there is an urgent need to detect spatial patterns and changes in the distribution and performance of these species in order to adapt the management of Protected Areas to the increasing pressures. Here, we present together with local administrative management a detailed analysis of the contribution of endemic species and of the respective threats that need to be addressed in adaptation strategies. Also we show how monitoring and the control of success can be implemented with the support of Earth Observation. The study is part of the H2020 Project ECOPOTENTIAL.

Key Words

National Park, MAB, La Palma, Invasive Species, Herbivores, Trade Winds, Precipitation Change

Introduction

Endemic species that are restricted to a small area of distribution and small total population sizes, respectively, are particularly threatened by extinction. Several Protected Areas (PAs) are designed and justified mainly for the protection of such species. On islands, and particularly on oceanic islands that are highly isolated and have never been in contact with terrestrial surfaces of continents, the proportion of endemic species is remarkably high compared to other land surfaces. Endemicity is even enhanced in the case of a pronounced topography on these islands of volcanic origin (Irl et al. 2015, Irl 2016, Steinbauer et al. 2016).

Climate change and the correlated increase of weather extremes are posing new challenges to nature conservation (Beierkuhnlein et al. 2016). Island biota in particular are threatened through these rapid developments, because they cannot escape from their isolated habitats (Harter et al. 2015a). Oceanic islands are generally poor in species, which even increases the importance to preserve populations of endemic species that contribute significantly to ecosystem functioning and to the provision of ecosystem services to mankind (Beierkuhnlein et al. 2011, Beierkuhnlein 2017).

The island of La Palma exhibits a strong altitudinal gradient (0 to 2426 m a.s.l.) with respective elevational zones of climate and ecosystems (Irl & Beierkuhnlein 2011). The constant trade winds lead to a humid windward side on the northeastern side with extensive laurel forest and dry, leeward climatic conditions in the southwest of the island with desert-like vegetation. Human population density is low because steep coastlines are not appropriate for mass-tourism.

Methods

The ECOPOTENTIAL Project applies Earth Observation, both in-situ and from remote sensing, to European PAs of international importance. The focus is to use existing information and to link this with geoinformation and data from satellite-born sensors such as the Sentinel mission. As part of the Canary Islands, the island of La Palma is protected in various ways. The entire island is a Man and Biosphere Reserve of UNESCO. Additionally, in the center of the island, the Caldera de Taburiente National Park, protects very natural and difficult to access ecosystems, mainly forests of the endemic *Pinus canariensis*. And, furthermore, national protected areas and European Union-based Natura 2000 sites are designated for instance in the laurel forest.

For this study, we use in situ data for endemic plant species that have been recorded by our group in previous years. On almost 2000 plots distributed on the entire island of La Palma the presence and relative abundance of endemic plants was recorded. Data were differentiated into single-island endemics and archipelago endemic species. Climatic data were derived from local weather stations and then interpolated by geo-statistical approaches (Irl et al. 2015).

Results

We find clear patterns of climatic conditions that are reflected in the diversity and in the proportional contribution of endemic plant species to ecosystem structures and functioning (IRL et al. 2017). On the island of La Palma, habitats in low elevation that exhibit both sufficient water availability (precipitation through rain or clouds) and a high topographic complexity (steep valleys with different aspects) and respective low human impact are hot spots of species richness and also show a high diversity of both, single-island endemics and archipelago endemics (HARTER et al. 2015b). However, with increasing elevation, the proportion of endemic species rises (STEINBAUER et al. 2016, 2017).

Surprisingly, also anthropogenic structures such as incised rocks from local roads offer secondary habitats even for single-island endemic plant species such as various members of the *Aeonium* genus (IRL et al. 2014a). However, there are enormous threats to the endemic species through introduced herbivores such as rabbits, goats and barbary sheep (IRL et al. 2012). Rabbit traces can be found all over the island and they selectively feed on endemic plants that have no protective strategies. Goats were more important in the past. *Ammotragus lervia* (Barbary Sheep) does not exhibit a large population, but it can access even the steepest slopes, where remnant populations of some endemic plants are located. Finally, fire is a natural driver of ecosystem dynamics on the island (Irl et al. 2014), which is reflected in the astounding capacity of *Pinus canariensis* to regenerate after forest fire. However, in recent times the fire interval seems to shorten, supported by increasing periods of drought, with unclear consequences for the state and value of PAs.

Discussion

The isolation of island habitats results in low species richness and low ecological complexity, respectively. This fact makes islands the perfect place to study ecosystem processes and functions. Also, the effects of climate and climate change can be well investigated in these natural laboratories (BEIERKUHNLEIN et al. 2011, BEIERKUHNLEIN 2017). Translating the insights from island systems to continental habitats has led to the development of outstanding and seminal theories and to their implementation in practice such as the theory of island biogeography (MACARTHUR & WILSON 1967) which is the basis for spatial concepts on PAs.

The clear climate-driven patterns of species richness and endemism are likely very susceptible to climatic changes in the near future, possible threatening endemic species on La Palma and other islands worldwide (HARTER et al. 2015a). High elevation ecosystems might be particularly threatened, owing to high degrees of range-restricted endemics (STEINBAUER et al. 2016, Irl et al. 2017), stronger temperature changes at high elevations than low elevation areas buffered by the ocean (EXPÓSITO et al. 2015) and advancing treelines (IRL et al. 2016). Future PAs need to address and account for the dynamics of a changing environment to optimally protect range-restricted endemics and prevent their extinction.

Figure 1: Two endemic legume species found on La Palma. Single-island endemic *Lotus pyranthus* (left) has become extremely rare, only few clones survived, and these need to be protected by fences from introduced rabbits. Archipelago endemic *Chamaecytisus proliferus* (right), in contrast, shows the economic potential of endemic species. It has become an important fodder plant in Australia, New Zealand and Africa. In consequence both need to be preserved but for different reasons.

Conclusion

Our study documents that decision making processes in the management of PAs need to be based on clear prioritization in nature conservation. The preservation of endemic species richness does not necessarily coincide with the preservation of ecosystems that are dominated by endemic species. We recommend a mixed strategy in order to cover all aspects of endemicity and endemic diversity.

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Postglacial evolution and recent siltation of the protected lake Taferlklaussee (Salzkammergut, Upper Austria)

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Abstract

The study focuses on the nature reserve 'Taferlklaussee' in Upper Austria. This small freshwater body fills a glacially overdeepened basin carved by the Aurach valley glacier isolated from the alpine ice flow network during the Last Glacial Maximum. Nature conservation versus human interaction causes multifaceted areas of conflict and views on future management are diverging. We provide first-hand data on short and long-term lake siltation using a bundle of methods and focussing on the postglacial infill history as well as decadal-scale trends of lake development.

Keywords

Postglacial Lake; Infill History; Overdeepened Basin

Introduction

Sediment production, (intermediate) deposition, remobilization, and (final) storage are strongly controlled by topography, climatic parameters, and particularly by glaciation and deglaciation. Overdeepened alpine basins and lakes are characteristic results of glacial erosion. They represent sedimentologically (semi-)closed archives most suitable to reconstruct postglacial landscape evolution and establish sediment budgets (HINDERER 2012).
Nature reserves are intended to preserve ecosystems but also the physical environment and landscape. Consequently, areas under nature conservation are widely unaffected by humans and represent undisturbed landscape archives. As nature conservation and human interaction with the environment often causes various areas of conflict, our research is intended to provide first data on the evolution of the protected alpine lake 'Taferlklaussee' (TKS) to underpin the current debate and inform best-practise management.

Major aims of our research include i) understanding decadal scale trends of siltation, ii) reconstructing the postglacial evolution of the lake basin, iii) quantifying the amount of postglacial sediment storage in the basin and iv) understanding the dynamics of erosion and sedimentation since deglaciation (Lateglacial, Holocene, Anthropocene). We use a bundle of direct and indirect methods, consisting of field surveying (mapping, DC-resistivity, core drilling), lab analyses (e.g. grain size and 14C dating), GIS modelling (sediment storage volume), and the interpretation of a set of historic aerial images.

Study Area

The TKS, a small lake (12170 m2, 763 m) in the Aurach catchment (3.02 km2, 763-1708 m; Salzkammergut region, Upper Austria), is located at the border of the Northern Limestone Alps in the south (Höllengebirge) and the Flysch Zone in the north. The east-west oriented Höllengebirge with its highest peaks of ca. 1700 m (eg. Brunnkogel, Hochlecken) is dominated by Wetterstein limestone and dolomite underneath (Hauptdolomit; below ca. 1200 m). The Flysch Zone (composed of marls, clays and sandstones) in the north of the study site is less rugged with highest elevations of 1090 m (Krahberg) (Fig. 1).

Several small streams drain the north facing cirques of the Höllengebirge and feed the TKS, where the Aurach river originates. The area is characterised by a mean annual precipitation of 1900 l/m2 and mean annual temperatures of 3.6 °C (Höllengebirge, Feuerkogel, 1618 m; 1971-2000; ZAMG).

The formation of the TKS basin is considered to result from glacial overdeepening (VAN HUSEN 1977). During the Würm glaciation the Aurach glacier was independent and not connected to the larger neighbouring glaciers (Traun outlet glaciers forming the Attersee and Traunsee basins). At the recent lake and further downstream, several recessional stages of the Aurach glacier are clearly marked by terminal moraines and attributed to glacier extends of the Last Glacial Maximum (LGM, MIS 2) and Late Glacial stadials (probably between 14 and 20 ka, VAN HUSEN 1977; Fig. 1). So far, no chronometric constrains exist for these depositional landforms and the age of the lake.

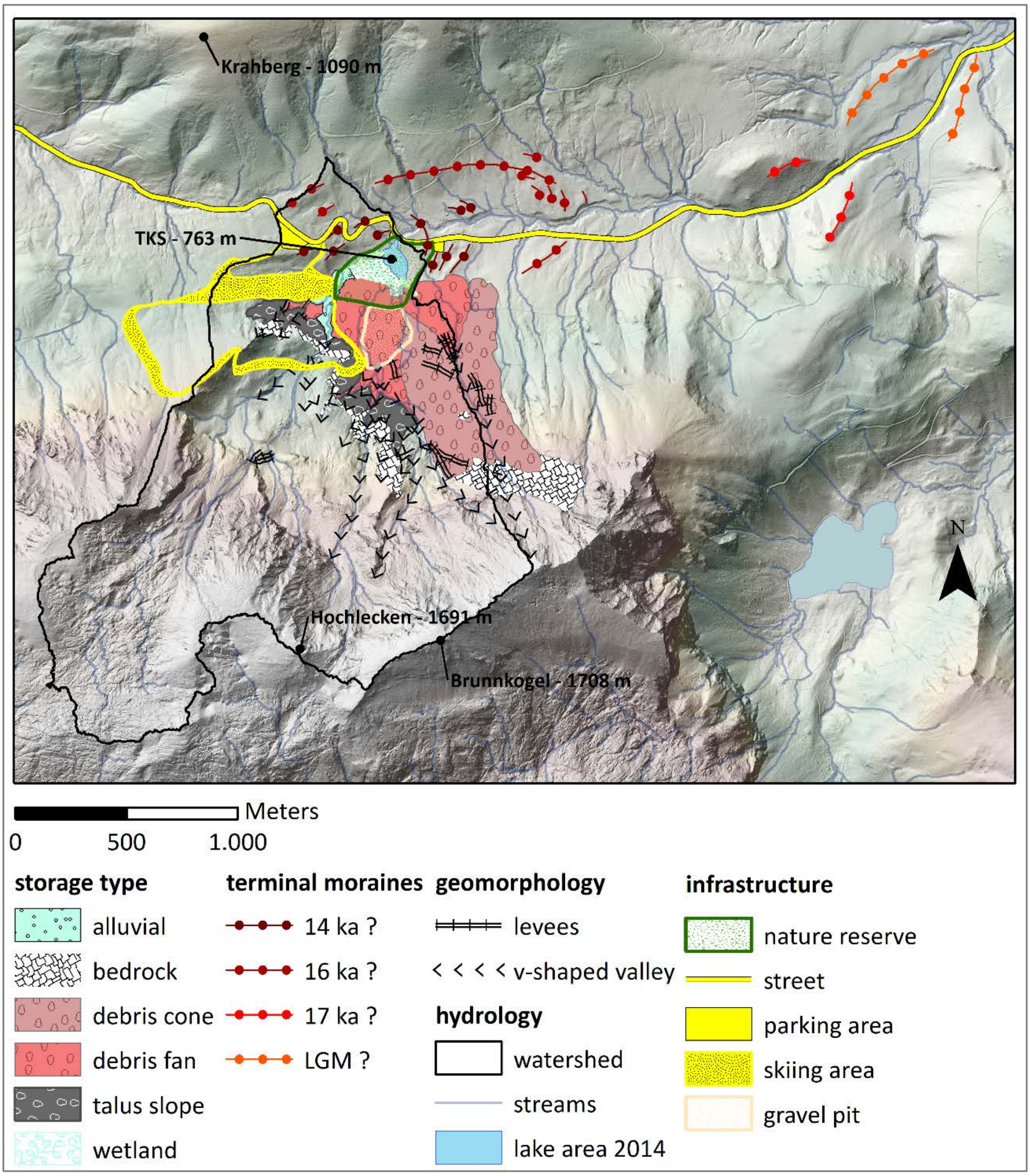

Figure 1: Overview map of the study area providing information on landforms, hydrology and infrastructure. Lateglacial stadials (ca. 17 ka = 'Ischler Stand'; ca. 16 ka = 'Jochwand Stand', ca. 14 ka = 'Goiserer Stand') refer to VAN HUSEN (1977). Location within Austria is marked with a red dot. Symbols refer to OTTO & DIKAU (2004).

In historical times, the area was deforested and the lake level artificially raised in AD 1716 to allow log rafting on the river Aurach. Today, the TKS is under nature conservation but highly frequented as recreational area for summer and winter sports.

Methods

We mapped depositional landforms, bed rock, hydrological features and infrastructure based on both, field surveying (GPS) and the interpretation of ALS data and derivatives (e.g. slope, curvature, hillshade; spatial resolution 0.5 m).

For the investigation of the thickness and internal structure of the postglacial basin fill, we acquired several DC-resistivity surveys (Wenner arrays) (Fig. 2). Three of them were taken as roll-along surveys (overlap 75 %) with total lengths of 596 and 496 m. Two shorter surveys (196 m) were acquired in the distal part of the basin.

Stratigraphic information of the basin fill is based on several drill cores (Fig. 2) and is also used to validate geophysical models. Two samples of organic material (from B2) were taken for 14C dating.
Historic aerial photographs and orthophotos available since 1953 (Fig. 3) were used to quantify the lake area on a decadal scale.

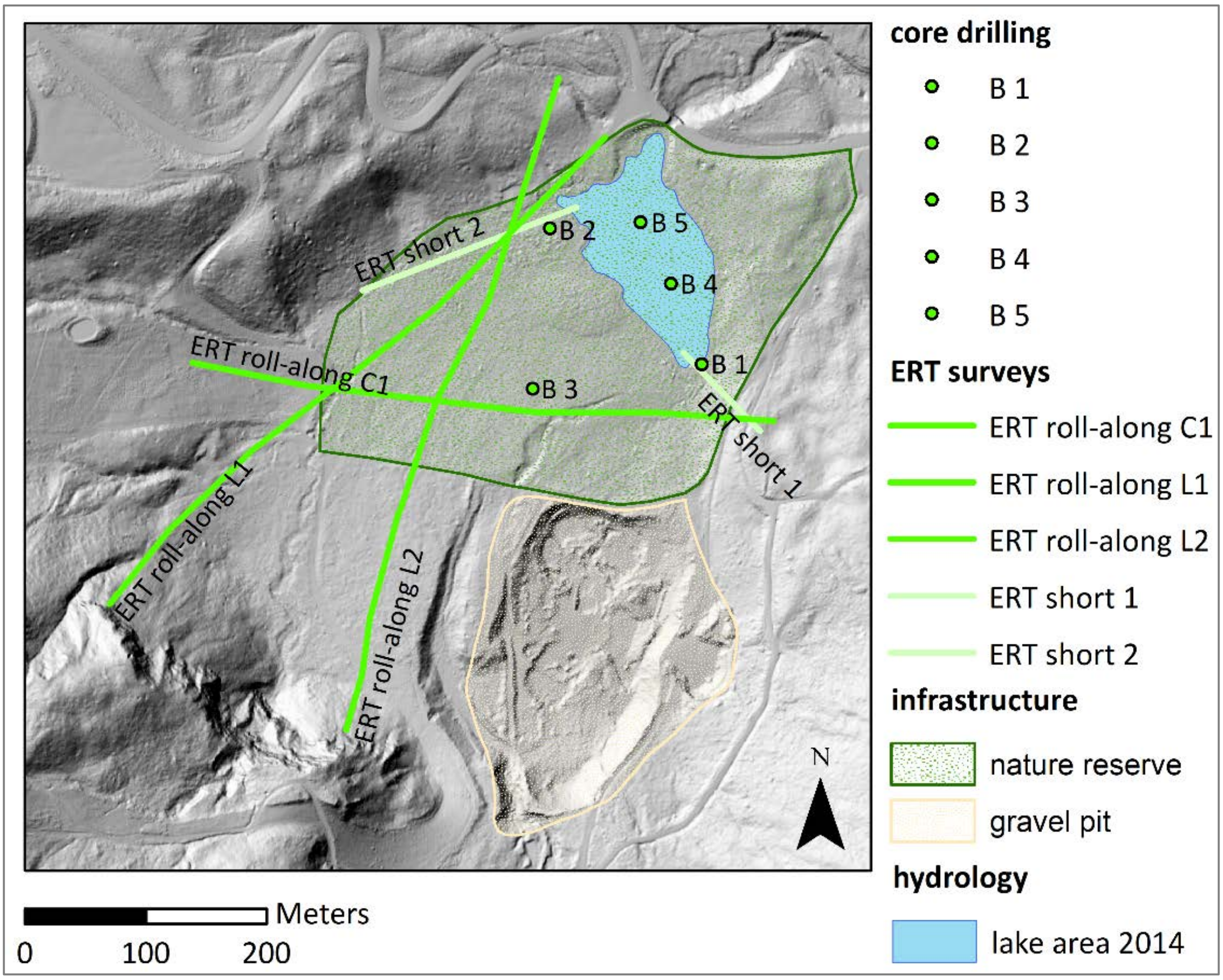

Figure 2: Locations of core drillings and DC resistivity (ERT) surveys in the TKS basin and the lake extend of 2014. Boundaries of the preserved area and the gravel pit are based on hillshaded ALS data (spatial resolution: 0.5m).

Results

The mapped landforms were categorised into alluvial plains, bedrock, debris cones/fans, talus slopes and terminal moraines (Fig. 1). Several debris flow channels drain the steep cirques in the southern part of the catchment and enter the basin in the proximal part. Large amounts of debris flow and rockfall material were supplied through these channels forming major fans and cones that cover the entire proximal basin. Since the 1960s a gravel pit is located within these fans for mining the dolomitic sediment.

ERT surveys show rather low apparent resistivities mainly below 500 Ωm, with highest measured values of up to ca. 2200 Ωm. The 2D tomographies of the roll-along surveys (Fig. 4) allowed capturing the entire basin length-(L1 and L2) and crosswise (C1). The basin boundaries (lateral moraines and talus slopes) show higher resistivities (ca. 400-2200 Ωm) and sharp borders to the material in the centre of the basin with significantly lower values (ca. 20-70 Ωm). This highly conductive material shows quite homogenous values, except for a high resistive near-surface layer (ca. 400-700 Ωm) in the basin centre. All three roll-along profiles show a parabolic-shaped structure running through the basin in depth between 5 and 35 m, with relatively higher resistivities (ca. 100-250 Ωm) compared to the material above and below.

The drillings in the siltation zones (B1 and B2) and within the recent lake (B4 and B5) reached depth between 4.6 and 6.5 m. With the drilling B3, located on a major debris fan and close to the ERT survey C1, we reached a depth of 10 m. First radiocarbon ages of two samples (core B2; sample depths: 2.2-2.3 m and 3.7-3.8 m) yielded ages of ca. 4600-4500 cal BC using Intcal13 (REIMER et al. 2013).
With respect to the (sub-) recent lake history the lake area diminished by 4540 m2 between 1953 and 2014 as shown below (Fig. 3).

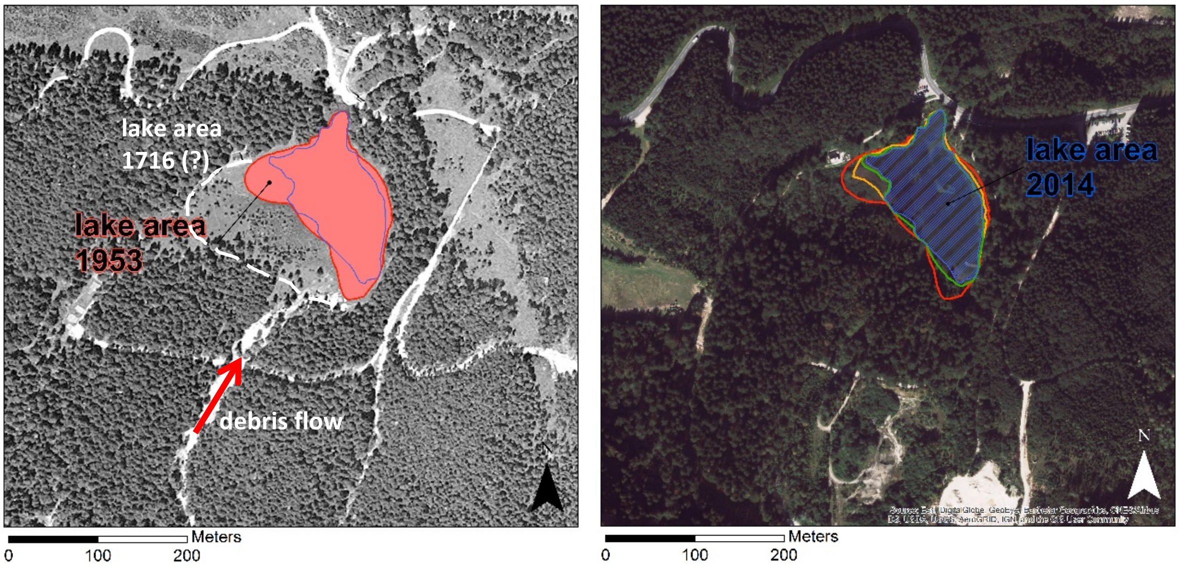

Figure 3: Orthophotos from 1953 and 2014 based on aerial photographs showing changes in lake area.

Discussion

Preliminary results of analysed surface, subsurface and temporal data indicate a glacially overdeepened basin, which is rather shallow in the distal part (ca. 5-7 m), whereas in the proximal part, sediment thickness increases strongly (up to ca. 35 m).

The basin infill can be summarised in a simplified model composed of four main units (Fig. 4): The first 2-5 m underneath the present surface show high resistivities. This major fan mainly consists of dolomite debris showing a loose, sandy to silty matrix. The fan sediments are underlain by well conductive lake sediments (from 5-35 m) mainly consisting of clay and silt. Underneath, a parabolic shaped structure with slightly higher resistivities indicates a layer of basal till which is interpreted as the lowest depositional material in the basin. Relatively low resistivities underneath suggest that the basin-base is composed of highly conductive material.

From first interpretations the stratigraphy of the drill cores in the distal part of the basin (B1, B2, B4 and B5) consists of three main sections (from bottom to surface): basal till, lake sediments (partially interrupted by dolomite debris) and peat. The stratigraphy of B3 fits well with the results of the DC-resistivity surveys and is composed of lake sediments (10-5.5 m) and dolomite debris (from 5.5-0 m). However, lower units and the base of the basin could not be reached.

Radiocarbon ages taken from B2 verify the hypothesis that a postglacial lake already existed in the basin before the recent TKS was dammed up in AD 1716. However, since samples from the basin-base have not been dated yet, the period of lake formation remains unknown but the similar ages of the two samples, though being ca. 1.5 m apart, suggest former periods of high sediment delivery.

The most recent lake development, as reconstructed from multi-temporal aerial photographs, shows that two zones of siltation have strongly expanded since 1953 and that lake area decreased by 4540 m2 (Fig. 3). Recent sediment input seems to be controlled by organic material and rare debris flow events. Several levees and lobes were recently deposited through active debris flows in the most proximal part of the basin, demonstrating that sediment delivery from the steep cirques above is still ongoing. Multiple debris flow generations are clearly recognizable in the field and give an idea of the high frequency and magnitude of past events.

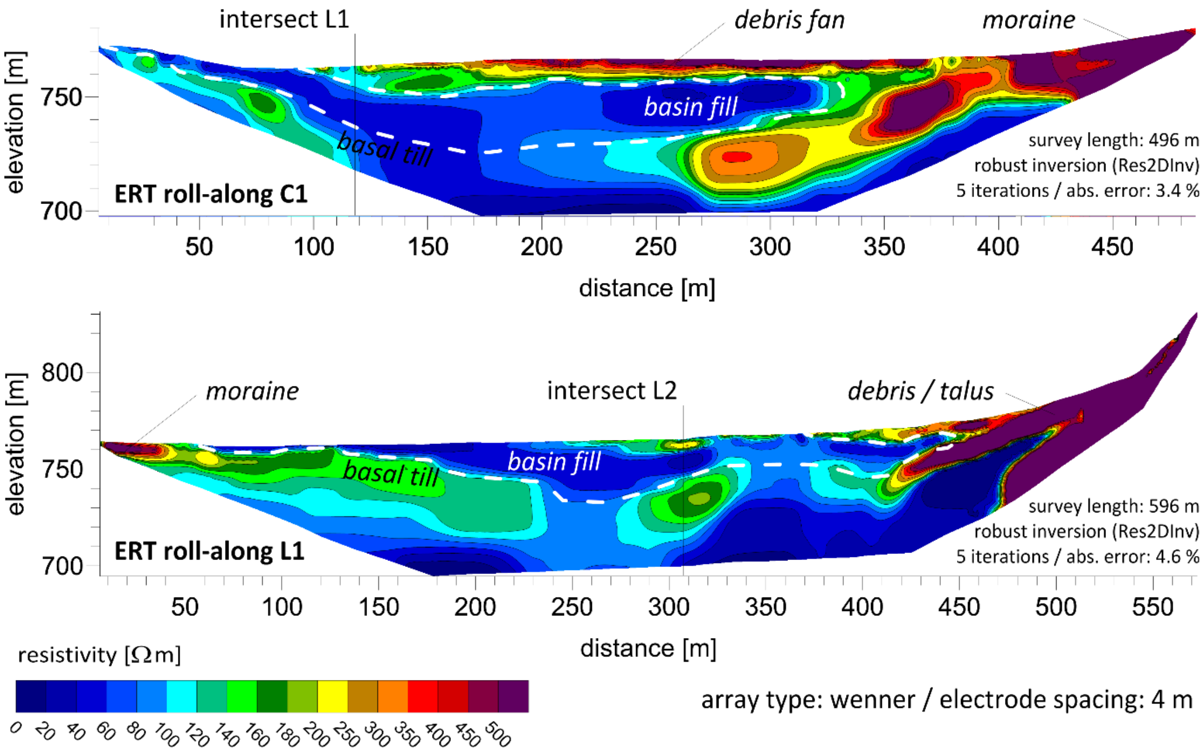

Figure 4: Electrical resistivity tomographies (ERT roll-along C1 and L1) with interpretation. For locations see Fig. 2.

Conclusion and Perspectives

To capture the extent/geometry of the TKS basin (recent lake area: 12170 m^2) and the surrounding depositional landforms, a combination of different methods has been applied (analyses of ALS-data and orthophotos, DC-resistivity, core drilling, radiocarbon dating). Most important preliminary results of our ongoing study show that

- an overdeepened basin framed by terminal/lateral moraines and talus slopes was verified by DC-resistivity surveys, core drilling and geomorphological mapping (cf. VAN HUSEN 1977),
- the depth of the recent lake basin is only ca. 5-7 m whereas the total depth of the sedimentary fill increases up to 35 m in the proximal part,
- the basin fill can be structured in four main units: the base of the basin potentially reflecting Flysch material, basal till, lake sediments, and alluvial/debris flow material on top,
- 14C ages of two samples from B2 suggest the existence of a lake in the basin after glacier retreat and before the lake level was risen AD 1716, and
- the lake area decreased since 1953 by 27% (4540 m2).

In the next steps, we aim to calculate sediment storage volumes and reconstruct the postglacial evolution of the basin. Finally, postglacial erosion rates and their Holocene variation will be investigated combining stratigraphic analyses, further radiocarbon ages, and GIS-modelling.

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People in German Biosphere Reserves

Claudia Bethwell

Abstract

As model regions for sustainable development Biosphere Reserves explicitly include human activities. We analysed the Biosphere Reserves in Germany as home for people based on official statistical data on a community level, including temporal developments. The population development impacts further human activities, like land-use activities, infrastructure use and provision, as well as actual utilization of ecosystem services delivered by Biosphere Reserves. We present different types of temporal population development with reference to spatial variations.

Keywords

types of population development, rural landscapes, Biosphere Reserves, spatio-temporal variation, socio-economic areas

Introduction

As model regions for sustainable development Biosphere Reserves explicitly include human activities (MAB-NK 2007, MAB 2016: Lima Action Plan 2016-2025). For a range of human activities, including Biosphere Reserves, the knowledge about the human population development and its components – migration and natural population development and the balances, gains and losses, is increasingly recognized as being of significant importance for assessing the regional chances and challenges for development. Especially, the population development impacts human activities, like land-use activities, infrastructure supply and demand, as well as actual utilization of ecosystem services delivered by the existent habitats and ecosystems. The model character of Biosphere Reserves for sustainable human activities includes the question, which types of socio-economic areas are represented by the Biosphere Reserves. In Germany, the Biosphere Reserves cover a wide range of socio-economic areas, from rural and peri-urban and urban areas. We aim to analyze different types of the population development, its components and balances represented by the German Biosphere Reserves.

Methods

<u>Case study regions</u>

Germany today has 17 Biosphere Reserves which cover an area of 1.994.273 ha, their sizes range from the small 'Hamburgisches Wattenmeer' with 11.700 ha to the 'Schleswig-Holsteinisches Wattenmeer und Halligen' with 443.100 ha (BfN 2017) and they are located in 12 of the 16 federal states of Germany.

<u>Analysis</u>

We analyzed the Biosphere Reserves in Germany as home for people based on official statistical data on a community level, including temporal developments. First, we selected the communities, which are full or partly located in the Biosphere Reserves with geoprocessing between the protected areas and the administrative units. Second, we attributed the administrative units with statistical data about migration and natural population development. Third, we identified for each administrative unit the type of population development. And finally, we compared the types of population development in the Biosphere Reserves in their spatio-temporal variations, basic components and representativeness.

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Can collaborative governance approaches enhance the spatio-temporal fit between agricultural related ecosystem services?

Claudia Bethwell, Claudia Sattler, Lenny van Bussel, Gregor Giersch, Angela Meyer

Abstract

Provisioning services show spatial and temporal trade-offs to other services, which makes assessments challenging. We identify trade-offs related to agriculture by using examples from three study regions (protected areas in The Netherlands, Austria and Germany) to deal with them.

Keywords

Provisioning services, trade-offs, synergies, collaborative approaches, agricultural production

Introduction

Ecosystem services (ES) which are related to agriculture, not only comprise provisioning services like agricultural yields, but also regulating ES like erosion control, supporting and habitat services, e.g. pollination , and cultural services including the landscape attractiveness (TEEB 2010a, 2010b). All ES delivered by agriculture are connected through trade-offs and synergies (POWER 2010). While acknowledging the main objective of agriculture to produce biomass for human uses - a typical provisioning ES - there is an increasing societal demand to shift the balance of the ES towards environmental sustainability, i.e. to strengthen ES other than provisioning. Not only trade-offs and synergies do occur between different ES, but these interrelations might be delivered at different times and in various locations, if supply and demand differ in these dimensions, as it is usually the case with the provisioning services. IVERSON et al. (2014) found four types of combination between ESs (lose-lose, lose-win, win-lose and win-win). The increasing requirements towards ES and their trade-offs and synergies call for management and steering procedures, which can be integrated into governance approaches. The intensity of the ecosystem services delivered by arable agriculture depends on the cultivated crops and the related management practices. Spatial trade-offs can occur on-site, off-site in different directions or distances and thus be decoupled in the further surroundings of the agricultural fields. Temporal trade-offs may also appear in various types, for example accelerated, constant and delayed. All these situations should be covered by specific governance approaches.

A suitable governance approach would take the trade-offs and synergies of ES into consideration, make their intensities and side-effects transparent, reduce trade-offs and enhance synergies (VATN AND VEDELD 2012). The increasing societal requests to agriculture are reflected in many governance approaches on the European level as well as on and national or subnational level, for example the agri-environmental-climate-schemes, which are based on the European Common Agricultural Policy (CAP). On a regional level, also collaborative approaches can be initiated (e.g. to improve structural and habitat quality of an agricultural landscape; to support marketing activities; to regulate the regional water balance for affected land users). Collaborative approaches can complement existing hierarchical and market-based approaches, like the agri-environmental-climate-schemes, especially due to the knowledge of stakeholders about local conditions, the focus on common regional objectives and the cooperation of different groups of stakeholders to approach the objectives.

We aimed to analyze and systematize the trade-offs and synergies of ES which are related to the agricultural production in study areas in three European countries. All are protected areas located in the Netherlands, Germany and Austria. Typically for agricultural landscapes, in each of these areas a multitude of governance approaches act simultaneously, representing a mix of different governance types. We analyzed the collaborative governance approaches to answer the question: can they complement other types of governance approaches, like hierarchical or market based approaches, in order to reduce trade-offs and enhance synergies, and if so, how?

Methods

Case study regions

The region 'Berg en Dal' (area size of 93 km²) in the eastern part of the Netherlands (province Gelderland) is part of the national landscape Gelderse Poort and so of agricultural, natural and historic value for the Netherlands. The most dominant agricultural activity in the region are livestock (dairy cattle, sheep) and arable farming with corn, sugar beets, wheat and potatoes as the main crops.

The region 'Spreewald' (475 km²) in the north-eastern part of Germany (Federal State of Brandenburg) is a Biosphere Reserve, and as such part of the UNESCO program 'man and biosphere', which is differentiated into four protection zones: core zone, management zone, harmonious cultural-landscape zone, and regeneration zone and which protects a very unique landscape within the vast delta around the river Spree which small watercourses and channels through the whole area, and it is characterized by forests, arable lands and grasslands. The arable farming is characterized by the cultivation of arable crops, especially rye, corn, winter oilseed rape, roughage such as clover-grass-mixtures, for livestock forage, and winter wheat. Region specific is the vegetable production, especially gherkins. The region 'Jauerling-Wachau' in Austria (state of Lower Austria) is protected as the nature park 'Jauerling-Wachau' and the area along the Danube river in Lower Austria is located within the Wachau cultural landscape region, a UNESCO Heritage site. The agricultural production covers wine and fruit (apricot) production, dairy farming as well as the cultivation of Christmas trees. The three regions, represented in this order, show increasing shares of non-agricultural used areas and declining land use intensity.

Analysis

We identified the regional agricultural production (like cultivated crops and management practice) and the regional ecosystem services related to agriculture and analyzed the trade-offs and synergies between these ES. We integrated regional and scientific knowledge to identify and assess the synergies and trade-offs between agricultural production and regulating, supporting and cultural ES. We analyzed how existing regional governance approaches can reduce trade-offs and enhance synergies between the agricultural related ecosystem services, especially the collaborative approaches.

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Nature Tourists and National Parks: How important are Nature and the Protection Status of an Area for Visitors?

Christine Bild & Christian Opp

Keywords

national park visitors, relevance of nature, relevance of territorial protection status

Summary

Nature or nature-based tourism is often defined as: '... *a form of travel to natural areas where experiencing nature is a key motivation of the tourist*' (STRASDAS 2006). Thus, natural settings and protected areas are and also are expected to be in the future attractive tourism destinations (HAWKINS & LAMOUREUX 2001; EAGLES 2007).
Protected areas belong to the most important nature conservation instruments (BFN 2016). According to HANNEMANN & JOB (2003), the status 'national park' functions as a positively occupied trademark and national parks are commonly associated with sound nature, pristine wilderness, unique flora and fauna also as great scenery (GHIMIRE/PIMBERT 1997 quoted from: JOB et al. 2003).
Visitors come to national park regions not only intentionally and not only because of the designated national park status (JOB et al. 2003). Moreover, many researchers agree that natural attractions (e.g. protected areas) are visited 'by a wide range of different types of tourists' (ARNEGGER et al. 2010). Analyzing the importance of nature and the protection status of an area for visitors is an interesting research topic. Findings can bring useful information for national park visitor management. Also, an impression can be gained about how important nature and protected areas are for tourism and recreational purposes.
There already exist a lot of studies dealing with the effects of protected areas (especially the larger-scaled ones: national parks, biosphere reserves and nature parks) on the destination choice (PRÖBSTL-HAIDER & HAIDER 2014). According to PRÖBSTL-HAIDER & HAIDER (2014), tourism research on destination demand has two main shortcomings: 1) neglecting the role of natural resources, and 2) analyzing only actual destination visitors.

The aim of this study is to show both the importance of nature and the importance of the status as national park of an area for visitors. The investigation also focuses on the actual visitors of the destination (national park), but tries to overcome the first mentioned shortcoming.
The analysis represents a small part of a PhD-thesis (forthcoming). The PhD-thesis deals with the 'product based typology for nature-based tourism' by ARNEGGER et al. (2010) and examines its practical applicability in three case study areas. The empirical data were collected during the summer season 2014 (July - September) by a face-to-face visitor survey in the three German national parks: Berchtesgaden, Kellerwald-Edersee and Schwarzwald. In total, the sample size counts roundabout 340 questionnaires.

The analyses on visitors' importance of nature and the status national park presented here, is limited to a descriptive statistical analysis.
To find out how much nature matters, the visitors were asked about their motivations coming to the area. Questions were raised, among others, about the importance of 'experiencing nature', 'learning about nature' and 'protecting nature'. In addition, the visitors were asked about how important they evaluate different items of nature (e.g. nature-near landscape, untouched nature, wilderness or biodiversity) for their stay in the area.
The importance of the status as national park was analysed by identifying visitors' national park affinity. This was done in a very similar manner as Job et al. did in their studies about the economic impacts of tourism in large-scale protected areas (e.g. JOB et al. 2003) by asking 'several successive questions' referring to the 'knowledge about the status as protected area and its relevance for visitation' (MAYER & WOLTERING 2017).
Also, as in those studies, a hypothetical question was raised, which is concerned whether the respondents would have come to the area without being it a national park.
The questions about the importance of the protected area status (national park) were put directly, which means that the term or label 'national park' was not operationalised. Accordingly, the responses must be interpreted. The responses reflect visitors' subjectively perceived importance of the protection status. This subjective perception does not necessarily correspond to the true meaning of the protection status for visitors, because it is not clear whether protected area visitors are aware of the effects a designation as protected area really has. For example, like WOLTERING (2012) points out, it is questionable whether a nature-near landscape can be preserved without designating the area as a protected area, like a national park.

The empirical data illustrate that 'experiencing nature' is one of visitors' key motivations. The various items of nature, however, are evaluated differently; wilderness, e.g., was less important/expected than nature-near landscape.
Furthermore, the analysis shows, as well as the study by PRÖBSTL-HAIDER & HAIDER (2014), that visitors' positive interest in nature or positive meaning of nature does not automatically mean that the status as protected areas is also of great importance.
Regarding the importance of the protection status, some respondents indicated, as in the WOLTERING study (2012), that they would have come to the region without it being a national park, but if it would look like the same. For other respondents the national park status neither was important, rather other aspects such as the existence of a certain natural attraction (e.g. a certain mountain, such as the Watzmann in Berchtesgaden), a certain type of infrastructure (e.g. cycling trails), or special infrastructure to experience or to learn something about the environment (e.g. lynx trail in Schwarzwald national park).

This study analysed explicitly visitors' importance of nature and the status as national park of an area. Concentrating on the subjective perception of the visitors, it is impossible to determine the whole meaning of national parks for tourism. Not neglecting the fact of social desirability in such surveys, the value of the national park (protected area) is underestimated, as it is often the case in other investigations (PRÖBSTL-HAIDER & HAIDER 2014).
The protected area status, evaluated as an important reason for visitation or not, helps to conserve the natural resources of an area and thereby it contributes to preserving the basis of nature-based tourism.
Research treating visitors' perception of nature and nature protection can be of great importance for protected area management and marketing purposes.

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Altitudinal shifts of Alpine grouse in the Veglia–Devero Natural Park, western Italian Alps

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Abstract

Alpine grouse are particularly vulnerable to climate and land-use changes. Average elevation of rock ptarmigan, dwelling the open areas above the treeline in the Alpe Devero, increased by 7.8 m/yr from 1996 to 2015, while the population decreased by 50%. In the same period, the forest dwelling black grouse population in Veglia-Devero did not show such a marked decrease, and the observed variations in the Veglia district (increase in average elevation, contraction of altitudinal range) can be explained in terms of change in population density. Spatial patterns of studied populations are discussed in relation to climate and treeline upward shift.

Keywords

Black grouse, rock ptarmigan, population trends, altitudinal shift.

Introduction

Alpine grouse represent isolated glacial relict populations of arctic species in the Alps, with specific adaptations to the mountain environment, and are therefore particularly vulnerable to climate and land-use changes (STORCH 2007). Both direct (excessive warming, shorter persistence of snow) and indirect (upward shift of plant species) effects of climate change can affect habitat suitability for these species. Similarly, the abandonment of traditional human activities led to an upward shift of the treeline, possibly affecting all animal populations living just below or above this limit. Both these factors can operate differently all over the Alps (PERNOLLET et al. 2015). An assessment of the elevational shift of these populations in different areas of their range is therefore needed, in order to disentangle the possible causes and to plan effective management actions. To this end, we monitored the populations of black grouse (*Lyrurus tetrix*) and rock ptarmigan (*Lagopus muta helvetica*) in a protected area in the western Italian Alps over two decades, and assessed the trend in density and elevation.

Methods

The study was carried out in the Alpe Veglia – Devero Natural Park and the Contiguous Area of Alpe Devero (Ossola Valley, north Piedmont, 46°19'N, 8°14'E). The protected area belongs to the Natura 2000 network (SCI and SPA IT1140016 Alpi Veglia e Devero – Monte Giove) and it is represented by large mountain basins of glacial origins and surrounded by the summits of the western Lepontine Alps (1600-3553 m asl). The lower part of the area is covered by meadows, pastures and larch *Larix decidua* woodlands with the understory dominated by rhododendron *Rhododendron ferrugineum* and bilberry *Vaccinium myrtillus*. Above the treeline the area is dominated by meadows (Poaceae and Cyperaceae), heaths with *V. uliginosum* and Alpine azalea *Loiseleuria procumbens*, rocks and screes with sparse vegetation.

Every year (1996-2015) a team of trained observers carried out separate counts for the two species, following the methodology described by CHAMBERLAIN et al. 2012 and BOSSERT 1997. For black grouse, the site was monitored at dawn from 24 fixed observation points, covered in 2 mornings (one for Alpe Veglia and one for Alpe Devero) during the second half of May. Observations of more than one male displaying within a maximum distance of 100 m from each other, and showing some kind of interaction, were considered as a lek (CHAMBERLAIN et al. 2012) and mapped as one observation.

The rock ptarmigan monitoring was carried out on a sample area of 2.7 km^2 located in Alpe Devero. It was selected taking into account the suitability for the species and the representativeness of the altitudinal range occupied by the species in spring. The site was monitored from 25 May to 15 June from 7 vantage points that allowed a comprehensive (visual and acoustic) cover of the area.

The location of each male/male group was then geo-referenced on QGIS (QGIS DEVELOPMENT TEAM, 2017) and elevation was assigned by mean of a D.T.M model. We calculated the average, minimum, maximum and range of elevation of the contacted males for each year. To account for non-independence of observations of males belonging to the same black grouse lek, we considered male group as the statistical unit. Then, we assessed the possible elevational shift of the populations over the study period by fitting a set of linear regressions with average, minimum, maximum elevation and range as dependent variable and year (or year + density) as explanatory variable. In the same way we assessed the temporal trend of each population by fitting a model with density as dependent variable.

Results

From 1996 to 2015 black grouse average density was 5.2 ± 1.59 males/km^2 in Alpe Veglia and 3.6 ± 1.01 males/km^2 in Alpe Devero, whereas rock ptarmigan population density was 4.8 ± 1.39 males/km^2. Population trend was positive only for black grouse in Alpe Devero (β = 0.10 ± 0.03, t = 3.15, $p < 0.006$), whereas was negative in Alpe Veglia (β = -0.14 ± 0.06, t = -2.41, p = 0.028) and for rock ptarmigan (β = -0.19 ± 0.03, t = -5.78, $p < 0.0001$) (Fig. 1).

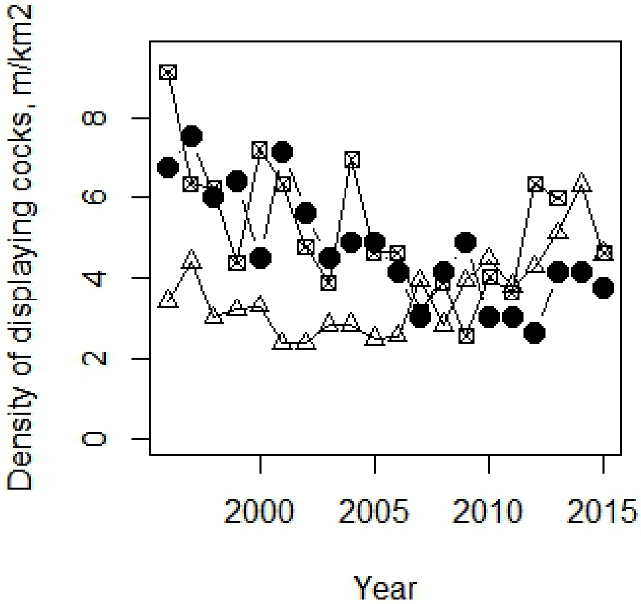

Figure 1:. Population trends of rock ptarmigan (black dots) and black grouse in Alpe Devero (triangles) and Alpe Veglia (squares).

Black grouse showed a significant positive trend in the average elevation of displaying cocks and a negative trend in maximum elevation and elevation range only in Veglia (Tab. 1., Fig. 2.), however all these trends disappeared when accounting also for population density, with maximum elevation and range significantly related with density. Average elevation of displaying rock ptarmigans showed a significant increase over the time (Tab. 1., Fig. 2.). This trend was significant even when we accounted for the change in population density, indicating that it was only partially affected by the observed population decrease in density (Tab. 2).

Black grouse, Alpe Devero			
	β ± S.E	t value	p value
Ave. elevation:	0.88 ± 0.54	1.632	0,119
Min. elevation:	2.30 ± 1.95	1.183	0,251
Max. elevation:	1.88 ± 1.06	1.779	0,091
Range:	-0.42 ± 1.87	-0,224	0,825
Black grouse, Alpe Veglia			
Ave. elevation:	1.06 ± 0.46	2.332	0,032
Min. elevation:	2.33 ± 1.40	1.665	0,114
Max. elevation:	-2.35 ± 1.10	-2.188	0,043
Range:	-4.68 ± 1.94	-2.408	0,028
Rock ptarmigan			
Ave. elevation:	7.79 ± 1.19	6.522	<0.0001
Min. elevation:	9.76 ± 2.85	3.426	0,003
Max. elevation:	3.50 ± 2.35	1.485	0,156
Range:	-6.26 ± 4.26	-1.471	0,16

Table 1: Regression coefficients ± standard errors, t and p value for linear regressions testing the trend in average, minimum, maximum and range in elevation.

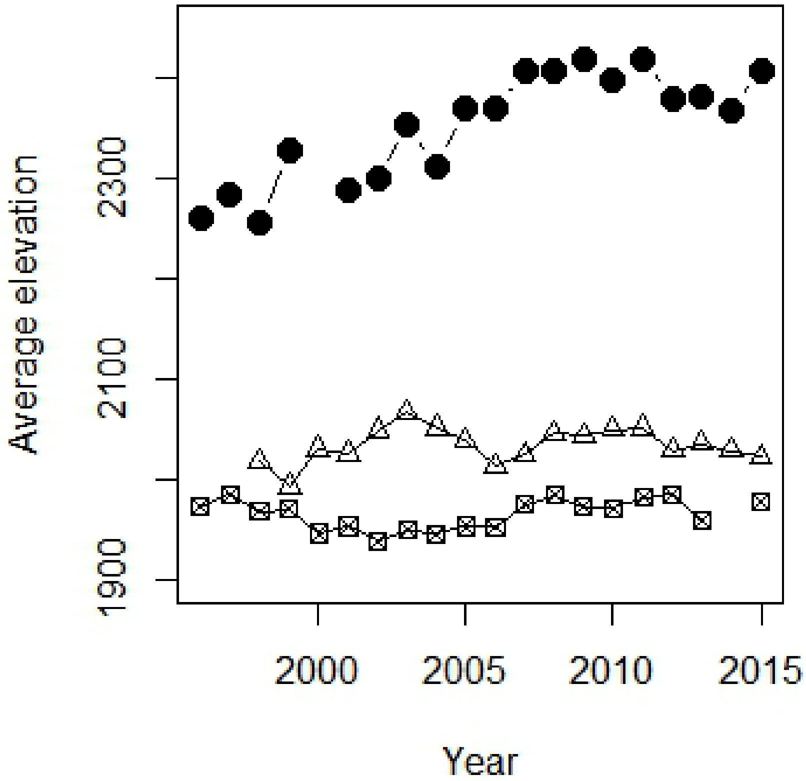

Figure 2: Trends of average elevation of displaying rock ptarmigan (black dots) and black grouse in Alpe Devero (triangles) and Alpe Veglia (squares).

	β ± S.E	t value	p value
(Intercept)	-6516.62 ± 4065.80	-1.603	0,128
year	4.46 ± 2.01	2.218	0,041
density	-16.12 ± 8.13	-1.083	0,065

Table 2: Parameters of the model testing the effect of density on trend in average elevation of rock ptarmigan (R^2=0.77).

Discussion

In our study area the population of rock ptarmigan showed a significant negative trend with population decreasing by 50% over the study period, in line with the trends shown by most of the monitored Swiss populations (FURRER et al. 2016). At the same time, the average elevation of displaying cocks showed a 7.8 m/yr increase, once again in line with the trend shown by population of southern Switzerland (PERNOLLET at al. 2015). In a previous study we showed how the dynamics of our population was mainly driven by climatic factors (IMPERIO et al. 2013). This could suggest that the observed shift in the average elevation could be at least partially caused by the reduction in population density. However, we now show that the observed trend in the population density only partially account for the observed altitudinal shift, indicating that some external factor is affecting the suitable area for this population.

Average winter snow depth cannot explain this shift, since there was no significant trend in this variable during the study period (β = 2.68 ± 1.86, t = 1.44, p = 0.17). Examining the aerial photos available online (http://www.pcn.minambiente.it/viewer/) for the study area it is possible to identify an upward expansion of larch saplings, starting from the end of the '90s, a pattern that could likely lead to the lost of suitable breeding habitat for rock ptarmigan, as observed in the Aletsch region by MARTI et al. 2016.

Contrary to rock ptarmigan, the two black grouse sub-populations monitored in our study did not show a significant trend in elevation of displaying cocks when accounting for population density, indicating that the ongoing environmental changes did not substantially reduce or expand the suitable habitat for this species in the study area.

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Tough forage on alpine pastures? Nutritional value, phenology and stand structure of alpine pastures over 20 years

Albin Blaschka, Thomas Guggenberger, Reinhard Huber

Abstract

Within the project presented, running from 2015-2018, nutritional value, phenology and the development dynamics of 16 alpine pastures in or close to the national park Gesäuse (Styria, Austria) are studied. Based on data from the years 1993-1996, ripening stages and development of raw fibre content of forage harvested are compared. Together with weather data, conclusions on temporal changes of energy content are drawn and guidance for good pasturing (stocking rate, start time of pasturing, duration) in the face of climatic changes can be given, also in regard to animal welfare. For the analysis, not the macroscopic phenological stages are used, but the raw fibre content and nutritional value/energy content, which can be analyzed more exactly and describes as a sum parameter quite well local growing conditions for plants.

As the project is still running at the time of the writing, all data and conclusions are only preliminary, but give already a coherent picture.

Keywords

alpine pastures, phenology, fodder value, adaption to climatic changes, land management

Introduction

Climate parameters are a proxy for several site parameters and represent abiotic site conditions, which influence directly the local vegetation. Ongoing and expected changes in climatic conditions will cause changes both on a species and community level, especially at higher elevations (KROMP-KOLB et al. 2014). Such changes in the metabolism of plants can be monitored by their metabolites, which influence the nutritional value for animals, among other properties (ABDELGAWAD et al. 2014). In our context, the most important relationship is that the phenologic age of a plant correlates positively with the raw fibre content.

These changes have an immediate effect on the suitability of high alpine pastures with its primary use of vegetation as forage for ruminants. A well-adapted use of the resources is the basis for a sound, sustainable agriculture which is the key for our cultural landscape, protected or not.

Therefore, based on the literature, the following hypotheses were formulated as the basis for this study:

- Hot summer cause an early start of vegetation period and accelerates the development of the plants and leads to an early ripening
- This accelerated development leads to a higher content of raw fibre in plants at the end of the vegetation period, which gives a decreased nutritional value.

Based on the hypotheses, we try to answer the following research questions:

- How high is the raw fibre content and the resulting nutritional value over the years (1993-1996 and 2015-2018) on selected plots?
- How does the within-season development of raw fibre content look like?
- Are there changes in the altitudinal gradient of raw fibre content between the two study periods (1993-1996 versus 2015-2018)?

Methods

Between 1993 and 1996 factors influencing yield and forage quality were studied by our research institution (GRUBER et al. 1998). To be able to characterise changes, a similar project was started in 2016 on the exact same locations, preceded by a small pilot study in 2015.

The study area is a 16km long transect north-east orientated, between the 'Schoberpass' and the town of Hieflau in the Gesäuse (see map in Fig. 1). The study area is in Styria, Austria, halfway between Liezen and Leoben (47.494°N and 14.668°E).

The line of the transect, which was defined already for the project 1993 – 1996 ('baseline'), cuts a mountain range with siliceous bedrock in the southern half and a range with calcareous bedrock in the northern half. Plots were fenced exactly at the following altitudes: 1100, 1300, 1500 and 1700. Crossing two mountain ranges, this gives 16 plots, 8 on each range, 4 oriented south, 4 oriented north (see Fig. 2).

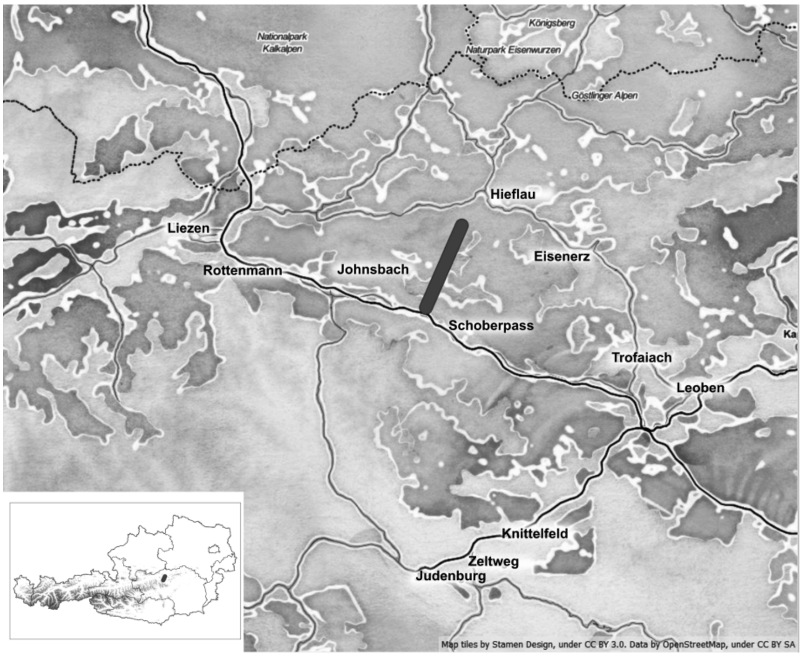

Figure 1: Location of the study area around the national park Gesäuse, Styria, Austria.

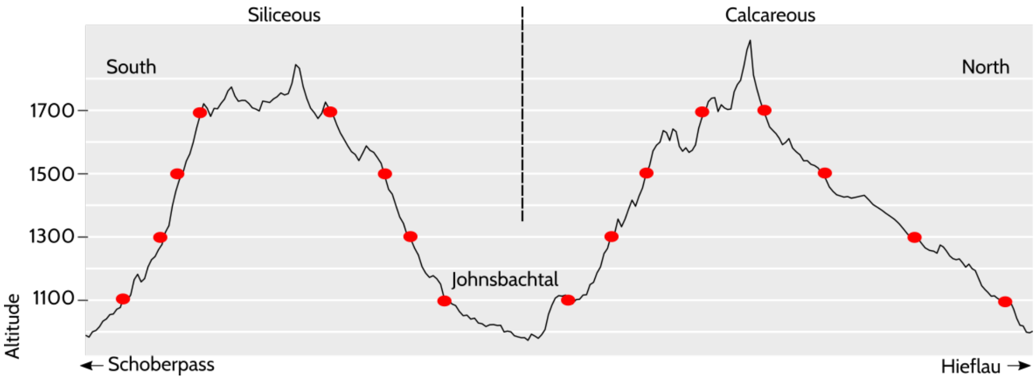

Figure 2: The transect with the distributions of plots over the two mountain ranges

During the baseline project, the plots were larger than the re-installed ones in 2016, which have now an extent of 7.5 x 7.5 m and are fenced with barbed wire. A sample is taken from an area of around 7.5 x 2.5 m (ca. 18m²). During the pilot study 2015, no fixed fences were built; just one sample on each plot was taken.

For the baseline, the main sampling date for each altitude was defined as the beginning of flowering of the characteristic grass species. To be able to monitor the development two weeks before and two weeks after this main date, additional samples were taken, overall three samples per plot. The dates were documented as the respective day of the year. The sampling starts around mid-May on the plots at 1100m and ends mid-August on the plots at 1700 m altitude.

In the current project, the forage samples are taken on the exact same days of the year (+/- 2d) on the exact same locations as during the baseline project. A botanical assessment is done just before the second sampling within the plot (on around 35m²). This gives in total 48 forage samples and 16 botanical assessments per year.
The forage samples are analysed following the method of Weender for structural substances (see KIRCHGESSNER 2011) and minerals at our research institution. The samples for the year 2017 are in the lab for analysis at the time of the writing.

Results

The raw fibre content shows relatively high amplitude and increases only marginally with altitude. Due to the small sample size and the high variation, the results split by altitude and year are not statistically significant (see Fig. 4). But together with temperature data (not shown) a clear trend between years becomes visible. Hot years like 1994, 2015 and 2016, the raw fibre content is higher than in the other years. The difference between 1994 and 2015 is at +19 g raw fibre/kg dry matter, which equals a faster development of one phenological stage (shooting stage versus start of flowering) at the same time of the year (Fig. 3) which equals to a clear loss of nutritional value as the digestibility increases.

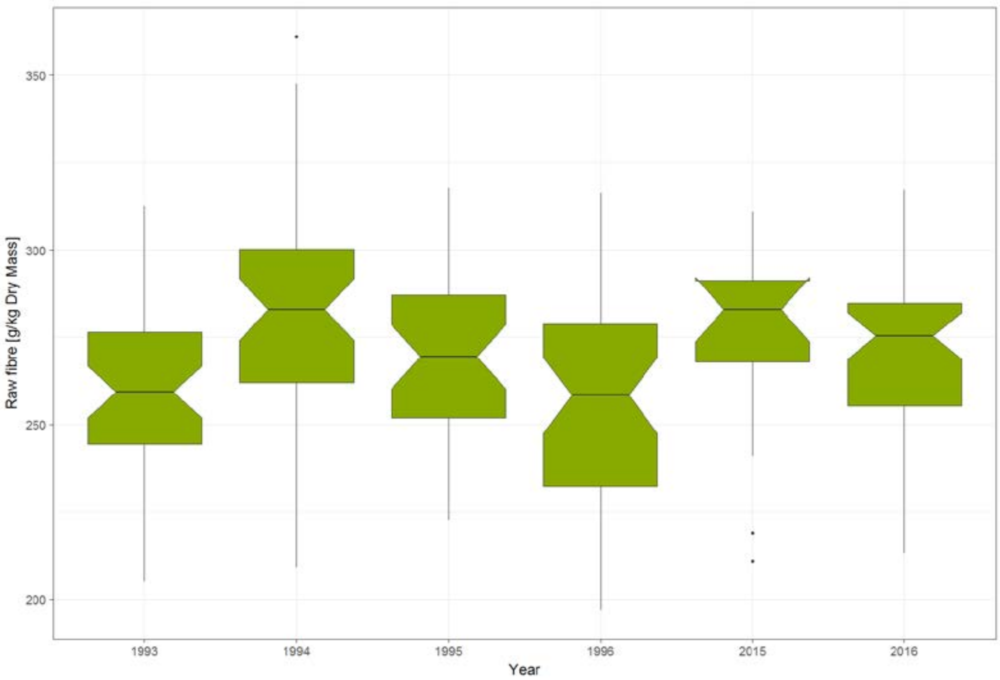

Figure 3: Raw fibre content by year. Hot years like 1994 and 2015 show a significantly higher content than the other years.

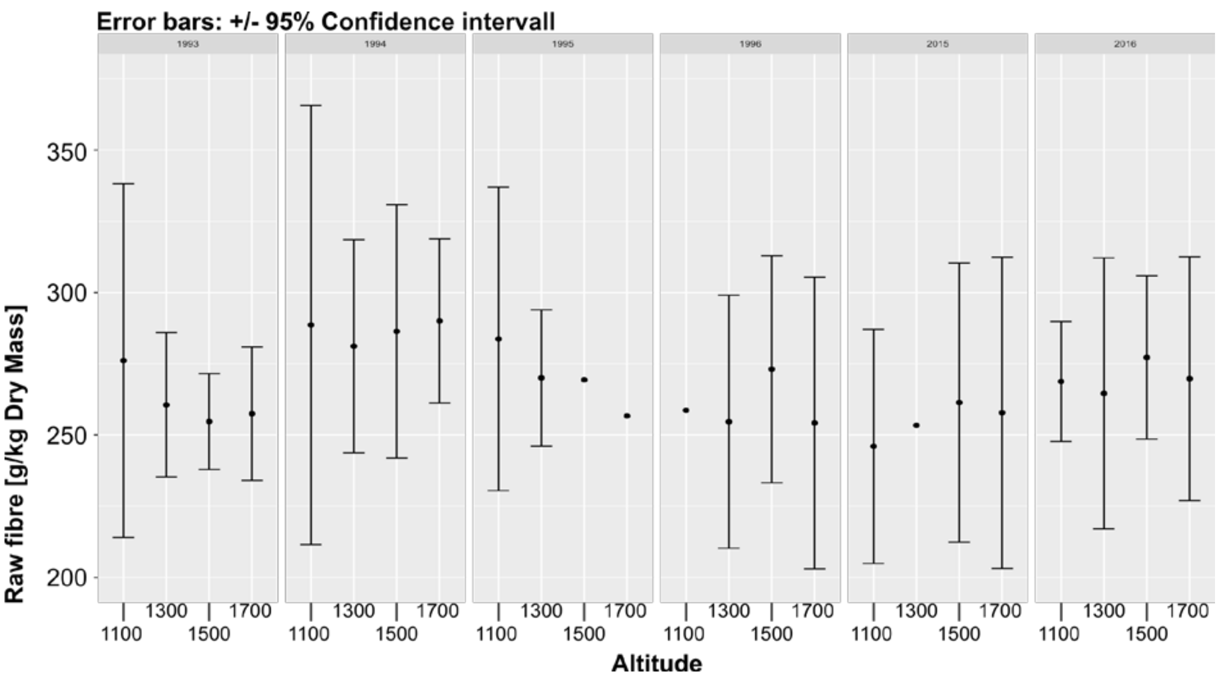

Figure 4: Raw fibre content by year and altitude. The differences are more complex, and due to small sample sizes no statistical significant effect can be shown.

Discussion

As the project is still running at the time of the writing, all data and conclusions are only preliminary, but give already a coherent picture.

The results clearly show a negative development of nutritional value of forage on alpine pastures in the study area during hot summers. What was found in 2015 and partly in 2016 was there already 1994, which was also one of the hottest years until then. The question if there are more hot summers than in earlier times was not part of this study. A hot summer leads to an earlier ripening of the forage available, by up to around two weeks. The longer vegetation period brings no advantages, as no fresh growth is coming. This is a challenge for all ruminants on alpine pastures, as with less energy the sometimes rough conditions on high pastures pose a serious threat, which touches also animal welfare questions. If there is a hot year, the altitudinal gradient in raw fibre content is also mostly flat, meaning there is a higher increase and bigger effect on the lower lying plots (1100 and 1300 msm) than on the higher ones (see Fig. 4).

Conclusion

In the course of history and the resulting traditions connected to alpine pasturing, dates for turn out and putting animals on pastures at different altitudes developed and proved useful, being site adapted and helping to avoid over use and damage to the pastures. These traditions get under pressure, be it because of a changing climate (like shown with our results) or other recent developments in the agricultural practice.

It is time for an evaluation of those traditional processes and management systems. Only with well adapted practices a sustainable, site adapted extensive land use will be possible in the future, which also helps to protect the co-developed biodiversity of our cultural landscape.

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Faunistic assemblages of natural springs in different areas in the Swiss Nationalpark

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Abstract

Springs are spatially restricted ecotones that are inhabited by highly adapted organisms. We examined 36 springs in eight different areas in the Swiss National Park to understand, if the species assemblages of springs are isolated from each other or if they are interconnected communities. We sampled the macroinvertebrate assemblages of the springs and measured environmental parameters. The similarity of the species assemblages of the springs within and the dissimilarities between the different areas were relatively high. The differences of the macroinvertebrate assemblages can be mainly explained by substrate composition. We conclude that rather abiotic characteristics of the springs have an influence on the species assemblages than their geographical distance.

Keywords

alpine springs, substrate composition, macroinvertebrates, isolation

Introduction

Springs are isolated ecotones (CANTONATI et al., 2006), provide overall relatively stable environmental conditions and a mosaic-like substrate composition (VAN DER KAMP, 1995; CANTONATI et al., 2012). Ecologically, springs are unique habitats as the fauna inhabiting springs consists of species of all compartments: spring-specialists, so-called 'crenobionts', co-occur with rhithrobiont taxa, groundwater specialists and also taxa from the water-land-interface, the *fauna liminaria*. Many water mite species (GERECKE & DI SABATINO, 1996), but also some Diptera and Trichoptera larvae are meant to be bound to springs (e.g. FISCHEr, 1996; WARINGER & GRAF, 2011). The patch dynamics paradigm (PICKETT & WHITE, 1985) can be seen as a basic mechanism explaining the metacommunity concept, which assumes multiple similar habitat patches that are interconnected by dispersal (LEIBOLD et al., 2004). Therefore, springs can be seen as single interconnected communities of a superimposed metacommunity. In contrast, due to the relatively stable environmental conditions and their isolation from each other, springs can also be seen as island-like aquatic habitats (CANTONATI et al, 2006). For conservation issues it is crucial to know, if springs are isolated islands or interconnected patches of a naturally fragmented spring metacommunity. In this study we investigated 36 springs in the Swiss National Park to answer the question if springs can be seen as islands or interconnected patches of a dynamic spring network. Answering this question will help to predict if a loss of natural springs will lead to a loss of biodiversity in future.

Materials and Methods

The investigated springs are situated between 1780 and 2334 m a.s.l.. The springs in the park are completely free of anthropogenic disturbances and are located in different areas (Fig. 1). Springs were mapped using an evaluation sheet developed in Switzerland, which includes substrate composition (LUBINI et al., 2014). Water temperature, oxygen concentration, pH and electrical conductivity were measured in the field. The macroinvertebrates of the springs were quantitatively sampled with a small surber-sampler (VON FUMETTI et al., 2007). Specimens were identified to species level whenever possible. An ANOVA was performed to analyse the differences of the abiotic conditions and the taxon diversity of the springs between the areas. Combined environmental and species data were analysed using Redundancy Analysis (RDA). An analysis of similarities (ANOSIM) was used for testing the grouping of the springs. We subsequently ran a SIMPER (Similarity Percentages) analysis to assess faunistic similarities within each area and dissimilarities between the areas.

Results

The pH of the springs ranged from 6.2 to 8.5 and the oxygen concentration ranged from 4.6 mg l^{-1} to 10.6 mg l^{-1}. The electrical conductivity ranged from 198 µS cm^{-1} to 575 µS cm^{-1}. The water temperatures were between 3.6 °C and 10 °C**.** An ANOVA of the measured abiotic conditions showed that Elevation (ANOVA: $F = 148.9$; $p = 0.006$), electrical conductivity (ANOVA: $F = 4.548$; $p = 0.007$) and oxygen concentration (ANOVA: $F = 3.92$; $p = 0.004$) were significantly different between the areas.

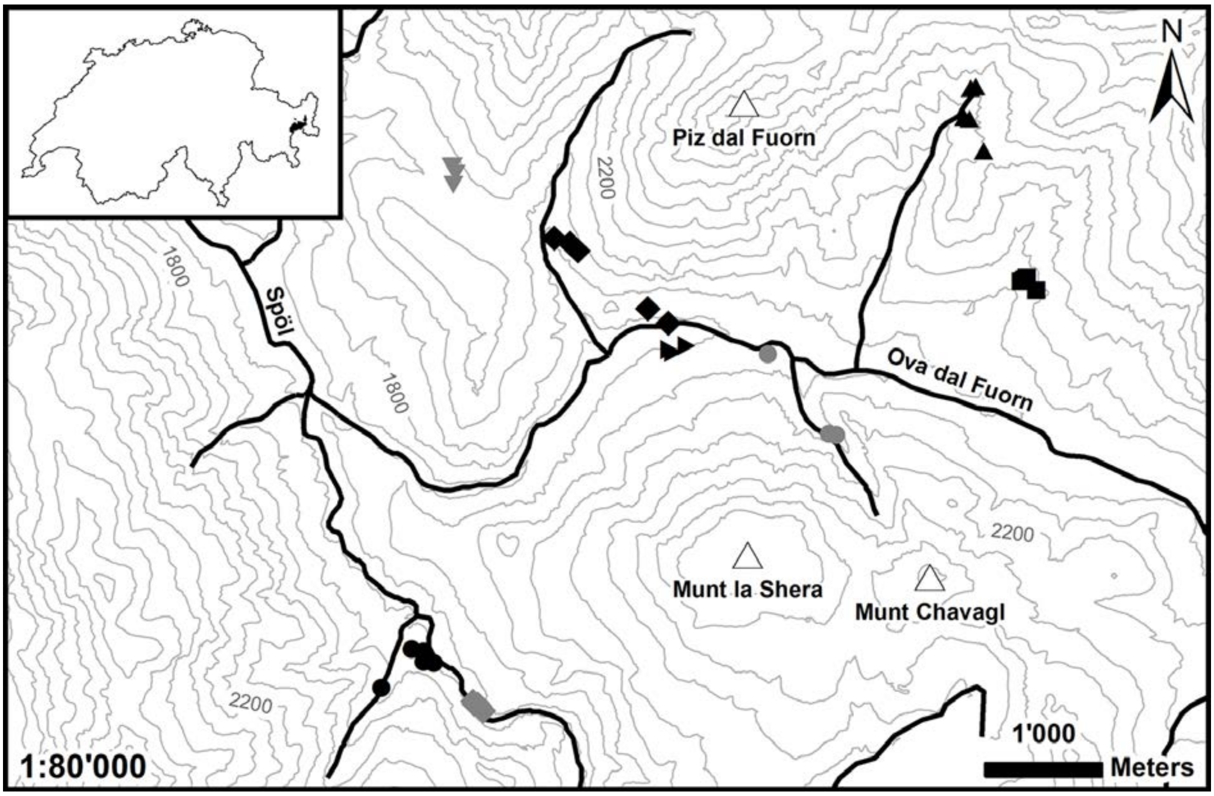

Figure 1: Map of the investigation area in the Swiss National Park (SNP). Springs located in the Val dal Botsch (VB), Val da Stabelchod (VS), Val Ftur (VF), Val Chavagl (VC), in the area Champlönch (CH) and the area God dal Fuorn (GF) discharge into the Ova dal Fuorn River, whereas the Val da l'Aqua (VA) and Punt Periv (PP) springs flow into the River Spöl. The linear distance between the areas ranges from 200 m (VF – GF) to 7.3 km (VB – VA). ● = Val da l'Acqua, ▲ = Val dal Botsch, ■ = Val da Stabelchod, ▼ = Champlönch, ● = Val Chavagl, ♦ = Val Ftur, ♦ = Punt Periv, ► = God dal Fuorn.

A total of 119 species and higher taxa were found. The number of taxa showed significant differences between the areas (ANOVA: $F = 5.632$; $p = < 0.001$). The Trichoptera (24 species) and the Hydrachnidia (20 species) were the most diverse taxa. The SIMPER-analysis showed that the species assemblages of the springs in the area PP were most similar (63 %), whereas the springs in the area VB showed the lowest similarity (36 %). The dissimilarity between two areas was highest between the neighbored areas VB and GF (79 %), whereas the lowest dissimilarity was found between the areas VC and VS. The ANOSIM significantly separated the eight areas (Global $R = 0.72$, $p = 0.001$). The RDA indicated differences between the springs and the areas. All environmental variables explained 58 % of the total variance. A forward selection revealed four significant explanatory variables: Elevation, boulder (both $p < 0.005$), roots and detritus (both $p < 0.05$). The first two axes indicated a separation of the macroinvertebrate assemblages according to the substrate composition of the springs. The areas are mainly split into two groups according to predominant substrate types: the springs in the areas PP, VS, GF and CH were dominated by organic substrates whereas springs in the areas VC, VB and VF provided mainly inorganic coarse substrates (Fig. 2a). As shown in the RDA plot, water mites tended to prefer springs which provide mainly organic substrates. Most Trichoptera taxa, especially species which belong to the genus *Drusus,* were mostly recorded in boulder dominated springs (Fig. 2b). Detailed results are given in VON FUMETTI & BLATTNER 2016.

Discussion

The macroinvertebrate assemblages of the springs were significantly different. This was mainly due to the location of the areas at different altitudes and the resulting abiotic conditions. Overall, no general spatial pattern was detected. The highest dissimilarity was not found between the areas with the largest distance to each other, as could have been expected assuming a strong isolation of the springs. Our findings indicate that the environmental prerequisites provided in a spring are much more important than the geographical distance between springs for the interchange of individuals. Especially for springs in a geographically isolated area such as in high alpine valleys the similarity or dissimilarity of the adjacent springs is of special importance. The lack of suitable nearby springs could prevent the dispersal of individuals despite short geographical distances. To this day little is known about the dispersal of crenobiont species. There is, however, evidence, that springs are less isolated than assumed and more often should be seen as complexes of one large metacommunity. If springs in a certain region are very different regarding their environmental conditions, the loss of one spring can lead to the loss of species. In those cases springs are island-like habitats and of special importance for conservation. Springs in protected areas can serve as reference sites for pristine springs and as potential stepping stones for taxa with high dispersal abilities. It has to be taken into account that only national parks guarantee total protection of nature.

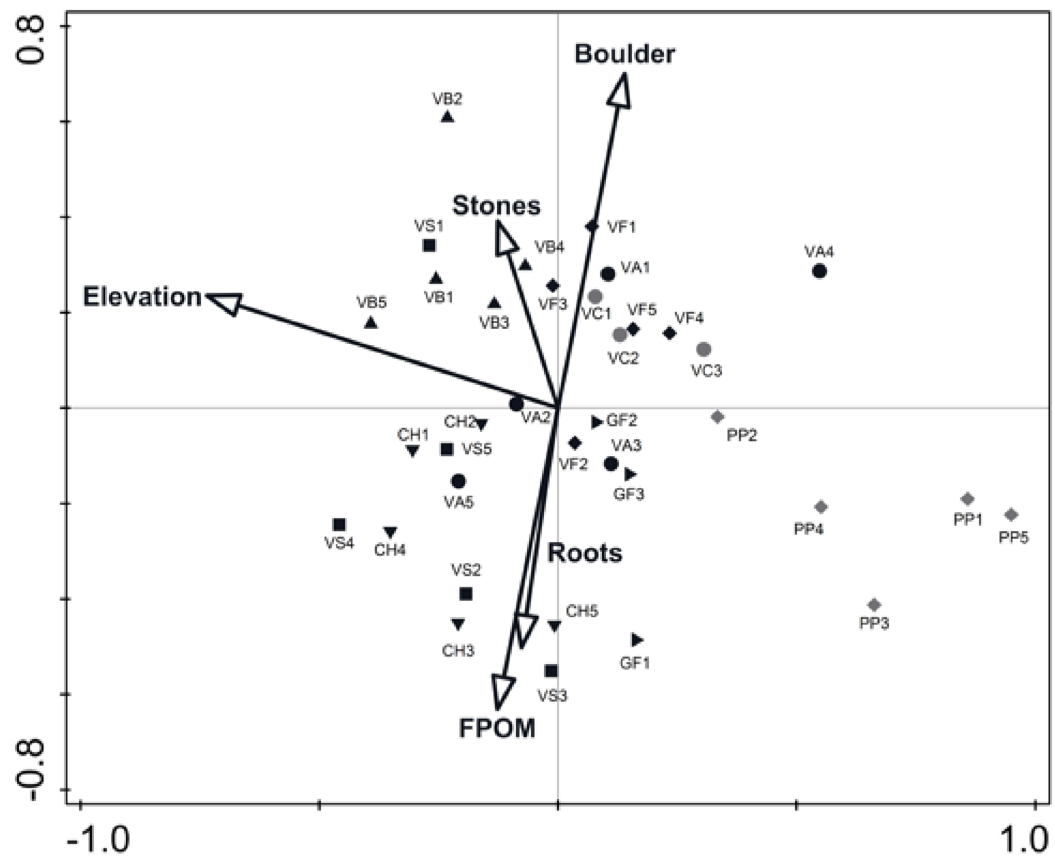

Figure 2 a: Ordination of 36 sites by a redundance analysis (RDA). The environmental variables with the highest explanatory power in the model are indicated by arrows.

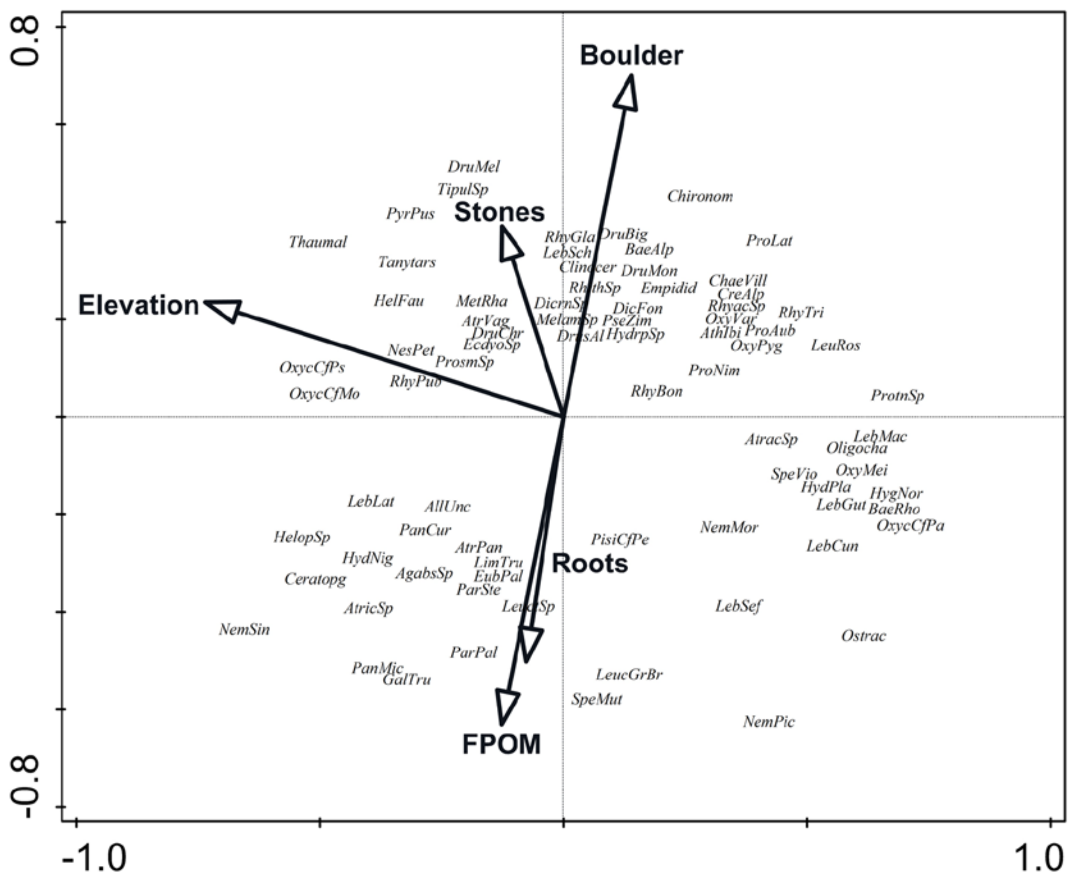

Figure 2 b: Ordination of 119 taxa by a redundance analysis (RDA). The environmental variables with the highest explanatory power in the model are indicated by arrows.

Conclusion

We were able to show that the geographical distance is less important than the environmental prerequisites for the macroinvertebrate assemblages. Neighbouring springs can be seen as interconnected patches of one large metacommunity if they share similar environmental parameters. If the abiotic conditions are very different, already the loss of a single spring can, however, have severe consequences for spring biodiversity.

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Basic principles for the optimization of wildlife management in 'Donau-Auen National Park'

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Keywords

Wildlife management, national park, ungulates, game reserves

Summary

According to the international guidelines of the IUCN protected areas of category II ('National Parks') are primary managed to conserve an ecosystem and to enable recreation. In a long-term perspective this should apply to at least three-fourths of the area (EUROPARC & IUCN 2000) and involves the management aim to minimize anthropogenic interferences on the protected ecosystem including wild ungulates (Nationalparks Austria 2011). The 'Donau-Auen National Park' (NPDA), reaching from city Vienna to the Austrian-Slovakian border, was founded in compliance to IUCN-criteria in 1996.

Diverse challenges can arise in National Parks such as the management of wildlife, especially of wild ungulates which are capable to impact the vegetation of the protected ecosystem and of the surroundings. Therefore, the regulation of the ungulate population by shooting might be necessary within a National Park. But consistent to IUCN criteria all wildlife management activities influencing the wildlife population (including population control) have to be reduced to a minimum. For this reason, non-intervention areas ('game reserves') are defined (Nationalparks Austria 2011).

The NPDA additionally aims the observability of wildlife for visitors. However, due to the disturbance caused by the ungulate-regulation and recreational activities (Jayakody et al. 2008; Reimoser 2012; Marchand et al. 2014), sensible game species tend to live reclusive by adapting their spatio-temporal habitat-use. Hence, these species are rarely visible for visitors. As a consequence of the concentrated distribution of ungulates, the local impact on the vegetation can increase. Once more the regulation of ungulates might be necessary.

In order to address the question of how other comparable protected areas deal with the mentioned conflicts in central Europa, a comprehensive literature research was conducted (December 2014 - February 2016) and complemented by personal communications with staff members. For the selection of protected areas following requirements were defined of which at least two had to be accomplished: (i) presence of game reserves, (ii) similar landscape, (iii) high frequency of visitors, (iv) observability of wildlife for visitors. Based on the findings basic principles for the optimization of the wildlife management in NPDA were deduced.

In general, the literature research revealed that a wildlife management approximating natural conditions (Günther & Heurich 2013, Dachs 2013) has been rarely realized so far, although recent efforts seem to increase. In comparison to the six selected National Parks (one in Austria and five in Germany) the NPDA already investigated the impact of ungulates on forest vegetation comprehensively. However, most examined National Parks including NPDA lack surveys about interacting factors affecting the protected ecosystem. Furthermore, most methods used to determine the population size of game species are not able to count individuals accurately.

The number of ungulates shot per year within the National Parks indicates that population control is still seen as an essential part of the wildlife management. Manifold regulation strategies with diverse temporal and spatial restrictions as well as diverse forms of methods could have been found. In contrast, the game reserves are often comparatively small or / and the period without any regulations is relatively short. Recently, temporally and spatially flexible concepts for the population control achieved higher importance. Though game reserves are included partially on single days per year due to short and successful regulations of wild ungulates.

To observe wild ungulates visitors still depend on guidance by staff members in most of the examined National Parks, what indicates *i.a.* an ongoing unpredictability of the human behavior for wildlife species (Jayakody et al. 2008; Reimoser 2012).

Most persuasive wildlife management concepts are based on verified research conducted within the National Parks. Studying local ecosystem dynamics and interactions, including management caused impacts, would allow most effective adaptations of the management. Moreover, scientific results can be used as well-founded arguments for public relations and in case of conflicts. From a wildlife perspective, future wildlife management concepts should still focus on the aim to minimize anthropogenic influences and should implement science-based and near-natural management strategies considering the management-caused impacts on the ecosystem critically. By implementing the last mentioned recommendations, NPDA could lead to seminal ways of wildlife management.

Acknowledgements

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How ship-induced wave trains affect shoreline communities in regulated rivers

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Keywords

Danube River, ship induced wave action, periphyton, drift, fish community, early stages

Summary

Fluctuating water levels at different time scales and with varying amplitudes are common in riverine ecosystems. It can range from seasonal (low water level periods to flooding events) to daily changes, which can cause short-term desiccation phases (Bondar-Kunze et al., 2015). At navigable rivers, ship-induced wave trains are an additional stochastic disturbance affecting the littoral zone with a short but major impact for organisms living along the shore line zones (Killgore et al., 2001). They increase water turbulence via sediment suspensions and can induce dislocation (e.g. abrasion or drift) of organisms from the sediment. Maximum wave height within the train is expected to be the key variable and the magnitude of this impact depends on the ship type, speed, distance to the shore and shore morphology (Liedermann et al., 2014; Schludermann et al., 2014; Gabel et al., 2012). Especially shoreline communities such as periphyton (Bondar-Kunze et al, 2015), macroinvertebrates (Brunke et al., 2002; Gabel et al., 2012) and fish assemblages (Arlinghaus et al., 2002; Wolter & Arlinghaus., 2003; Schludermann et al., 2014) are effected by a pulsed increase in shear velocity, which can lead to a biomass decrease (Bondar-Kunze et al., 2016, Cashman et al., 2017) or increased drift densities of fish larvae. The aim of this study was to evaluate the effect of ship induced wave trains on periphyton communities and on the drift of early stages of fish by comparing two different shore line habitats (wave sheltered groyne field and gravel bar). For the periphyton investigations, we also disentangled the combined effect of wave action and desiccation stress, and therefore we sampled two sites in the wave sheltered groyne field (NWND = no wave action and no desiccation affected zone; DA = desiccation affected zone) and two sites on the gravel bar (WA = wave action affected zone; WADA = wave action and desiccation affected zone).

The first hypothesis was that wave impacted sites have a lower algal biomass due to a loss via abrasion, but a higher photosynthesis rate and enzyme activity to compensate the biomass loss. Furthermore the question was addressed, to which extend the settlement and drift rate of early stages of fish in two different nurseries habitats was affected by ship-induced waves. The hypothesis was that drift rates should be higher during time periods of wave impacts compared to periods with no or lower impacts. We applied a spatial design to understand in-situ effects of ship-induced wave actions on periphytic algal biomass, composition and activity. For fish drift the following ship-induced wave variables were analysed: wave height, frequency, swash, draw down and velocity. These were correlated with the drift density of early larval stages.

The results showed that up to 60 % of periphytic biomass can be potentially abraded after single ship-induced wave train events. Contrary to our first hypothesis, we found no significant lower periphyton biomass (expressed in chlorophyll-a) in the wave affected zones compared to the non-impacted ones. Reasons for this pattern could be a fast re-settlement of algal cells (Reynolds et al., 1990), high immigration rate of periphytic algae (Peterson et al., 1990; Robson et al., 2008) and less grazing pressure (Gabel et al., 2011) in wave affected zones. Regarding the photosynthesis efficiency (measured as maximum quantum yield) after single ship-induced wave train events, a frequent damping effect of the maximum quantum yield of photochemical energy conversion was observed and thus, the photosynthetic efficiency was reduced.

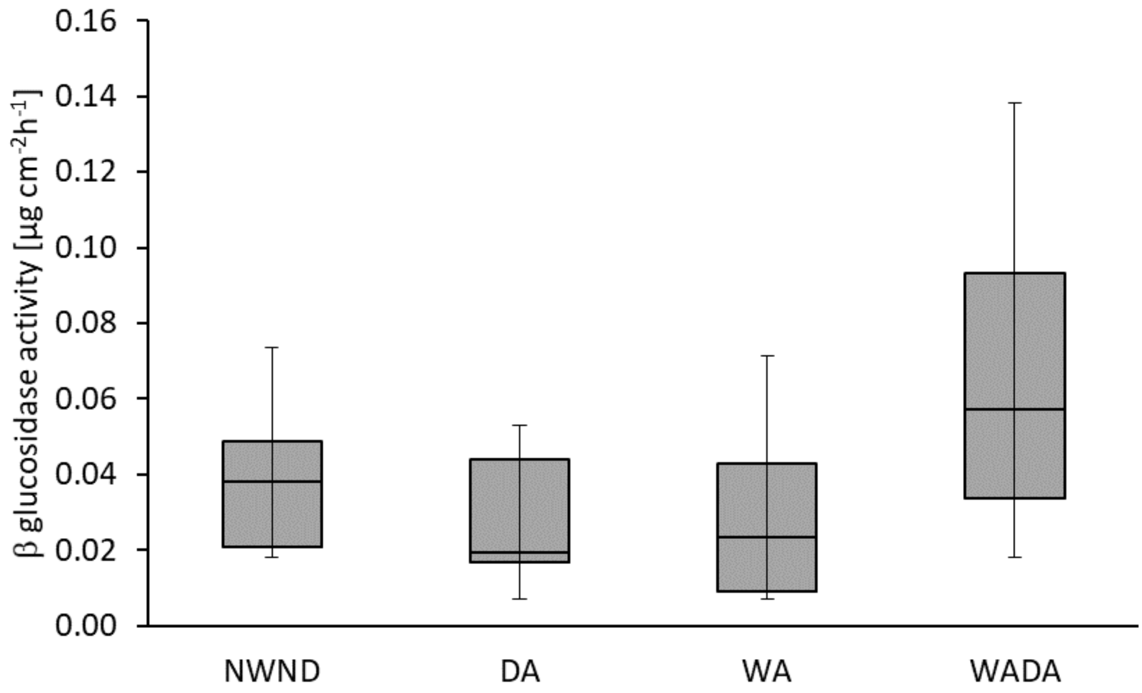

Figure 1: Periphytic β glucosidase activity at the four different zones after four weeks during low to mean water level. NWND = no wave action and no desiccation affected zone; DA = desiccation affected zone; WA = wave action affected zone; WADA = wave action and desiccation affected zone. N= 10 per group.

Looking at a heterotrophic process (enzymatic activity [here β glucosidase activity]) of the periphytic community, the results showed a decrease in activity at the desiccation and wave action affected sites (WADA) compared to the non-affected site (Fig. 1). The combined effect of wave action and desiccation stress led to a significant increase, which can be attributed on the one hand to an increase in dead algal material due to desiccation stress and on the other hand to an increased turbulence due to wave action and thus higher oxygen supply.

The drift of fish larvae showed strong diurnal fluctuations whereas the activity strongly increased during night. For minimizing this natural effect and for observing the influence of waves on young fish, further investigations were conducted during daytime. Continuous short-time samples during the day enabled the comparison of wave-impacted and non-impacted samples. The drift rates of these samples were compared and related to wave parameters by a correspondence analysis. The analyses revealed significant relations between wave oscillation, wave induced changes in flow velocities and the drift rates of fish larvae. Moreover, taxa specific differences were found. The highest drift densities were observed within the Cyprinidae (carps), followed by the Percidae (perchs) and the Gobiidae (gudgeons). Also fish stage specific differences regarding the effects of waves within the fish families of Cyprinidae as well as Percidae were observed.

Our results emphasise the need of river bank structures with shallow areas, protected from swash and draw down of ship-induced waves to maintain heterogeneous periphyton communities and serve as nursery habitat for several fish species in navigable regulated rivers.

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Challenges for future wildlife management in and around protected areas

Peter Brang

Abstract

Wild ungulates are an important part of the fauna in protected areas such as national parks. They often shape their habitat and influence species richness, e.g. by preventing forest expansion into grassland or by influencing the tree species composition of forests. Ungulates are often managed in different ways in and around protected areas. Examples from Europe will showcase the long-term challenges for wildlife management in and around protected areas, including rising impacts of ungulates related to their increased abundance, a higher need for strongly browsed tree species in forestry in order to ensure adaptation to changing climates, the potential spread of diseases from wild ungulates to domestic livestock, and the arrival of large predators. Addressing these challenges requires a good understanding of the ecosystems managed and decision makers which are flexible, willing to develop new solutions, patient and able to communicate.

Keywords

protected areas; wildlife management; climate change; large predators

Wildlife in protected areas: a success story

Wildlife is an important component of many protected areas (PA) such as hunting reserves, biosphere reserves and national parks, and its protection has often been an important motivation for their creation which mainly took place in the 20th century. In Switzerland and in other countries networks of hunting refuges were created to restore viable populations of wild ungulates such as red deer (*Cervus elaphus*), chamois (*Rupicapra rupicapra*) and ibex (*Capra ibex*). In cases were these species were extinct, reintroduction efforts were undertaken, e.g. for ibex in the Swiss National Park. Managing wildlife in PA therefore meant first increasing wildlife abundance. These efforts were very successful in that wildlife populations markedly increased (e.g., Swiss National Park, SCHLOETH 1972). A similar long-term increase of wildlife populations occurred in many PA, and populations developing within PA served often as source populations which spilled over to surrounding areas.

However, in many PA large predators lack behind in developing viable populations. In Slovenia, for instance, half of the hunting reserves contain viable populations of predators such as lynx (*Lynx lynx*) and wolves (*Canis lupus*) and brown bear (*Ursus arctos*) . An overview of 16 national parks in Central Europe showed presence of large predators only in 50% (GÜNTHER & HEURICH 2013). In the Swiss National Park, individuals of these predators are only temporarily present, and it is unclear if they will be able to increase in abundance in the near future. The habitat of their potential prey therefore lacks an important component: ungulate populations live in a 'landscape of trust' instead of a 'landscape of fear' (LAUNDRÉ et al. 2010), in particular so since the animals get also accustomed to the large number of visitors, e.g., in national parks. The consequence of this 'predator gap' is that the density of ungulates, which is otherwise limited by predators in northern ecosystems (RIPPLE & BESCHTA 2012), continuously increases, although the strength of predator impact is not well known (KUPFERSCHMID & BOLLMANN 2016). In cases with no hunting, I do not see that the increase of ungulates in PA has reached a plateau.

Wildlife in protected areas increasingly shapes habitats

Large populations of ungulates can shape their habitat. Effects such as promotion of species richness on mountain grasslands (SCHÜTZ et al. 2003) and prevention of natural reforestation in heavily grazed areas (SCHÜTZ et al. 2003) have been demonstrated, while effects on tree seedlings (<10 cm) and saplings (≥10 cm) on the landscape level seem to be small (BRÜLLHARDT et al. 2015). In a study in a Swiss hunting reserve (Aletschwald) with high ungulate densities, long-term undesirable impacts on tree recruitment were considerable (BALLMER et al. 2014). Given variability in seasonal habitat use by ungulates, in forage availability and in anthropogenic disturbance, and given highly lagged and spatially heterogeneous patterns, it is plausible that effects on tree regeneration are not well understood.

In addition, it is not clear how any changes, e.g. by a decelerated tree regeneration, should be valued, in particular in PA where natural processes have priority. Traditional indicators of overuse of the habitat by ungulates seem inapplicable since no particular expectation on how it should develop is valid. However, several reasons may justify a deviation from a pure laissez-faire management:

1. an unnatural ecosystem development, and
2. inacceptable impacts on adjacent ecosystems.

Which wildlife populations are 'natural'?

An argumentation based on naturalness is often routed in unstable ground since, for many landscapes, the natural state of an ecosystem is unknown. The long debate about whether large ungulate populations were, before the arrival of men, able to shape their habitat by keeping it open, has not lead to conclusive results. While it seems plausible that deer and mega-herbivores were able to keep floodplain forests open, other arguments make it unlikely that the example of floodplain forests is a generally valid pattern: Silver fir (*Abies alba*), a highly palatable species, was largely dominant before the arrival of man in central Europe, even in the lowlands (TINNER et al. 2013), large predators are able to control populations of their prey species (RIPPLE & BESCHTA 2012), there was little non-tree pollen before the arrival of man (ZOLLER & HAAS 1995) and the forests north of the Alps were described by the Romans as dense (ZOLLER & HAAS 1995).

I therefore believe that we face, in many PA, an unnatural overpopulation by ungulates and at the same time an unnatural underpopulation of their predators. This situation persists for about 60 years, in some cases even longer, and will reshape forest structure in the long term (BRANG 2017). However, it has to be admitted that we are probably unable to describe which states (and which variability) of ungulate populations would be 'natural'. The idea of any long-term steady state seems erroneous, which means that any management meant to mimic the impact of predators should be variable in time and space. Current hunting practices in PA (GÜNTHER & HEURICH 2013) seem so far unsuitable to achieve this, and to promote more natural ecosystem dynamics. In some countries, the motivation to hunt in PA is even to generate income from hunting guests, which is in contradiction to mimicking predation.

It seems also undesirable that most of the few remnants of old-growth forests in central Europe are, at the same time, hotspots of ungulate abundance. This means that these precious relicts will evolve, in the long term, from old-growth to senile forests, because their tree recruitment is largely absent or reduced to unpalatable species, which also limits their value to preserve genetic diversity. This even raises the question of whether some wildlife refuges would need to be protected from wildlife.

Impacts of wildlife populations on adjacent non-protected areas

Management goals in and outside of PA are often different. Around the Swiss National Park, for instance, forests protecting humans and assets against natural hazards such as snow avalanches (protection forests) predominate. Current best practices in these forests are to create mixed forests in which a small-scale disturbance regime is mimicked, which is likely to prevent any large scale breakdown of the protective effect (BRANG et al. 2008). However, this requires constant recruitment of several tree species, and is partly unfeasible or unreasonably costly (fencing) if ungulates are abundant in wintertime and browse on tree seedlings. Hunting has limited effect since it is restricted to short time periods in fall when the animals can hide in areas with a hunting ban, such as the National Park. This example shows the need to work on solutions which integrate conflicting goals at the landscape scale.

Similar conflicts may arise in the future with large predators which are not hunted in PA, but cause damage to livestock in adjacent areas with agricultural use. In addition, arriving large predators will not only feed on previously unchallenged prey populations within PA, but may also lead to a more even distribution of their prey species in the landscape, including non-protected areas where higher ungulate populations can be in conflict with other land uses. All these phenomena will require careful communication to the public and, possibly, adjusted wildlife management.

Climate change will cause a marked, although delayed change of the vegetation. In forests, this means that tree species which are currently found in warmer and drier climates will be able to occupy new habitats (BRANG et al. 2016). Most of these locally new species are highly palatable species such as silver fir or oak (*Quercus spec.*). If they are unable to establish due to abundant ungulate populations, which is currently often the case (KUPFERSCHMID et al. 2015), the future forests will be less resistant and resilient to disturbance, which is highly undesirable.

Finally, new diseases may spread from wildlife to domestic livestock and vice-versa. Conservation, farming and health interests will need to be weighed, and difficult decisions made.

Perspectives for wildlife management in and around protected areas

Given the challenges associated with undesirable impacts, which originate in PA and affect their surroundings, the management of PA is facing significant challenges. One challenge is to revise current hunting schemes to ensure the natural process of predation, as long as there are not enough natural predators present (DACHS 2013). I do not advocate the simple adoption of hunting practices from adjacent areas, and do also not see a great urgency for immediate large-scale action, given the long time scales involved in ecosystem dynamics. However, I am in favor of starting tests of new practices with proper scientific consultation and monitoring. This would also increase the acceptance of PA among the local population.

In the case of forests, the long-standing conflicts around PA that arise from large ungulate populations are exacerbated by climate change and should be addressed soon. Currently, the interest groups (including the administrations of PA) seem either to ignore the conflicts or only to agree that they disagree.

With the ongoing climate change and the global spread of diseases, we face high uncertainty in natural resource management. This calls for leaving behind simple command and control approaches, for efforts to get prepared and to anticipate what could happen (scenario techniques), for openness for unusual solutions, for courage to test them and monitor the outcome, and for accepting the results and adjusting practices.

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Trajectories of Protected Area Creation in the Austrian Alps: two case studies

Valerie Braun & Andreas Haller

Abstract

Conflicts between nature conservation and human resource use are intensifying. At the focus of this study are two protected areas, which are set aside to protect biodiversity and to maintain a 'natural' character. At the same time, due to their natural resources and sometimes close vicinity to urbanized areas and tourist resorts, they are met by various interests. The present study focuses on conflicts that accompanied the establishment of two protected areas in the Austrian Alps over several years.

Keywords

conflict, resource use, nature parks, European Alps

Introduction

According to the Oxford English Dictionary, a conflict is a serious incompatibility between two or more opinions, principles, or interests. Transferred to conservation, conflicts occur where parties have different opinions about or interests in conservation objectives and activities, and where one party is perceived to assert its interest at the expense of another (REDPATH et al. 2015a). In protected areas, various conflicts occur, for example, dealing with resource use (e.g. multiple use of water resources, see e.g. BRAGAGNOLO et al. 2016), large carnivore presence and abundance (e.g. REDPATH et al. 2015b; CHYNOWETH et al. 2016), recreational and tourism activities (e.g. STERL et al. 2010; STREBEROVÁ & JUSKOVÁ 2015), restrictions concerning land use (e.g. FRYS & NIENABER 2011; KÖCK & BRENNER 2015), land use changes (e.g. KOVÁCS 2015), and conflicts between different land use groups (e.g. KOVÁCSA 2014) – to name but a few. Conflict analysis is the systematic study of a given conflict with the aim to understand the conflict, to identify the actors involved, and to analyse the impacts. Within the process of designating a protected area many interests of different local and non-local stakeholders and policymakers can be identified and analysed. We will present two case studies of the Austrian Eastern Alps.

Methods

We searched both digital repositories and local archives to identify and analyse newspaper articles, notifications of the environmental authority of the federal government, records concerning the legislative framework conditions, declarations of support, letters written to convince the opposing parties, and brochures of different interest groups. The oral history method was applied to interview experts involved in the designation of the two nature parks.

Results and Discussion

The two case studies presented mirror the overall conflict between the use of resources and protection of biodiversity. The nature park and quiet area 'Zillertal valley and Tux main ridge' is in close vicinity to large ski resorts, and the nature park, nature protection and Natura 2000 site 'Tyrolean Lech' is one of the last wild streams in the northern parts of the Alps. The designation of the nature park Zillertal valley took two decades whereas the designation process of the Lechtal valley to become a Natura 2000 site took almost three decades. Results from the Lech valley show tensions between a 'pristine' rural periphery and stakeholders from the Tyrolean capital. The fear of losing economic possibilities due to the designation of a protected area is evident and nature conservation is seen as an idea imposed by stakeholders coming from the capitals. It is criticized that urban stakeholders want to use the pristine periphery for recreation – without considering sufficiently the local population who economically depends on the use of resources in the Lech valley. The Zillertal valley case study underlines the conflict between the tourism/hydropower industry and nature conservation. The valley is well-known as a major Austrian tourist centre, where the interests of the ski industry were initially opposing the designation of a protected area. Although, in recent years, the nature park has become an attraction for visitors who appreciate Alpine cultural landscapes in summer, this sort of alternative tourism promoted by the nature park only plays – in economic terms – a minor role.

Conclusion

Conflicts increasingly emerge from the growing interest in the production of renewable energy, which requires new production facilities. Especially hydro power sites are currently in the focus. Moreover, conflicts are found where skiing infrastructure is planned within or near the borders of protected areas. Finally, top-down decisions by non-local policymakers cause resistance against nature conservation projects. Communication, awareness rising and education, trust-building between different stakeholders may facilitate positive outcomes for all actors involved. To guarantee effective communication, the driving forces behind past and present conflicts need to be better understood. Future research should consequently focus on identifying regionally specific conflict variables, to pave the way for conflict-poor development of protected areas, bridging the gap between sustainable use and conservation.

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Environmental damages in the Atlantic Forest Biome: A case study

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Abstract

We identify the main impacts, drivers, and restoration projects for Atlantic Forest in Northwest of the Rio Grande do Sul State, Brazil. The objective was to analyze the quantity, distribution, and causes of the environmental crimes in the last fourteen years. The main environmental damage found were deforestation outside permanent preservation area (20%) and those related to Permanent Preservation Area (37%). Environmental crimes in these areas fall into two categories: native and exotic vegetation removal (17%), and impediment to natural regeneration (20%). The sizes of degraded fragments were similar among the five municipalities with a major number of environmental crimes. There was a relationship between the size of the degraded fragment and the restored area. An efficient enforcement by forest authorities together with projects of environmental awareness can minimize and prevent these harmful effects on the environment. Atlantic Forest fragments need to be recognized and preserved as an ecosystem with a unique ecological function by the population and public administration.

Keywords

environmental degradation, forest ecosystem, permanent preservation areas, environmental management

Introduction

Among the environmental damage caused by human over-exploitation are deforestation and forest degradation. Causes of deforestation are land clearing for agriculture, logging, fuelwood collection, population growth, and world timber trade (Kamlun et al. 2016). Forest fires and selective logging destroy capacity carbon stocks, contribute to the greenhouse gasses emissions, have impacts on forest function, change freshwater biodiversity, stream flow and nutrient retention on watersheds, and cause vulnerability of human populations (Tsujino et al. 2016; Osone et al. 2016; Dolný et al. 2012; Valiela et al. 2013; Valente-Neto et al. 2015; Fugére et al. 2016; Morris et al. 2016). In Brazil, the Atlantic Forest is one of the most threatened ecosystems. The forest stretches along the coast of Brazil, but due to deforestation, this ecosystem is currently distributed in ~245,000 fragments (Ribeiro et al. 2009). The remaining forests fragments continue to be degraded by illegal land use in protected areas, biodiversity loss or nutrient stock (Tabarelli et al. 2005; Villela et al. 2006; Nunes de Oliveira et al. 2017). Proposed activities for sustainable land use in the Atlantic Forest include rural tourism, natural regeneration or matrix restoration with structural and functional connectivity (Uriarte & Chazdon 2016; Wheeler et al. 2016; Alves-Pinto et al. 2017). The aim of this study was to identify the impacts, drivers, and restoration projects for Atlantic Forest in the last fourteen years. Two research questions were defined: 1) Is the number of environmental crimes related to both area and population of the municipality?; 2) Are the sizes of the degraded fragments related to the restored areas?

Materials and Methods

This work was carried out in the Biodiversity Department of the Rio Grande do Sul State/Brazil. It encompasses 43 municipalities located in the Uruguay River Basin, with a population of ~384,000 inhabitants and 48,000 rural establishments. We analyzed environmental crimes from 2000 to 2014 from fines/infractions of administrative processes. We used analysis of variance (ANOVA) to verify differences in environmental damage for the five municipalities with more quantity of crimes. A logarithmic transformation of damaged areas data and a correlation between restored areas and quantity of seedlings planted was used. A Principal Component Analysis (PCA) was performed on the main environmental damages categories and the population of the municipalities.

Results

We analyzed 915 processes containing 1314 environmental damages. Data were distributed into eight categories (Fig. 1). Thirty-eight percent of the environmental damage occurred inside a permanent preservation area (PPA), vs. 62% that was outside of a PPA. The main environmental damage found were *deforestation outside of a PPA* (20%) and those *related to a PPA* (37%). Environmental crimes inside PPAs fall into two categories: *native and exotic vegetation removal* (17%), and *impediment to natural regeneration* (20%). The latter includes livestock grazing in the riparian forest, crops in both riverbanks and wetlands, buildings, and dams. The majority of the environmental crimes occurred in 2012 (11%), followed by 2008, 2010, and 2013.

The sizes of the degraded fragment were similar among the five municipalities with the higher number of environmental crimes (ANOVA: $p > 0.05$, $F = 1.24$; df= 241). The mean size of the damaged area and the municipality geographical area were not related ($p > 0.05$). A total of 682 environmental processes were associated with an environmental restoration project, while 230 did not. The size of the degraded fragment was related to the restored area and the number of seedlings planted ($p < 0.001$). A segregation between the less and the most populous municipalities was found with the PCA analysis along PC1 (51.7%), while PC2 represented 19.2 % of the total variation (Fig.2).

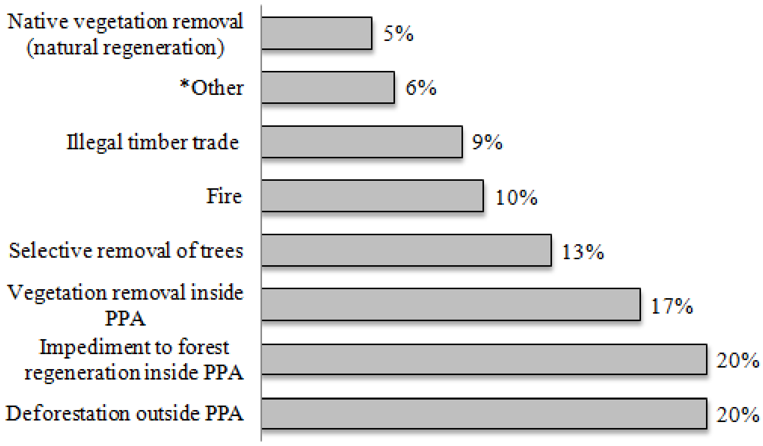

Figure 1: Categories of environmental damages found in the Northwest Rio Grande do Sul State/Brazil from 2000 to 2014. *Other (tree felling without a licence in urban areas, improper waste disposal).

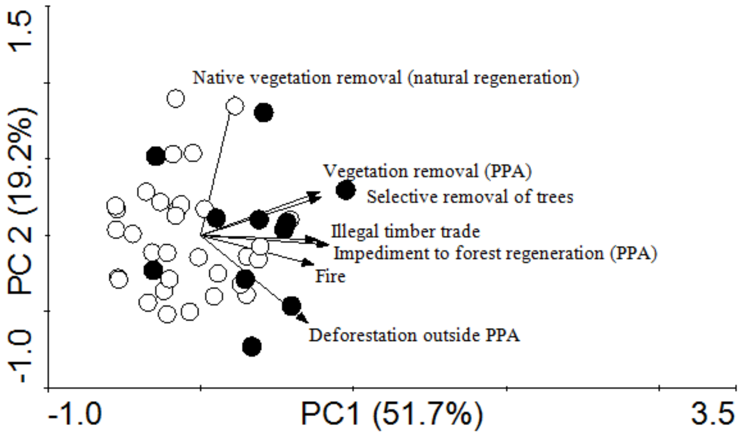

Figure 2: Principal Component Analysis (PCA) of environmental damages and population of the municipalities of the Northwest Rio Grande do Sul State: ......Municipalities with up to 10,000 inhabitants;

Municipalities with more than 10,000 inhabitants.

Discussion

Deforestation drivers both inside and outside of PPAs can be related to agriculture. Although the majority of rural properties in Northwest Rio Grande do Sul State comprise household farmers and subsistence agriculture, 8% of the rural properties are non-family farming and are responsible for the production of larger amounts of soybean, wheat, and corn. Another of the main environmental crime inside of PPAs is removing native and exotic vegetation, regarding mainly to tree plantation of *Eucalyptus sp.* in riparian zones. In the case of protected areas, a licensing is necessary to remove eucalyptus trees, and the area must be recovered by native plants. The size of the degraded areas did not differ significantly between the municipalities, and the average of the areas was 0.10 ha. De Sylos Cintra et al. (2006) also reported that most degraded areas were less than 5 ha in the Cerrado ecosystem. Among municipalities with more environmental crimes, Santa Rosa was the most urbanized (IBGE 2010). Rural exodus has increased in recent years, and the movement of people to the town is associated with great pressures for deforestation and forest degradation (DeFries et al. 2010). Forest restoration projects were based on the native seedling plantation, which objective was the recovery of degraded areas considering different species of plants and the functionality of the system. Strategies for forest restoration include the production of plants resistant to environmental stresses and to allow connectivity and dispersion of forest fragments (Jacobs et al. 2015).

Conclusions

Deforestation and forest degradation have direct or indirect drivers. The most populous municipalities showed the highest number of environmental crimes, and the majority of degraded areas were recovered by planting native seedlings. An efficient enforcement by forest authorities together with projects of environmental awareness can minimize and prevent these harmful effects on the environment. Atlantic Forest fragments need be recognized and preserved as an ecosystem with a unique ecological function by the population and public administration.

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The formation of glacial lakes in Austria and in the Hohe Tauern National Park since the Little Ice Age

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Keywords

glacial lake, lake inventory, lake distribution, lake formation, Little Ice Age, Austrian Alps

Introduction

The Global temperature rise in the 20th and 21st century led to massive deglaciation and the formation of numerous glacial lakes. One obvious indication for the global warming and high changing rates can be observed in rapid deglaciation in the European Alps (Haeberli & Beniston, 1998; Paul et al., 2007). The glaciated area is reduced by 50% since the end of the little Ice Age (LIA) until 2000 (Zemp et al., 2006). The areas under rapid changes are directly influenced by creating new landscapes. Glacier lake development and lifetime are controlled by the complex interplay of climate and geological boundary conditions, geomorphological process activity and glacier dynamics. New lakes in formerly glaciated alpine areas significantly contribute to changing geomorphologic, hydrologic and ecologic conditions at high altitudes. New glacial lakes deserve a closer look referring to their different functions in high alpine environment, especially in terms of global warming.

High alpine lakes are responsible for retention and buffering of (Schiefer & Gilbert, 2008). In terms of sediment connectivity (Heckmann & Schwanghart, 2013) geomorphic systems are decoupled within by glacial lakes by preventing coarse sediment transport. Especially sediment delivery is extremely reduced to suspended and solute sediment load (Geilhausen et al., 2013). Also glacial lakes function as sediment traps, if the kind of damming (e.g. bedrock) is persistent. But glaciated high mountain environment is well known as unstable and sensible to climate (Haeberli & Beniston, 1998; Haeberli et al., 2013), because of destabilization through melting processes.

We present an inventory of lakes in the Austrian Alps (> 1700 m a.s.l.). The inventory is a central part of the project FUTURELAKES that aims at understanding and modelling the development of glacier lakes in Austria. We intersect glacier lake locations with glacier inventory data to understand how deglaciation controls lake evolution (Figure 1).

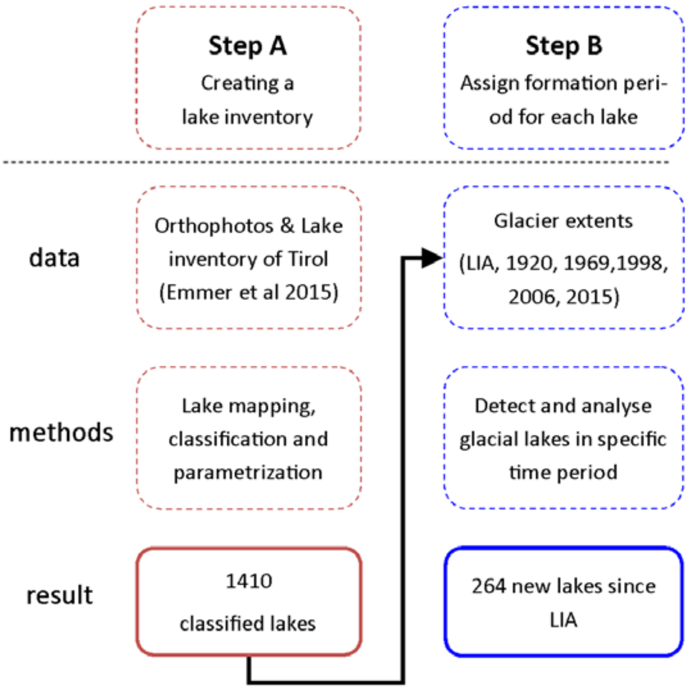

Figure 1: workflow to analyse historical lake formation in Austria

Methods

The timing of lake formation is reconstructed by comparing emerged lake area with vanished glacier area at six points in time from Little Ice Age (LIA) to 2015 – a unique timespan not covered by any other glacier lake inventory worldwide. Deglaciated area and volume for Austria is given by four different Glacier inventories (LIA, 1969, 1998, 2006 by FISCHER et al., 2015). Additional information for glacier extent around 1920 is given by (GROß, 1987) and was validated by historical maps. A recent glacier extent (2015) was mapped on google earth imagery.

The lake inventory contains 1410 mapped lakes with a minimum size of 1000 m² covering an area of more than 17 km². All lakes were classified according to their damming material (bedrock, debris, ice, Tab. 1). The dominant lake type is bedrock-dammed (55.1%), followed by debris-dammed lakes (44.5%). Six lakes ice-dammed lakes have been observed during the time of mapping in Austria. Bedrock-dammed lakes store two-third of lake water area above 1700 m a.s.l..

material	Number (percentage) of lakes	sum area [km²]
bedrock	777 (55.1)	11.51
debris	627 (44.5)	5.61
ice	6 (0.4)	0.04

Table 1: Dam types of glacial lakes in Austria

Results

In Austria, 264 lakes have formed since LIA. Both the total number of glacial lakes and total lake area increased exponentially from LIA to 2015, while glacier area shrunk correspondingly. The number of new lakes per year grew from 0.8 (LIA-1920) to 6.5 (2006-2015) and new lake area per year increased from 7,423 m² (LIA-1920) to 78,534 m² (2006-2015).

Within the National Park Hohe Tauern 309 lakes have been mapped (Figure 2). Equally, bedrock-dammed lakes prevail over debris-dammed lakes. Lake formation dynamics are slightly lower in the National Park area compared to the entire Austrian Alps with a seven-fold increase of new lakes per year since the LIA. In contrast to the picture from the entire Austrian Alps, in the Hohe Tauern region lake formation peaked in the period of 1998-2006 and stagnated or slightly decreased in the most recent period (Tab. 2).

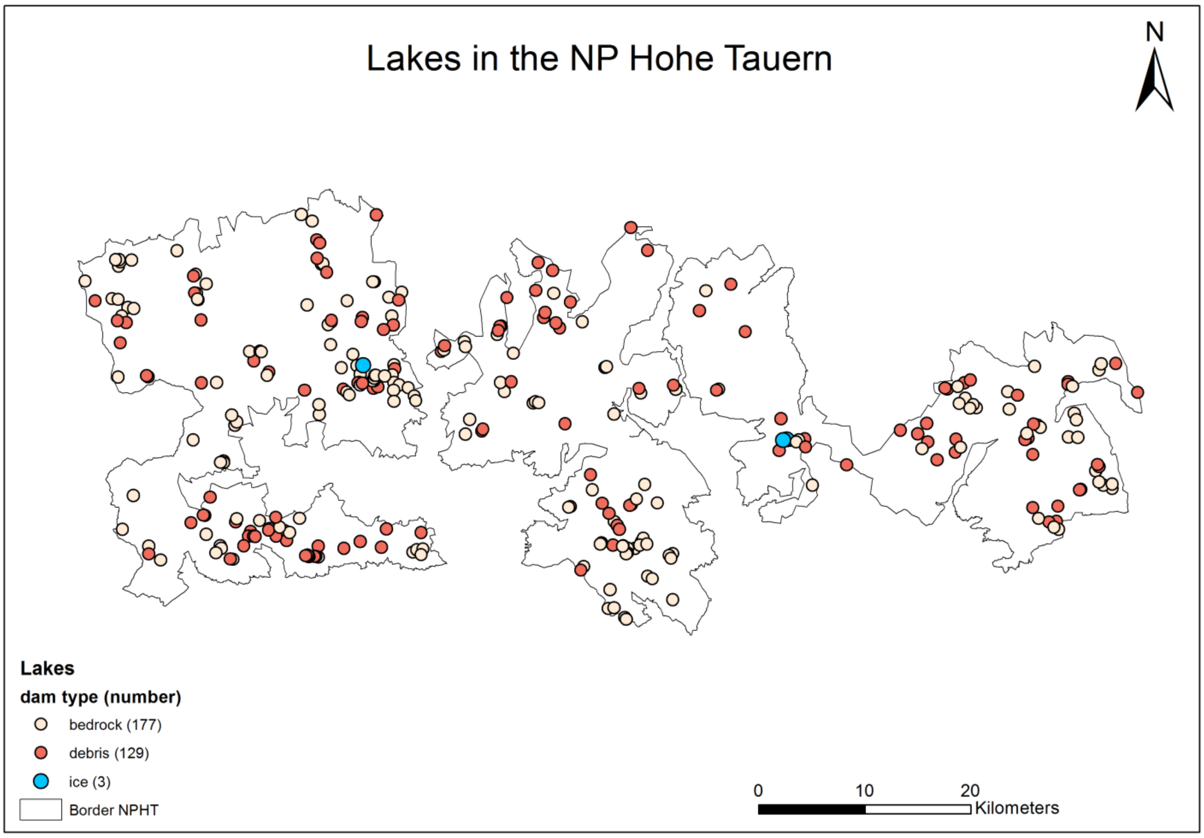

Figure 2: Lakes in the NPHT, classified by dam type

	1850-1920	1920-1969	1969-1998	1998-2006	2006-2015
n lakes	18	27	19	19	20
new lakes per year	0.3	0.5	1.5	2.4	2.2

Table 2: Lake formation over different time periods

Conclusion

We analyzed the formation of glacial lakes in the Austrian Alps combining a detailed lake inventory with an extensive record of glacier retreat since LIA. The formation of glacial lakes reflects glacier erosional and depositional dynamics in the study area. From LIA to 2015 264 new glacial lakes developed following glacier retreat and rising temperatures. Lake formation has been subject to constant acceleration throughout the entire observation period in Austria. This observation is in concordance with glacier retreat and can be related to increasing positive temperature trends within the last 35 years. Within the National Park Hohe Tauern, lake formation peaked in the early 2000s and stagnated since then. We consider the lake inventory a valuable database for further analysis ranging from applications in hazard research and hydrology to hydropower generation or other fields.

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Increasing Research Interest in Protected Areas in Switzerland

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Abstract

Swiss Park Research maintains a database of research projects related to all parks of national importance in Switzerland. An evaluation of the more than 1000 projects in the database according to disciplines, project types and topics revealed a very high level of research activities for the fields of biology and environmental sciences. However, social sciences too are important scientific actors in Swiss parks, gaining ground especially in connection with the creation of new park categories. Still, the efforts addressing research and its documentation differ among the observed protected areas.

Keywords

Research, protected areas, Switzerland, evaluation, database

Introduction

Since the implementation of a new legislation enabling the creation of parks of national importance in Switzerland in 2007 a total of 15 new parks have been established and three regions are candidates for the park label. Hence, together with the already in 1914 created Swiss National Park (IUCN category 1a) and three UNESCO World Heritages, the country today encompasses 22 parks. This boom of protected areas of different categories presents a unique research opportunity to observe developments and impacts of such labels on the certificated regions. Furthermore, park managements gain important information about their areas and also profit from scientific results relevant for more than one park.

As coordinating office, Swiss Park Research is mandated by the Swiss Federal Office for the Environment (FOEN) to document and evaluate research related to parks of national importance. In close consultation with park managements and researchers the office maintains a database of scientific projects associated to these protected areas. After a first evaluation in 2011 the project database has been analysed again in 2016, revealing an increase of research interest on protected areas.

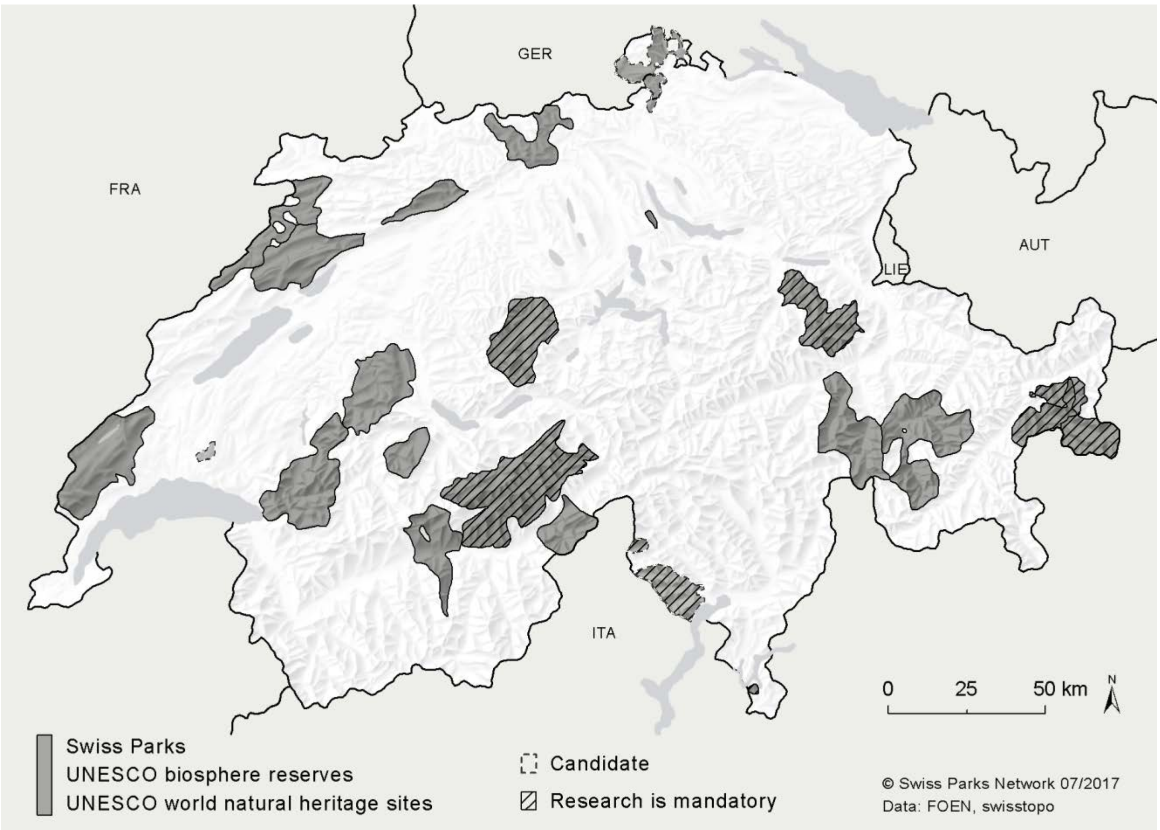

Figure 1: Current situation of Parks in Switzerland

Mostly Ecology & Biodiversity but also Social Sciences

The analysis of the research projects carried out in Swiss parks revealed that the natural sciences are very strongly represented with a total of 67% of all projects. Especially the share of the field of biology with 41% is noticeable. The second most represented discipline are environmental sciences. For biologists and environmental scientists, parks offer a great opportunity for investigating species, biodiversity and environmental questions. Their research does generally not concern the parks themselves but profits from the services and conditions that protected areas provide.

Parks as institutions and their socio-cultural context are an emerging research topic in the social sciences and the humanities. In recent years, there has been increasing interest in the process of establishing and governing protected areas, as well the social processes among local communities with respect to the implementation of a new park. For this purpose, the Swiss system offers an especially interesting environment, as the Swiss park legislation follows a bottom up approach, where every new park has to be initiated by local associations.

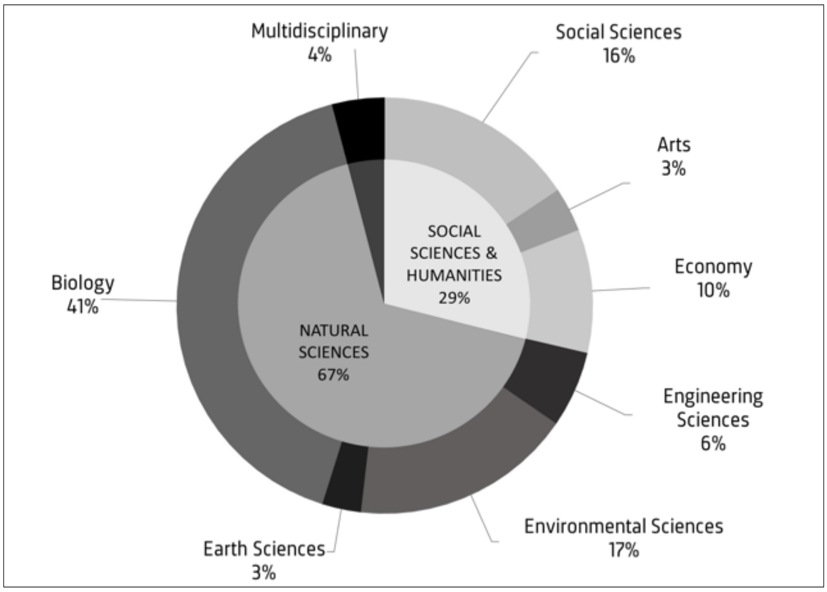

Figure 2: Disciplines of research projects in Swiss Parks

Parks Very Popular for Academic Projects

Concerning the types of research projects, studies realized in context of academic education are very strongly represented amounting a total of 55%. This shows that parks offer a very beneficial environment for students.
Up to now there have been only few management-oriented and long-term projects going on in Swiss parks. Such projects are important for impact monitoring. For the future, it would be desirable that park managements initiate more such projects in order to improve impact assessment.

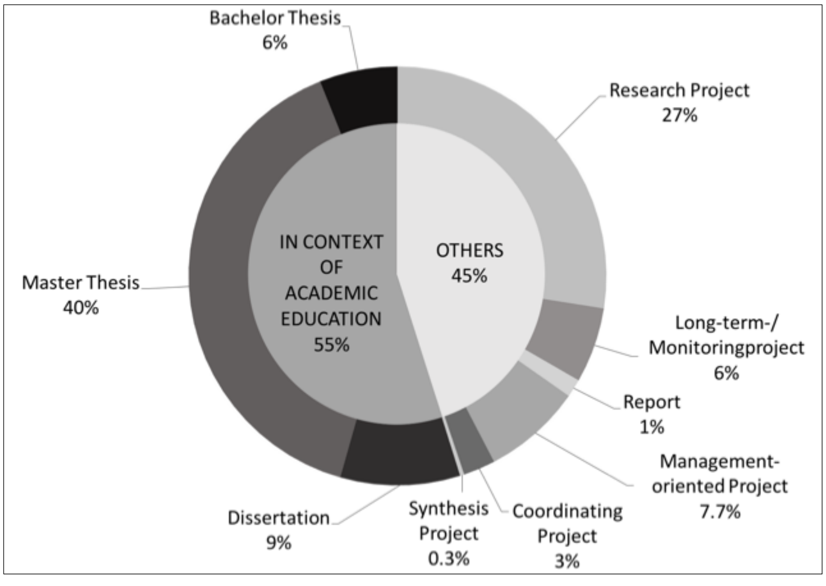

Figure 3: Types of research projects in Swiss Parks

Conclusion and Outlook

After seven years, the project database led by Swiss Park Research offers a broad source of information on research in Swiss Parks of national importance. The here presented data have to be interpreted against the different individual backgrounds of the parks. According to the legislation, research is only mandatory for national parks as well as biosphere reserves. So far this is true for only four parks and the three World Heritage Sites. Therefore, for many other parks research has not been a priority in the first implementation phase. Hence the completeness of recorded projects differs among the parks.
To increase networking between scientists and parks in the future, Swiss Park Research depends on the cooperation of all involved actors. Only in this way a fruitful exchange of the park management's demands for research on the one hand and scientific outputs on the other can be achieved.

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Ecosystem services provided by the bio-physical structure of natural capital in the Danube Delta Biosphere Reserve Romania

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Abstract

The Danube River is the second largest in Europe and the most international river of the world, before flowing into the Black Sea, it creates a delta covering 5,165 km^2 that is one of the best preserved in the world. Bio-physical structure of Danube Delta natural capital consist of 38 different ecosystem types supporting a very rich biodiversity area. We matched the ecosystems types to their potential services then ranked them with local, regional and national stakeholders using a participatory GIS approach.

Keywords

Danube Delta Biosphere Reserve, ecosystem services, GIS

Introduction

As defined by millennium ecosystem assessment, the ecosystem services are the benefits people obtain from ecosystems (MEA 2005, TEEB 2010). Thus, knowing the biophysical structure of natural capital (i.e. type of ecosystems, their state, dynamics and the complex interrelations established inside and between them, availability and type of resources etc.) it is very important for the assessment and mapping of ecosystem services.

The Danube River is the second largest in Europe and the most international river of the world. Its basin, covering an area of 8,684 km^2, comprises 19 countries, its springs lay in Germany, and it ends up at the border between Romania and Ukraine after having passed through Austria, Slovakia, Hungary, Croatia, Serbia, Bulgaria, and having touched four capitals: Vienna, Bratislava, Budapest and Belgrade before reaching the Black Sea.

At the end of its catchment, the Danube River forms a huge delta covering a surface of 5,165 km^2, an area covered by 38 different ecosystem types (EEA 2015). The Danube Delta is the second largest delta in Europe, after the one of the Volga River, and it is shared between Romania (86%) and Ukraine (14%).

The dynamics of the river arms, transported sediment, low altitudes and the presence of the sea is creating a complex landscape formed by freshwater ecosystems (canals, shallow lakes, and wetlands), flood plains, alluvial forests, reed-beds, lagoons and coastal area. Delta's territory is still spreading seaward at a rate of 24 to 30 meters annually, despite the sediment deficit due to the construction of dams on the river and its tributaries in the last 70 years (Rafferty 2011)

The complex biophysical structure of the Danube Delta landscape sustain a large variety of habitats for many species. More than 300 species of birds and 80 species of fish can be found in the Delta. About 160 species of migratory bird species are here because the Delta is located on the major migratory routes, and its environment provides favorable conditions for nesting and hatching. Flora is composed by almost thousand species, and more than three thousands species of invertebrates were found here. The Danube Delta is home to over 60% of the world's population of pygmy cormorants (Phalacrocorax pygmeus), 50% of red-breasted geese (Branta ruficollis) and the largest number of white pelicans (Pelecanus onocrotalus) and Dalmatian pelicans (Pelecanus crispus) in Europe (Nankinov 1996).

Being a wetland dominated landscape, the reed forms one of the largest compact areas in the world, covering about 2400 km2. Other notable ecosystem types are Letea and Caraorman forests that are located at the northern limit of the two rare species of oak found more frequently in the south of the Italian and Balkan peninsulas.
There are about 14,000 inhabitants (INS 2002) in the Danube Delta, living in 25 settlements (a town – Sulina), concentrated along the Danube arms on the areas of dry land, most of them being reachable only by boat. Thus, the area is one of the less populated in Europe with a population density of about 2.8 inhabitants per square kilometers. Also, due to the historic set-up of the area, cultural heritage is also notable.

Because of its rich diversity, both biological and cultural, the entire delta area gained a triple international conservation designation: UNESCO World Heritage Sites, Biosphere Reserve since 1990 and Ramsar site due to its importance for migratory birds. At EU level, the Danube Delta is recognized as part of Natura 2000 network for the great diversity of birds listed on the Bird directive, as well as for the habitats and other species listed on the annexes of Habitat directive.

In the current work, we are exploring the potential of this unique complex of ecosystems to generate services. We used high resolution maps of ecosystem types that were matched with their potential of generating services. Then, this potential was assessed on the bases of stakeholders' knowledge that ranked their importance. Maps with ranked values of general categories of ecosystem services were produced. The assessment and mapping of ecosystem services from a protected area is a valuable asset for a sustainable management and informed decision.

Acknowledgments

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Methods

Study area

Our research was focused on the Danube Delta Biosphere Reserve that lies between 44°80 ' and 45°27 ' N and 28°45 , and 29°46 ' E, and is approximately 100 km long. The delta shape starts were the river divides into three main arms that enclose an area dominated by marshes and lakes of varying sizes and depths, most of them shallow. Numerous channels are natural while others have been cut through the marshes mainly to facilitate the access to these lakes for fishing. Also, the main arms were dredged and straightened for navigation purposes (Fig. 1), the northern one, named Chilia, being preserved as close as its natural regime, while Sulina arm, the one in the middle is managed as a maritime shipping lane.

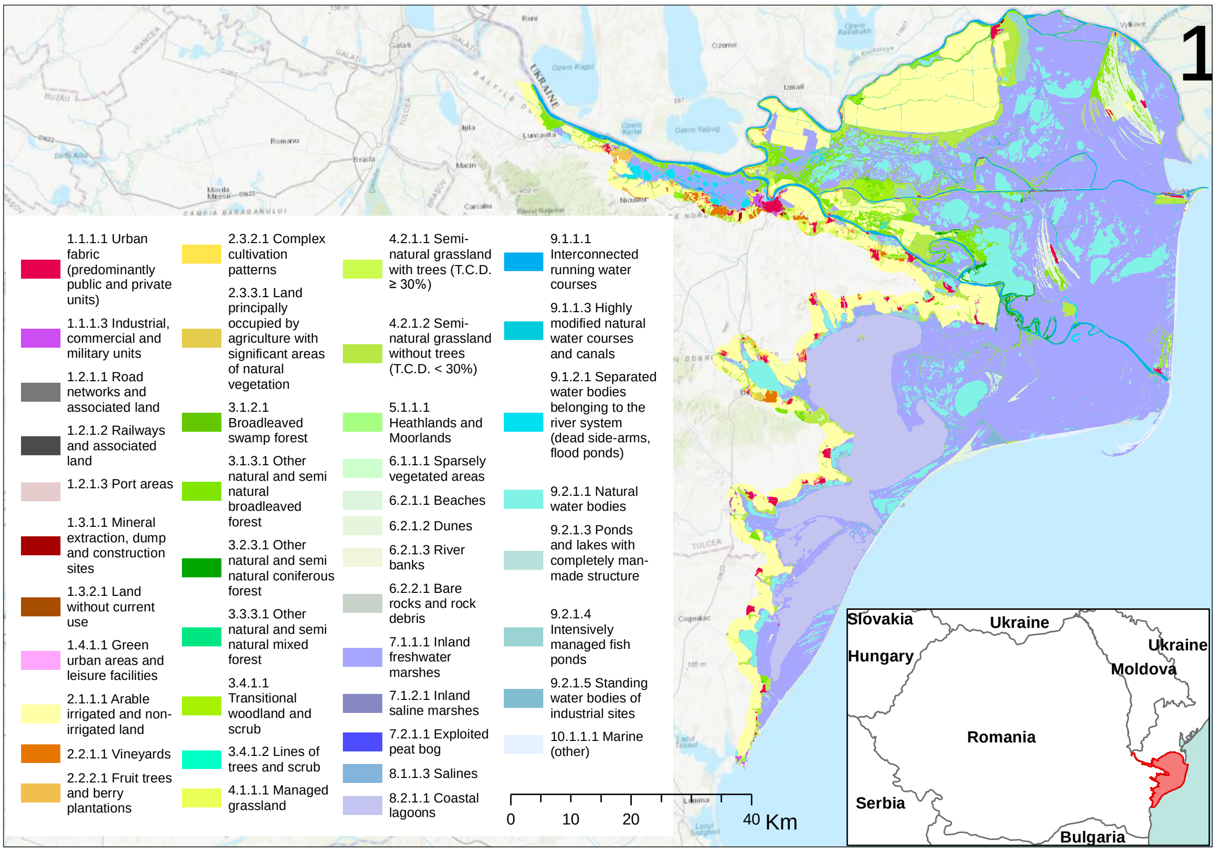

Figure 1: Location of the Danube Delta and the distribution of ecosystem types according to MAES level 4 classification.

Ecosystem identification

Ecosystem identification was based on semi-automatic classification of satellite data with pixel resolution varying from 1.5 to 2.5 m that were acquired during 2010-2014. Ecosystem types were named following the MAES level four classification scheme (MAES et al. 2016). The Minimum Mapping Unit (MMU) is 0.5 with a Positional Accuracy less than 5 m (RMSE > 5m). Such level of spatial resolution allow us to capture the most important ecological features on the ground.

Ecosystem services

Each ecosystem type was associated to a potential list of ecosystem services in accordance to common international classification of ecosystem services (CICES) (HAINES-YOUNG & POTSCHIN 2013). We used high resolution maps of ecosystem types and matched these with their potential in providing different services considering their functions and stakeholders opinion. Each ecosystem type received a rank between 0 – not provided to 5 - maximum provided in accordance with the type and importance of providing a specific service (BURKHARD et al. 2014). Median value of specific ecosystems service ranks were mapped as general category of ecosystem service. Subcategories of services are presented in the Tab. 1.

Ecological Integrity	Provisioning services
Exergy Capture (Radiation)	Crops
Entropy production	Energy (Biomass)
Storage capacity (SOM)	Fodder
Reduction of Nutrient loss	Livestock
Biotic waterflows	Fibre
Metabolic efficiency	Timber
Abiotic heterogeneity	Wood Fuel
Biodiversity	Capture Fisheries
Regulating services	Aquaculture
Global climate regulation	Wild Foods
Local climate regulation	Biochemicals / Medicine
Air Quality Regulation	Freshwater
Water flow regulation	Mineral resources
Water purification	Abiotic energy sources
Nutrient regulation	**Cultural services**
Erosion Regulation	Recreation & Tourism
Natural hazard protection	Landscape aesthetics, amenity and inspiration
Pollination	Knowledge systems
Pest and disease control	Religious and spiritual experiences
Regulation of waste	Cultural heritage & cultural diversity
	Natural Heritage & natural diversity

Table 1: List of ecosystem services and their categories. Ecological integrity can be understood as structures and processes relevant for ecosystem self-organization (MÜLLER 2005)

Results

Weight and distribution of ecosystem types

We identified nine main categories of ecosystems in the Danube Delta, the most dominant ones are, as expected, the aquatic ecosystems (formed by wetlands, rivers and lakes, marine inlets and transitional waters, and marine) that are cumulating about 72% of the entire surface, followed by man dominated ecosystems (cropland and urban) with a cumulated surface of about 17%, the rest are woodland and forest, grassland, sparsely vegetated areas, and heathland and shrub (Fig. 2, Tab. 2). Increasing the spatial resolution and classification level we can distinguish 38 types of ecosystems (Tab. 2) from which the most important are inland freshwater marshes covering 44.8 % of total area.

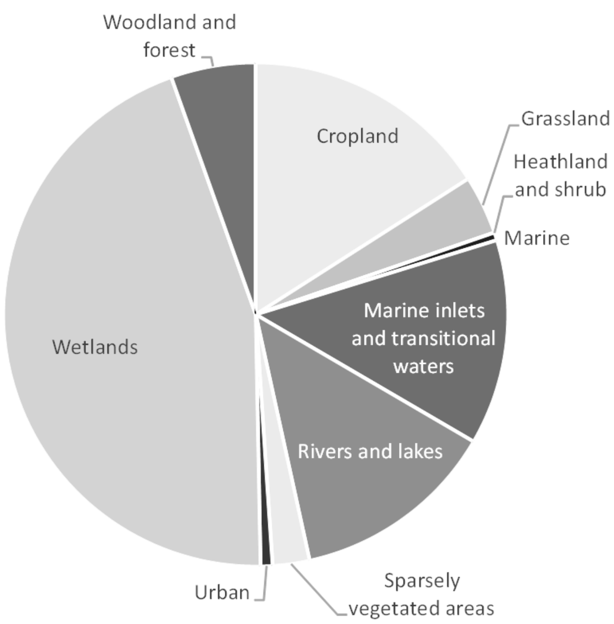

Figure 2: Wight of main categories of ecosystems from the Danube Delta

Ecosystems general categories	MAES Ecosystem level 4	%/subcategory %	Ecosystem integrity	Regulatory services	Production services	Cultural services
Cropland		**15.94**	**4**	**2**	**3**	**2**
	Arable irrigated and non-irrigated land	97.73	4	2	3	2
	Complex cultivation patterns	0.79	3	2	3	2
	Fruit trees and berry plantations	0.60	3	2	4	3
	Land principally occupied by agriculture with significant areas of natural vegetation	0.25	3	2	3	2
	Vineyards	0.64	3	1	2	2
Grassland		**3.78**	**4**	**2**	**3**	**4**
	Managed grassland	2.93	4	1	5	2
	Semi-natural grassland with trees (T.C.D. < 30%)	0.85	4	2	3	4
	Semi-natural grassland without trees (T.C.D. < 30%)	96.22	4	2	3	4
Heathland and shrub		**0.002**	**4**	**3**	**2**	**4**
	Heathlands and Moorlands	100.00	4	3	2	4
Marine		**0.50**	**2**	**3**	**3**	**4**
	Marine (other)	100.00	2	3	3	4
Marine inlets and transitional waters		**13.19**	**2**	**3**	**1**	**3**
	Coastal lagoons	99.08	4	4	4	4
	Salines	0.92	1	2	0	2
Rivers and lakes		**13.15**	**3**	**3**	**4**	**4**
	Highly modified natural water courses and canals	5.99	3	3	4	4
	Intensively managed fish ponds	5.14	4	2	5	4
	Interconnected running water courses	16.51	3	3	4	4
	Natural water bodies	68.48	3	3	4	4
	Ponds and lakes with completely man-made structure	0.12	4	2	5	4
	Separated water bodies belonging to the river system (dead side-arms, flood ponds)	3.76	3	3	4	4
Sparsely vegetated areas		**2.36**	**1**	**2**	**1**	**1**
	Bare rocks and rock debris	0.29	3	1	0	4
	Beaches	6.43	1	2	1	2
	Dunes	77.87	1	2	1	2
	River banks	0.56	1	2	1	2
	Sparsely vegetated areas	14.84	1	1	0	0
Urban		**0.77**	**1**	**0**	**1**	**2**
	Green urban areas and leisure facilities	1.11	3	1	1	2
	Industrial, commercial and military units	8.56	1	0	1	1
	Land without current use	0.84	1	0	1	2
	Mineral extraction, dump and construction sites	3.10	2	0	5	1
	Port areas	4.66	1	3	0	1
	Railways and associated land	0.03	2	0	0	1
	Road networks and associated land	9.09	2	0	0	1
	Urban fabric (predominantly public and private units)	72.62	0	0	1	3
Wetlands		**44.87**	**4**	**2**	**1**	**2**
	Inland freshwater marshes	100.00	4	2	1	2
Woodland and forest		**5.43**	**4**	**4**	**4**	**4**
	Broadleaved swamp forest	0.23	4	5	5	5
	Lines of trees and scrub	0.05	3	2	1	2
	Other natural and semi natural broadleaved forest	80.20	4	5	5	5
	Other natural and semi natural coniferous forest	6.78	4	5	5	5
	Other natural and semi natural mixed forest	0.88	5	5	5	5
	Transitional woodland and scrub	11.86	3	2	1	2

Table 2: Weight of ecosystem general category and sub category and their associated categories of ecosystem services ranks (0 – no potential of services, 5 – full potential)

Ecosystem services

The biophysical structure of complex of ecosystems provide in different degree a set of ecosystem services. The importance of these ecosystems are reflected by their ranks (Tab. 2, Fig. 3).

Maps of ecosystem services

Ranks associated to different ecosystems where mapped so the distribution of different ranking values can be observed spatially (Fig. 4).

Discussion

We are considering that our exercise is useful for capturing in a participatory way the end-users perceptions regarding the services provided by ecosystem in an area. Linking the ecosystem distribution map with their services is important especially when communicating the importance of different ecosystems as well as for planning and making decisions.

We noticed that the knowledge and experience of experts or stakeholders involved in the ranking process of ecosystem services importance can greatly influence the final result. So that, analysis and selection of stakeholders are very important in such an approach.

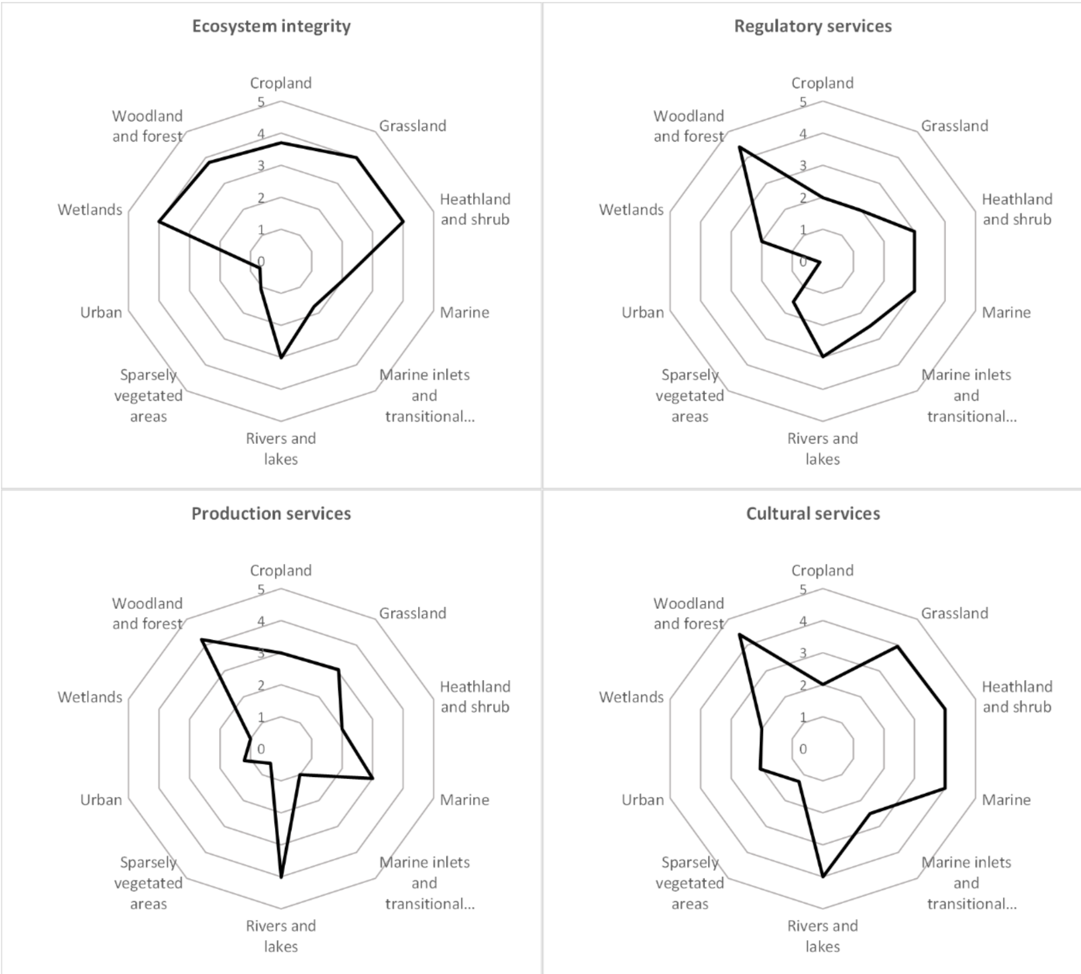

Figure 3: Importance of different ecosystem types for the provisioning of different services

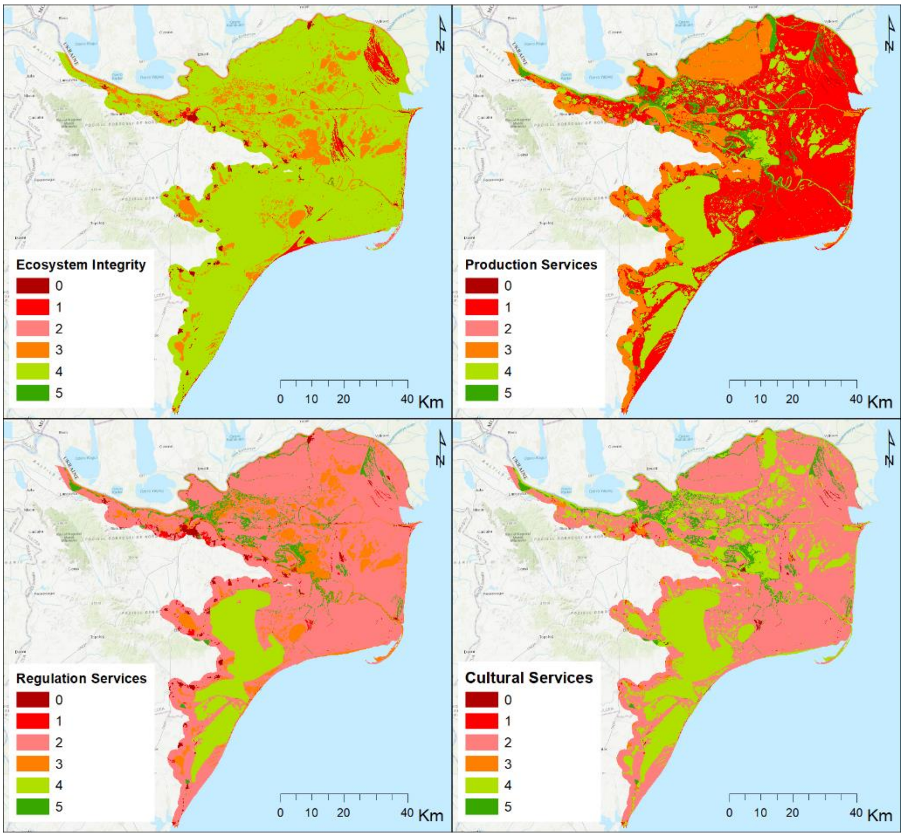

Figure 4: Maps of general categories of ecosystem services: a) ecosystem integrity, b) production services, c) regulatory services, d) cultural services (0 – not provided service, 5 – full provided service)

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A multi-taxa approach in mountain ecosystems: a shared protocol between 6 Italian Parks

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Keywords

biodiversity monitoring, multi-taxa approach, elevational gradients

Introduction

Elevational gradients are natural laboratories to study species diversity and community level responses along patterns of environmental variation. Understanding how multiple contrasting taxa respond to elevation along the same gradient, as well as how the same taxa respond to different elevational gradients, is still an important and urgent task in conservation biology. Protected areas play a key role in reducing losses of biological diversity as climate and land-uses change (Kharouba & Kerr 2010). For these reasons, in 2006-2007 Gran Paradiso National Park (GPNP) developed a monitoring scheme to study animal biodiversity in mountain ecosystems along altitudinal gradients and to set the basis for the development of an historical dataset, focused on multi-taxa community data. The protocol will be repeated every 5 years (2 years monitoring - 4 years stop) in order to analyse variation through space and time.
Main objectives are:

- to **measure the biodiversity status**, describing animal biodiversity along altitudinal gradients. This is fundamental for creating a baseline against which to identify future changes and for planning highly focused conservation actions;
- to **forecast the biodiversity status**, for estimating the risk of biodiversity loss, also through the application of environmental change scenarios. This will allow to identify the threshold beyond which the risk of biodiversity loss will be extremely elevated and to identify potential 'vulnerability and safety'.

Led by GPNP, in 2007-2008, the project was extended to two other protected areas in the NW Italian Alps (Orsiera-Rocciavré Natural Park and Veglia Devero Natural Park), representing the first attempt to develop a protocol for long-term monitoring of multiple taxa in the Italian Alps. As planned, in the years 2012-2013, the 3 protected areas carried out the first repetition of the sampling activities. Moreover, in 2013-2014, 3 more Italian National Parks (Dolomiti Bellunesi NP, Stelvio NP, Val Grande NP), located in the Alps, started the same monitoring project. Currently, **6 Italian Parks,** all located in the Alpine Region and covering its natural variability, are sharing a common protocol to study animal biodiversity in mountain ecosystems.

Methods

24 altitudinal transects (550 - 2700 m a.s.l.), covering three vegetation belts (montane, subalpine, alpine), were distributed between the 6 Parks. In each transect we selected circular plots of 100 m radius (5-7 plots per transect), located along the altitudinal gradient and separated by an altitudinal range of 200 meters, for a total of **132 sampling stations** (Fig. 1).

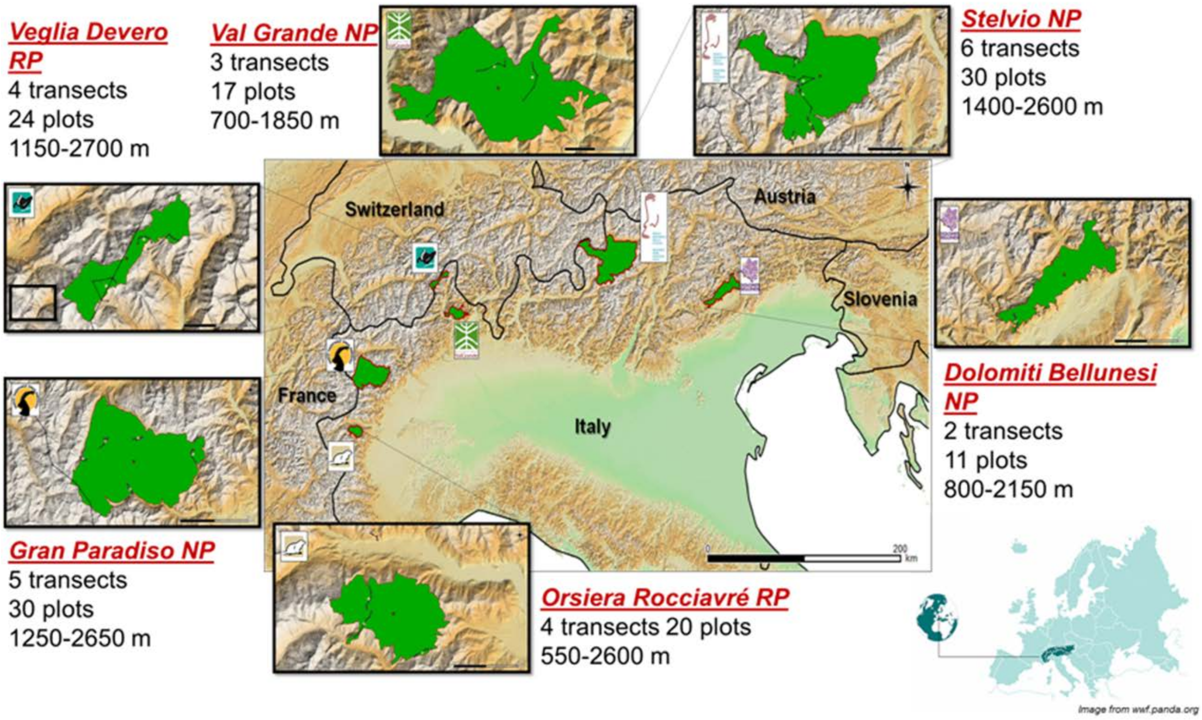

Figure 1: Protected areas involved in the projects with number of transects, plots and altitudinal range covered for each study area. RP=Natural (Regional) Park; NP=National Park.

In these plots, **7 taxa** were monitored, using standardized, easy to apply and cheap sampling techniques. **Birds** (*Aves*) were monitored by means of point counts and each plot was visited twice during the reproductive season. We sampled **butterflies** (Lepidoptera Rhopalocera) and **grasshoppers/crickets** (Orthoptera) using transects along the diameter of the plot (200 m in length), walked at uniform speed, once a month from May to September. We collected **surface-active arthropods** (Coleoptera Carabidae, Coleoptera Staphylinidae, Hymenoptera Formicidae, Araneae) using pitfall traps (plastic cups, diameter of 7 cm, filled with 10 cc of white vinegar, controlled every 15 days). In each plot, we also collected micro-climatic data, through the positioning of temperature data-logger (iButton DS1922) located in field for all the sampling season, topographic variables and micro-environmental parameters (in situ vegetation data).

Results and Discussions

Not all the data collected in 2012-2013-2014 are currently ready for all the 6 protected areas, but some patterns have already been recognised using data of the already available taxa (birds, butterflies and grasshoppers/crickets). We firstly focused on β-diversity expressed as total dissimilarity (Sørensen index), decomposed in its turnover and nestedness components. We observed that turnover is always higher than nestedness in all the cases. Canonical Analysis of Principal Coordinates has been used in a Variation Partitioning framework, to quantify the proportion of variation due to environmental and spatial factors. For all the taxonomic groups and for both the β-diversity components, altitude, habitat and climate explain more than the spatial factors. The spatial components have a higher role for invertebrates and the relative importance of space is higher for nestedness (Fig. 2).

We then used non-random occurrence of species along the altitudinal gradient to identify indicator species of the different altitudinal classes (De Caceres & Legendre 2009). Our results showed significant indicator species both at low and at high altitude, allowing us to identify altitudinal specialists (Fig. 3). Future changes in the distribution of these species across the Italian Alps can be considered a first signal of environmental transformations.

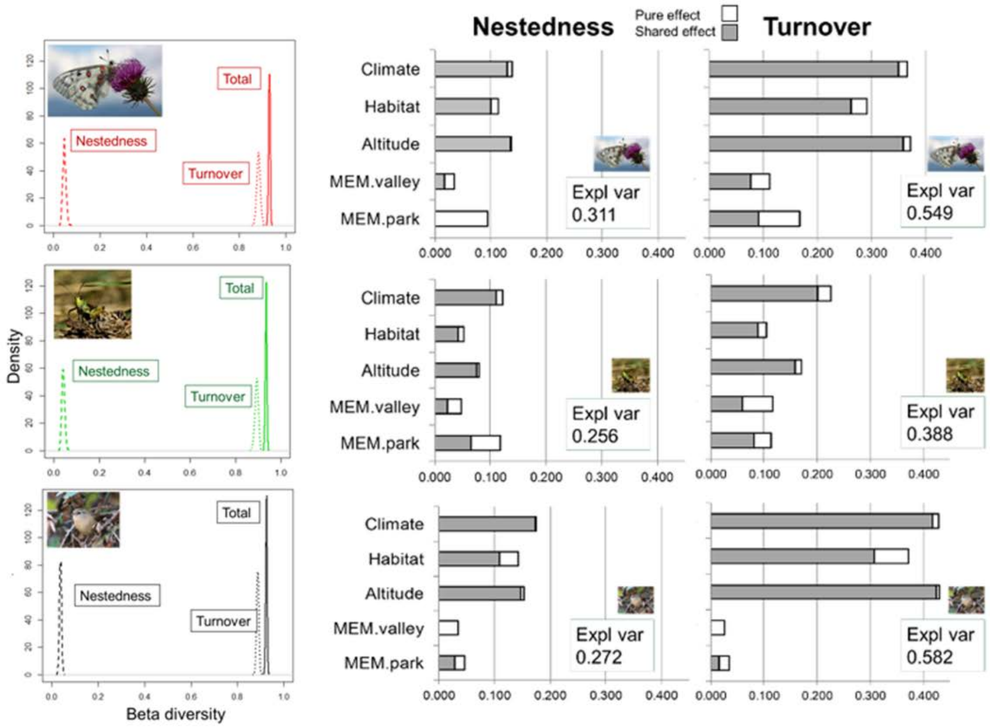

Figure 2: The total β-diversity and its two components (turnover and nestedness) were computed and analysed for the taxa with complete and already available datasets (butterflies, grasshoppers/crickets, birds). The relative importance of environmental and spatial factors in explaining the β-diversity components (nestedness and turnover) has been calculated through Canonical Analysis of Principal Coordinats (CAP) in a Variation Partitioning framework. Climate is represented by the Annual Mean Temperature and the Annual Precipitation from WorldClim. Habitat is a categorical variable, that considers the dominant vegetation type. Altitude is a continuous variable. Spatial component was modelled using Moran's Eigenvector Maps, from transect centroid (MEM.valley) and park centroid coordinates (MEM.park).

Low altitude specialists			
Altitudinal Bands		Indicator Species	
500-1000 m		*Parus caeruleus*	bird
1050-1400 m		*Parus major*	bird
1450-1800 m		*Aegithalos caudatus*	bird
1850-2200 m			
2250-2700 m			
500-1000 m		*Sylvia atricapilla*	bird
1050-1400 m		*Turdus merula*	bird
1450-1800 m			
1850-2200 m			
2250-2700 m			

High altitude specialists			
Altitudinal Bands		Indicator Species	
500-1000 m		*Colias phicomone*	butterfly
1050-1400 m		*Erebia pandrose*	butterfly
1450-1800 m		*Anthus spinoletta*	bird
1850-2200 m			
2250-2700 m			
500-1000 m		*Erebia epiphron*	butterfly
1050-1400 m		*Oenanthe oenanthe*	bird
1450-1800 m		*Aeropus sibiricus*	grasshopper
1850-2200 m			
2250-2700 m			

Figure 3: Indicator species (IndVal) for the different altitudinal classes. In grey are indicated the altitudinal bands that have significant indicator species for the three taxonomic groups under analysis.

Conclusion

Such a network of protected areas, sharing the same monitoring protocol, offers the possibility to gain a better understanding of biodiversity pattern along altitudinal gradients and more robust evidence of the effects of climate and habitat changes on α- and β-diversity. Similar results, when available, can strongly improve the adaptive strategies of the protected areas.

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Water-use strategies of conifer trees from the Swiss National Park to recent climatic changes

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Abstract

We aim to reveal the long-term physiological response of larch (*Larix decidua*) and mountain pine (*Pinus mugo var. uncinata*) trees that grow on north- and south-facing aspects in the Swiss National Park to recent and past climate changes. We measured and analyzed $\delta^{13}C$ and $\delta^{18}O$ in wood chronologies from 1900 to 2013. We found that July temperature influenced larch $\delta^{18}O$ from both aspects and pine from the south-facing aspect. A decrease in water availability was reflected in increasing $\delta^{13}C$ and decreasing tree-ring width for larch trees in July and for pine trees in May. Intrinsic water use efficiency (WUEi) calculated for larch trees since 1990s reached a saturation, which may indicate the trees' plasticity to elevated CO_2. Opposite, divergent trends between pine WUEi and $\delta^{18}O$ are most likely indicating a decline of mountain pine trees and decoupling mechanisms between needles and tree-ring width.

Keywords

tree-ring width; $\delta^{13}C$ and $\delta^{18}O$ in wood; intrinsic water use efficiency, climate

Introduction

Over the last decades forest ecosystems have been affected by water deficits during summer droughts due to increasing temperatures and shortage in precipitation (ALLEN et al. 2010; CHURAKOVA (SIDOROVA) et al. 2016). Climate models predict that drought frequency will continue to increase during the 21st century and beyond (CH 2011, IPCC 2014). In the future, increasing temperatures will enhance the evaporative demand and water loss from plants and may reduce productivity and carbon sequestration in many forest ecosystems (SIDOROVA et al. 2009, ANDEREGG et al. 2012).

Temperature, water availability, air humidity and ambient CO_2 (c_a) influence photosynthetic CO_2 assimilation and water balance, which is reflected in the isotopic carbon and oxygen isotope ratios of the plant organic matter, yielding a specific isotope pattern in the wood of tree rings. Under warm and dry conditions trees respond to limited water resources by reducing stomatal conductance (g_s), resulting in a diminished CO_2 uptake and biomass production, in reduced intercellular CO_2 concentration (c_i). The latter leads to reduced ^{13}C discrimination (FARQUHAR et al. 1989) and increased $\delta^{18}O$ values (FARQUHAR & LLOYD 1993). The $\delta^{18}O$ values in tree rings are reflecting the condensation temperature during rain formation, which represents the source water for trees and leaf water enrichment (CRAIG 1961, MCCARROLL et al. 2004).

Enrichment in ^{18}O occurs in the needles during transpiration, which may be enhanced under drought conditions (YAKIR 1998). A mixed seasonal signal of water source and water enrichment in leaves is finally stored in the wood and cellulose of tree rings (SAURER et al. 1997, RODEN & EHLERINGER 2000).

In this study, we addressed the following research questions:

1. Which of the climatic factors are predominantly reflected in δ18O of wood in larch and mountain pine trees in the long-term?
2. Do mountain pine and larch trees show different water use efficiency strategies under recent climatic changes?

Material and Methods

The study site is situated at 1959-1964 m a.s.l. at Champlönch in the Swiss National Park, Switzerland (46°N, 10°E). Around 28% of the SNP are forested, 21% are alpine grasslands and 51% unproductive terrain. Mountain pine (*Pinus mugo* subsp. *uncinata*) and dwarf mountain pine (*Pinus mugo* subsp. *mugo*) predominantly grow on limestone in the SNP, and cover ca. 73% of the forests in the SNP.

The study site is characterized by a continental climate. According to the climate station Buffalora (ca. 5 km from study site; 1968 m a.s.l., 46° 38' N and 10° 16' E) the average winter temperature is -9.2°C and summer temperature is +9.5°C (monthly averages from 1917 to 2013). Since the 1990s mean annual and spring temperatures increased by 0.5°C and 1.0°C, respectively, while the average summer temperature increased by 0.6°C. The annual sum of precipitation is 910 mm (period 1917 to 2013). Since the 1990s annual precipitation decreased by 88.9 mm compared to the mean value of 931.2 mm from 1917 to 1989.

We selected two contrasting aspects at Champlönch, a south-facing (-S) sunny slope at 1964 m a.s.l and a north-facing (-N) shady slope at 1959 m a.s.l. Tree cores were collected from twelve trees per species and aspect for the construction of tree-ring width index chronologies. Each tree core from larch and mountain pine was glued on core mounts and cut for visualization of tree cells (COOK & KAIRIUKSTIS 1990). Then tree rings were counted and measured using a LINTAB 5 measurement bench (Rinntech, Germany) under a stereomicroscope (Leica MZ6). The cross-dating procedure to determine the exact formation year of each tree ring and for building individual tree-ring width chronologies was carried out using TSAPWin (Rinntech, Germany) and the software COFECHA (HOLMES 1983). To remove the age trend for each tree-ring width series we standardized each series by applying a negative exponential or linear function (HOLMES et al. 1983). For the further analysis residual tree-ring index chronologies were used.

Two increment cores from each tree were sampled for the stable isotope analysis from the same trees used for tree-ring analysis. Resins from the samples were extracted with a Soxhlet apparatus with a 1:1 ethanol-methanol mixture during 48 h. Tree cores were then washed with distilled water for 24 h and air dried at room temperature. For a better visualization of the tree rings the surface of the tree cores were slightly cut by hand without polishing or application of powder, to avoid cross contamination between the tree-rings, which must be considered for the $\delta^{13}C$ and $\delta^{18}O$ stable isotope analysis in wood. The tree rings were measured and cross-dated against the dated tree-ring series, which were used for tree-ring analyses. For each tree, each annual ring (including early and late wood) was split separately using a scalpel. Wood samples were then milled to fine powder and packed into silver capsules. Simultaneous measurements for $\delta^{13}C$ and $\delta^{18}O$ of wood samples were performed with a vario PYRO cube (Elementar, Hanau, Germany) via thermic decomposition at 1450°C and conversion to CO under O_2 exclusion in helium (WOODLEY et al. 2012).

Results and discussion

To reveal the driving factors of tree growth in the long-term we calculated Pearson's correlations between tree-ring index, $\delta^{13}C$ and $\delta^{18}O$ in wood chronologies and temperature, precipitation, and drought index (DRI) for the period from 1917 to 2013. Carbon isotopes and larch tree-ring index chronologies suggest that a decrease in water availability occurs in July, while for pine from both aspects mainly in May and July. Mountain pine trees from both aspects were sensitive to changes of relative humidity during warm June and July. The positive significant correlations between $\delta^{18}O$ for larch with May and July precipitation could be explained by a high vapor pressure deficit (VPD). A similar finding was reported by SCHOLLAEN et al. (2013), who revealed a positive relationship between $\delta^{18}O$ in tree cellulose and precipitation during dry seasons. Mountain pine trees indicate a developing water shortage during earlier spring only, and show a positive significant relationship with VPD, resulting in a reduction of stomatal conductance reflecting in further increase in ^{18}O enrichment of needle water, which is not the case for larch trees. In contrast, STREIT et al. (2014) reported a positive linear relationship between $\Delta^{18}O$ and VPD for both larch and mountain pine at Stillberg (Davos, Switzerland). The contrasting patterns at our study site, e.g. high positive correlations between pine trees and VPD and negative correlations with larch trees suggest different hydrological conditions, which could be explained by differences in the root development resulting in different water sources for these tree species (ALVAREZ-URIA & KÖRNER 2007). We found that the physiological response of mountain pine trees is different from larch trees. RH and July temperature highly influenced larch trees, while the impact of precipitation becomes more important for pine trees. This indicates that pine trees rather use the soil surface water, whereas larch trees seems to be able to utilize water from the deeper soil layers and most likely can penetrate with their rooting system into rock cracks and access water from deeper ground levels.

Intrinsic water use efficiency (WUEi) for larch from south- (LS) and north-facing (LN) aspects (Fig. 1 a) showed increasing trends over time with saturating characteristic since the last 20 years. This is in agreement with increasing tree-ring values (Fig. 2a) and increasing trends of c_i/c_a for both aspects (Fig. 2c), that could be explained by the plasticity of larch trees to improving growth conditions, i.e. rapidly increasing CO_2, and non limiting water supply for larch (deep rooting tree).

In contrast, we found a divergent trend between WUEi for PS and PN (Fig. 1b) and $\delta^{18}O$ during the last 20 years (Fig. 1d). WUEi increases for both aspects (Fig. 1 b) along with a slight decrease c_i/c_a (Fig. 2 d), while tree-ring width did not change significantly (Fig. 2b) suggesting a constant assimilation rate. Surprisingly, $\delta^{18}O$ decreases (Fig. 1d).

According to Scheidegger et al. (2000) decreasing $\delta^{18}O$ in organic matter reflects an increase in stomatal conductance (g_s). Considering the results above this is not plausible from eco-physiological point of view. However, it could be the consequence of an impaired stomatal regulation, which is often observed in either senescing or dying plants.

Eventually, this will lead to a decoupling of the isotopic signals between needles and tree-rings. PFLUG et al. (2015) observed a progressive decrease in tree ring growth and photosynthesis with increasing drought. They found that the amount of carbohydrates became insufficient for tree ring growth. Thus, the isotopic signal formed in the needles during periods with growth limiting conditions is no longer stored in the tree rings. What remains are the sections of the tree rings, which were formed under less limiting, usually more humid conditions during spring and fall, when δ^{18}O in precipitation is more depleted than in summer.

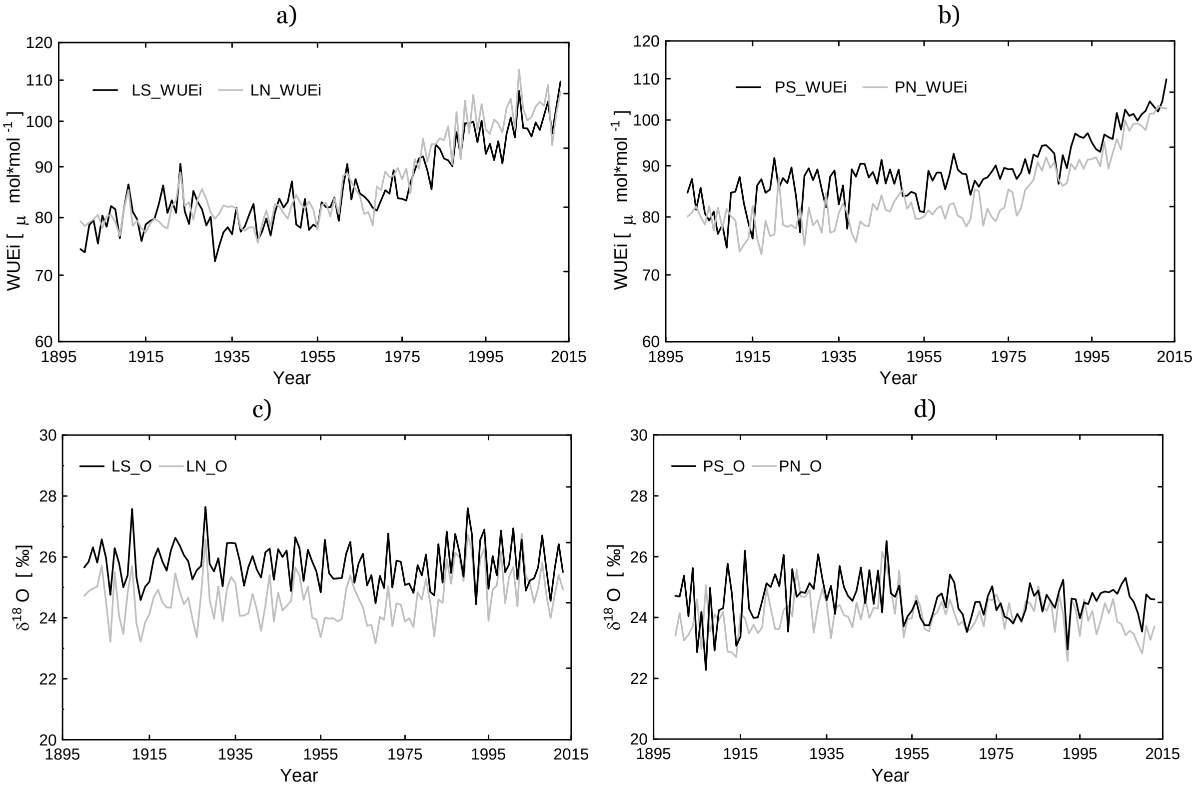

Figure 1: Intrinsic water use efficiency (WUEi) calculated for larch from south- (LS) and north-facing (LN) aspects (a) and mountain pine trees from south- (PS) and north – (PN) facing aspect (b) and δ^{18}O isotope chronologies in comparison for larch (c) and pine (d), respectively.

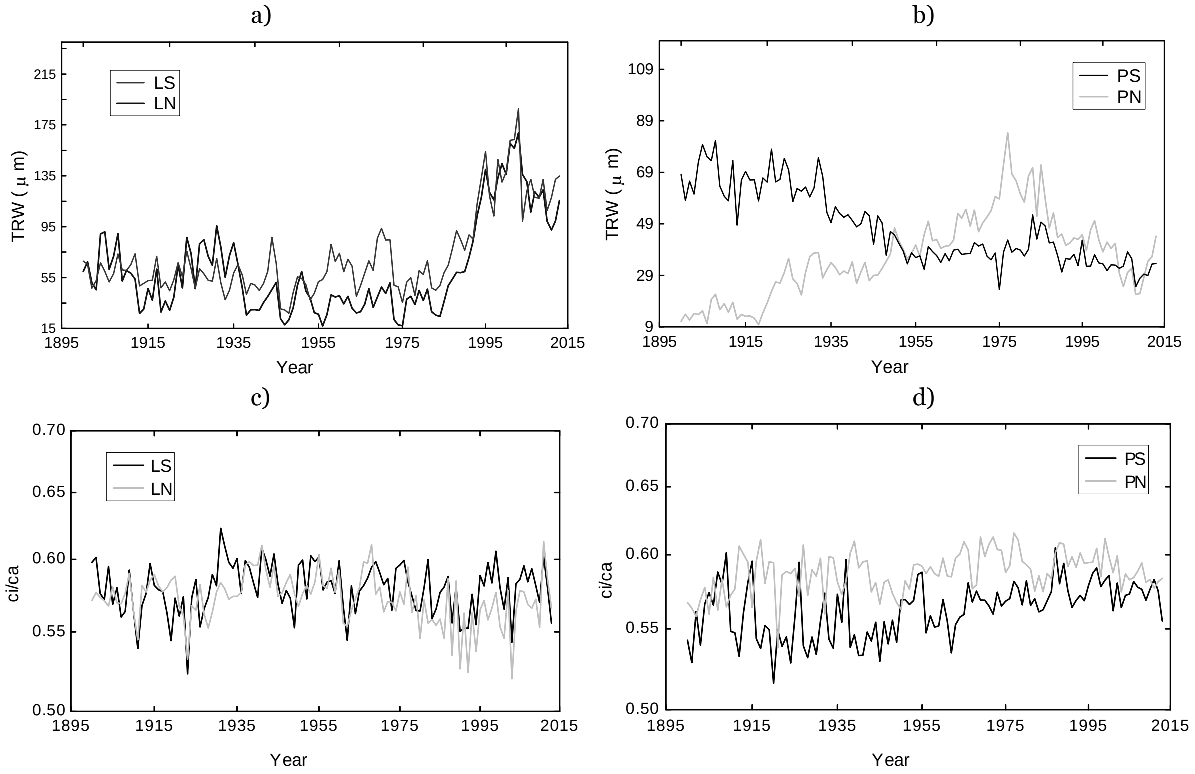

Figure 2: Tree-ring chronologies and calculated ratios of intercellular CO_2 vs. ambient CO_2 (c_i/c_a) for larch (a, c) and mountain pine (b, d), respectively.

Conclusion

Our study showed:

1. The $\delta^{18}O$ of wood in larch at both aspects and mountain pine from the south-facing aspect captured the July temperature signal. The $\delta^{13}C$ and tree-ring index chronologies suggest a decrease in water availability for larch during July and for mountain pine most likely during May and July.
2. Water use efficiency (WUEi) strategies differ between mountain pine and larch trees under recent climatic changes. Since the 1990s WUEi calculated for larch reached saturation, possibly showing an adaptation to elevated CO_2. However, WUEi calculated for mountain pine trees from the same period continuously increased. Divergent trends between pine WUEi and $\delta^{18}O$ values and narrow tree-ring widths could be the result of senescence or declining mountain pine trees in the Swiss National Park resulting in a decoupling isotopic signal between needles and tree-ring with chronology.

Acknowledgements

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Connecting nature, local cultures and tourism in subarctic landscape – a case study of local communities attached to the Varanger Peninsula National Park in Northern Norway

Morten Clemetsen & Knut Bjørn Stokke

Abstract

In Norway, there has traditionally been a segregative approach to nature protection, focusing on protecting nature from human activities. However, in recent years we have seen a more integrative approach, focusing on a beneficial interaction between parks and local communities. The aim of this paper is to present recent research output from the Varanger Peninsula National Park in the far north of the Norwegian mainland. The region is multicultural with Sami, Finnish and Norwegian inhabitants. The region is subject to increasing nature-based tourism, particularly related to bird watching. Through applying a 'landscape resource analysis', we have identified some preconditions for integrated sustainable development, connecting local cultures and tourism with the National Park management.[1]

Key words

Subarctic landscape, local cultures, nature based tourism, landscape resource analysis

Introduction

We can trace the integrated and holistic perspectives on nature conservation and society back to the generalist tradition represented by Patrick Geddes in Scotland in the late 19th century (MACDONALD 2009). Still, in Norway there has been a strong tradition of separating nature conservation areas from rural development. Up to recent years, the policy has been to protect 'untouched' nature and to leave it 'on its own'. To some extent, this could make sense as long as the designated areas were located in remote mountain area, far from settlements and infrastructure. However, it becomes more problematic as several national parks now are established in lowlands, coastal areas and other productive and human influenced landscapes. Still, little attention has been given to processes of involvement and participation from local communities.

The integrated and dynamic approach to conservation and sustainable development gained momentum through the European Landscape Convention (COE 2000), (GAMBINO & PEANO 2015). The landscape perspective focus less on boundaries, and more on connectedness and interaction of man and nature, in local and regional contexts. The landscape approach implies also a sense of 'strong forward looking', not only concerning legal/ formal planning and management, but for innovative value creation, based on situated natural and cultural resources (HAUKELAND (ed.) 2010).

Nature based tourism in Norway has traditionally been developed by farmers and on large landowner properties (salmon rivers and terrain for game hunting etc.), which means that the experiences offered to a less degree were depending on engagement and services from local communities. When nature and landscape now increasingly has become a major asset for recreation purposes and for commercialised tourism in easier accessible areas, the question of how the encounter of visitor and resident takes place, is of importance. 'Adding value through the encounter' is an expression from a Norwegian Regional park – pointing at the motivation and personal outcome of a genuine meeting with other people – or through a nature experience, often planned and facilitated by people in the local communities. Nature-based tourism is largely a cultural product, nourished by practical skills in combination with the stories communicated locally. The sustainability of nature based-tourism in the future will therefore largely depend on the capacity of the communities connected to National Parks and other nature areas, to raise awareness of local resources.

The aim of this paper is to present and discuss some experiences from a workshop on the Varanger peninsula regarding methods to identify and activate potential resources embedded in nature, culture and the relational dimension of place. The value based, ethical dimension of integrated nature conservation, nature based tourism and local community development is essential in a sustainable perspective.

Our main research questions are; do we have methods to access and communicate the values, knowledge and skills of local communities, and how can the processes of identifying these resources contribute to community development?

[1] The paper is based on the BIOTOUR-project (From place-based natural resources to value-added experiences: Tourism in the new bio-economy – project no. 255271). The project is funded by the Norwegian Research Council (2016-2020). Norwegian University of Life Sciences (NMBU) is lead-partner of BIOTOUR in co-operation with four Norwegian and five international partner organizations.

‘Landscape Resource Analysis’ has been developed as a general methodology for community led processes in identifying place based assets and potentials for revitalizing communities (CLEMETSEN & JOHANSEN 2015). The methodology is grounded in early models of holistic and inter-disciplinary landscape –scale planning, presented by the Scottish ecologist, regional planner and social reformer, Patrick Geddes (1854 – 1932) (RITCHIE 2015, CLEMETSEN 2016). The method was conducted in Varanger through processes combining participatory sense of place studies and landscape analyses on local and regional level. How do the inner and outer landscape correspond in a community context? In our case, we wanted to find out how people’s personal values can be shared and eventually function as an interconnected basis for local communities to develop a distinct and proactive profile linked to nature based tourism products. Consistency with the National Park qualities and the sub-arctic landscape of Varanger is also an essential element of this.

The Varanger-Peninsula case area is located in the north-east part of Finnmark County in Northern Norway, with the Barents Sea as neighbor and close to Russia. There region consists of the municipalities Berlevåg, Båtsfjord, Vardø, Vadsø, Nesseby (Figure 1). The road along the Varanger fjord from Varangerbotn to Hamningberg (ca. 160 km) is a National Scenic Route. The region is multicultural with Norwegian, Saami and Finnish settlements.

Figure 1: The Varanger Peninsula National Park (Varangerhalvøya nasjonalpark)

Method

The Landscape Resource Analysis was in this case designed as a half-day workshop with 9 invited actors (tourism providers, landscape and heritage mangers, farmer, reindeer herder and social entrepreneurs) from three municipalities (Nesseby, Vadsø, Vardø). A storyteller facilitated the process and to conduct the process, driven by four principal questions related to values, landscape characteristics, product development and community relevance.

Preliminary results and discussion

The workshop turned out to be very inspiring for all involved persons. The facilitator had asked the participants to bring a ‘token’ that could say something important about their values and relation to the area (a flat stone, a salmon fishing fly, a reindeer horn, a pair of knitted gloves, etc). The essential idea was to understand how the quality of the resources for nature based tourism were reflected in the personal values, through the stories told. This turned out to be very informative and inspiring as input to further discussions on the value added potentials in the interface between nature-based tourism, local economy and community development.

A common and distinct understanding of the landscape perspective and its multiple dimensions also appeared through the workshop; Nesseby represented the continuous Sami settlement story from prehistoric time 12000 years back, Vadsø the Finnish heritage, and Vardø the Sea and the great fishing resources.

The Varanger Peninsula National Park was not regarded as very attractive for commercial nature based tourism in itself due to the remoteness. However several of the participants experienced how visitors were seeking activities that could give them a genuine experience of the quality of the Park. In this respect, there is a great potential in storytelling, guided activities and high quality nature experiences to be developed by local entrepreneurs in and around the communities, being beneficial to both visitors and the residents.

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Effects of floodplain dynamics on richness, abundance, composition and functional diversity of grasshopper assemblages in the Donau-Auen National Park (Austria)

Nationalparks Austria Science Award 2017

Agnes Demetz & Christian H. Schulze

Abstract

Inundation events are shaping arthropod communities of floodplain ecosystems. This study from the Donau-Auen National Park (Lower Austria) investigated to what extent species richness, abundance, and functional diversity of grasshopper communities on meadows are affected by annual floods. Hence, grasshoppers were sampled from June to September 2012 on meadows prone to yearly summer inundations (N = 12) and meadows protected from inundation (N = 13) by a levee. Grasshopper abundance was negatively affected by flooding. Species richness, functional diversity and relative abundances of hygrophilous grasshoppers and generalist species did not differ significantly between both meadow types. In contrast, the relative abundance of xerophilous species was significantly higher on non-flooded meadows. This study shows that natural floodplain dynamics still have an impact on grasshopper assemblages of meadows in the Donau-Auen National Park.

Keywords

grasshoppers, Caelifera, Ensifera, species richness, abundance, functional diversity, Donau-Auen National Park, floodplain ecosystem

Introduction

The community structure of aquatic and terrestrial plant and animal communities of floodplain ecosystems is shaped by hydrological dynamics (Ballinger et al. 2005, van Diggelen et al. 2006, Reckendorfer et al. 2006; but: Truxa & Fiedler 2012). In this study, conducted in the Donau-Auen National Park, we analyzed to what extent species richness, abundance and functional diversity of grasshopper communities on meadows are shaped by summer inundations. So far, effects of flood events on grasshopper communities have been only rarely investigated (Fischer & Witsack 2009, Dziock et al. 2011). Grasshoppers have high conservation relevance because a substantial fraction of species is highly bonded to specific habitats and is reacting sensitively to environmental changes. Hence, they are frequently used as 'bioindicators' (Reich 1991, Gerlach et al. 2013, Bazelet & Samways 2012).

Methods

Study area

This study was conducted in the Donau-Auen National Park (IUCN Category II, 1997), which is still influenced by the dynamics of the river Danube due to water level fluctuations of up to 7 m amplitude throughout the year, causing periodic and stochastic overbank flows (Nationalpark Donau-Auen 2013). Study sites were located north of the river Danube between the villages Mannsdorf and Bad Deutsch Altenburg. The study area is divided by a levee hich protects the area situated to the north against flooding during periods of high water level. In contrast, meadows south of the levee are still flooded almost every year. Grasshoppers were sampled on twelve meadows south of the levee, and 13 meadows north of it (Fig. 1).

Grasshopper sampling

On each meadow grasshoppers were sampled in five sampling rounds in Summer 2012. All visually and acoustically detected grasshoppers were counted. Identification was facilitated by available field guides and song recordings. In our analyses *Phaneroptera falcata*, which is not associated with meadows (Zuna-Kratky et al. 2009), and all *Tetrix*-species which cannot be reliably surveyed with our sampling method, were excluded. Additionally, mowing frequency, dominance of grasses and vegetation height was recorded for each meadow. For classification of species according to their habitat preferences compare Demetz et al. (2013).

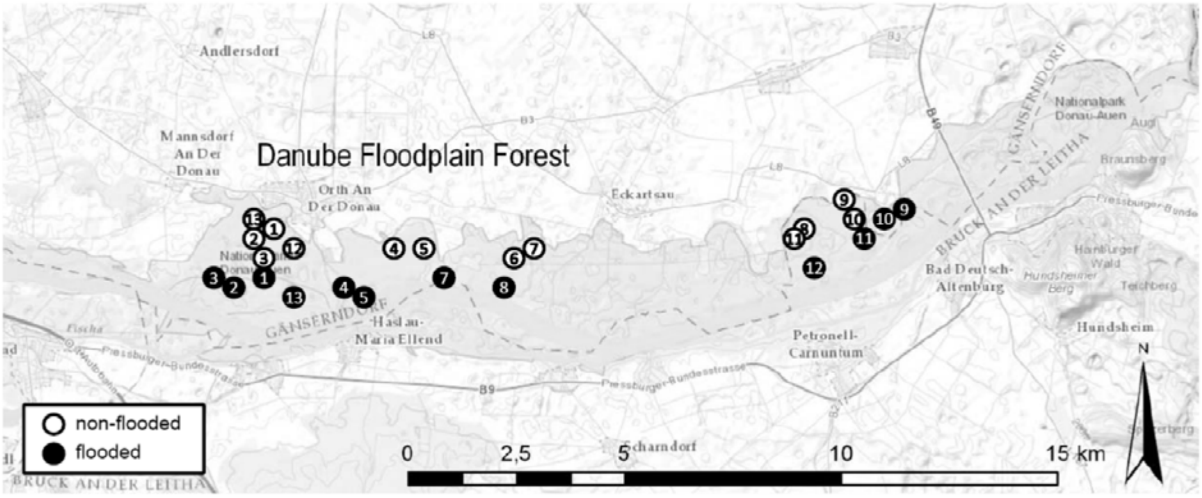

Figure 1: Map of the study area indicating sampled regularly flooded and non-flooded meadows

Results

Species richness and abundance

A total of 22 grasshopper species were recorded on flood-prone and non-flooded meadows, respectively. A generalized linear model (GLM) testing for effects of flooding, mowing frequency, dominance of grasses, herb layer height and plant species richness on the number of grasshopper species recorded per sampled meadow did not achieve a significant level. In contrast, a GLM testing for effects on total grasshopper abundance indicated a strong effect of flooding regime . The abundance of grasshoppers per 10 m transect was higher on non-flooded than flooded meadows (Fig. 2).

Effects on grasshoppers with different habitat preferences

While the relative abundance of hygrophilous species and grasshopper with indifferent habitat preferences did not differ significantly between flooded and non-flooded meadows (Fig. 3a-b), the relative abundance of xerophilous grasshoppers was higher on non-flooded meadows (Fig. 3c).

Functional diversity

GLMs testing for effects of meadow variables on functional diversity measures (functional richness, functional eveness, functional vivergence; e.g. LALIBERTÉ & LEGENDRE 2010) did not indicate any significant effects.

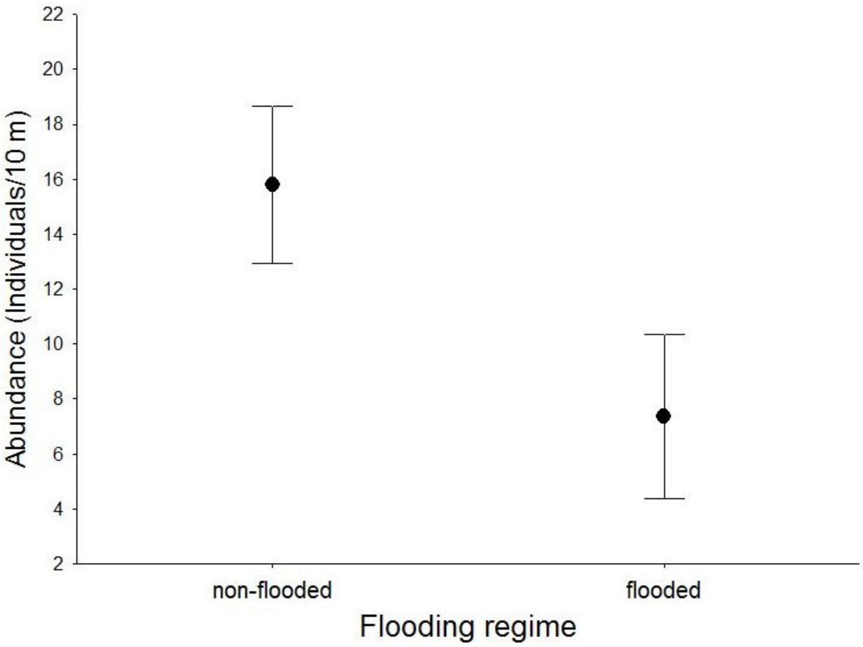

Figure 2: Mean abundance of grasshoppers on flooded and non-flooded meadows.

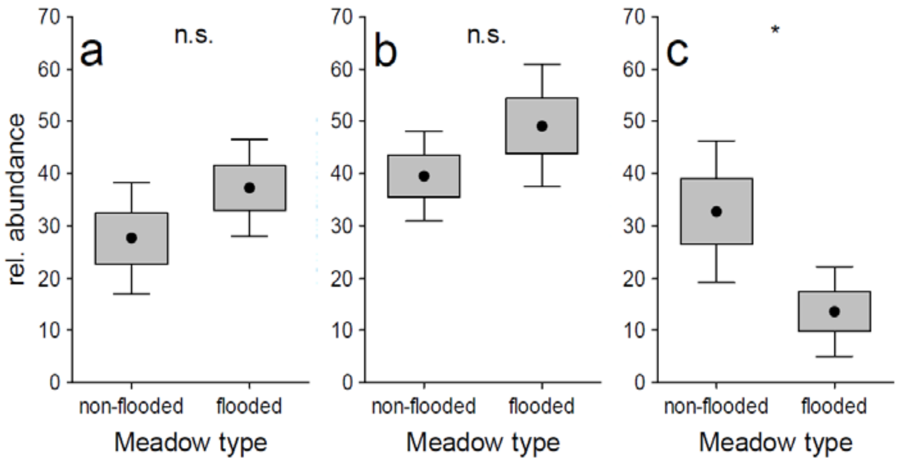

Figure 3: Mean relative abundance ± SE (box) and 95% CI (whiskers) of (a) hygrophilous, (b) indifferent and (c) xerophilous species on flooded and non-flooded meadows. Results of t-tests: n.s. – non-significant, * – $p < 0.05$.

Discussion

Species richness and abundance

Regular flood events did not prove to affect species richness of grasshopper assemblages on meadows in the Donau-Auen National Park. In contrast, flooding appeared to have the major impact on grasshopper abundance. Most likely, a large number of grasshoppers drown in the flood. The only way to survive a flooding event is in the egg-phase or by flying away (macropterous species). Although macropterous species can repopulate areas after a flood event, this apparently cannot compensate for the increased mortality during flooding events. Overlapping egg-generations are necessary for grasshopper populations to survive (FISCHER & WITSACK 2009). In 2012 there was a flooding event in the middle of June, which could have had a big influence on grasshoppers species as most of the species are in the last larval stage at this time. Grasshopper larvae have the least chance of surviving a flood, because they are not able to escape the inundation by flight.

Species composition and habitat preferences of species

While inundation did not prove to affect species richness in our study, it had a strong effect on the composition of grasshopper species assemblages (DEMETZ et al. 2013).

While the relative abundance of hygrophilous grasshoppers and species without pronounced habitat preferences did not prove to differ between flooded and non-flooded meadows, xerophilous species were negatively affected by inundation. VAN WINGERDEN et al. (1991) found differences in the duration of postdiapause development (PDD) of grasshoppers, which takes place in spring until hatch, according to the temperature and humidity of the habitats. In humid habitats the PDD was shorter and in dry habitats longer. Wet sites were colder than dry ones and xerophilous species showed longer PDDs than hygrophilous species. The maximum temperature in the egg environment is a selective factor in habitat determination (van WINGERDEN et al. 1991). Hygrophilous species were found more often at flooded meadows, but the result was not significant. FISCHER & WITSACK (2009), who compared grasshopper assemblages of regularly flooded and non-flooded meadows along the river Elbe, documented that grasshopper species were more connected to the type of meadow, than to the flooding regime.

Effects of flooding on functional diversity

Our study did not provide any evidence that functional diversity of grasshopper assemblages was negatively affected by disturbance caused by flooding events. In contrast, GERISCH et al. (2012) found a decline in functional diversity from non-flooded to flooded meadows for ground beetle communities on periodically flooded grasslands along the Elbe River in Germany. In our study the ecological niches of regularly flooded and non-flooded meadows seemed to be similarly filled by grasshopper species. Most likely a rapid recolonization of meadows after the flooding through dispersal appears to prevent a decline in functional diversity.

Conclusion

Although species richness and the relative abundance of hygrophilous and generalist grasshoppers appears to be not severely affected by flooding events, natural floodplain dynamics still have a significant impact on species composition (DEMETZ et al. 2013) and the abundance of xerophilous grasshoppers on meadows in the Donau-Auen National Park (this study).

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From long-term ecosystem monitoring to regional modelling of ecosystem function in the National Park Kalkalpen, Austria

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Abstract

Here we show the usefulness of Long-Term Ecosystem Research (LTER) for scrutinizing climate change impacts on forest carbon (C) sequestration in the National Park Kalkalpen, Austria. Climate change will accelerate forest disturbances causing a decrease in forest C sink strength in the future. Delayed forest regeneration after stand replacing disturbances due to ungulate browsing opens an additional window for enhanced C loss. However, the dense grass layer, developing after large-scale disturbances, reduces ecosystem C loss by half, causing less climate feedback than expected. By applying two ecosystem models, we could show that wind and spruce bark beetle disturbances, which occurred during the last two decades throughout the National Park, increased soil organic C decomposition by 20% and will, together with future climate change, cause a 4% drop in forest ecosystem C stock by the year 2200.

Keywords

ecosystem monitoring, LTER, climate change, carbon sequestration, modelling

Introduction

Site-based infrastructure for Long-Term Ecosystem Research (LTER) has already been established in the 19th (e.g., 1891 Plön, Germany; 1840 Rothamsted, UK) and the 20th centuries (e.g., 1906 Lunz, Austria; 1925 Trout Lake Station, Wisconsin, US; 1955 Hubbard Brook, New Hampshire, US; 1960 Solling, Germany). In recent years, LTER has gained momentum since the research infrastructure strategy of the European Commission (ESFRI) is establishing a coherent network of LTER sites and seamless access to long-term data (MIRTL 2010). Since function, state and trends in unmanaged natural ecosystems are particularly interesting, many LTER sites are located in protected areas.

The National Park Kalkalpen, Upper Austria, with the LTER master site Zöbelboden is one such example where ecological monitoring infrastructure and long-term data is increasingly used by researchers. The site has been set up in the framework of the pan-European monitoring programmes in 1992 to evaluate abatement measures for the reduction of air pollutants being harmful to ecosystems (sulphuric acids, nitrogen, ozone, etc.). These days, LTER Zöbelboden focuses on several environmental changes (air pollution, climate change, forest management) and their effects on ecosystem services provided by mountain forests (pollutant filtration, carbon sequestration, biodiversity, etc.). During the last 25 years, LTER Zöbelboden became the most intensively investigated mountainous karst ecosystem in Austria, participating in many national and international monitoring and research projects.

As an example of a successful integration of LTER-born knowledge for supporting decision making in the National Park Kalkalpen, we present results addressing the carbon (C) sink function of forests and its modification due to forest disturbances from wind and spruce bark beetle (*Ips typographus* L.). Temperate forests currently act as sinks for atmospheric C. However, wide-spread tree damage, which has been occurring in increasing intensity during the last two to three decades, causes a release of C thereby increasing the CO_2 concentrations in the atmosphere. In an effort to scrutinize the impacts of forests disturbances on C sequestration in the National Park, long-term ecological monitoring data, additional field measurements, reconstruction of historic forest management and disturbance, and regionalized ecosystem modelling were employed.

Methods

Several design characteristics serve an efficient usage of LTER Zöbelboden data and infrastructure for National Park management purposes. Key components of the forest C cycle of widespread regional forest types (i.e. tree growth, litter fall, soil C dynamics) have been monitored at intensive measurement plots since 1993. In addition, soil CO_2 efflux surveys in combination with the root trenching method were conducted in order to calculate net ecosystem production (NEP), which is the net amount of C released or sequestered over time in an ecosystem. With tree replacing disturbances occurring in these plots after the year 2004, effects of forest disturbance on the forest C cycle could further be monitored. Additionally, space-per-time substitution was used to study long-term post-disturbance changes in the NEP. Two different well-established ecosystem models (LandscapeDNDC, http://svn.imk-ifu.kit.edu/; iLand, http://iland.boku.ac.at/startpage) used these data in combination with (monitoring) data of the National Park (forest inventory, modelled soil maps, Lidar data, aerial photo interpretation) for model initialization, calibration and validation at the landscape level. These model exercises aim to study both the historic and the future temporal trajectories of forest C sequestration within the National Park Kalkalpen (Fig. 1).

Results and discussion – Forest carbon sink

Field measurements in the LTER site Zöbelboden showed that mature forest stands on Cambisols with Norway spruce as the major tree species sequester 0.5 to 2 t C ha^{-1} per year (KOBLER et al. 2015, ZEHETGRUBER et al. 2017). Shortly after stand replacing disturbance, large amounts of C (~5.5 t C ha^{-1} y^{-1}) were released. Fast growth of a dense grass layer subsequently reduced C losses by ~50% (ZEHETGRUBER et al. 2017). After that, disturbed sites gradually return to a C sink due to accelerated C uptake from tree regeneration (Fig. 2). In contrast to these stand-replacing disturbances damage of single trees or group of trees did not fully diminish the C sink. KOBLER et al. (2015) found, that replacement of 31% of all trees in a spruce dominated stand at Zöbelboden did not lead to negative NEP.

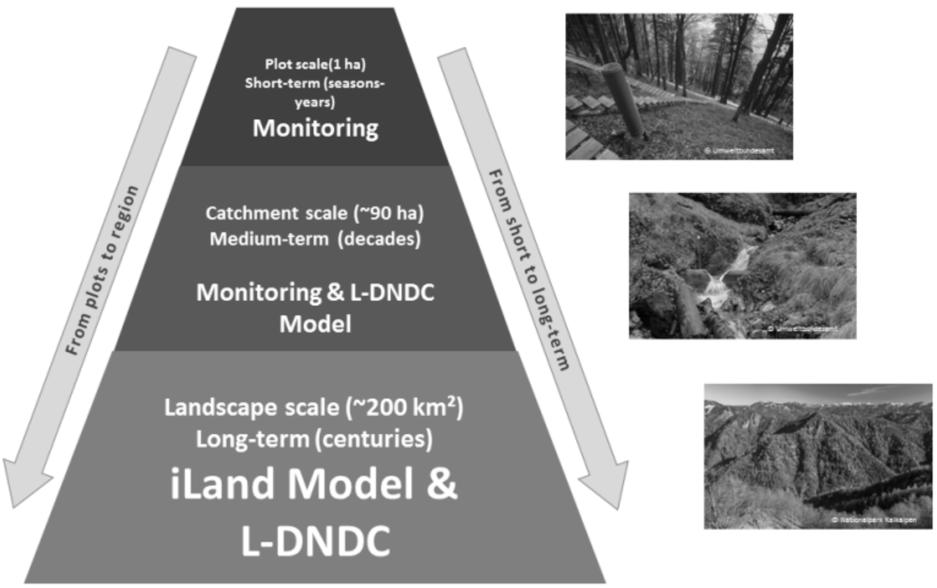


Figure 1: Using long-term monitoring data (plot to catchment scale) and ecological modelling (iLand and LandscapeDNDC) to study forest C sequestration at the landscape scale.

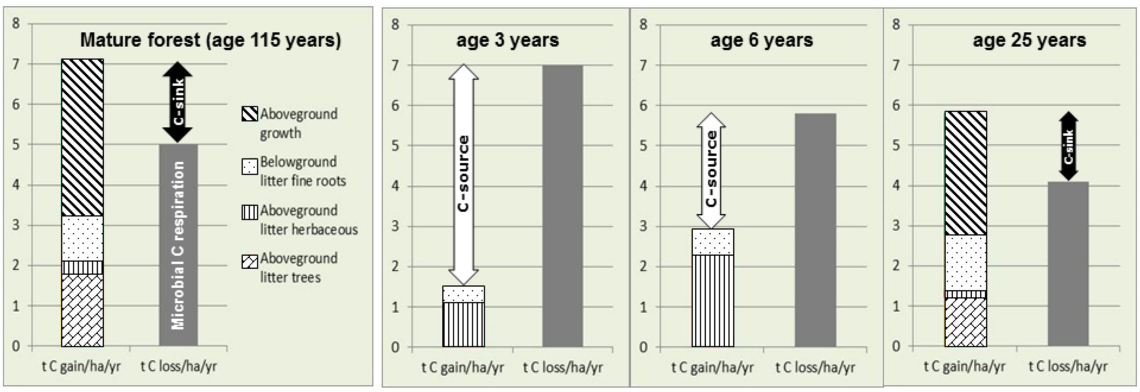
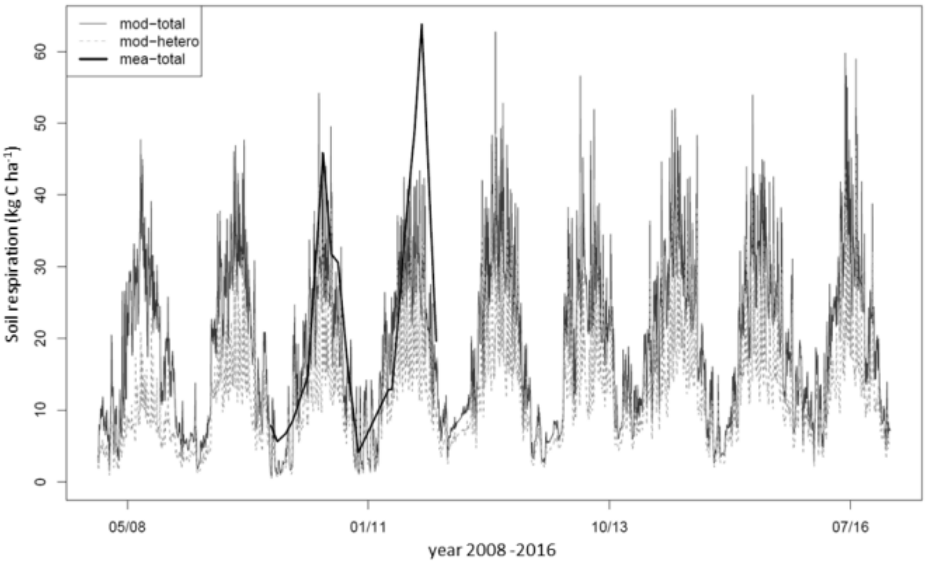


Figure 2: The forest C sink and source of spruce dominated forests three, six and twenty-five years after stand replacing disturbance in the LTER site Zöbelboden.

LandscapeDNDC, an ecosystem model for C, nitrogen and water cycles was successfully calibrated with long-term plot measurements from the Zöbelboden monitoring program (Fig. 3). The regional application of the model showed that forest disturbances during the last decade caused a 20% increase in soil CO_2 emissions (= soil respiration) (Fig. 3).

By applying iLand with roughly the same input data and climate scenarios to the National Park Kalkalpen area, THOM et al. (2017) showed that climate change, including disturbances, induced a reduction in tree biomass between -11.6% to -14.9% resulting in a -4% drop in the total C stock by the year 2200.
In an ongoing EU research project (www.ecopotential-project.eu) we are exploring the potential of the most novel remote sensing products for their usefulness in improving C-related modelling. These activities aim at finding a practicable monitoring schema for the National Park.



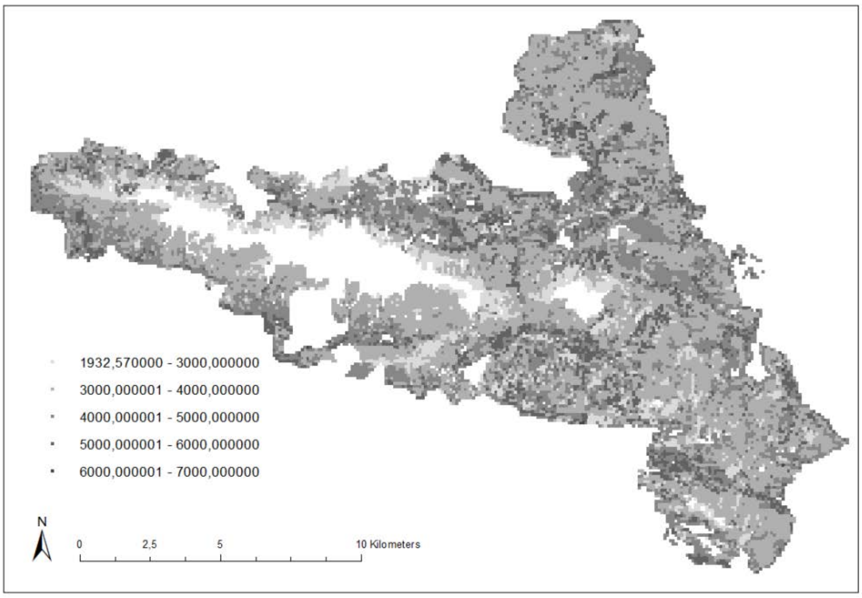


Figure 3: Top: Measured and modelled (LandscapeDNDC) soilrespiration at LTER Zöbelboden. Bottom: Modelled microbial soil C respiration (kg C ha^{-1} y^{-1}) for the National park area.

Conclusions

Our studies on climate feedbacks in the National Park Kalkalpen show that climate change will accelerate forest disturbances causing a drop in their C sink strength in the future. This lowering effect is due to a loss in standing biomass and respiration of large amounts of soil C by soil microorganism right after disturbance. Soil C respiration seem not to be significantly affected in the often small scale, patchy outbreaks of bark beetle infestations and wind throws of single trees or group of trees because soil climate is still regulated by the surrounding forest. In larger-scale disturbance areas, vital tree regeneration usually reduces C loss during only a few years after stand replacement. However, tree regeneration fails for many years when browsing pressure by large ungulates is too high. We found that the dense grass layer developing in such areas reduces ecosystem C loss by half, causing much less climate feedback than expected. That's however only half the truth because delayed forest regeneration after stand replacing disturbances opens a window for enhanced C loss, thereby causing a positive feedback on climate warming. Non-intervention management during and after forest disturbance, as is applied in many protected areas, has to additionally address regulative measures for controlling large ungulates.

Acknowledgements

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Invasion of non-indigenous carnivores in Austria – the current status of the raccoon (*Procyon lotor*) and the raccoon dog (*Nyctereutes procyonoides*) and prospects of their future distribution

Tanja Duscher

Dissertation of the University of Veterinary Medicine Vienna

Keywords

non-indigenous species, raccoon, *Procyon lotor*, raccoon dog, *Nyctereutes procyonoides*

Summary

The spread of invasive alien species (IAS) is a key factor for the worldwide decrease in biodiversity. Consequently, the prevention, monitoring, and regulation of IAS are major goals of many international commitments, including the new EU regulation 1143/2014. The non-indigenous carnivore species raccoon (*Procyon lotor*) and raccoon dog (*Nyctereutes procyonoides*), occurring in Austria since 1974 and 1983 respectively, were classified as invasive according to this regulation and have to be monitored and managed appropriately. Within the present study 149 raccoon records and 121 raccoon dog records of different categories were documented between the years 2009 and 2016. These records show a wide distribution of both species throughout Austria, particularly in the lowlands and river valleys. However, we failed to estimate their population densities since both raccoon and raccoon dog are not very common, yet. Low population densities (showing an increasing trend) are also indicated by hunting bag data of several Austrian provinces.

In view of a further spread of these successful and highly adaptable invaders it makes sense to identify the focal areas for future management, e.g. with the help of species distribution models (SDMs). Thus, we used a presence-only model (MaxEnt) to predict the probability of the raccoon's and the raccoon dog's presence in Austria. The expected core areas of raccoon colonization are mainly located in big cities and in large river valleys (Danube, Rhine, Inn, Salzach, Mur, Drau). Furthermore, the predicted probability of presence was relatively high along the northern border of the Alps, e.g. in the Vienna Woods, as well as in the Muehl- and Innviertel in the north-west of Austria and in the Klagenfurt Basin and the Graz Basin in the south. In contrast, the modelling of the raccoon dog's distribution prefigures a population increase in the eastern and northern parts of Austria, particularly in the Pannonian as well as the pre-alpine regions and the Austrian part of the Bohemian Massif (forest quarter). The predicted probability of presence is also comparatively high in the Klagenfurt Basin as well as in the Rhine Valley and the Bregenz Forest in western Austria.

With the aid of the modelling we also managed to determine the environmental drivers of those alien carnivores` distribution. The further spread of the raccoon seems to be influenced by climate as well as land cover data - with temperature parameters (number of hot days, mean temperature in January etc.), proportion of coniferous forests and of settlements, as well as elevation being the main drivers. In contrast, the raccoon dog's distribution seems to be mainly limited by climatic factors (snow depth, duration of snow cover, winter precipitation and mean annual temperature) and is consequently strongly linked to elevation. As a result, we assumed the Alps to be a certain barrier for the spread of the raccoon and especially of the raccoon dog throughout Europe. Due to climate chance, the ecological permeability of this barrier is expected to increase. Moreover, we have managed to exemplify, that habitat requirements of adaptive generalists such as the raccoon may change depending on the stage of invasion. It can thus be concluded that the importance of elevation as an ecological driver will decrease in influence with the ongoing colonization.

We investigated the parasitic fauna of the raccoon and the raccoon dog in order to determine its impact on human health. The eight examined raccoons were found nearly free of pathogens including the raccoon roundworm *Baylisascaris procyonis*. Therefore, raccoons can be assumed to have a low epidemiological impact at this stage. Out of ten raccoon dog specimens we found one from western Austria to be infected with the fox tapeworm *Echinococcus multilocularis* and another three from the eastern wetland regions to harbour adults of the Duncker's muscle fluke *Alaria alata*. Thus, the raccoon dog seems to be a relevant host, at least for these zoonotic pathogens and we suggest further monitoring of the raccoon dog's parasitic fauna.

Acknowledgements

I thank all the co-authors of my scientific manuscripts, especially Ursula Nopp-Mayr for her essential help and her friendly guidance concerning ecological modelling as well as scientific writing and submitting. I thank Sam Zeveloff for friendly and discreetly motivating me to complete my dissertation project, and Georg Duscher for his uncomplaining intra-family advice. I thank the genuine raccoon and raccoon dog specialists Frank and Berit Michler, Norman Stier and Astrid Sutor for their pleasant as well as helpful phone calls and e-mails. Moreover, I thank Nina Matousek for proofreading and gently commenting my first publication as well as the framework manuscript (addendum). Of course, I also thank Fritz Reimoser, who was an honest adviser even beyond his retirement. Last but not least, I thank my beloved husband Andreas Duscher for supporting me strength in bad times.

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Long term-monitoring of birds reveals drastic changes in the bird communities at the national park Neusiedler See – Seewinkel

Michael Dvorak, Georg Bieringer, Alfred Grüll, Eva Karner-Ranner, Bernhard Kohler, Johannes Laber, Erwin Nemeth, Georg Rauer, Beate Wendelin

Keywords
Neusiedler See, Seewinkel, Burgenland, bird monitoring

Introduction

The area of the Lake Neusiedler See, comprising Lake Neusiedl itself (including one of the largest reedbeds in Europe) and the adjacent Seewinkel with its unique soda lakes is one of the most important sites for the conservation of wetland birds in Central and Eastern Europe. Quantitative bird monitoring in the area started earlier than in most other sites of similar importance and there are comparable data on population sizes for many bird species from the early-1980ies onwards. In 1993 parts of the Lake Neusiedl area, in particular about 10 % of the reedbed of the Lake and parts of the Seewinkel were declared a national park and since then enjoy a certain degree of protection and, more importantly, also some large scale management measures. Regarding the avifauna the recreation of large areas of wet and dry grassland and the re-introduction of a large scale grazing regime with mainly cattle and horses had the most pronounced effect. While bird monitoring started long before the creation of the national park basic research and long term monitoring were important goals of the national park Neusiedler See – Seewinkel right from the beginning. This paper gives a concise summary of the results of the bird monitoring programs running in the area since about 35 years, concentrated on breeding birds. It evaluates the success of past management measures for bird conservation and draws conclusion for the further management regime of the national park. The results also elucidate some general patterns of avifaunal change in Central Europe during the last decade and can serve as a baseline to describe and discuss long term environmental changes and their influence on ecosystems and their animal communities.

Material and methods

The monitoring program covered 39 breeding bird species. These were selected on the basis that i) they are threatened on a national or international basis, ii) the Lake Neusiedl area is of special value for the species or iii) the species is of a high ecological significance for the area (e.g. because of their high numbers and therefore significant impact on the ecosystem). For some species qualitative and semi-quantitative data were available already for the 1950ies. For no less than 25 species quantitative surveys started in the early to mid 1980ies, for the rest in the mid-end 1990ies. Starting in 2001 and continuing until 2016 and in the foreseeable future, the national park started a comprehensive bird monitoring program with counts and surveys on a yearly basis for most species. For most species standard bird survey methodology was adapted to the particularities of the study area and refined over the years, for some species new methods had to be developed. Comparability over the years was of outmost importance, therefore, with one well justified exception counting methods remained the same for all species and in most cases also the personnel involved remained the same over the years. Trends were calculated for three periods of time: long term: ~ 1950 until 2015, medium term: 1981-2015 and short term 2001-2015 (for details see DVORAK et al. 2016).

Results
(see Tab. 1 & 2)

In the long term, only 31 of the 39 species covered by the monitoring program were already present as breeding birds in the early 1950ies. Eight species are new breeding birds not present historically. All of them colonized the area post-1980 and most (six) of them since 1995; three are very recent arrivals with first breeding in 2007, 2009 and 2012. Particularly noteworthy is that all these species are now well established and are today among the most common wetland breeding birds of the Lake Neusiedl area. Of the breeding bird already present 65 years ago, no less than 12 showed a population decline in the long term, nine have stable populations and only six showed an increase. Four were fluctuating or their status in the 1950ies is unknown.

In the medium term (1981-2015) ten species are still on the decline but another ten were increasing. Eight species show no clear trend and were fluctuating, most of them according to fluctuating water levels in the area.

From 2001 until the present only four species show negative population trends, seven are stable and no less than 11 have increasing or recovering populations. However, the majority (16 species) shows fluctuating population sizes in the short term. This partly reflects our better knowledge of exact population sizes (some species that were judged to be stable in the long term may have been fluctuating in reality), but also rapidly changing environmental conditions (for details see DVORAK et al. 2016).

Bird species	short term (2001-2015)	medium term (1981-2015)	long term (1950-2015)
Greylag Goose (Anser anser)	large increase	large increase	large increase
Common Shelduck (Tadorna tadorna)	large increase	new breeder (1995)	absent
Gadwall (Anas strepera)	fluctuating	stable	stable
Pintail (Anas acuta)	fluctuating	small decline	small decline
Garganey (Anas querquedula)	fluctuating	fluctuating	small decline
Northern Shoveler (Anas clypeata)	fluctuating	small decline	small increase
Red-crested Pochard (Netta rufina)	fluctuating	large increase	new breeder (1980)
Common Pochard (Aythya ferina)	fluctuating	fluctuating	stable
Ferruginous Duck (Aythya nyroca)	fluctuating	small increase	large decline
Little Grebe (Tachybaptus ruficollis)	fluctuating	fluctuating	small decline
Black-necked Grebe (Podiceps nigricollis)	fluctuating	small decline	large decline
Great Cormorant (Phalacrocorax carbo)	new breeder 2012	absent	absent
Pygmy Cormorant (Phalacrocorax pygmeus)	new breeder 2007	absent	absent
Bittern (Botaurus stellaris)	fluctuating	fluctuating	fluctuating
Night Heron (Nycticorax nycticorax)	fluctuating	fluctuating	fluctuating
Little Egret (Egretta garzetta)	fluctuating	new breeder (1995)	absent
Great White Egret (Egretta alba)	stable	large increase	large increase
Grey Heron (Ardea cinerea)	stable	large increase	stable
Purple Heron (Ardea purpurea)	stable	stable	stable
White Stork (Ciconia ciconia)	large decline	large decline	stable
Eurasian Spoonbill (Platalea leucorodia)	small increase	fluctuating	large decline
Little Crake (Porzana parva)	large decline	large decline	small decline
Water Rail (Rallus aquaticus)	fluctuating	fluctuating	stable
Black-winged Stilt (Himantopus himantopus)	large increase	new breeder (1981)	absent
Avocet (Recurvirostra avosetta)	large increase	large increase	large increase
Kentish Plover (Charadrius alexandrinus)	stable	small increase	large decline
Northern Lapwing (Vanellus vanellus)	stable	stable	stable
Black-tailed Godwit (Limosa limosa)	large decline	small decline	small decline
Redshank (Tringa totanus)	fluctuating	stable	stable
Common Tern (Sterna hirundo)	large increase	large increase	small decline
Whiskered Tern (Chlidonias hybrida)	new breeder (2009)	absent	absent
Black-headed Gull (Larus ridibundus)	stable	small increase	large increase
Mediterranean Gull (Larus melanocephalus)	large increase	new breeder (1988)	absent
Hoopoe (Upupa epops)	small increase	fluctuating	stable
Bluethroat (Luscinia svecica)	fluctuating	large decline	large decline
Savi's Warbler (Locustella luscinioides)	fluctuating	small increase	small increase
Moustached Warbler (Acrocephalus melanopogon)	small decline	large decline	unknown
Reed Warbler (Acrocephalus scirpaceus)	stable	small decline	unknown
Great Reed Warbler (Acrocephalus arundinaceus)	large increase	small decline	large decline

Table 1: Popuation trends of 39 bird species in three time periods (see text). Large decline/increase (+/- 50 % and more, decline/increase (+/- 20-50 %)

	long term	medium term	short term
large decline	6	4	3
small decline	6	6	1
stable population	9	4	7
small increase	2	4	2
large increase	4	6	9
fluctuating	2	8	16
new breeder	1	4	3
not occuring	7	3	0
trend unknown	2	0	0

Table 2: Summary of trends for 39 bredding species in the three time periods (see text and Tab. 1)

Discussion

The result of the long term bird monitoring in the Lake Neusiedl area clearly shows that in the long term, a large percentage of species (12 out of 39) showed a decline in numbers. These are mostly habitat specialists and species showing large scale declines Europe- or worldwide.

On the other hand short term trends since 2001 are mostly positive, only four species have a continuing decline. A more detailed analysis demonstrates that some of these recovering species have benefitted from management measures of the national park. Among these, the promotion and re-establishment of large scale grazing by far plays the most important role. Without the pastureland recreated by the national park the conservation status of many breeding bird species would be much worse.

However, these successes of the park management are overshadowed by the negative impacts of the deteriorating water regime of the area. Large scale drainage (some of it illegal) continued until recently and still continues. Intensive agriculture outside the national park (in many cases with crops unsuitable for the relatively dry climate of the area) drains heavily on the ground water resources and contributes massively to the ongoing environmental disaster happening in the Seewinkel. The Lacken die-off ('Lackensterben') has led to the disappearance of a large percentage of the soda lakes; what is still there is in most cases in a bad to terrible conservation status. Some bird species (most pronounced Black-tailed Godwit *Limosa limosa*) showed a promising increase during the first years of management but are now again on a (final?) decrease.

The last pattern emerging is the establishment of eight new breeding species within the last 35 years. These newcomers are now (some only when conditions are favorable) common breeding birds and make up a large part of the bird community. A few species (e.g. Black-winged Stilt *Himantopus himantopus*) have without doubt benefitted from national park management. But all are species of a southern or south-eastern origin generally on the increase all over Europe and expanding rapidly their distribution area. These species have changed the wetland bird community in the Lake Neusiedl area completely, they are now dominating while species with a more northerly distribution (e.g. Shoveler *Anas clypeata* or Pintail *Anas acuta*) and habitat specialists (Kentish Plover *Charadrius alexandrinus*) are declining. The waterbird fauna of the Seewinkel today resembles the one of a wetland in Northern Greece or Southern Spain 40 years ago. This faunal changes exactly match the shifts in breeding areas predicted by models as recently as 10 years ago (e.g. HUNTLEY et al. 2008). While from some point of view this can be also seen as a gain let's hope that in 50 years' time the Seewinkel will not resemble an oasis in today's central Sahara.

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Modeling grazing intensity of grassland

Gregory Egger, Susanne Aigner, Katharina Posch

Abstract

The land use model called ‘Grass Pre’ was developed to simulate the grazing intensity of alpine pastures. Model input parameters are 1) the total energy requirement of all livestock of the entire study area, which is calculated from i) the sum of all different types and number of livestock, ii) milk production, iii) duration of the grazing period, and 2) the ‘attractiveness’ of each polygon, for which the yield per ha is used as an indicator. The model output parameters are the used yield per hectare and the land use intensity of each polygon (see application example in the presentation of S. AIGNER).

Keywords

alpine grassland, grazing intensity, livestock.

Introduction

Since the mid of the 20th century the ongoing intensification of agriculture has led to a dramatically decline of extensive pasture land. Since the Second World War the area size of common pastures, bedding meadows and alpine pastures decreased with almost 70 %. The greatest decrease took place in the 60s and 70s of the 20th century. For example, in Austria from the 596 000 ha extensive pasture land of the 60s only 174 000 ha are left. The rest was intensified, afforested, or marked by scrub encroachment, and already reforested. The permanent grassland got an increase in area size of 713 000 ha in the last 50 years. In the patch of intensive grassland and trefoil-grasses an increase in area size of 40 000 ha is recorded. The trend of abandoning extensive pasture land can be seen in whole Europe. For example, also in Bavaria the area of permanent grassland is declined with 420 000 ha in the last 30 years. As a result the proportion of agricultural area is reduced from 42 % to 35 %. The number of dairy cattle declined with 22.5 % and the number of dairy cattle herder even with 50 %. In the same time period the milk yield of the Bavarian cows increased with 20 %. This increase is achieved by adding concentrated feed, as wells as through the use of silage, and by hot-air drying of the nutrient optimized green fodder. The increase of area and animal performance happen also in Austria. Especially in the most favored areas the livestock increased in the last five years. Whereas in the mountain regions this development is not observed due to the steepness of the areas. These regions are in particular be hit by land abandonment. Even in the succession phase to forest the biodiversity can be lower than in a usual cultivated meadow, pasture or alpine pasture (POSCH, 2005).

The most important consequences of this development are summarized here:
- Concentration of the use on well accessible and productive areas
- Extensification and abandonment of lands with marginal yields
- Increase of forest areas at the expense of extensive pasture land

Those changes have effects on the economy, on the image of a landscape and on biodiversity. In this light is a prediction of changes of animal stocks on the intensity of land use of concrete individual areas of particular importance. However, it is observed that for example the halving of the numbers of mountain livestock leads not automatically to a halving of the intensity of land use. It is rather a question that qualitative valuable and well accessible pasture areas are be eaten and be visited from the livestock slightly smaller. Whereas areas with lower quality for livestock are going to become grazed even in a smaller extent and disappear by increased lack of pasture maintenance – whereby the quality of pasture decrease even more and which finally can lead right up in an entire release from land use. Afterwards lower profitable areas are often this areas, which are in interest of nature conservation and are rated as in danger or as protected. Especially the extensive pasture land is be hit by these tendencies of land abandonment, scrub encroachment and reforestation. In return, an intensification of land use can lead by a missing offer of pastoral economically valuable pasture land to an overgrazing of extensive pasture land and with that again to a threat of scarcer and protected plant and animal species.

In the frame work of this paper the model ‘GrasPre’ (Predictive Model For Grassland Use) will be introduced, which predicts the intensity of land use (in large livestock unit per area; GVE/ha) of all subareas of a defined and for the grazing cattle accessible total area (e.g. alpine pasture) (see POSCH, 2005). The specialty of the pasture land use model ‘GrassPre’ is that it does not simply model linearly the intensity of land use by the ‘attractiveness’ of the individual areas. It rather determines the intensity of land use of the individual areas by considering simultaneously each attractiveness of every other subareas as well. Are there comparatively further similar pastoral economically attractive subareas available, they are tending to be grazed in a similar heavy manner. However, are there mostly pastoral economically unattractive subareas in the region, then this will accordingly be regarded in the model. Primarily, the most attractive subareas of the intensive pasture land will be grazed disproportionally intensive compared to the pastoral economically ‘unattractive’ extensive pasture land.

‘GrassPre’ is based on the evaluation model of alpine pasture, which was developed in the frame work of the research project called ‘GIS based modeling of yields to optimize pasture management of alpine pastures’ (In German: ‘GIS gestützte Ertragsmodellierung zur Optimierung des Weidemanagements auf Almweiden’) (EGGER et al., 2004). The evaluation model of alpine pasture enables a rapid and area-wide determination of the economic value of alpine pasture areas. The model output is the available quality yield per forage area. The purpose of the model ‘GrassPre’ is to model the land use of areas, for example of alpine pastures. The output of this model is the used quality yield per forage area. Within the frame of the symposium contribution of AIGNER & EGGER ‘Application example for modeling grazing intensity: National Park Hohe Tauern’, there will be presented an application of the model ‘GrasPre’ with more details exemplarily for the National Park Hohe Tauern.

Model design

The model simulates the decision of a grazing cattle whether and how intensive it will graze the subarea of a region. The model is based on two starting point parameters:

– Total energy requirement of a region. This results from genus of cattle, number of cattle, animal performance (milk yield, meat increase) and the duration of pasture.
– Attractiveness of the subareas. As decisive factor for this, the quality of pasture per ha is used. It can therefore be assumed that the gross energy yield (product of yield (in quintals dry mass per ha)) and the quality yield (in mega joule NEL) are pivotal for the decision of a cattle to use the area heavily, less heavily or not all.

The hypothesis of the land use intensity model is that firstly the best pastoral economically subarea with the highest quality yield will be used. With increased grazing of this subarea the attractiveness of it is also reduced. Is the quality yield of this best area decreased to the extent of the next best area, then this area will be involved in the land use (see Fig. 1). The higher the difference between quality yields of subareas the longer the time period until the next area will be involved in the land use. The inclusion of the further areas takes place by the same pattern until the whole energy requirement of the region is covered.

In accordance with an extensification scenario, a reduction of livestock (decrease of energy requirement) happens, consequently the pastoral economically less attractive areas (lower quality yield) will be only used in a smaller extent or not all. It is proceed from an unlimited accessibility of the subareas.

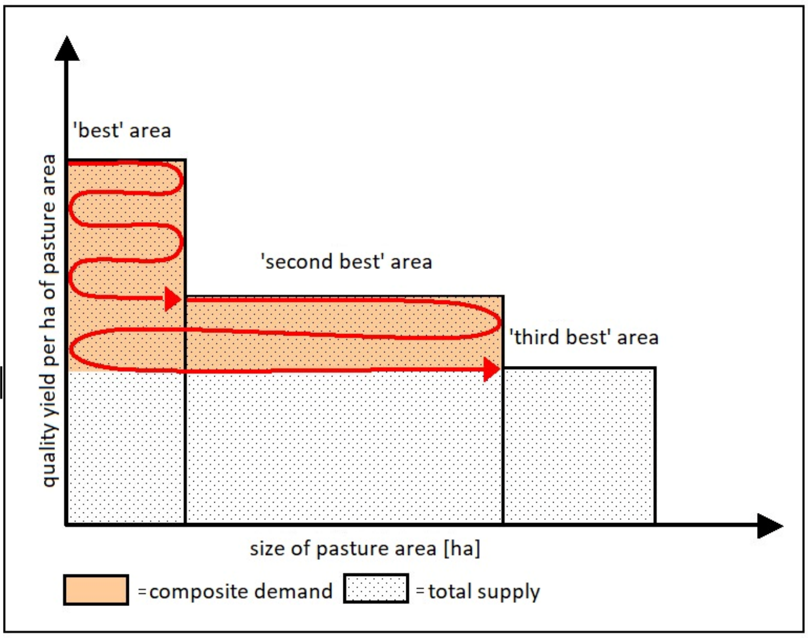

Figure 1: Schematic representation of the procedure of the land use model (modified; POSCH 2005).

The result of the simulation is the used quality yield per forage area. The coding of the model was done in Microsoft Visual Basic 6.0 in the office software of Microsoft called Excel 2000. The model output is the used quality yield per subarea or per hectare. The consequences of this is the calculation of livestock density and land use intensity (proportion of the used gross energy yield from the useable gross energy yield of the region in percentage) of the subareas. The output parameters of the model for every subarea are:
– Used quality yield absolute [MJ NEL]
– Used quality yield per hectare [MJ NEL/ha]
– Absolute livestock density [GVE] (= number of mountain cattle of alpine pastures in the region [GVE] * modeled used quality yield of the subarea [MJ NEL] / used quality yield of the region [MJ NEL])
– Livestock density per hectare and time period of alpine pasture [GVE/ha/WP]
– Livestock density per hectare and 100 days of pasturage [GVE/ha/100WT]
– Intensity of land use [%]

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Endemic vascular plants in the high mountains of the Sierra Nevada National Park (Spain)

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Abstract

The Sierra Nevada National Park contains an outstanding number of endemic vascular plant species, especially at higher elevations. We sampled the floristic composition of 20 sites along an elevational gradient from 2000 up to 3482 m a.s.l. Thereby, patterns of endemicity, species richness and leaf colours had been investigated to quantify diversity aspects of endemics. This study is part of the H2020 ECOPOTENTIAL project and improves the link between high-elevation endemic species and their climatic endangerment with modern sampling approaches (magnetic site marking, remote sensing products).

Keywords

Endemism, Elevational gradient, Mediterranean high mountains, Plant colours, Sierra Nevada

Introduction

Mountain ecosystems cover almost 25 % of the global land surface (BARTHLOTT et al. 1996) and often contain outstanding levels of species richness (LEVIN et al. 2007). Furthermore, they can harbour high rates of endemic, rare and threatened species. Mountains offer diverse habitats as environmental conditions such as temperature, soil conditions, elevation and topography change rapidly among small-scaled distributions (PAULI et al. 2003). They therefore pose appropriate possibilities to study species distribution patterns along elevational gradients (HUTTER et al. 2013; STEINBAUER et al. 2016).

While the elevation-species richness relationship shows heterogeneous patterns, proportion of endemic species seems to follow more general rules and must not necessarily correspond to the observed pattern of species richness (STEINBAUER et al. 2016). Percentage of endemism rather increases monotonically with elevation, which has recently been shown for islands as well as several continental mountain ecosystems (STEINBAUER et al. 2016). Similar mechanisms of island biogeography can thus be applied to other elevational gradients. Summits of continental mountain ranges are highly isolated and hence act as ecological islands (HOWELL 1947; TRIGAS et al. 2013).

With around 25,000 plant species, therein more than half endemic, the Mediterranean Basin is one of the 25 Biodiversity Hotspots defined by MYERS et al. (2000) worldwide. Here as well, mountain ranges play an important role for the distribution of plant species, especially endemic ones. Within the Baetic Region in southern Spain, only the highest elevations hosted glaciers, while lower elevated sites remained mostly uncovered by ice (Gómez-ORTIZ et al. 2015). Many of these glacial refugia act as biodiversity hotspots in present time (MÉDAIL & DIADEMA 2009), showing high species richness and high levels of endemism (PAULI et al. 2012). With more than 2,100 vascular plants the Sierra Nevada is one of the most important mountain ranges regarding plant species richness in the West Mediterranean Basin (BLANCA et al. 1998).

The following study aims to test if commonly reported patterns of decreasing species richness and increasing percentage of endemism also apply for the flora of Mediterranean high mountains. A further analysis on how leaf colours of these species change with elevation allows an insight into adaptive strategies of high mountain plant species.

Methods

The study transect was placed between 2,000 and 3,470 m a.s.l. on a southern slope towards the Muhlacén, the highest summit in the Iberian Peninsula. Within twenty sampling sites along approximately 1,500 meters of elevation, all present vascular plant species have been recorded. Furthermore, total vegetation cover and proportions of soil particles were estimated. Leaf colours of the main species have been measured using the Munsell colourspace for plant tissues. Subsequently, all endemic species have been categorised into four different endemic classes in accordance with their biogeographic origins: Sierra Nevada, Baetic, Ibero-African and Arctic-Alpine endemics.

Results

A total of 89 different species were recorded within the 20 sampling sites. Almost half (n = 40) of the recorded species belonged to one of the four endemic categories, the rest (n = 49) had wider distribution areas. Sierra Nevada Endemics were the most abundant group (n = 24), followed by Baetic Endemics (n = 9), Ibero-African Endemics (n = 4) and Arctic-Alpine Endemics (n = 3). While species richness monotonically decreased with elevation, general percentage of endemic species significantly increased. Different endemic classes showed variable patterns (Fig. 1). Leaf colours of 350 individuals of 20 different plant species were measured and included into the analysis of overall-species-colours along the transect. The lightness of leaf colours decreased, while blue and green proportions increased with elevation.

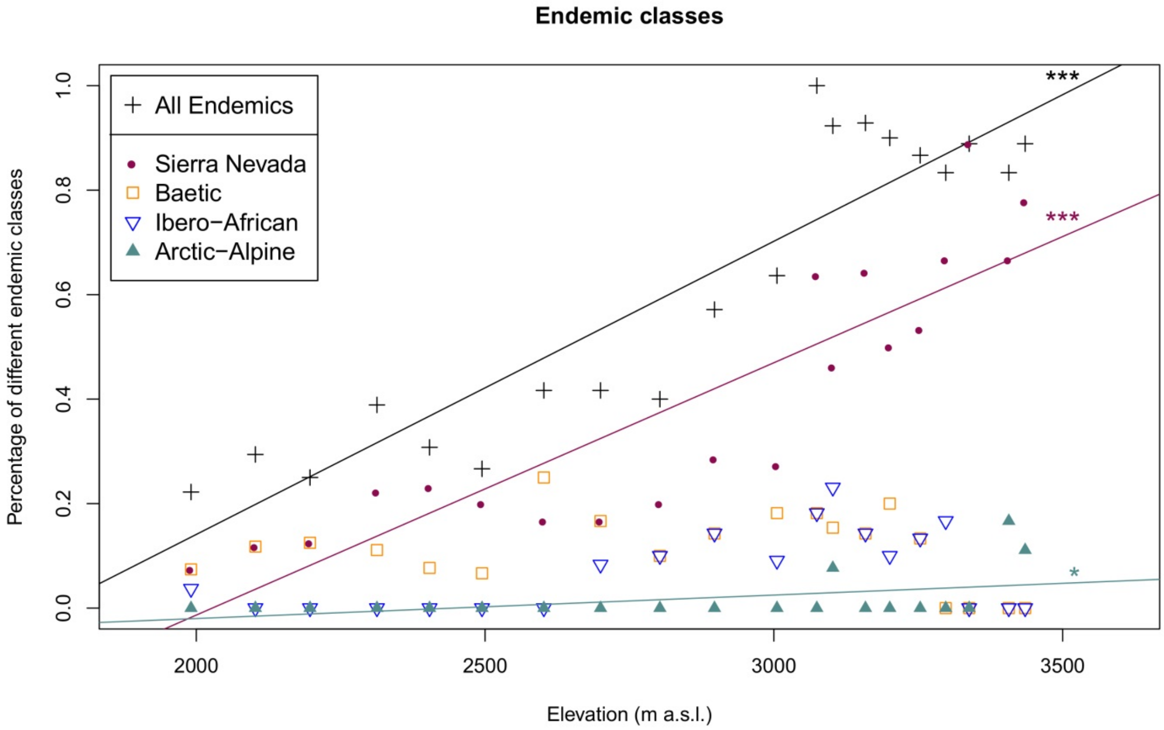

Figure 1: Percentage endemism increases with elevation for all endemic species (adj. R2 = 0.76) and Sierra Nevada Endemics (adj. R2 = 0.76). Baetic and Ibero-African Endemics do not show any trend, while Arctic-Alpine Endemics are only present within a few elevated sites (adj.R2 = 0.16). (Author: Pia Eibes)

Discussion and Conclusion

When considering species richness and endemic richness in general, patterns of the Mediterranean high mountain flora in the Sierra Nevada are consistent with findings from most other studies: with a general decrease for species richness and a proportional increase of endemism at high-elevation sites (e.g.: Jump et al. 2012, Vetaas & Grytnes 2002, Irl et al. 2015). However, the endemic species of the Sierra Nevada provide a particular opportunity to study individual endemic groups with different biogeographic origins. Continental mountains have often been described as ecological islands (e.g.: Whittaker & Niering 1968) and indeed, it seems that most of the theories originating from island biogeography can be applied to them, such as the explanation of isolation. Phylogenetic studies showed that endemic species at continental mountains are relatively young and indicate recent in situ speciation (Comes & Kadereit 2003). Hence, most endemic species in mountains can be considered as neo-endemics, which are assumed to be influenced by similar drivers as species on islands.

However, in continental mountain ranges, other origins of endemism can be found and percentage of endemism cannot simply be related to neo-endemism and in situ speciation. Deconstruction into finer biogeographic origins facilitates a better understanding of the general patterns (Jiménez-Alfaro et al. 2014). This deconstruction reveals that patterns for neo endemics and relict endemics are not identical, which indicates various drivers for different endemic classes. Hence, it is important to define to which range species are endemic and to include their potential origins and migration paths. A detailed analysis might be challenging when global datasets are used to search for generalities, because underlying patterns of different endemic groups will disappear at this scale. However, if knowledge on the flora of local elevational gradients exists, interpretation of the study findings obviously benefits from including this information.

The same applies to the integration of additional features, here, the study of leaf colours, which apparently change along elevational gradients. The fact that leaf colours change with elevation indicates that high mountain plants have characteristic colour adaptations through varying incorporation of different amounts or compounds of plant pigments, since these are the main components which leaf colours originate from (LEE 2007). Several protection mechanisms were expected to brighten leaf tissues colours of the plants in the Sierra Nevada high mountains, but the reverse effect was found. These results might point to enhanced amounts of several pigments, such as chlorophylls and anthocyanins. The first might explain the increase of green, whereas increased amounts of the latter might result in more blue leaves.

Numerous factors remain that complicate the research for drivers of biodiversity and the climate change will make it even more complex. Changing climatic conditions will impact the high mountain flora of the Sierra Nevada as well. High mountain plant species are particularly endangered, because they lack potential migration paths. Findings of this study indicate, that some endemic plant species such as the Arctic-Alpine endemics already have reached the sites with their possible climatic limits and further upward movement to suitable sites is impossible.

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Influencing behaviour of visitors and residents in protected areas

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Abstract

Inappropriate behaviour of visitors and residents is a critical challenge for managers of protected areas. Traditionally, to protect areas from inappropriate use, managers relied heavily on information sharing for example through pamphlets and signs in the area, and often in combination with strict enforcement of regulations. In many situations this approach has proven inefficient for the protection of sensitive areas and costly for critical relationships of parks management and interest groups.

Over the past decade the scientific understanding of how behaviour of individuals and socially connected groups is formed has substantially evolved, and it is certainly still growing. We propose a refined model, focused on understanding how user behaviour in protected areas is formed and can be influenced.

We also explore whether and how a broader tool set of interventions, such as it is applied in Community-Based Social Marketing (CBSM) (BALINT et al. 2011; KOTLER & LEE 2008; MCKENZIE-MOHR 2008; MCKENZIE-MOHR et al. 2012), would be effective in complex challenges for environmental and conservation concerns.

We find the model improves understanding user behaviour, and propose that park managers consider the model and a broader tool set to foster appropriate behaviour in protected areas.

Keywords

Degradation through users, behaviour management, visitor management, stakeholder relations, land use conflicts, conflict resolution;

Introduction

What factors play into the perceived acceptability of a behaviour from a user perspective? How can managers effectively influence user behaviour in protected areas? What factors explain differences in compliance with park rules between visitors and residents and how can they be addressed? In the session parks and people – reconciling park management with local and regional development - activities on the ground, we explore a refined model for how user behaviour is formed, and what intervention options exist to influence behaviour.

We test the test model against empirical observations in our work with consensus based participatory processes and behaviour management programs based on the Community-Based Social Marketing (CBSM) model.

CBSM is a methodology to influence behaviour of target groups by analyzing barriers and benefits of selected behaviors' from a user perspective. In CBSM an initial analysis identifies the best suited behaviours in terms of behaviour change and effectiveness for conservation objectives. Strategies in CBSM build on a broad toolset of consensus building and communication, and apply some or all of the following tools: Commitment of users to encourage the realization of attitudes and intentions in consistent actions, social norms to create a social environment for individual choices, social diffusion to increase awareness and adherence to norms through trust networks, signals and reminders to act in accordance with norms and commitments, and effective messaging and incentives. A rather unique approach in community based social marketing strategies is looking at ways to increase the convenience of promoted behaviors and simultaneously making inappropriate behaviour less convenient.

Methods

We reviewed scientific literature on planned behaviour and analyzed empirical observations from CBSM projects and experiences from our professional services to help implement or maintain protected areas.

Results

Models of planned behaviour propose that behaviour can be predicted and explained by attitudes, subjective norms and behavioural intentions. Following the model one would expect that behaviour of individuals or groups would change with corresponding changes in their attitudes, and one would focus on changing attitudes to induce such behaviour changes. Although attitude-behavior research shows an overall strong attitude-behavior relationship when methodological artifacts are eliminated it also finds that attitudinal relevance affects correlation.

This is just one explanation for why CBSM approaches have shown success in environments where attitude-behaviour based interventions did not succeed in promoting appropriate behaviour; here the link between attitude and behaviour seemed to be weak or buffered by other factors. There are other indications and a growing body of research how the rather simplistic attitude - intentions - behaviour chain is skewed by a few other factors and conditions.

In our refined model we propose self-identity, including attitudes and subjective norms, interact with social relations of the agents and the situational context in which they make choices. In our model, it is indeed the complex interaction of all those factors that leads to a displayed behavior, and which may not be explained by simplistic attitude-intentions-behavior models.

Discussion

Our refined model offers an explanation why interventions purely focused on raising awareness and changing attitudes fail when social relations or situational context affect the choices of targeted park users. The refined model still allows for the case where success through information sharing and coercion is achievable. However, in adding the elements of social relations of the agents and situational context in which they make choices the models ability to explain varied user behaviour in protected area is increased.

For example in a situation where tensions between the parks management and resident users manifest themselves in vandalism against park infrastructure the behaviour is a case of retaliation against a perceived overreach of managers - a incident rooted in a social context - and not founded in attitudes toward the natural environment. In situations where excessive littering is devaluing resting or gathering places in parks and affecting sensitive ecosystems the visitor attitudes may well be the same as in other parks, though the norm signalling effects of the situational context skew the behavioural intentions and open the door for the otherwise renounced littering.

Again, the refined model allows that information sharing through signs and printed material, possibly in combination with enforcement efforts, may have some effect, though it suggests those efforts will probably be limited in how many users are reached and how effectively behaviour is influenced.

By adding social relations of the agents to the planned behaviour model the refined model offers opportunities for a parks management to review their tool set for influencing user behaviour. It suggests that material punishment, traditionally a staple measure to coerce cooperation in matured social environments, is not the only or most effective way to influence user behaviour. An important lesson, especially when local interest groups are involved. This is not saying fines have no place, though they may be more effective when used in a nuanced tactical approach where the primary effort is to strategically build and use social relations to achieve the same goal without disrupting the foundational relationships between parks management and local user groups. In the end good relationships matter - a lot. Strained relationships come with great costs for the day to day work of parks management and erode crucial support in key moments.

Recommendations

We propose that managers should have a strategic focus on the social context of their protected area to build shared stewardship communities. This includes creating support for a collaboration of area managers with open minded and also with historically critical interest groups.

We propose that park managers test the proposed refined planned behaviour model with self-identity, including attitudes and subjective norms, social relations of the agents, and situational context to explore why users in their park make certain choices. Building on the refined model park managers can identify and apply a broader tool set of interventions - beyond information sharing and enforcement.

As a side note to the model development we found that the concept and the broader tool set of CBSM is more responsive to the various factors that affect choices users make in protected areas, and to key differences between resident users and visitors. Through the inherent analysis, strategy development and evaluation in CBSM projects management can also help to further the concept itself and further improve the tool set, especially for the specific context of protected areas.

Future perspectives

The scientific understanding and the applied methodology for influencing user behaviour is a growing field of knowledge that has practical value for the application in the management of protected areas. We suggest that managers of protected areas consider using this toolset and establish a Community of Practice for the application of CBSM in the specific context of protected areas to further their understanding and the methodology itself.

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Aspromonte National Park
The heart of the Metropolitan City of Reggio Calabria: design scenarios

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Abstract

The Metropolitan City of Reggio Calabria has a complex territorial system with different fields and context from the morphological and settling point of view to economic development. Inside of the city we find the Aspromonte National Park, almost like a 'metropolitan garden', a mountainous park of more than 65,00 hectares, which is an almost unique example on European level. The Park is in fact one of the five homogeneous territorial areas as identified by the latest Statute of the metropolitan city. The territory of the Aspromonte National Park is a sort of show, full of history and culture which arouses sense of belonging in the established communities, also for the significant relationships between man and nature which could become a source of interest to the potential opportunities of project. The proposed paper put in evidence the fact that in order to develop a different growth/improvement plan, it is necessary to have a complex and coordinated projectual strategy in the PNA settlement system, aimed at combining economy and enhancement of cultural and landscapes' resources with environmental protection. We want to propose of the possible design scenarios regarding the link between a proper growth of the territory (which has to be congruent with history, heritage and resources of the landscapes) and the necessity to be actively involved in the development of a wider territorial system, the one of the Metropolitan city which it is part of.

Keywords

Enhancement strategies, Metropolitan City, Settlement heritage, Connective and Networks

Introduction

The Metropolitan City of Reggio Calabria is characterized by a complex territorial system with different settings and contexts for each morphological form, settlement nature and levels of economic growth. Its territory coincides with the one of the former province, while links and vocations can be found in more territorial systems full of different details and identities. The PNA is one of the five homogeneous territorial areas of the metropolitan city (the other are the plain of Gioia Tauro, the Strait, the Locride and the Grecanica area). This choice represents one of the most innovative aspects of the Statute that recognizes the Park Area as a metropolitan territory which wants to par with other territorial contexts to activate Forms of development and enhancement consistent with the peculiarities of the places. The presence of a protected area (the Aspromonte National Park, a mountainous park of more than 65,000 hectares) included in the metropolitan perimeter, is a unique example on European level. It is an area which is characterized by an extraordinary landscape, cultural heritage and a rural but also mountain settlement system in which the residential side is becoming more connected to the tourist attraction with cultural, landscape, historical, archeological, enogastronomic and naturalistic goals. Inside the park there is a mixture of places characterized by a rural worlds that combines itself in a thousand different narratives, and it is push out to the future in a common and at the same time peculiar project. The territory of the Aspromonte National Park is a sort of show, rich in history and culture that wants to give a strong uniqueness in established communities. Its barycentric position in the 'vast' context of metropolitan territory, which includes 37 municipalities, one third of those that make up the entire area, represents a strong point in the metropolis process of the city of Reggio Calabria. In addition, the multiplicity and variety of so many local contexts give rise to so many settlement systems, the most often fragile centers of the metropolitan context. They also produce a geography, another view, for which we need to find forms of aggregation and specific spaces for intervention in the process of constituting the Metropolitan City, especially in the light of the homogeneity that provides the territory of the Park. Geography, therefore, reveals a territory that has experienced more or less positive events, depopulation phenomena, demographic and economic crisis, and ultimately the phenomena of physical degradation of the territory, all accompanied or otherwise resulting in a general depletion of the Territory itself. Here, therefore, processes are opening up to new geographies that intercept new issues: environmental, cultural-identity, strategic-infrastructure, bringing attention to the upgrading of the territory and the infrastructure network, the reorganization of services and the public space, on the necessity of physical accessibility, not of places and things, of reconnection of different parts of the city and of the territory through the project of red, green and blue networks.

The relationship between metropolitan system and park

The identity of the settlement characteristics of the PNA system have created structured links between urban centres and defines active contexts in local projects that are expressed in the search for forms of related development. From a functional point of view these areas present types of integration and exchange, and the characters of settlement systems, strongly influenced by the various morphological configurations, allow an aggregate reading to which you can associate the search for a primary vocation that each of them can unitarily carry in a comprehensive metropolitan city project. The settlement of the Aspromonte Park land characters allows detection of macro cultural areas, according to different homologous and identity matrices and functional relationships that are present in the territory of the park, which have created structured links between centers and areas themselves. The configuration of the metropolitan city territory is therefore closely linked to the presence of the Aspromonte massif. The rugged orography does not favour the establishment of inhabited centers and productive settlements; the greatest concentration of soil is recorded along the coastal strip of territory with the poles of greater aggregation species in the municipalities of Reggio Calabria, Palmi and Gioia Tauro on the Tyrrhenian side and in the municipalities of Marina di Gioiosa Ionica, Siderno, Bovalino and Locri on Ionic slope. The most impervious centers and least accessible areas of the territory do not reach the thousand inhabitants.

The reading of the metropolitan city's territorial system reflects the twentieth-century settlements dynamics and is characterized by the presence of a fragile infrastructure web both in connection with vast territory and in the relationships between the inner areas and the progressive abandonment of the inner centers for the benefit of Coastal areas, a process that tends to increasingly marginalize them. These considerations lead to the definition of a kind of reading of the settlement system of the heart of the metropolitan city, that is, of the PNA, functional to the design of the metropolitan city, determining for the structuring of a polycentric territorial armour made up of carriers, over-local system and systems Local areas that concern both the functional system of services and the accessibility network to converge and contribute to the design process of metropolitan city.

The system can be read through its features:

Settlement centers are the urban centres that represents the central settlements of the Park territory, as the 'directional' poles of a network of mountain settlements related to them. Equipped with discreet accessibility, they allow easy penetration to the highest odds. The territories of these municipalities are rich in interesting landscapes and have no significant environmental detractors. The factors of tourist attraction, in particular for Gerace and San Giorgio Morgeto, are distinguished by the rarity of the offer, also in terms of urban quality and image and atmosphere of the places. The level of services for residence and tourism is satisfactory and excels at Gambarie in winter sports, with the presence of interregional reconnaissance facilities.

Centers with strong identity and landscaping have compact and closed urban planning matrices and locations with strong perceptual suggestions. Characterized by a perched and defensive position, camouflaged in the landscape and not visible from the coast, dominate the surrounding area with a wide perception of the Mediterranean. They mainly belong to the Grecanic area and the Ionian hinterland, and are united by urban matrices, dwelling forms and building technologies, which together define a cultural lab that feeds and is renewed even under unfavourable conditions. The territories of the communes are rich in interesting landscapes and the factors of tourist attraction are predominantly historical-cultural and landscaping. In the case of Bova, the particularly striking atmosphere of urban places is enriched with numerous monumental-testimonial emergencies. Accessibility has critical elements in the Grecanic area, while it appears more appropriate to local needs in locals. The level of services for residence and tourism is very modest despite the presence of tourist accommodation along the coast.

Sea-mountain integration centers are located in the 'pre-pard' spatial area. These centers are characterized by a barycentric or strategic position in the coast-mountain relationship in a sort of 'hinged areas' between the strong coastal settlement system and the weak mountain linkage system. On the Tyrrhenian side, these centers represent the crown of hilly centers with a good level of infrastructure – logistic and cultural – that mark the Piana in a fan that has the summit of Gioia Tauro and as correspondence the arch of the coast stretching from Palmi to San Ferdinando. In the Strait area, the integration axis between Gambarie and the coastal area is strengthened by the presence of Santo Stefano d'Aspromonte, which marks a crucial stage of introduction to the discreet infrastructure park. On the Ionian side it is possible to interpret a kind of bijective mountain-coast relationship by linking the centers to an area characterized by the possibility of passing, in little more than half an hour, from mountain tourism to coastal-bathing. Overall development is achieved through a dense integration of the roles and the mutual support of mutual collaboration between mountain and coastal centers and the strengthening of relations between the Tyrrhenian and Ionic side.

The centers of the rural economy are those not otherwise charcterizable. These are agricultural centers that experience a difficult balance between the landscape quality of the sites and the extreme weakness of the territorial dynamics. They exhibit weak identity matrices and are affected by progressive phenomena of depopulation and the consequent shrinking of valuable crops.

Bosch and Forestry Economics Centers are characterized by rather fragile development dynamics that are amplified in relation to depopulation processes. The urban matrices from the centers have the typical characteristics of fragile economy agglomerations, often associated with low quality and recognizable building growth.

Settlement islands of great cultural and landscape interest have strong elements of fragility both from physical and socio-economic point of view. In the process of depopulation of some centers due to floods and instability, it is associated with the abandonment of other villages such as Amendolea of Condofuri for the migration processes towards the coast and the progressive demographic decline of the entire cultural area of Grecanica. The fires of great potentials can be a great opportunity for settlements of great potential because of places of pilgrimage (Polsi of San Luca), of solidarity (meeting community of Don Gelmini in Zervò) and of high altitude and climatic settlement. The future of these places and highlands that preside and structure is closely linked to the ability to understand the various potentialities in a network logic.

The Rural Fractions of the Rural Economy are characterized by a close relationship between residence and agricultural management of the funds. They are affected by progressive phenomena of depopulation and have very weak identity matrices.

The rural nucleus of the territory consists of the rural nuclei of the Grecanica and the Ionian slopes that serve as a function of mountainous territory. They are linked to the valorization of hiking trails, as they compose, together with the forty-two trains of the forest, a potential network of hiking service (huts, shelters, information)

In the typology of the **Places of Memory**, ancient settlements fall under the condition of no longer recoverable ruins that can be of tourist interest as sites of memory (organized in thematic networks) that insist on areas of extraordinary landscaping interest. The creation of thematic networks and integrated nature-culture-memory circuits is of extreme interest to the metropolitan city project as they allow the relationship between the little known natural resources, the network of memory centers, the complex of archeological goods and the numerous testimonies Architectural features of Calabrian history in favour of a cultural tourism strongly rooted in the complex character of the Aspromonte's territory.

Design themes and lines of action. The Park as the heart of the metropolitan city

The design themes that emerge from the interpretations of the settlement system lead to the possibility of exploiting the potential expressed by the 'new metropolitan city' to overcome the current fragmentation of the places. Strengthening the prospects for functional integration through conscious and innovative use of resources can be a challenge of great complexity, but potentially capable of producing benevolences that are very important to the metropolitan airline in its entirety. The great issues that emerge from readings can therefore be summarized in four values to guide the planning actions of the metropolitan city's formation process: **quality, vivacity, identity and productivity.**

- **Quality** of landscapes, beginning with those most frequently perceived by the main axes of penetration and quality of settlements and built in terms of image and atmosphere of the resort, urban furnishings, characteristics of the settlement and urban fabric.
- **Vivacity** in seizing the opportunities and in the ability to valorise the strengths and to transform fragile elements into their own favour; Vivacity in adopting the new level of technical procedures and methods and expressions of hospitality, receptivity, cordiality and conviviality.
- The propensity to innovate can well coexist with the affection of traditions and the concept of **identity** that can be combined with the historical, cultural and environmental peculiarities of the places and in the area of typical and enogastronomic products that more than any other call attention and Tourist attractions.
- **Productivity** as a capability to gain visibility and recognition in a precise market segment and progressively refine the product, gain quality awards, promote its diffusion and marketing. It certainly represents an advantage for the planning of the Park's residential environment, in the metropolitan context, pursuing these values that already belong to the context, and stunted however for the many obstacles to development that permeate most of the internal territories.

Working on the progressive implementation of the called values means directing every energy, every opportunity that is determined within the Park territory project in it towards the metropolitan context, outwardly towards the guiding principle of the continuous, progressive and shared improvement process.

The methods and the ways to operate are of a different kind. There are direct Park Party interventions to improve relations between the established environment and the Park, which must ensure the weight and role of pilot interventions to indicate design guidelines and generate reverberating effects in the sphere of contiguous transformations of the vast metropolitan context.

A second mode is related to the role of directorship improvement that the Park Authority can play in steering **the transformation** government towards the continuous improvement of the quality of settlements centers, fractions and nuclei even through incentives for the progressive achievement of a Quality of the established environment.

A third planning orientation concerns the activities that the Park Authority can express for the **formation of a new culture of residency and of living** more adherent and meeting the Park conditions in a metropolitan reference context in formation.

All of the recalled interventions modes allow a for the first structuring hypothesis for design themes the **park's directional locations**, the promotions and enhancement of the park's central park system complementary roles in the centrality system;

- **The material connective networks** for the multi-functional valorization and integration of the various existing types;
- **The network of receptivity and reception**, for the rationalization, enhancement and promotion of diffused, qualified and diversified receptivity and for the promotion of local tourist offer systems;
- **The network of cultural and recreational infrastructures**, the promotion of projects for the enhancement of cultural structures and the creation of educational and scientific laboratories and an integrated system of leisure activities;
- **The quality of the settlement environment and the safety** of the parks for the promotion of projects aiming at the progressive achievement of the quality of the established environment of integrated projects in support of the high rural areas and of environmental re-qualification.

All this leads to the transformation of settlement system into attractive poles, bringing those types of economy that form new social and cultural aggregation models raising the quality level of the entire metropolitan context.

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Combined use of KDE+ software and empirical observation to identify animal-vehicle collisions' hotspots in South Tirol, Northern Italy

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Abstract

Animal-vehicle collisions (AVC) with red and roe deer in South Tirol, norther Italy, count some 700 cases per year, with several socioeconomic and ecological implications. For an effective and timesaving identification of AVC hotspots, we have applied a combined methodology of empirical observation of wildlife in the proximity of the road network and statistical analysis on AVC data. The integration of the results coming from different methodologies allowed for a better objective selection of significant clusters and for the risk ranking of the hotspots according to their significance and collective risks.

Keywords

Kernel density estimation, Animal-vehicle collisions, Hotspots, Bolzano, South Tirol, Italy

Introduction

Animal-vehicle collision (AVC) is a serious environmental, socioeconomic, healthy and traffic issue all over the World. Roads can affect wildlife in numerous different ways, both direct and indirectly. Habitat loss, degradation and fragmentation (EWERS et al. 2006), as well as animal mortality (ROGER et al. 2007) are acknowledged as direct effects for the reduction of permeability (BISSONETTE & ADAIR 2007). South Tirol is an Italian Province located at the northeastern corner of central-eastern Alps. Due to the high level of anthropic presence and to the size of deer population, AVC are around 700 cases per year, on all the main local, provincial and national roads.

<u>Research Questions</u>

How is it possible to better identify the most dangerous hotspots of AVC?
What information can be gained from AVC in order to improve local ecological connectivity?
How can we stimulate a common approach on the topic by protected areas, hunter guards, local administration and research?

<u>Session: The different dimensions of ecological connectivity</u>

The Province Administration is currently engaged in a detailed study on the provincial ecological network and on the effects of local roads on it. In order to identify the resolution strategies for AVC, it is fundamental to carry on an objective identification of locations on transportation networks, where AVC occur more frequently than expected (hotspots). This approach needs the cooperation of different local actors, who provide their expertise and knowledge on wildlife presence, dispersal, ecological needs and reaction to roads.

We applied the KDE+ (BÍL et al. 2013, 2016) method to AVC data, collected by the Hunters' Association of South Tirol in the entire South Tirolean road network, in order to identify AVC clusters and hotspots. Local hunters, hunting guards and wildlife managers on behalf of the Autonomous Province of South Tirol (TORNAMBÉ & HALILAJ 2015), have joined the KDE+ hotspots' results with the empirical ecological corridors identification and wildlife movements.

Methods

<u>Study Area</u>

South Tirol is an Italian Province located in central-eastern Alps, close to the Austrian Border (Fig. 1). The Provincial Road Network has an extension of 5016 km, which correspond to 677,8km/1000km2 (ASTAT 2012). This province shows a high presence of ungulates. Each year around 8000 roe deer and 3000 red deer are hunted in the Provincial territory (PROVINCE OF BOLZANO 2015).

Figure 1: Location of South Tirol (northern Italy)

Ecological corridors in South Tirol

Already in 2000, Gufler prepared a map of gene-flow potential and main barriers to wildlife in South Tyrol (see TORNAMBÉ & HALILAJ 2015). This was followed in 2013 by an analysis of the permeability of the South Tyrolean landscape to wildlife, in particular red deer and roe deer, based on wildlife collision statistics for these species (EISENSTECKEN 2013). In early 2016, the Department for Nature, Landscape and Spatial Development, Landscape Ecology office of the Autonomous Province of Bolzano presented a new study on ecological corridors in South Tyrol (TORNAMBÉ & HALILAJ 2015). The study comprises numerous examples of ecological corridors in South Tyrol from direct observation of wildlife behaviour and movement in proximity of the road network by hunting guards and wildlife managers.

The KDE+ Method

The KDE+ method allows for the objective selection of significant clusters and for the ranking of the hotspots. The idea behind the application of a clustering method is the existence of two fundamental causes of traffic crashes (ANDRÁŠIK & BÍL 2015; BÍL et al.. 2013 and 2016): local factors that influence the crash occurrence at a given location and global factors that influence traffic crash occurrence on regional scale.

Results

The KDE+ application to the South Tirol road network

KDE+ analysed 2368 AVC crashes, 49.5% (1092) of which were detected in 343 clusters. These clusters comprise only 0.86% of road network length. Ratio of crashes with red deer in clusters is only 35%, which comprised 0.10% of network length.

Overlapping empirical detected corridors with AVC clusters – a case study

According to their collective risks, the highest risk of AVC with Red and Roe deer is in the same locations identified by local hunting guards, hunters and wildlife managers as ecological corridors (TORNAMBÉ AND HALILAJ 2015). Figure 2 focuses on the clusters 69 and 116, located, respectively, in Ultimo Valley, and on the motorway Merano-Bolzano (MeBo), inside of the identified corridors, in the Adige Valley. The Adige valley, a densely populated and intensively used valley by irrigated agriculture, hosting a motorway, several provincial and local roads and a railway, has already been addressed as one of the greatest barriers for wildlife dispersal (Kohler et al. 2008; Peters et al. 2015).

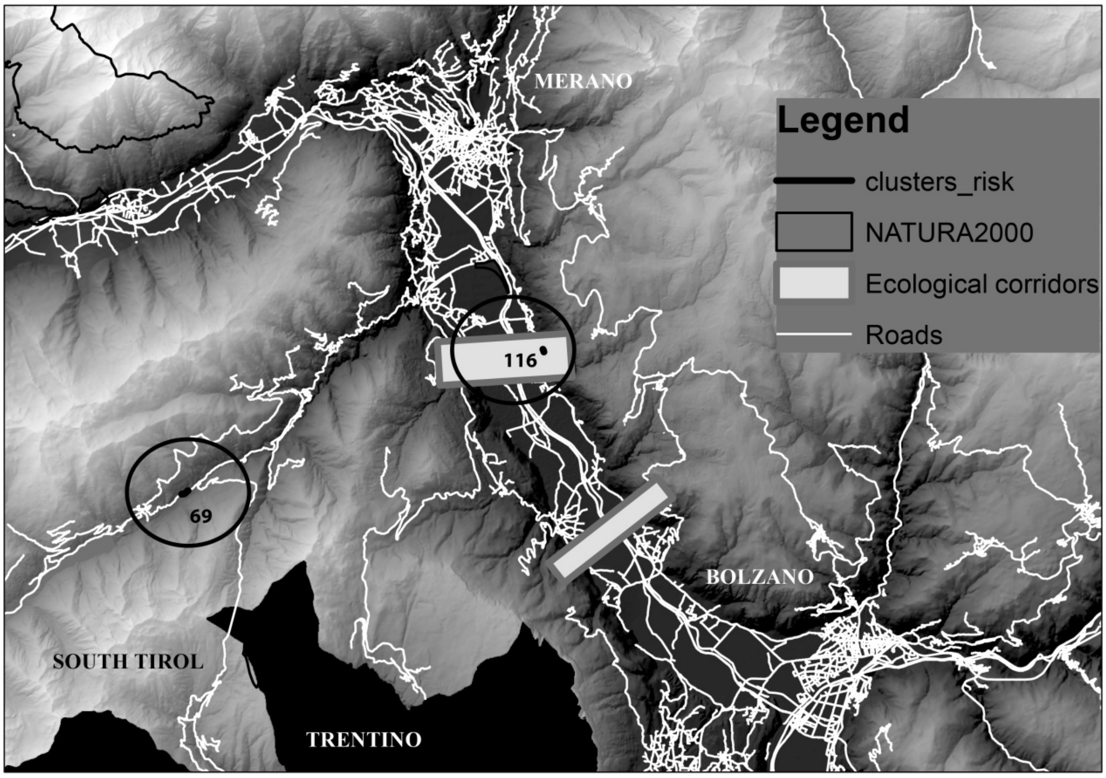

Figure 2: The two clusters with the highest collective risk in South Tirol

The Ultimo Valley is one of the most remote valleys of South Tirol; it belongs to the Merano hunting district and shows one of the highest concentrations of Red Deer populations (Fig. 3).

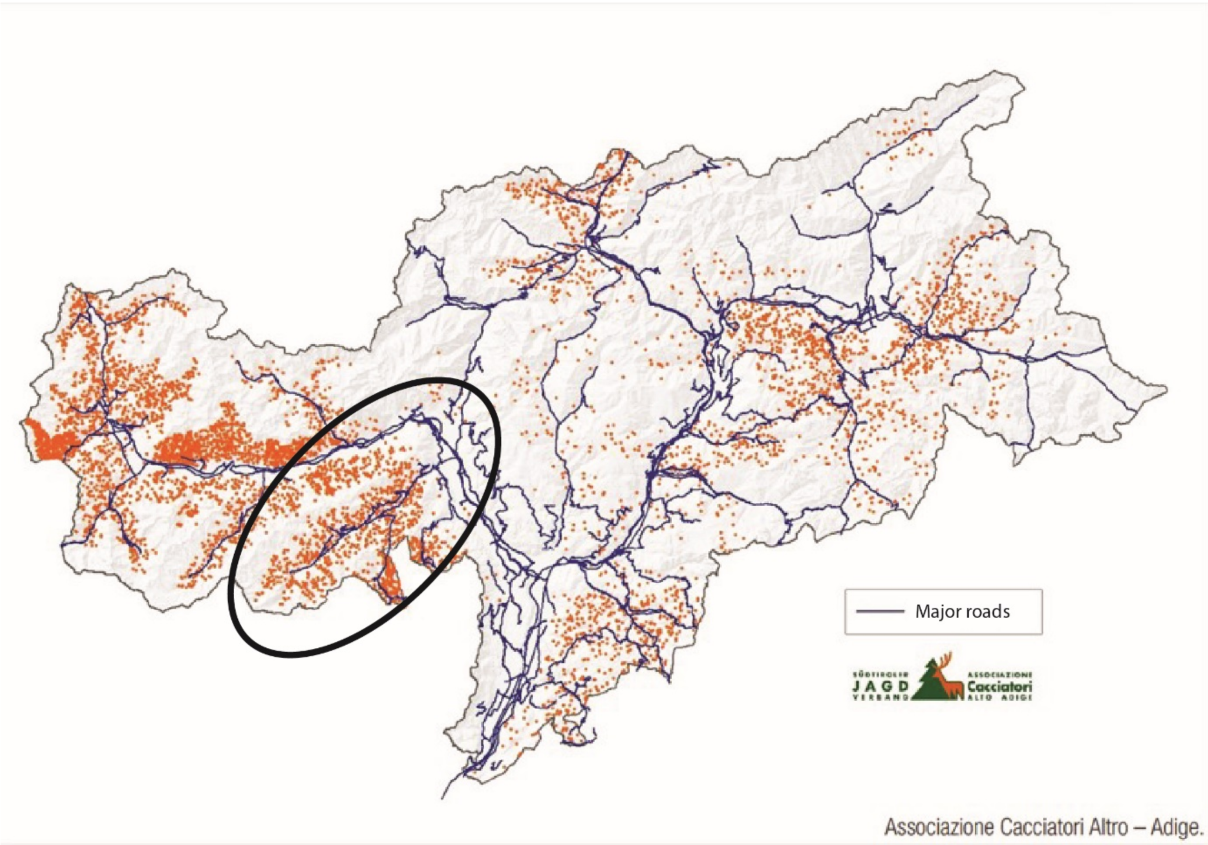

Figure 3: Location of the Ultimo Valley, with presence data from Red Deer census of 2013
(modified from http://www.provincia.bz.it/foreste/fauna-caccia/caccia-alto-adige.asp).

Discussion

We analysed traffic crashes with roe and red deer in the South Tirol Province in the period 2012 – 2014, using an integrative approach of KDE+ analysis and direct observation. The amount of crashes, their temporal and spatial patterns appear to be caused by an interaction of factors related to the drivers' behaviour, the animals' activities and the characteristic of the sites. In the top collective risk hotspots, local factors can be referred to the familiarization of drivers to the local roads, to the traffic flow, which has been attested between 28.000 and 37.000 vehicles/d on the MeBo (ASTAT 2016), and to landscape and ecological factors. Ecological factors are due to intensive activities (moving) due to feeding, dispersal movements of sub adult bucks, as well as establishing of territories of adult bucks. This approach enabled the identification of the most risky places of AVC, which is an important knowledge for all the local actors dealing with wildlife, ecological connectivity and road administrations. Effective mitigation of hotspots can save lives of both drivers and animals (BÍL ET AL., 2016).

Final Consideration and recommendations

Further studies will be required to distinguish between the contributions of different factors, without limiting primarily to animal-related factors, such as population and dispersal, but accounting for site characteristics, drivers' behaviour, traffic intensity and people's awareness. The present work wish to contribute to the reduction of human-wildlife conflicts in South Tirol due to road infrastructures, aiming at the continuation and deepening of the research on mitigation and prevention systems for AVC, currently on going in the provincial territory. The paper wants to highlight part of the interferences occurring between humans and mobile wildlife species in a mountainous and highly anthropic environment like South Tirol, in order to improve humans' and wildlife's safety and the general human-wildlife coexistence.

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Sustainable hunting plan as a tool of wildlife management: the Italian case

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Abstract

Sustainable hunting plan is an interesting tool for managing game species in order to avoid potential conflicts with other ecosystem services (biodiversity conservation, recreation and the preservation of economies and cultures in rural areas). If wildlife population increases too much, natural ecosystems functionality can be threatened by ungulates' browsing and grubbing. Conversely, when species conservation is at risk, the hunting itself needs to be limited. Sustainable hunting plans can managed emerging conflicts. The aim of this study is to analyze hunting in Italy - through the provision of up-to-date statistics - in order to inform local planners and managers for the developing of local sustainable hunting plans. The results show that the main hunted large mammals species are wild boar in Central Italy and red deer and roe deer in North Italy, while the main hunted small mammals are wild rabbit and European hare.

Keywords

wild game species, hunting statistics, ecosystem service, Italy.

Introduction

Sustainable hunting is defined as the use of wild game species in a way and at a rate that does not lead to the long-term decline of biodiversity or hinder its restoration (Brainerd 2007). In accordance with the definition of 'sustainable use' by art.2 of the Convention on Biological Diversity (CBD), sustainable hunting has the goal to maintain biodiversity to meet the needs and aspirations of present and future generations, as well as maintaining hunting itself as an accepted social, economic and cultural activity. In other words, hunting can positively contribute to the regulation of game populations and their habitats, so that also society can benefit (Milner-Gulland et al. 2009). From the theoretical point of view, sustainable hunting removes the number of individuals added to the population through natural population growth (logistic equation). In addition, hunting affects the distribution of population by age, sex and stage classes (Calvete et al. 2005), and the structure and function of the community as whole (e.g. ecosystem services provisioning such as biodiversity conservation, recreation and the preservation of economies and cultures in rural areas) (Fischer et al. 2013). The key tool to regulate hunting in a sustainable way is the 'sustainable hunting plan'. The objective of the sustainable hunting plan is to establish the annual number of individuals to be hunted by species based on the wildlife censuses and natural population growth. Therefore, in order to develop sustainable hunting plans at national and local level a key point is to have constantly updated hunting statistics.

Starting from these preliminary considerations, the aim of this contribution is to provide the hunting statistics at national level in Italy. The need to provide national hunting statistics is particularly felt in Italy because the 21 Regions and Autonomous Provinces have total freedom in the hunting data recording system.

Game hunting management in Italy

In Italy, game hunting management is arranged in four administrative levels: national, regional, provincial and a sub-provincial level. At the national level, the State establishes that protection of wildlife species is the rule and game hunting is the exception (art.2 National Law n.157/1992). For that reason, the National Law n.157/1992 makes a detailed list of which species can be hunted distinguishing between sedentary and migratory species, the time when they can be hunted and how they can be hunted (art.18). In addition, the National Law establishes that the whole rural area (agricultural lands, forests and grasslands) must be managed through a management plan aimed at organizing game hunting on the basis of the number and the reproductive capacity of the species in the area (art.10). This National Law also states that it is responsibility of the Regions (21 Regions and Autonomous Provinces) and Provinces (110 Provinces) to formulate the game hunting management plan. Each Region and Province has to draw up a Regional Game Hunting Plan ('Piano Faunistico Venatorio Regionale' - RGHP) and a Provincial Game Hunting Plan ('Piano Faunistico Venatorio Provinciale' - PGHP).

The RGHP is a large-scale plan that establishes the criteria to determine the optimal land use and the criteria needed to set up private game hunting organization (called 'Aziende Faunistico Venatorie'-AFV and 'Aziende Agro-Turistico-Venatorio' AATV). In addition, the Regions promulgate regional laws and regulations to integrate the National Law and to adapt the game hunting activities to local peculiarities. In particular, the National Law established that 20%-30% of regional rural area must be assigned to the protection of wildlife species (this percentage is reduced to 10-20% in Alpine area), a maximum of 15% can be reserved to private game hunting (AFV and AATV); and the remaining part of rural area must be managed through a game hunting management plan.

The PGHP identifies which part of the provincial rural area has to be assigned to different uses, in accordance with the principles laid down by National Law n.157/1991, Regional laws and regulations. Each Province identifies the optimal land use destination and the institutions for managing the game hunting activities at local level (sub-provincial level). In Italy, four institutions (two public institutions and two private institutions) are responsible for managing wildlife at local level: 'Ambiti Territoriali di Caccia' (ATC), and 'Comprensori Alpini' (CA), 'Aziende Faunistico Venatorie' (AFV) and 'Aziende Agro-Turistico Venatorie' (AATV).

ATC and CA are public institutions responsible for game hunting at local level. These institutions are also responsible for the census of wildlife and for assigning the number of animals to be killed for each hunter. Hunters have to be registered at least in one ATC or CA, and they can hunt only in that ATC or CA. They can be registered in more than one ATC or CA or they cannot, depending on ATC or CA statute. ATC and CA may have a maximum number of registered hunters established by the Region on the basis of their rural area. ATC and CA have the same competences and powers but with a substantial difference: CA can only exists in the Alpine area, while ATC in the rest of the country.

AFV and AATV are game hunting private organizations, but with some differences.: (1) AATV are profit organizations while AFV are not; (2) in the AFV hunters pay a membership fee, while in the AATV hunters are not members but pay a ticket for hunting; (3) AFV are required by law to have a plan for wildlife protection and to respect the game hunting calendar, while AATV are not bound to have a wildlife protection plan and to follow the calendar.

Specifically, the game hunting calendar is a period of the year when game hunting is allowed. The National Law defines the stars and ends of the calendar for each species, but the Regions are allowed to modify this period. The game hunting calendar is reported in the hunting card ('tesserino venatorio'), that is a one year effective document in which hunters report all hunted animals. At the end of the game hunting season, hunters have to return the game hunting card to the institution provided by the regional laws (e.g., ATC, CA). Consequently, the information on the number of animals hunted by specie are collected at local level from several different institutions: ATC, CA, AFV and AATV. These local institutions should send the data to the highest administrative level (Province or Region). However, according to the National Law the local institutions are not forced to register the number of hunted animals and all other information included in the hunting cards.

Taking into account these considerations, in order to collect the data concerning the number of hunted animals it was necessary to request the information at all administrative levels (Fig.1): local level (ATC, CA, AFV and AATV), provincial level and regional level.

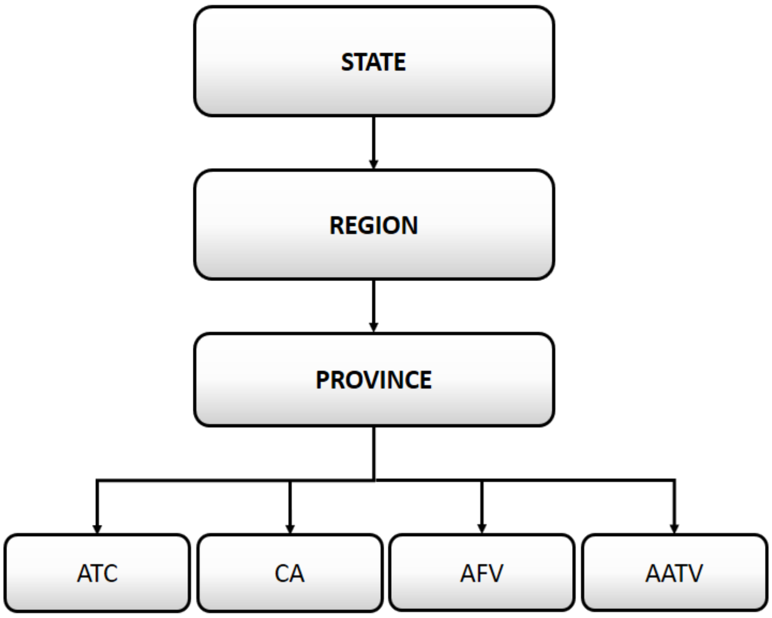

Figure 1: Framework concerning the public and private institutions involved in the game hunting management in Italy.

Materials and methods

The research framework aimed to investigate the number of animals hunted in Italy and the resulting economic fallout has been divided into the following three steps:

1. identification of total number of institutions involved in the game hunting management and total rural area managed;
2. development and administration of a semi-structured questionnaire aimed to collect the basic information about game hunting at local level;
3. statistical elaboration of the collected data in order to produce national statistics on game hunting.

The questionnaire was divided in six thematic sections. The first thematic section focuses on the personal information of respondent (name, role in the institution), the second one is about institution information (rural area divided in protect area and game hunting area). The third and the fourth thematic sections focus on the numbers of hunted animals by species and the number of hunters that are member of the institution, on a three years base (2013-2016). The last two thematic sections focuses on the cost-benefit analysis of game hunting (values of trophy and meat). The first version of the questionnaire - designed for the local institutions (ATC, CA, AFV and AATV) - was adapted to the peculiarities of Provinces and Regions.

The preliminary version of questionnaire was pre-tested with two ATC and one Region in order to check for any problems and difficulties in filling it.

Region / Specie	Chamois	Roe deer	Red deer	Fallow deer	Moufflon	Wild boar	Total
Valle d'Aosta	857	1072	285	0	0	409	**2623**
Piemonte	1996	4101	1470	159	139	n.a.	**7865**
Liguria	39	1053	0	305	0	13856	**15253**
Lombardia[1]	604	528	1210	7	138	2155	**4642**
Trento	2820	4195	1818	0	227	0	**9060**
Bolzano	3558	8916	3115	0	3	3	**15595**
Veneto[2]	1213	2079	1811	150	650	n.a.	**5903**
Friuli Venezia-Giulia	629	4018	1201	3	131	2281	**8263**
Emilia-Romagna	0	16551	1086	1216	0	22270	**41123**
Toscana	0	18197	679	1500	330	74146	**94852**
Umbria	0	783	0	157	0	2345	**3285**
Marche	0	2287	0	62	0	7395	**9744**
Abruzzo	0	0	0	0	0	3443	**3443**
Molise	0	n.a.	n.a.	n.a.	n.a.	n.a.	**n.a.**
Lazio	0	66	0	6	0	3802	**3874**
Campania	0	0	0	0	0	1129	**1129**
Basilicata	0	n.a.	n.a.	n.a.	n.a.	n.a.	**n.a.**
Puglia	0	n.a.	n.a.	n.a.	n.a.	n.a.	**n.a.**
Calabria	0	n.a.	n.a.	n.a.	n.a.	n.a.	**n.a.**
Sicilia	0	0	0	0	0	719	**719**
Sardegna	0	0	0	0	0	10582	**10582**
Italy	**11716**	**63846**	**12675**	**3565**	**1618**	**144535**	**237955**

Table 1: Large mammals species hunted per year by species and Region (2013-2016 average).[1] The number refers to the provinces of Brescia, Como and Sondrio. [2] The number refers to the provinces of Belluno and Vicenza.

Region/Specie	Eurasian Skylark	Teal	Woodcock	Snipe	Fieldfare	Wood pigeon	Hooded crow	Carrion crow	Rock partridge	Pheasant	Black grouse	Moorhen	Magpie	Mallard	Jay	Blackbird	Rock ptarmigan	Red-Legged partridge	Barbary partridge	Quail	Grey Partridge	Song thrush	Redwing	Turtledove	Total
Valle d'Aosta	0	0	22	0	0	12	3	0	0	0	0	0	0	0	0	327	0	0	0	0	0	78	0	0	**442**
Piemonte	3482	346	7816	3044	3228	4756	2478	501	229	28058	441	503	509	10640	739	0	0	184	0	1539	399	4294	2063	451	**75700**
Liguria	3	29	4511	116	729	15273	324	96	0	6309	52	35	1666	258	8600	41715	872	0	0	156	695	87817	9704	980	**179940**
Lombardia	146732	7780	28941	17135	134902	45671	7054	371	226	140355	593	9901	2335	42295	6045	323956	250	2926	0	6446	14217	1085626	154759	2803	**2181319**
Trento	339	2	4459	26	15438	260	52	72	0	3679	0	0	0	790	4297	39331	0	0	0	2	0	36165	6133	20	**111065**
Bolzano	0	10	244	0	4622	183	0	532	49	6	343	0	225	818	1651	3823	232	0	0	0	0	466	0	0	**13204**
Veneto[1]	66190	1288	6316	4987	16514	10548	321	20	2	35441	55	670	1026	12969	1516	70365	4	0	0	16467	8092	274801	30444	1093	**559129**
Friuli Venezia-Giulia	20299	2604	8234	1259	9887	6984	1403	92	0	54851	82	985	485	9579	2389	23729	124	99	0	7608	2038	31302	9237	138	**193408**
Emilia-Romagna	22658	21870	9545	3361	14287	29229	3489	0	0	97390	0	1500	2130	39870	4760	48213	0	3310	0	1712	1510	52602	15778	10575	**383789**
Toscana	50181	n.a.	11309	n.a.	n.a.	98157	863	n.a.	n.a.	74394	0	n.a.	n.a.	5363	n.a.	159957	0	n.a.	0	3572	n.a.	335886	n.a.	n.a.	**739682**
Umbria	33476	679	3039	725	0	34808	1372	0	0	7928	0	0	0	955	2171	38648	0	362	0	4583	718	117405	12473	6487	**265829**
Marche	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	0	n.a.	n.a.	n.a.	n.a.	n.a.	**n.a.**
Abruzzo	4775	190	3632	287	418	26858	511	0	40	4096	0	22	243	302	487	5465	0	0	0	2906	404	25876	1066	3944	**81522**
Molise	n.a.	1	769	23	2	996	n.a.	n.a.	n.a.	250	0	n.a.	n.a.	n.a.	n.a.	58	n.a.	n.a.	0	n.a.	n.a.	387	74	n.a.	**2560**
Lazio	34617	2723	12930	3227	1448	20525	11578	0	0	14368	0	1224	2149	2110	2721	29653	0	0	0	4925	213	138920	13258	6428	**303017**
Campania	23284	1107	8385	2280	645	9410	1428	41	1	800	0	250	1869	446	1689	5950	0	2	0	9971	615	59597	7288	7453	**142511**
Basilicata	7094	114	4387	352	977	7610	508	0	0	618	0	35	569	445	948	2574	0	0	0	2688	0	19780	888	2627	**52214**
Puglia	27176	n.a.	4233	n.a.	607	1420	n.a.	n.a.	n.a.	123	0	n.a.	n.a.	n.a.	n.a.	24797	n.a.	n.a.	0	6339	11	n.a.	n.a.	1638	**66344**
Calabria	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	0	n.a.	n.a.	n.a.	n.a.	n.a.	**n.a.**
Sicilia	14155	8198	8198	1823	558	46398	0	0	0	31	0	671	1147	624	424	6865	0	0	0	4434	3	44918	1895	7518	**147860**
Sardegna	5808	531	1955	1955	223	62160	2223	0	0	0	0	433	0	3327	2416	6829	0	0	5962	6710	0	135788	20761	10829	**267910**
Italy	**460269**	**47472**	**128925**	**40600**	**204485**	**421258**	**33607**	**1725**	**547**	**468697**	**1566**	**16229**	**14353**	**130791**	**40853**	**832255**	**1482**	**6883**	**5962**	**80058**	**28915**	**2451708**	**285821**	**62984**	**5767445**

Table 2: Birds hunted per year by species and Region (2013-2016 average). [1] The number refers to the provinces of Belluno and Vicenza.

Results

The response rates (in surface) distinguishing between groups of hunted species are the following: 92.3% of rural area (87.0% of hunting rural area) for birds species, 80.1% of rural area (75.8% of hunting rural area) for large mammals species, and 62.7% of rural area (57.8% of hunting rural area) for small mammals species.

In the period 2013-2016 (three years), the main two large mammals species hunted are (Tab. 1): wild boar with 60.7% of ungulates hunted (144,535 animals per year) and roe deer with 26.8% of ungulates hunted (63,846). The main three birds species hunted are (Tab. 2): song thrush with 42.5% of total birds species hunted (2,451,708), blackbird with 14.4% of total birds species hunted (832,255), and pheasant with 8.1% of total birds species hunted (468,697). Among the small mammals species the most hunted species are (Tab.3): wild rabbit (144,941) and European hare (105,595).

Observing the data by region, the Lombardia is the Italian region where most bird species are hunted with more than 2 million of individuals (around 50% are song thrush). Conversely, in the Toscana the largest number of large mammals species is hunted (about 95,000 individuals per year, corresponding 40% of total large mammals species hunted) and in Sicilia the largest number of small mammals species is hunted (around 137,000 individuals, corresponding 53% of total small mammals species).

Region/Specie	Red fox	Wild rabbit	European hare	White hare	Sardinian hare	Total
Valle d'Aosta	23	0	211	22	0	**256**
Piemonte	n.a.	n.a.	n.a.	n.a.	0	**n.a.**
Liguria	n.a.	n.a.	n.a.	n.a.	0	**n.a.**
Lombardia[1]	594	694	10442	123	0	**11853**
Trento	n.a.	n.a.	n.a.	n.a.	0	**n.a.**
Bolzano	1610	0	2756	373	0	**4739**
Veneto[2]	275	400	7706	53	0	**8434**
Friuli Venezia-Giulia	527	15	7128	0	0	**7670**
Emilia-Romagna	n.a.	n.a.	58423	0	0	**58423**
Toscana	0	2083	7899	0	0	**9982**
Umbria	203	159	5221	0	0	**5583**
Marche	n.a.	n.a.	n.a.	0	0	**n.a.**
Abruzzo	567	0	2939	0	0	**3506**
Molise	n.a.	n.a.	n.a.	0	0	**n.a.**
Lazio	714	0	2601	0	0	**3315**
Campania	189	16	269	0	0	**474**
Basilicata	n.a.	n.a.	n.a.	0	0	**n.a.**
Puglia	n.a.	n.a.	n.a.	0	0	**n.a.**
Calabria	n.a.	n.a.	n.a.	0	0	**n.a.**
Sicilia	1167	135963	0	0	0	**137130**
Sardegna	935	5611	0	0	2378	**8924**
Italy	**6804**	**144941**	**105595**	**571**	**2378**	**260289**

Table 3: Small mammals species hunted per year by species and Region (2013-2016 average). [1] The number refers to the provinces of Brescia, Como and Sondrio. [2] The number refers to the provinces of Belluno and Vicenza.

Conclusion

The present study has collected and analyzed hunting statistics in Italy distinguishing between regions or provinces and wildlife game species. The results of this study can be considered as the starting point for the development of sustainable hunting plans at the provincial and regional level.

The future steps of the study will be to provide annually hunting statistics by defining a standardized data collection system and to integrate current knowledge gaps (regions with partial or unavailable hunting statistics). Annual hunting statistics can provide useful information to decision makers (planners and managers) for managing hunting activities in a sustainable way.

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YOUrALPS: Integrating young people's concepts, educators' teaching principles and stakeholders' educational tasks for a transformation of education and society towards sustainability in the Alps

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Abstract

The EU Alpine Space project *YOUrALPS* enables the alpine youth to acquire the knowledge and develop the skills they want and need to better shape both their personal future and the one of the Alps. For a first time in history of environmental education and education for sustainable development, a trans-Alpine network of stakeholders is being created in order to synchronize measures and activities of formal and non-formal education in the Alps for instilling an up to date Alpine identity among Alpine youth.

Keywords

Environmental education, education for sustainable development, key competences, action orientation, self-determination, participation, target group, protected areas

Introduction

Global developments such as the depletion of natural resources, accelerating global warming or rapid demographic changes will pose challenges for mankind and require societal transformations. With their unique ecological, economic, and cultural value, mountain environments represent the complex interrelatedness and are essential to the survival of the global ecosystem. Especially young people (in mountain regions and lowlands) will not only be longer and more intensively confronted with these challenges but will also play a crucial role as future decision makers in business, politics and science. Among many other competencies and attributes, environmental awareness and nature-connectedness are key prerequisites to sustainable lifestyles.

YOUrALPS takes up the challenge to increase the sensibility and value of the alpine heritage especially among youth by better integrating related topics into the educational curricula and practices. In the context of YOUrALPS, extensive research involving multiple stakeholders has been undertaken in order to orientate future endeavors at the diverse needs of all key actors in Mountain-oriented education (MOE). This short paper at hand includes methodology, preliminary results and conclusions of the surveys as well as recommendations. It is assumed that a stronger coordination between formal and non-formal education represents a big potential for the sustainable valorisation of the Alps.

Methodology & Approach

"*An open and flexible approach to learning that is both lifelong and life-wide*" is claimed to be crucial in a constantly changing world which is "*characterized by new levels of complexity and contradiction*" (UNESCO 2015). This given, formal and non-formal education have to work hand in hand in order to fulfil these requirements.
But how can these necessary objectives be achieved under the predominant circumstances and by respecting the needs of all stakeholders (students, teachers, institutions, etc.)?
How can young people's concepts, educators' teaching principles and stakeholders' educational tasks be integrated in order to lay the foundation for the transformation of education and society towards sustainability in the Alps?
A first step consists of an empirical study of four actor groups relevant for MOE:

- Internal survey among all project partners about their ideas and concepts of MOE
- Young beneficiaries from 10-30 who are the main target group of already existing/future activities and measures
- Involved practitioners in both formal and non-formal education sectors
- Responsible persons of NGOs, legacy, protected areas, etc. that are main decision-makers in the field

This mixed-methods research design in terms of data triangulation (Flick 2008) ensures a holistic approach to the object of investigation and aims at deepening and widening one's understanding of this object (Olsen 2004).

Main results of the empirical study can be regarded as input factors for the development of a so-called Alpine School Model in which all activities and measures of MOE are being bundled, theoretically underpinned and promoted for its future implementation and extension in various learning settings throughout the Alps. Due to the ongoing data collection only preliminary results of the young beneficiaries survey and interviews with involved educators can be presented in this paper.

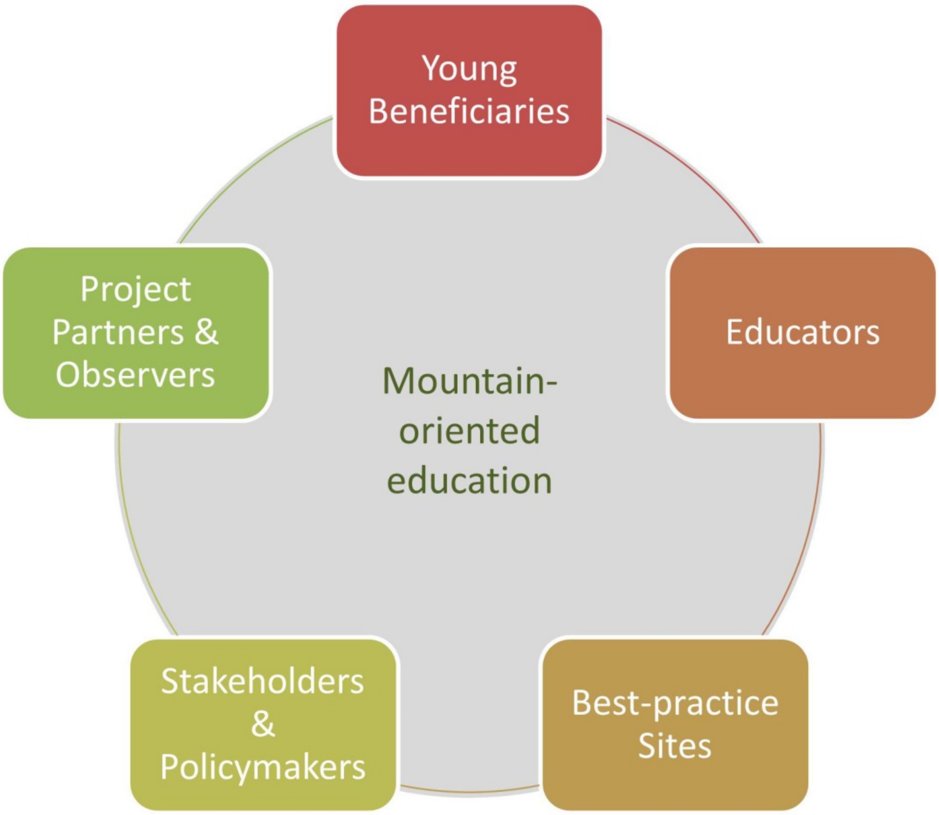

Figure 1: Multiperspective research on mountain-oriented education (own illustration)

Preliminary results

Young beneficiaries

In total 300 valid cases are included in the data evaluation process. By far most young beneficiaries are students at high schools or vocational schools. Valid statements can be made about Slovenia, tendencies about Austria and Italy. In France and Germany, the sample sizes are far too low to allow for any conclusions.
Young people regard their own future brighter than the future of the earth. The future of the Alpine Space is envisioned rather positive and positive. 10-14 year olds have a **more negative** outlook on the future of the Alpine Space than 15-19 year old teenagers. **Returning to a traditional lifestyle**, acquiring more knowledge and getting actively involved are regarded more important to tackle present and future challenges than technical solutions.

10-19 year old young people perceive the Alpine Space as 'Recreation area' (ca.35%), 'Living Space' (ca. 30%) or space for retreat (ca. 10%). The same subset perceives **protected areas very similarly to the Alpine Space**, except for one major difference: A considerable number also regards protected areas as 'learning locations'. Nature is predominantly regarded as an 'essential ingredient of life' and 'source of joy' by 15-19 year old young people. While humans are seen as part of nature by most young people (80%), they are not seen as having the right to make use of nature. **Nature conservation** is commonly regarded as **human obligation** and in some cases seen as **personal responsibility**. The sample does not allow for a clear picture about self-efficacy of young people. Responsibility for nature conservation is predominantly ascribed to businesses, NGOs and politicians – to a lesser extent to scientists.

'Enjoying untouched nature', 'seeing wild animals' as well as 'gaining knowledge' and 'spending time with family/friends' are the most common expectations of young people from protected areas. 'Walking on nature trails' and 'taking guided tours' are the most performed activities in protected areas. **Personal observations** are the most important source of knowledge about nature for young people before parents, school and experts.

Involved educators

Stated learning objectives range from **abstract long-term goals** to concrete **detailed goals**. As has been yet established in formal education, there is a strong indication for a clear definition of micro and macro goals in the form of **learning outcomes** of each MOE-related activity also in non-formal education. Strong emphasis on the interrelation between internal and external influence factors of environmental friendly behaviour can be reported: Educators especially stress the importance of **role models**, **positive messages** and learning settings that allow for individual approaches and thus experienced self-efficacy in **confined fields of activity**.
Knowledge transfer is no longer sufficient to prepare alpine youth for future grand challenges. Educators place a strong focus on the development of **soft skills** which require different **evaluation methods** such as working diaries, portfolios, self-assessment or partner-assessment.

Discussion & future perspectives

(Environmental) education is one of the major pillars of every protected area. First qualitative analyses in the course of this project reveal that learning settings in formal and non-formal education differ significantly. Evaluation of the closed-ended questions of the young beneficiaries survey shows ambiguous results of youth's concepts of nature as well as perceptions and approaches of the future and accompanying grand challenges. Involved educators emphasise the importance of a clear definition of learning outcomes also in non-formal education.

More target-group tailored, individual educational activities and measures on the part of non-formal education that incorporate more rigidly the two fundamental teaching principles self-determination and action-orientation are strongly indicated when considering young beneficiaries' preliminary concepts and perceptions of nature and the Alpine Space in the context of global change. At the same time, interviewed educators claim more standardised programmes in cooperation with non-formal education as in all Alpine countries, but strict requirements in the curricula only allow for minor room for not explicitly listed so-called soft and therefore hard to evaluate learning outcomes in connection with MOE. More light will be hopefully shed on this matter by means of a thorough analysis of national curricula and political strategies in the field of environmental educations in all participating countries as a next activity of the project timeline.

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Analysing the impact of drivers and pressures on the conservation goals of protected areas along a large navigable river, the Danube River

Andrea Funk & Thomas Hein

Keywords

Natura 2000, Habitat Directive, Bayesian network

Summary

Large river–floodplain systems are among the most endangered ecosystems worldwide. They are target to EU water as well as EU nature legislation. The importance of the EU Water Framework Directive (EU WFD, EC 2000) for river-floodplain management is widely recognized, since no other EU-strategy has initiated more water body related measures. Across Europe a specifically high proportion of remaining floodplain areas are protected by habitats directive (HD) and birds directive (BD) (SCHINDLER et al. 2016), owing to its high biodiversity value. Additionally, the EU floods directive (FD) aims reducing risk of flooding along watercourses e.g. due to natural water retention measures, or floodplains are target to EU Green Infrastructure Strategy (ICPDR, 2015). In turn, the EU TEN-T Regulation envisages a 'good navigation status' of inland waterways. Additionally, hydropower generation and agriculture or forestry within the riparian area are examples of important socio-economic benefit of large rivers.

Environmental problems are particularly acute in the case of the Danube (HEIN et al. 2016). Along the navigable stretch of the River Danube approx. 70% of river-floodplain length is protected by BD and HD, while these river stretches are at the same time assigned as heavily modified water bodies according to the EU WFD (HMWB). Therefore, it is especially challenging to achieve conservation goals for protected areas since the maintenance or improvement of the water status under EU WFD is an important factor in their protection. The environmental objectives for water bodies are lowered to good ecological potential, since the respective hydro-morphological measures to reach good ecological status would significantly affect water uses such as navigation, flood protection or hydropower generation (KAIL & WOLTER, 2013). These restrictions limit the potential to achieve the EU nature protection goals.

Analysing the importance of main hydro-morphological drivers and pressures for the conservation status of multiple species and their habitats is an important step for the integration of those targets. Therefore, we spatially link data on drivers, pressures and state within ArcGIS and analyse the relationships using a quantitative Bayesian network approach. We use open access data including a continuous hydro-morphological assessment for the navigable Danube River compliant with WFD requirements (SCHWARZ, 2014). Land cover/Land use (LCLU) data were obtained from the European Riparian Zones dataset developed by the local component of Copernicus Land Monitoring Services. In addition, data collected on the status of the waterway, critical locations for navigation and navigation class, as well as information on position and impacted river length for hydropower plants were included. Finally, information on conservation status of widely distributed protected species, including fish and amphibians, collected for HD and BD for approx. 120 sites (Fig. 1) along the navigable stretch of the river Danube were added. For Natura 2000 sites information is provided within a pan-European database.

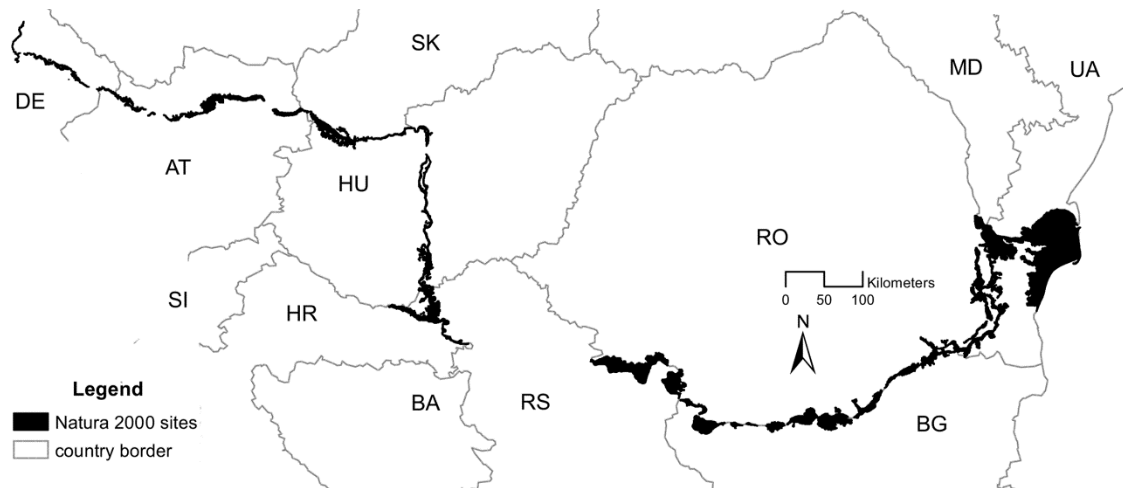

Figure 1: Protected areas (Natura 2000) along the navigable main stem of the Danube River

Our result show that interactions between drivers and pressures are complex and intertwined. Nevertheless, our Bayesian approach indicates that the relative importance of different drivers and pressures varies markedly between the indicators of the nature directives, and is significantly related to species traits. Impact assessment within the models also allows us to quantify species thresholds related to manageable hydro-morphological pressures. Therefore, our approach gives a first statistical proof of driver-pressure-state relationships along the navigable stretch of a large river-floodplain system, the Danube River, and can serve as a basis for a strategic and more integrated management approach and restoration planning at large scales.

The research is performed within the EU project AQUACROSS (Knowledge, Assessment and Management for AQUAtic Biodiversity and Ecosystem Services aCROSS EU policies, Grant Agreement no. 642317; http://aquacross.eu).

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Monitoring Alpine rivers: recent progress and future challenges

Leopold Füreder, Georg H. Niedrist, Stefan A. Schütz

Abstract

Alpine freshwaters are sensitive to climate change as hydroecological processes respond to changes in climate and alter ecosystem properties and function. In a long-term monitoring we have been studying environmental conditions, nutrients and benthic invertebrates in glacier-fed/spring-/groundwater-fed streams in four glaciated catchment in order to develop meaningful tools for the abiotic and biotic indication of climate change effects. After eight years of implementation, we report on significant results, recent progress and discuss future challenges.

Keywords

glacial, benthic invertebrates, aquatic insects, climate change, monitoring tools

Introduction

Alpine freshwaters are sensitive to climate change as hydroecological processes respond to variabilities in climate and consequently alter ecosystem properties and function (e.g. MILNER et al. 2001; FÜREDER 2007, 2012). The effects from climate change are particularly noticeable at high altitudes through glacier shrinking and permafrost melt influencing adjacent freshwaters in their catchments (MCGREGOR et al. 1995; MILNER et al. 2001; FÜREDER et al. 2001; BROWN et al. 2007). Aquatic organisms have been successfully used to indicate environmental change including the effects from climate alterations (e.g. MILNER et al. 2001; NIEDRIST & FÜREDER 2016). Under these circumstances a river monitoring was initiated in four glaciated catchments in the Hohe Tauern Nationalpark (Eastern Alps, Austria), with the goal to develop an effective long-term monitoring system (FÜREDER & SCHÖNER 2013). Together with the regular recording and measurement of abiotic parameters and hydrological characteristics, the indicator function of aquatic insects and other invertebrates was considered significant as adequate monitoring tools (FÜREDER & SCHÖNER 2013). Interim analyses of faunistic characteristics enabled the testing of several biological indices for their suitability and applicability in high mountain rivers (FÜREDER 2012). From relevant studies in the Alpine and other regions comprehensive knowledge was available (see MILNER et al. 2001; FÜREDER 2012), which could be employed for the analyses of spatial and temporal patterns in ecosystem structure and function. The pilot study produced essential theoretical and practical know-how, so that - together with the relevant scientific background and the hydrological, geomorphological and habitat characterizations – biological data could be used to provide information on the biodiversity of Alpine riverine systems, its spatio-temporal patterns of structure (community structure, taxa composition and dominance, diversity, abundance) and function (functional feeding types, species traits of resilience, resistance and environmental fitness) and potential effects from climate and environmental change. These hydromorphological, abiotic and biotic parameter and indices are essential data and tools for the monitoring, analyses and interpretations of alterations of freshwater systems in mountains.

Aim of this presentation is, based on several years of implementation of the monitoring program i) to predict community structure, taxa composition, abundances and diversity from so-far elaborated abiotic and biotic data and ii) to affirm these predictions through the comparison with new assessments and analyses. This is to test and evaluate appropriateness and applicability of tools and measurements, defined and applied as indicators of climate/environmental change effects in Alpine river ecosystems.

Methods

Fieldwork was carried out in four glaciated catchments in the Hohe Tauern Nationalpark during summer 2014 (Fig. 1). The methodology of hydro-ecological assessments and measurements of environmental characteristics followed FÜREDER et al. (2012). Benthic sampling was a stratified random sampling with a Surber sampler (100 µm mesh-size) of six replicate samples in each river stretch. Samples were preserved in the field and sorted into orders and/or families back in the laboratory. There, the animals were identified to the best taxonomic level possible. For this study, they were classified into the evaluation criteria taxa number, abundance, relative density, diversity and evenness. Indices were calculated with computer-assisted tools.

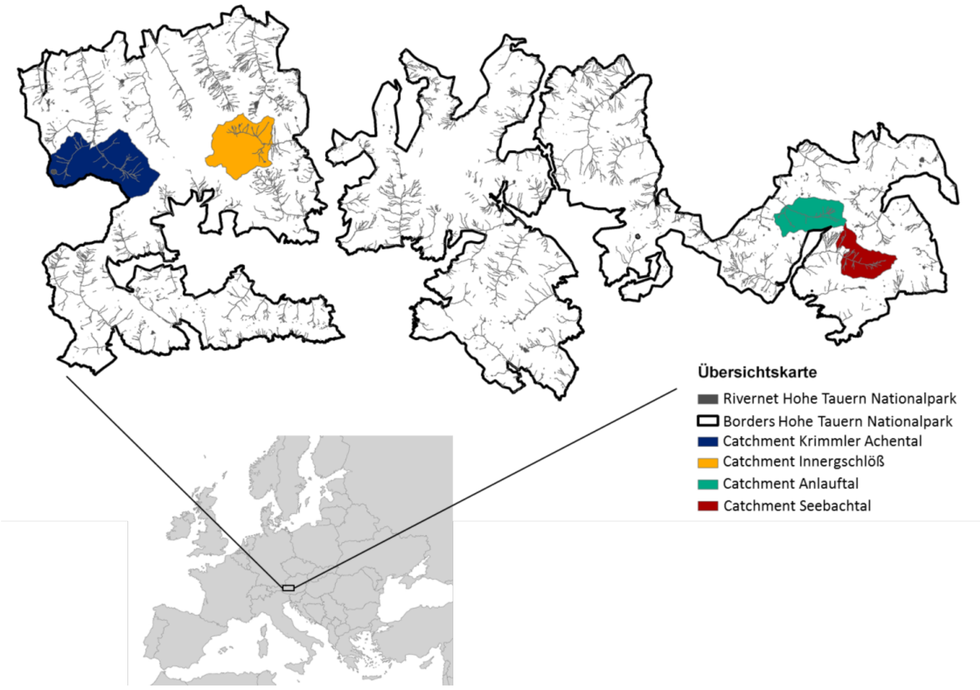

Figure 1: Catchments within the Hohe Tauern Nationalpark, Austria, selected for the river monitoring (source: HABITALP, NP HOHE TAUERN 2012; www.europakarte.org; partly produced by A. Mätzler).

<u>Analyses</u>

As the major aim of this study is the testing and evaluation of methods and analyses applied within the long-term monitoring, we divided the work flow into three steps: prediction, diagnosis and control (Fig. 2).

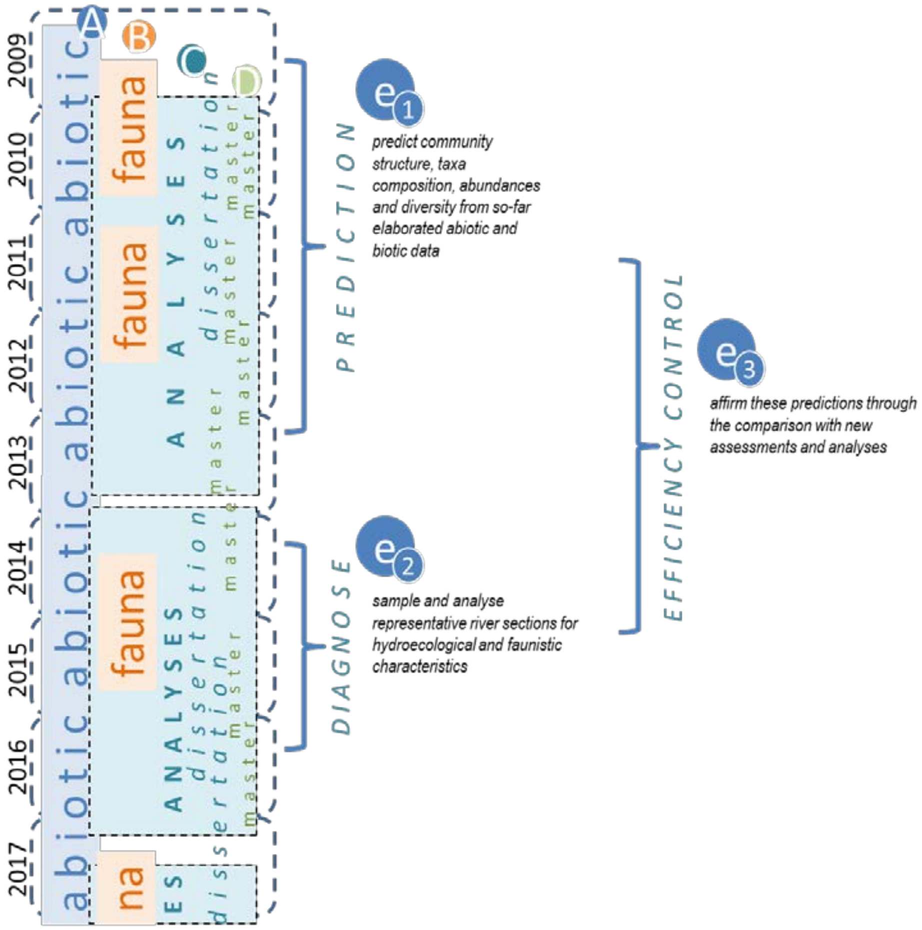

Figure 2: Scheme of efficiency control in order to test and evaluate appropriateness and applicability of tools and measurements, defined and applied as indicators of climate/environmental change effects in Alpine river ecosystems.

Results

Abiotic conditions and benthic invertebrates

In the cold (Fig. 3), highly-dynamic and nutrient-poor river systems, highly specialized invertebrate taxa occur. Most of them are restricted to a narrow range of environmental conditions, usually expanding their amplitudes when conditions get more benign. Taxa number, abundance and diversity follow this general trend: Less taxa occur in glacier-fed rivers, more in groundwater and spring-fed systems. A similar pattern is true for abundances and diversities. The dipteran family *Chironomidae* seems to correspond in particular to these predictions.

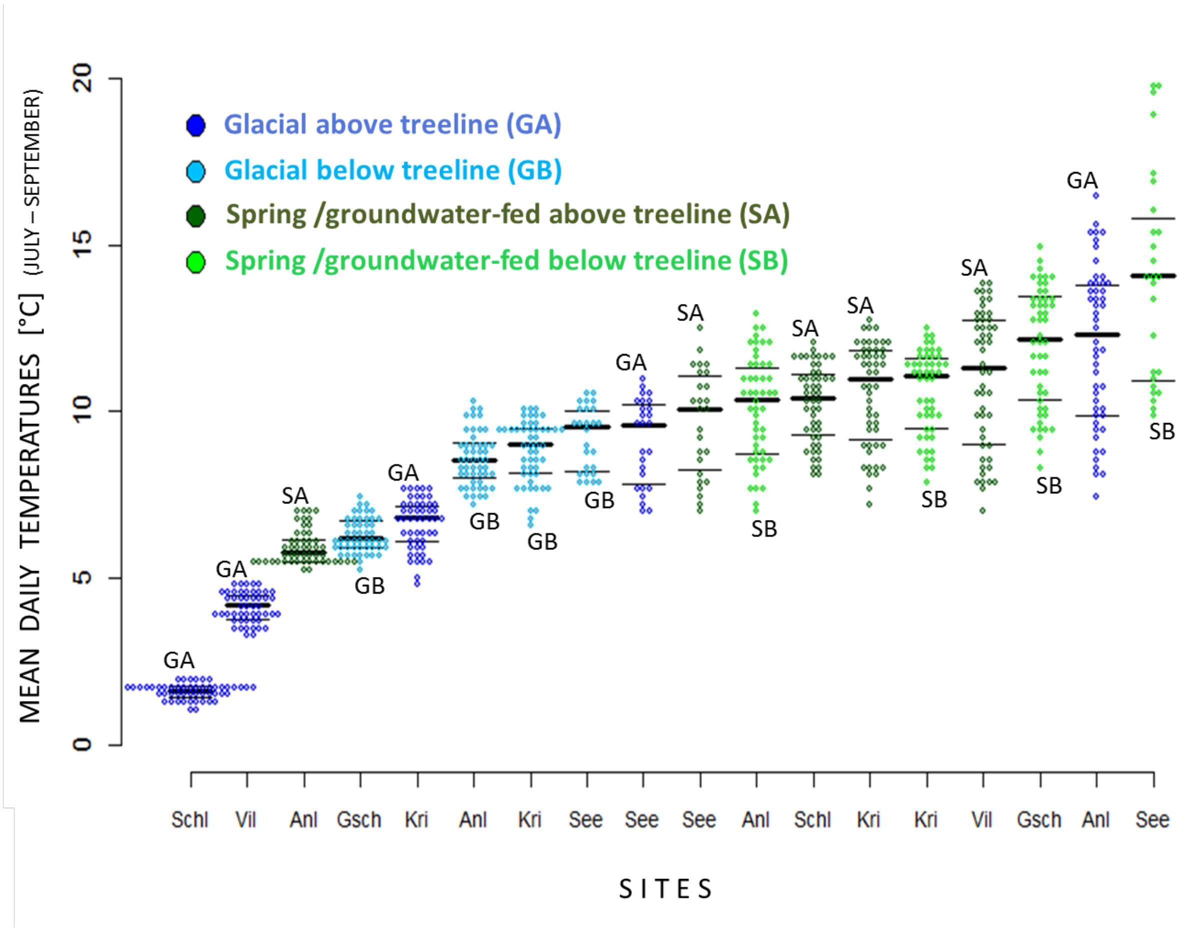

Figure 3: Box-Whisker Plot of mean daily temperatures of sites from July to September in 2015. Colours indicate stream type and position.

Appropriate indicator groups

The individual river stretches show differences in taxa numbers, abundances and diversity. Therefore it was necessary to test which taxa group was more appropriate to demonstrate the effect along the gradient of abiotic conditions. Four insect orders, i.e. *Ephemeroptera*, *Plecoptera*, *Trichoptera* and *Diptera*, are the dominant benthic invertebrates. The latter is primarily presented by the family *Chironomidae*, which reaches highest numbers in taxa, abundances and diversities the harsher the relevant environmental parameters are, i.e. glacier-fed vs. groundwater/spring-fed streams, above vs. below treeline (Fig. 4).

Prediciton & affirmation of community structure

From available abiotic and biotic data we predicted the range of benthic macroinvertebrates abundance, taxa number and diversity and compared the model with new data from 2014 (Fig. 5, left). The elaborated model allowed us in a second step to compare the causal relationship of predicted and newly assessed results (abundance, taxa number and diversity) with abiotic factors (Fig.5, right).

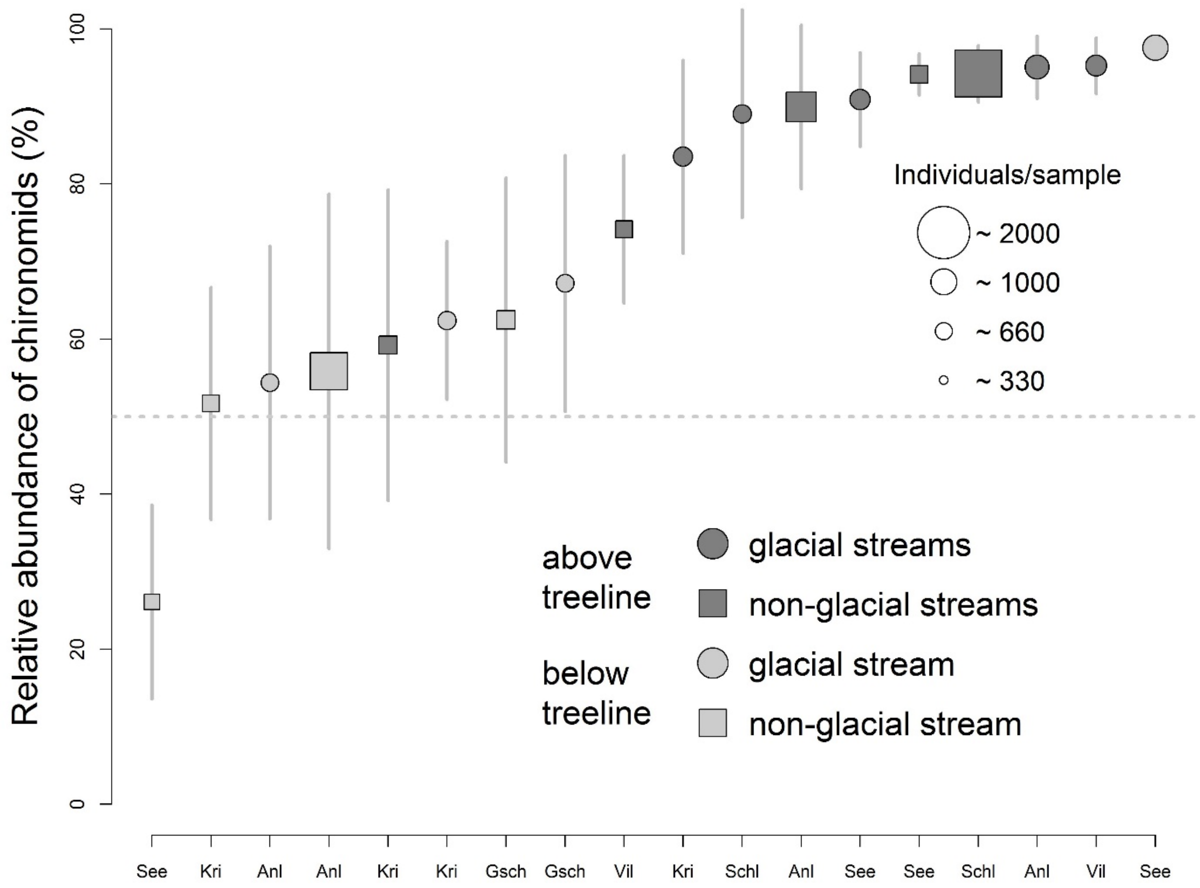

Figure 4: The relative abundance of *Chironomidae* in the Alpine rivers. With these patterns, the *Chironomidae* follow a reverse trend compared to the other three orders. While chironomid taxa number, abundance and diversity increase in harsh conditions, *Ephemeroptera, Plecoptera* and *Trichoptera* show lower values the harsher the conditions get.

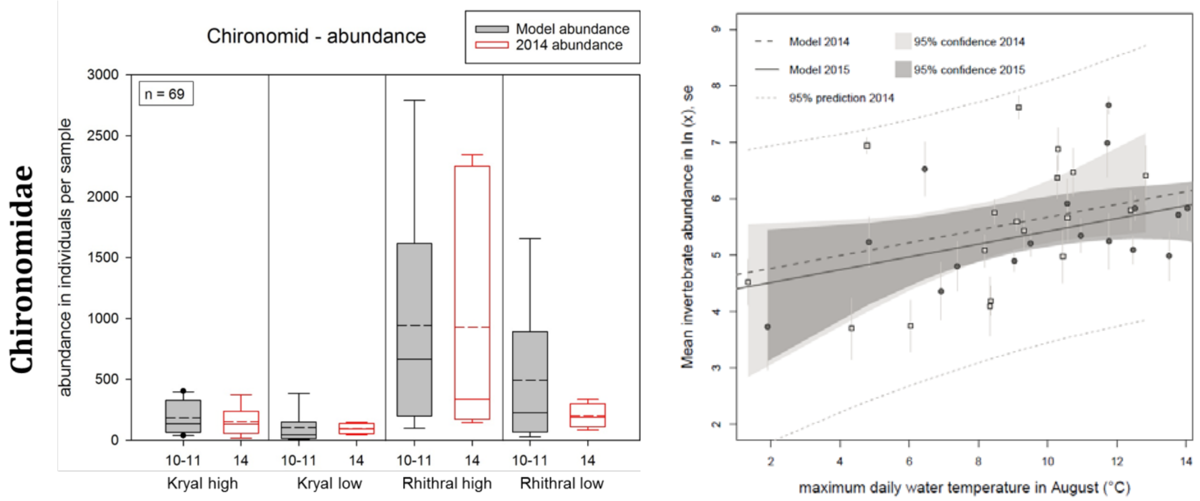

Figure 5: here chironomid abundance (grey boxes, 2010-11) and elaborated new data (empty boxes, 2014) for comparison are shown on left graph. Right graph compares causal relationship of predicted and newly assessed results with abiotic factors (here abundance and temperature shown).

Discussion and conclusion

Due to climate change in mountain areas the degree of glaciation and therefore mountain hydrology will change (McGregor et al. 1995; Brown et al. 2007). These alterations of environmental conditions will certainly change ecosystem structure and function of rivers (Füreder 2007, 2012). In the long-term river monitoring project in four glaciated catchments of the Hohe Tauern Nationalpark we measure and identify the causal relationship between environmental conditions and biology with the aim to develop and define indicator tools to detect and predict potential effects from climate/environmental change.

This approach seems to be meaningful and successful, as demonstrated by our results:

1. The chosen methodologies, to combine the information value and explanatory power of abiotic and biotic parameters and indices provide a comprehensive picture and understanding of ecosystem structure and function.
2. At the same these investigations deliver important information on the biodiversity of a widely distributed ecosystem in mountain life zones, previously barely known.
3. With the elaboration and demonstration of causal relationships between key environmental conditions and biotic features the modelling of potential climate change effects is feasible.
4. Our results indicate that only through the regular observations and measurements within the long-term monitoring, robust information on the spatial and temporal patterns of ecosystem properties is available, which is the essential requirement for reliable indication and prediction.
5. Fundamental requirements for such powerful indication are the elaboration of a comprehensive physico-chemical and biological data set, based on a robust taxonomy.
6. This kind of long-term monitoring on Alpine river ecosystems is unique, as to our knowledge no other program approaches these questions in this detail, spatial resolution and frequency.
7. Climate change research, biodiversity assessments in remote and understudied areas, investigations in extreme habitats and species adaptations are scientific topics that achieve high international significance and visibility and up value the management efforts in protected areas for ecosystem services provision.
8. The biggest challenge for this freshwater monitoring is the perpetuation of this kind of activities. Given the many pros of this program and promising results, joint effort is highly needed to guarantee its continuation. Funding, administration and scientific bodies have been supporting and collaborating with enthusiasm all the activities. Nevertheless, achievements for long-term observations are still in their initial phase.

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The Triglav Glacier: Seventy Years of Regular Observations

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Abstract

The Triglav Glacier is one of two glaciers in Slovenia; it lies in Triglav National Park. The year 2016 marks the passage of seven decades since the first survey of the glacier was carried out. For that occasion, an extensive research volume and an exhibition were prepared. The glacier's size in 1946 was 14.4 hectares, but it has since shrunk to just less than 0.4 hectares. The glacier no longer has all of the glacial characteristics. Therefore it can only be called a glacier due to its past, when it still had all the crucial alpine glacier characteristics.

Keywords

Triglav Glacier, Julian Alps, Slovenia, glacier measurements, climate change

Introduction

The year 2016 marks the passage of seven decades since the first formal survey of the Triglav Glacier was carried out on September 5th, 1946. The anniversary of regular research on the glacier was the reason for the exhibition on the Zeleni plaz 'Green Avalanche', as the glacier was called in the first written record from 1778. The exhibition started out at the Slovenian Alpine Museum in Mojstrana and then traveled to information centers and some larger places in Triglav National Park. The Triglav Glacier lies on the southeastern-most part of the Alps—namely, in the Julian Alps below Mount Triglav (2,864 m), the highest mountain in Slovenia. Based on Holocene glacial variations in the Alps, the Triglav Glacier is most probably a remnant of the Little Ice Age and cannot be considered a remnant of Pleistocene glaciation (FERK et al. 2017). Its size at the time of the initial survey was 14.4 hectares, but it has since shrunk to less than 1 hectare. The glacier no longer has all of the glacial characteristics; it has no crevasses and it does not move. Therefore it can only be called a glacier due to its past, when it still had all of the crucial alpine glacier characteristics. Regarding its location and size, it is not comparable to the large Alpine glaciers; more reasonable is a comparison with very small glaciers, known as glacierets (GABROVEC ET. AL. 2014), in neighboring Austria, Italy, and some Balkan countries (KUHN 1995; TRIGLAV ČEKADA et al. 2012; COLUCCI & GUGLIELMIN 2015).

Figures 1 and 2: The Triglav Glacier from the north in September 1940 (Photo: Joško Šmuc) and September 2012 (Photo: Jaka Ortar).

Methods

Annual observations serve as the base for establishing changes in the Triglav Glacier. Early surveys were simple: the researchers used a measuring tape and compass, which enabled them to measure the glacier's retreat from colored marks on the rocks around the glacier (MEZE 1955). In the 1990s, researchers started using more accurate geodesic measurements: standard geodesic tachymetric measurements, photogrammetric measurements (from both the ground and air), GPS measurements, and LIDAR (TRIGLAV ČEKADA & GABROVEC 2008; GABROVEC et al. 2014). The thickness of the ice was measured three times using the ground-penetrating radar method (VERBIČ & GABROVEC 2002; DEL GOBBO et al. 2016). The glacier has been systematically photographed (once a month from the same spots) since 1976, using a panoramic non-metric Horizont camera. The photos were transformed from a panoramic to central projection in order to allow the calculation of the area and estimation of the volume (TRIGLAV ČEKADA et al. 2011; TRIGLAV ČEKADA & GABROVEC 2013). The size of the glacier during the Little Ice Age can be determined based on moraine accumulation (ŠIFRER 1963; GABROVEC 2008). In addition to these surveys, the use of old paintings, photos, and maps is also important for evaluating long-term change (MEZE 1955; GABROVEC et al. 2014).

Figure 3: In 2013, ground-penetrating radar surveys of the glacier were performed. Photo: Matija Zorn.

Fluctuation of the Triglav Glacier

The extent of the glacier at the end of the Little Ice Age in the nineteenth century was reconstructed from the 1877 Austrian topographic map showing that the glacier covered 40 ha. The measurements of the glacier since 1946 can be divided into four time periods distinguishing two phases of rapid retreat and two phases of glacial stagnation; the latter two are primarily connected with greater quantities of precipitation during the accumulation season. The period of measurements from 1946 to 1964 is characterized by shrinking and thinning of the glacier from 14 to 10 ha. In the last years of this period, horizontal recession also occurred in the lower section. The second period, between 1965 and 1982, is marked by stagnation of the glacier. In these years the lower section of the glacier was mainly covered with snow at the end of the melting seasons, and only in central section ice was bare. During those years, up to the end of the melting season continuous snow fields extended all the way to the moraines from the Little Ice Age above the north face of Mount Triglav. The result of snow accumulation on the glacier was also seen in its increasingly convex cross-section. The turning point occurred in 1983 and was caused by the extremely warm summer. The period from 1983 to 2003 was marked by the most rapid melting of the glacier. The size of the glacier was then the smallest in the entire period of regular measurements (i.e., from 1946 onward). Typical of these years was intense thinning of the glacier, particularly in its upper section. The glacier annually thinned by 1 to 2 m and, in some sections, disintegrated into several parts. After the hottest summer in 2003, the measured area of the glacier was 0.7 ha, and later, in 2007 only 0.6 ha. After 2012, the glacier has never been completely exposed; it was entirely or partly covered with firn and/or snow from previous winters. Most of the ice melted at the upper edge of the glacier only (GABROVEC et al. 2013, 2014). An even greater change occurred in the volume of the glacier than in its area. During the observation period the glacier thinned by more than 35 m in some places. Its volume therefore decreased from 2 million m³ in 1952 to 7,400 m³ in 2013 (GABROVEC 2002; GABROVEC et al. 2014; DEL GOBBO et al. 2016).

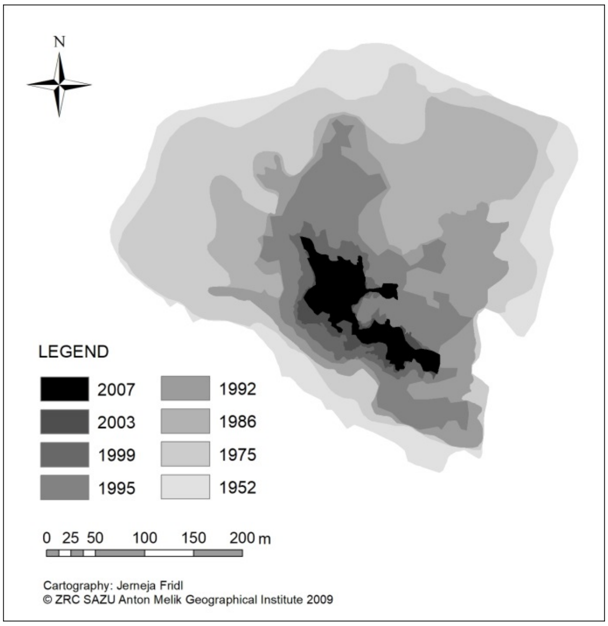

Figure 4: Changes in the glacier's area between 1952 and 2007.

Climate changes at the Triglav Glacier

Due to its small size, the Triglav Glacier is highly sensitive to climatic changes and hence a good indicator of them. The direct vicinity of the meteorological station near Mount Kredarica (2,539 m) makes possible an analysis of the dependency of the glacier's fluctuation on weather changes (GAMS 1994; GABROVEC & ZAKŠEK 2007; ERHARTIČ & POLAJNAR HORVAT 2010). The mean annual air temperature at the Kredarica meteorological station (2,514 m) shows an upward trend during the monitoring period, especially during meteorological summer (June–August), for +0.4 degrees Celsius/decade (GABROVEC et. al. 2014). The fall precipitation quantity is increasing. Solar radiance exposure data show an upward trend in winter and spring and a decreasing trend in fall, which corresponds to the precipitation increase. The maximum seasonal depth of the snow cover, usually measured in mid-April, is also decreasing (GABROVEC et al. 2014) and first/last day with snow cover (start/end of the snow season) are on average two weeks later/earlier.

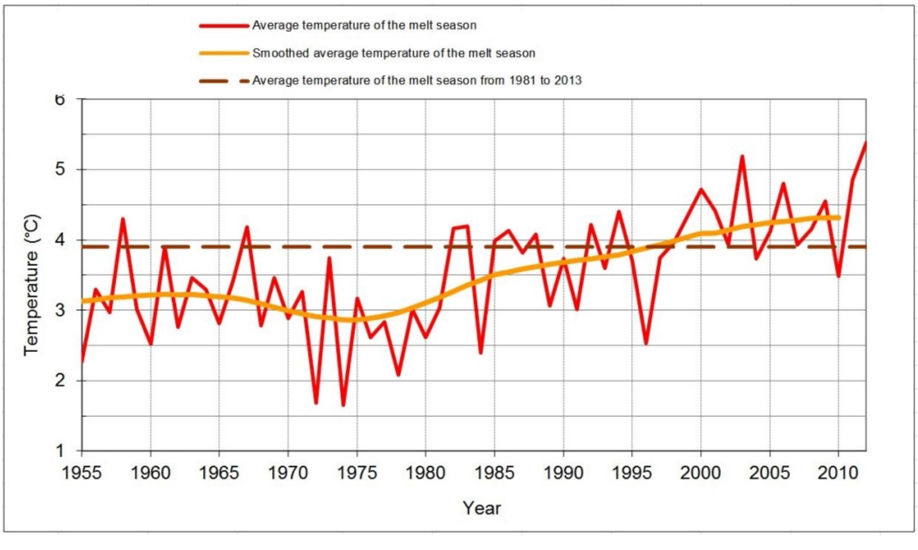

Figure 5: Average temperature of the melt season (May–October) on Mount Kredarica between 1955 and 2012 (Source: Slovenian Environmental Agency)

Conclusion

The glacier surveys and observations are strongly steeped in the rich cultural heritage connected to the highest Slovenian peak and Triglav National Park. As an object of study that is changing in a sensitive high-elevation environment—specifically, its shrinking over seven decades—the Triglav Glacier is one of the few direct evidences of climate change and its consequences. This exhibition on seventy years of observations, hosted by information centers in Triglav National Park, makes an important contribution to informing visitors about changing natural heritage as a result of climate changes.

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The National Park Gesäuse Partnership: From resistance to cooperation

Christoph Gahbauer

Keywords

national park partnership, cycle of translation, actor-network, social capital, socio-economic development, cooperation

Introduction

The National Park Gesäuse Partnership (NPGP) is an organization that establishes the cooperation between the National Park Gesäuse (NPG) and a group of approximately 90 local partner companies that are all scattered throughout the municipalities of the Alpenregion Nationalpark Gesäuse. The local companies that are enrolled in the NPGP belong to the activity sectors of accommodation, education, art and culture, direct sellers, 'Jausenstationen', leisure and sports, gastronomy, trade/commerce, handcraft and trade, alpine huts, mobility and associations. The NPGP is representing itself symbolically through a logo, which visualizes and communicates the collective identity of the NPG and partner companies (see Fig. 1). In my research I offer an ethnographic account of the main reasons why the NPGP was created in 2004 and how it subsequently developed until 2014. My analysis highlights that the NPGP is beneficial for the people living in the surrounding municipalities and the NPG itself. With the Partnership project the NPG is actually trying to implement policies that strengthen local socio-economic development in the Gesäuse area.

Figure 1: The National Park Gesäuse Partner Logo, Source: Nationalpark Gesäuse GmbH

Methods

By using a combination of questionnaires and qualitative interviews, conducted with key-informants, and participant observations of events (see Fig. 2), I generated the data on the NPGP, which I subsequently analyzed by using key-concepts drawn from Michel Callon's idea of the cycle of translation. I used the four 'moments' that compose the cycle of translation (problematisation, interessment, enrollment and mobilization) as an analytical guide to look into some of the different kinds of interactions and power relations between many human and non-human actors involved in the genesis and evolution of the Partnership, which I broadly interpret as an actor-network.

Results

My analysis highlights that the NPGP was created in order to solve two specific problems, namely the low rate of local acceptance to the establishment of the NPG and the weakness of the local economy in the Gesäuse area. Despite some initial difficulties in the first stages of its formation, the Partnership eventually developed into a solid, but still evolving, actor-network that was successful in overcoming the scepticism of local people towards the park and to convince local companies to collaborate amongst themselves and with the National Park. Furthermore, my analysis points to how the Partnership was able to create a new social capital in the area and contributed to strengthening the local economy. My research project broadly contributes to academic and policy-making debates on nature conservation and local socio-economic development by providing an analysis of some of the reasons why such partnerships are established and how they may develop.

Figure 2: National Park Gesäuse partner workshop at Gasthof Hensle, St. Gallen, 26.3.2014, Photo: Christoph Gahbauer

Conclusion

The cycle of translation enabled me to point to how the NPGP is an actor-network composed of a heterogeneity of actants, human and non-human, such as, for example, the NPG directors, the NPGP project managers, policy makers, consultants, local associations of inhabitants and politicians, visitors and tourists; nature, natural resources, agro-food products, international and Austrian laws, local and institutional regulations, contracts, advertising materials and events (see Fig. 3). I have highlighted that the interactions of all these human and non-human actants contributed to the formation and evolution of the Partnership.

My analysis highlights that the NPGP played an important role in appeasing oppositional voices to the NPG and in creating local support and consent for the park. One the one hand, the creation of the Partnership has been successful in bringing some local businesses together into a network to collaborate with the NPG and, on the other hand, it has encouraged these companies to cooperate one with another. Therefore, the NPGP was useful to generate in the Gesäuse area a social capital which was (and still is) functional to generate (new fruitful and durable) economic relationships between some socio-economic actors in the area; namely the NPG and the companies now belonging to the NPGP. It can be argued that the Partnership project generated communities, in which many social interactions among individuals are established through the participation in relatively non-hierarchical associational activities (e.g. events), and through the establishment of trust and reciprocity, which, in turn contributed to the economic development of the Gesäuse area.

Figure 3: NPGP project excursion to National Park Doñana, Spain, 2014, Photo: Nationalpark Gesäuse GmbH

Furthermore the NPGP has contributed to promote a positive image of the National Park amongst the inhabitants; and most of them have today a positive attitude towards the park. It can be argued that the creation of the NPGP harmonized the three conflicting views of ‘nature’ (as something to be ‘preserved’ from harmful human intervention; as a resource to be ‘exploited’ for tourism and for making a living from cultivating the land, hunting and breeding animals; and as something that must be ‘tamed’ in order to protect humans from nature’s own interventions) that clashed when the NPG was established. My analysis suggests that, today, these three ideas of nature keep coexisting in local understanding and perceptions of the NPG area, but in a less conflicting way than when the NPG was established.

I believe that my research can provide useful information for policy makers working in other national parks that may struggle with similar problems that the NPG had to tackle since the beginning of its establishment. Project ideas and activities of the NPGP could be adopted and implemented in other national parks to foster sustainable local development and forms of socio-economic cooperation because such ‘cooperative partnerships’ seem to have a potential to engender several (social, economic and environmental) benefits.

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Remote sensing based comprehensive monitoring of land cover change in protected areas

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Keywords

remote sensing, land cover change, Gran Paradiso National Park, ECOPOTENTIAL, Landsat, shrub encroachment

Summary

Land cover changes - due to climate or land use change – are a common challenge for the management of protected areas. Over the last decades, large parts of the European Alps have experienced forest expansion and shrub encroachment as a consequence of land abandonment. Also the Gran Paradiso National Park experiences such vegetation successional processes, which might be a threat to some local habitats and species. Remote sensing is in general a unique tool to map rates and spatial pattern of land cover change even for remote areas that are hard to monitor. In this study, hence, we aim to explore the potential for identifying hotspots of land cover change over the entire area of park based on remote sensing data.

Land cover changes for the entire Gran Paradiso National Park are explored from 1984 to 2016 based on all available Landsat TM, ETM+ and OLI images at a spatial resolution of 30 by 30 m. To map forest expansion and shrub encroachment we combined bi-temporal and time-series change detection methods and validated our results using orthophotos.

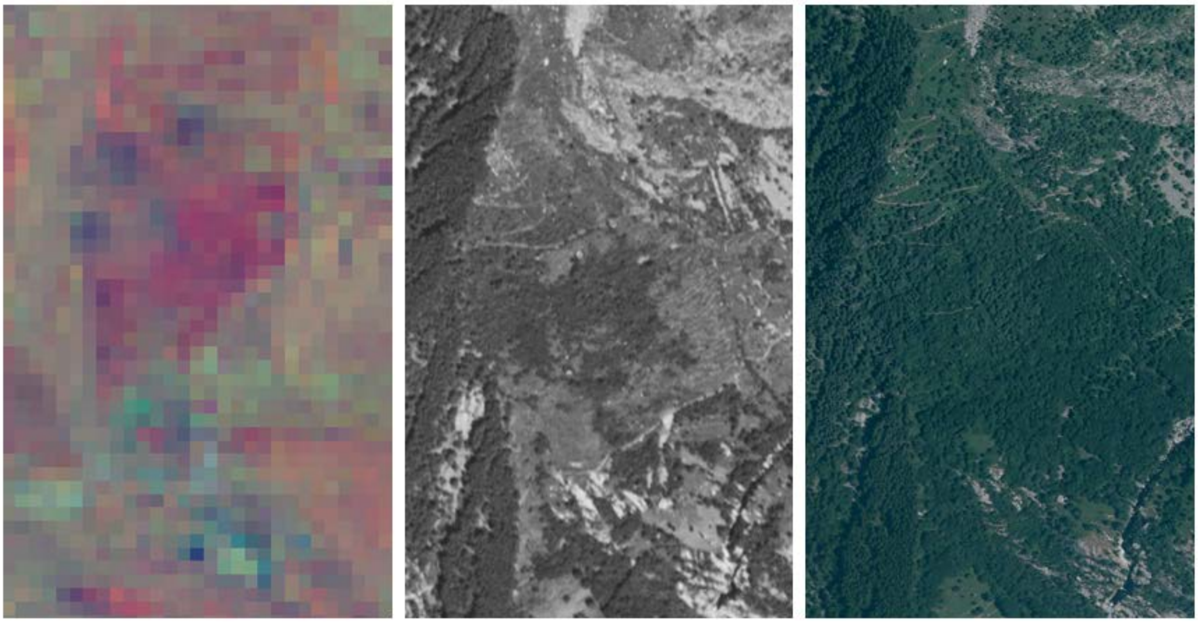

Figure 1: NDVI-Difference-Image (1988:2015) and Orthophotos from 1988/89 and 2012 show expansion of vegetation

First results show that both forest ingrowth and upward shift can be detected in several parts of the National Park (Fig. 1 with one example). Moreover, vegetation trends suggest that grasslands have been modified by shrub encroachment. They further indicate the overall diversity of change processes occurring in the park, including also changes due to disturbances (mainly avalanche tracks, see Fig. 2) and the expansion of settlement infrastructure close to the borders of the National Park.

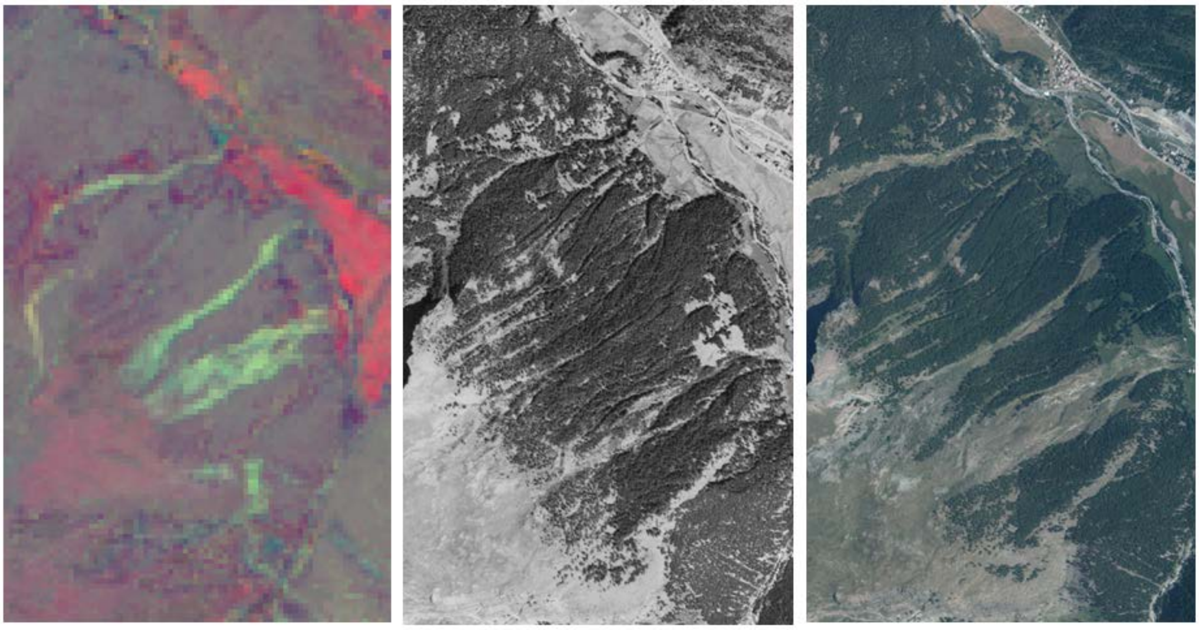

Figure 2: NDVI-Difference-Image (1988:2015) and Orthophotos from 1988/89 and 2012 show decrease of vegetation

Improving and adaptation of future management can influence such processes. Future studies have to discuss whether this is desirable.

Acknowledgements

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Tackling jointly the challenges of rural development and biodiversity conservation in protected areas

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Paper based on research findings from Civil-Public-Private-Partnerships (cp³): collaborative governance approaches for policy innovation to enhance biodiversity and ecosystem services delivery in agricultural landscapes (BiodivERsA/FACCE-JPI 2013-2014. Funding by FWF: Project ID: I 2041-B25)

Abstract

European rural communities in protected areas are facing a complex set of challenges. While demographic changes, agricultural concentration processes and globalized markets lead to enormous economic pressure for farmers in small rural structures, the intensification of the agricultural sector puts under threat the preservation of biodiversity and ecosystems. By referring to three examples, this paper discusses how collaborative approaches can help in finding a sustainable way of environmental governance that allows to effectively combine economic interests with environmental concerns.

Keywords

Rural development, cultural landscapes, biodiversity, collaborative approaches

European rural agricultural communities in protected areas are facing a complex set of challenges. More and more integrated and globalized markets, competitive and volatile prices for agricultural products and the need to modernize the mode of production and rise the capital stock in order to keep pace with the market are increasingly challenging, especially for farmers in small structured cultural landscapes and in protected areas. As a tangible result, more and more family farms are giving up every year and traditional production systems within cultural landscapes are progressively dependent upon subsidies. After decades of top down policies aiming at mitigating these market driven changes, many rural communities in cultural landscapes and areas under protection face a difficult future. While a decline in small farming and rural depopulation can have significant socio-economic impacts for a whole region, agricultural concentration processes together with the intensification of the agricultural sector also put under threat the preservation of biodiversity and ecosystems. A number of ecosystems are linked to traditional agricultural production practices. Both, giving up marginal land (especially meadows, steep or inaccessible land) and intensifying the production elsewhere bear a significant risk of losing biodiversity and may lead to increased vegetation homogenisation. In addition, land use changes may also promote soil erosion and negatively affect water stocks and ground water quality.

Current governance approaches that aim to address and tackle the problem of increased pressure on small farmers, rural depopulation and resulting challenges for the ecosystem usually are based either on command-and-control type arrangements or on market-based incentives. In command-and-control type arrangements, rules and regulations as well as decision-making are linked to hierarchical authority. Command expresses the idea of standards to comply with, control that of negative sanctions as result of non-compliance (see Baldwin, Cave & Lodge, 2011). Hierarchical structures such as governments can build on democratic processes as well as on authoritarian bases. In the context of environmental protection, command-and-control arrangements can include regulations at the European, national or sub-national level. In terms of environmental governance, command and control based approaches e.g. include rules and regulations to conserve protected areas as well as the allocation of subsidies for organic farming.

In contrast, market-based approaches are less prescriptive but rely on voluntary exchanges which are guided by individual interests and economic capacities. Decision making is influenced by economic incentives and financial capacities of concerned actors, including individuals, households, companies, governments, etc, while resource allocation is determined by willingness to accept and willingness to pay (WTA/ WTP). Whereas markets are generally seen as being regulated by demand and supply, it is worth noting that also hierarchies can operate here, with decisions being influenced by power relations. Market-based approaches to environmental governance include e.g. agro-environmental schemes, emission trading and other tradeable permit systems, environmental labels or more generally payments for ecosystem services (PES).

However, in many cases, both hierarchical and market-based governance approaches are not very suitable and effective in helping rural communities to address current challenges. In particular, main limitations are that they are generally too short-term or too general, i.e. not adapted enough to specific local problems and circumstances. Against this backdrop, the aim of Civil-Public-Private-Partnerships (cp³), a research project implemented under ERA-Net BiodivERsA/FACCE-JPI, is to analyse how collaborative approaches in environmental governance can help providing a better fit between agro-ecosystem management and the need to reach specific Ecosystem Services (ES), food production and biodiversity targets in rural landscapes.

For this purpose, research is conducted in three case study regions in Germany, the Netherlands and Austria. All three are protected areas where different forms of collaborative environmental governance have been developed. In the biosphere reserve Spreewald, 100 km south-east of Berlin, on the one hand a citizen foundation ('Stiftung Kulturlandschaft Spreewald') works towards raising funds to promote the preservation of the cultural landscape. On the other hand, a local backwater association ('Staubeirat') is meeting twice a year to discuss and plan the issues related to water management and to advise on water level regulation. The case study in the Netherlands is the municipality of Berg en Dal, situated between the river Waal, Nijmegen and the German border and part of the national landscape Gelderse Poort. With a view to promote landscape conservation, a development plan has been set up with the participation of multiple stakeholders, including the government, civil society and businesses. Long term funding for farmers carrying out nature conservation activities has been made possible through the participation of a number of private funders. In Austria, the analysed case study is the Naturpark Jauerling-Wachau. Here, the seven municipalities located in the park have formed an association to closely collaborate and pool community resources. Main activities include the joint park management and biodiversity protection, environmental awareness raising especially among children and supporting local farmers in marketing their products and homemade goods.

By referring to these case studies and preliminary research results, the aim of this paper is to emphasise and discuss how collaborative approaches can contribute to finding a sustainable way of environmental governance that allows to effectively combining rural development needs with environmental protection and conservation concerns. The paper first presents more in detail the challenges and problems that local communities in the studied cultural landscape have to face. It then analyses how local cooperation at the community level can help address these difficulties and contribute towards balancing or combining different economic and ecological interests. Presented data has primarily been collected through exchanges and interviews with local stakeholders, as well as through Net-Map activities. The paper finally discusses strengths and limitations of collaborative strategies as solutions for both sustainably managing the local agro-ecosystem and mitigating the impacts of the ongoing transition of the agricultural production system. Despite the focus on particular examples, the paper is intended to stimulate broader reflections on how rural communities in protected cultural landscapes can cope with the above mentioned challenges.

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Biology, conservation, and promotion of Skylark populations in subalpine and alpine zones of the Beverin-Naturpark, Switzerland

Roman Graf, Pauline Aelvoet, Claire Guyot, Reto Spaar

Keywords

Skylark, *Alauda arvensis*, breeding success, breeding phenlology, alpine and subalpine meadows, habitat choice

Introduction

In Switzerland, populations of Skylarks *Alauda arvensis* have decreased not only in the lowlands but also in upland areas (KORNER et al. 2017). The current process of agricultural intensification in the subalpine zone seems to be the main reason for this development (GRAF et al. 2014a). The most recent surveys reveal that the Alps hold a substantial part of the total Swiss population of Skylarks and, therefore, the subalpine and alpine populations are of great value for conservation efforts (GRAF et al. 2014b).
Conservation strategies of subalpine and alpine Skylark populations will be developed within the regional nature park 'Naturpark Beverin'. The following research questions are addressed:

1. **Population density and territory distribution**
   - What are the population densities of Skylarks in the subalpine/alpine zone?
   - Are there annual differences in territory occupancy?
   - Are there patterns in territory distribution (e.g. clustering)? If so, how can they be explained?
2. **Habitat characteristics**
   - How can densely populated areas be distinguished from low-density sites regarding land-use management and topographical parameters?
3. **Breeding biology and population dynamics**
   - What is the phenology of Skylark breeding activities?
   - How many fledglings are produced per territory
   - What are the causes for nest losses?
4. **Habitat improvement**
   - Which measures have already been taken in favour of Skylark populations? Are these effective? Are there additional conservation measures to be initiated within and beyond a regional nature park (socio-economic aspects)?

Methods

Our study area was the Schamserberg (833 ha). This is a gently sloping plateau at 1440 - 2350 m a.s.l., situated in the inner alpine Valley 'Val Schons', within the 'Naturpark Beverin', Switzerland. A large part of the study area is used as nutrient-poor or low-intensity fertile meadow. In higher elevations (above 2100 m a.s.l.) pasture use dominates. A complete census of the vegetation types was conducted in 2016 on-site, using the ALL-EMA-Method (BUHOLZER et al. 2015). In 2016 and 2017 we conducted a skylark territory mapping with four visits (Mai until beginning of July).
In order to improve our understanding of habitat selection of Skylarks, we extended 2017 our study to eight other areas in the subalpine-alpine zone in geographical proximity to our study area. Some of these areas are known to be fairly densely populated by Skylarks, while others have only small Skylark numbers according to previous research (Graf et al. 2014b). In these additional areas we conducted a Skylark census and vegetation mapping using the same methods as in 'Schamserberg'.
Furthermore, we interviewed the local farmers in order to know their opinions about a proposed regional land consolidation and infrastructure project.

Results

- From 2016 to 2017 the number of territories decreased from 212 to 154; this corresponds to a density of 2.55 and 1.85 territories/10 ha, respectively. Reduced densities were mainly observed in the lower areas in 2017.
- A higher Skylark territory density as in the 'Schamserberg' area is hardly found in any other region of Switzerland (MÜLLER & ERNST 2014).
- 2016: Arrival of Skylarks in the study site could'nt be observed; 16 pairs with documented breeding activity but only 12 nest sites found. Six of them failed (4x predation, 2x snowfall); first eggs layed on 31st May, last nestlings leaved the nest on 20th July. There was no second broods but several replacement broods.
- 2017: Weather conditions much more favourable; Arrival of Skylarks between 25th March and 3rd April; 25 pairs with documented breeding activities observed but only 21 nest sites found (only 3 failed); Most pairs raised two broods. First Brood: First eggs layed on 15th May, last nestlings around 26th June; Second brood: first eggs on the 15th June, last nestlings on 26th July. .
- In both years we didn't observe agricultural work (mowing, hay harvest) to be responsible for any nest loss.

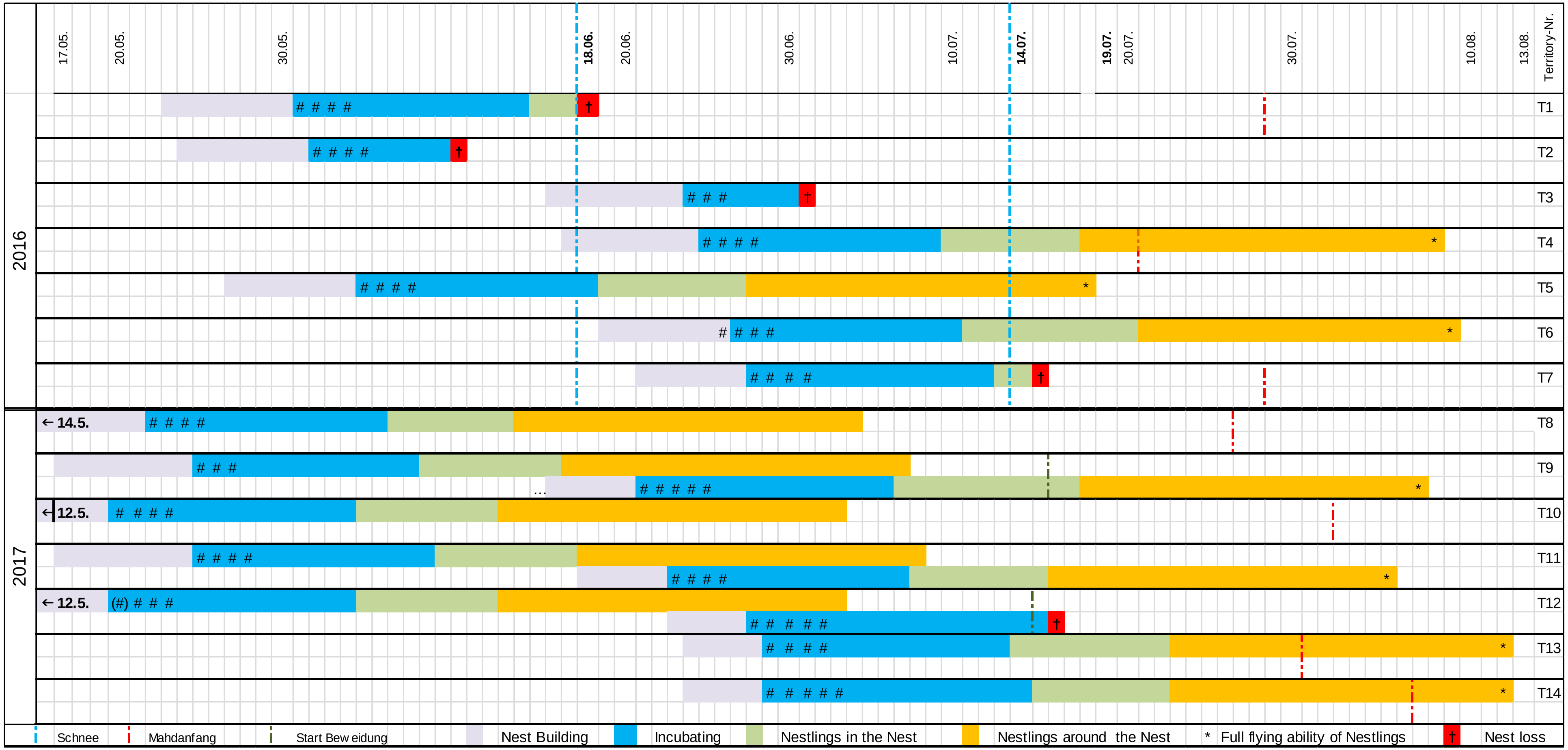

Figure 1: Breeding process at Schamserberg in 2016 (16 Territories observed). © Schweizerische Vogelwarte Sempach

– The analysis of the habitat selection data is still under way. However, we already know that:
  - the majority of the territories is situated in mown meadows (not in pastures),
  - the most common vegetation types (Nardion and Trisetion) are used by Skylarks largely according to their availability (Table 1), and
  - a habitat mosaic of low-intensity and low-nutrient meadows, a small proportion of high vertical structures, and overall very late mowing (ensured by management contracts) seem to be key factors for the good situation of the Skylark population at 'Schamserberg'.

Interviews showed that most farmers are willing to maintain the low-intensity management of their meadows in the important Skylark areas, even after the planned land consolidation and infrastructure improvements.
Highest Skylark-densities are found on moderately steep south-eastern to eastern slopes between 1800 and 2000 m a.s.l.

Study Area	Sub-Area	Elevation	Surface (ha)	Territories 2017 (n)	Density (Terr./10ha	*Polygono-Trisetion*	*Poion alpinae*	*Calthion*	*Caricion davallianae*	*Caricion ferrugineae*	*Seslerion*	*Caricion curvulae*	*Nardion*	*Dwarfshrub Heathland*	*Forest vegetation*
MAIN STUDY AREA															
Schamserberg	Blasatscha Oben	2000-2350	111	30	2,7	10,6	14,2			5,3	5,3		53,1		
Schamserberg	Blasatscha Unten	1800-2140	89	29	3,3	33			8,8	8,8			20,9		
Schamserberg	Culmiez Oben	1960-2390	86	31	3,6	20,2	8,3				13,1		41,7		
Schamserberg	Cumiez Unten	1780-2280	103	15	1,5	12,2			5,6	29,9	22,4		15,9		
Schamserberg	Libi	1820-2240	125	50	4,0	38,1	5,6						25,4	14,3	
Schamserberg	Lohn	1440-1960	99	2	0,2	39,2	5,2				6,2		9,3		
Schamserberg	Mathon	1860-2240	109	54	5,0	51,4				2,7	8,1		26,1	5,4	
Schamserberg	Zwölfihorn	1820-2240	111	25	2,3	13,2			9,7	8,8	10,5		31,6	17,5	
ADDITIONAL AREAS															
Alp Neaza	Cuolm da Pignia	1950-2360	100	0	0	6			8	21	8		17	8	21
Alp Neaza	Schumanet	2100-2550	100	0	0		15			5	4	5	37	9	
Radons	Tgeps	2140-2490	100	0	0		20	12	6	4	10		20	10	
Radons	Tranter Uals	1840-2090	100	16	1,6		7	6	11	6	21		15	6	
Seeberg	Cufercalhütte	1930-2370	100	13	1,3	9	9			6	35		29		
Seeberg	Roten Turra	1990-2330	100	2	0,2	23	12				13		17		
Tschappina	Oberurmein	1480-1740	100	4	0,4	57	6		6				11		
Tschappina	Rascheins	1630-1910	100	8	0,8	58	10		7				14		

Tabel 1 : Number of Skylark territories, Skylark density, geographical parameters and vegetation composition in subdivided areas of Schamserberg and in the additional study sites in the region. Vegetation units are only listed when their proportion exceeds 5%.

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Effects of green exercise and waterfall aerosol on mucosal immunity and chronic stress
A randomized controlled clinical trial

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Abstract

Green exercise and the specific microclimate of alpine waterfalls with high levels of ionized water aerosols has been suggested to trigger beneficial health effects. In the present three-armed randomized controlled clinical trial (RCCT) we focused on import medical and physiological functions of human health: (i) immune reagibility, (ii) physiological stress response and (iii) stress-related psychological parameters.

Methods: 102 participants with increased stress levels were included in the present study. Two groups (n=65) spent an active sojourn with daily hiking tours in the National Park Hohe Tauern (AUT). One group was exposed to water aerosol of an alpine waterfall for 1 h/day (WF+, n=33), whereas the other group spent the same time at a distant site (WF-, n=32). A third arm (CO, n=26) had no intervention (except vaccination). The effect of the interventions on the immune system was tested by oral vaccination with an approved cholera vaccine and measuring salivary IgA antibody titers. Lung function was determined by peak expiratory flow measurement. Electric skin conductance, heart rate and adaption of respiration rate were assessed as physiological stress parameters. Psychological stress-related parameters were analyzed by questionnaires and scales.

Results: Compared to the CO group, both intervention groups (WF- and WF+) showed improvement of the lung function and of most physiological stress test parameters. Analysis of the mucosal immune response revealed a waterfall-specific beneficial effect with elevated IgA titers in the WF+ group. In line with these results, exposure to waterfall revealed an additional benefit concerning psychological parameters such as subjective stress perception (visual analog scale), the Global Severity Index (GSI) and the Positive Symptom Total (PST).

Conclusion: Our study provides new data that strongly supports a beneficial health effect of waterfall environment and green exercise on immune function, physiological and psychological stress parameters.

Keywords

Waterfall, Aerosol, Ions, High-altitude, Nature therapy, Chronic stress, Green exercise, Mucosal immunity, Hiking

Introduction

The specific microclimate of alpine waterfalls has been suggested to trigger beneficial immunological and psychological effects, for example for the treatment of allergic asthma (GAISBERGER et al. 2012). Waterfalls produce high levels of inhalable, negatively charged nano-water particles hovering in the air, while the positive-charged fragments sink to the ground (KOLARŽ et al. 2012). Negative air ions have been shown to influence psychologic well-being and increase serotonin levels (WU et al. 2011). Waterfalls also create a specific microbiological atmosphere, which may influence immunological parameters (CRAIG et al. 2016).

Chronic stress decreases sIgA expression and reduces the humoral immune response to a vaccination (GALLAGHER et al. 2008). Reduced IgA in turn weakens our immunity, as it is secreted in all mucosal surfaces and part of the first line of defense. The level of specific ABs in response to a vaccination is a proper model to monitor stress relief and immunity.
The present RCCT tests the hypothesis of a stronger vaccine-specific AB response due to waterfall exposition and stress relief, when combined with high-altitude climate therapy and physical activity.

Methods

Subjects

91 persons (age 19-61; 44 ♂/47 ♀) working in care professions (inclusion criterion: increased TICS score).

Intervention

Except for the control group (CO, n=26), all participants spent 1 week at Großkirchheim (Carinthia, A), hosted in hotels and receiving the same meals. For 1 h each day, the groups were separated for intervention into a waterfall- (WF+, n=33, waterfall exposition) and a "non-waterfall" group (WF-, n=32, no exposition). Individuals of the CO group stayed at home (no intervention except vaccination). Data Gartl Waterfall: 50 m drop height, water flow 0.6 m^3/s, 42660 neg. $ions/cm^3$.

Vaccination & sIgA

Mucosal immunity was tested by oral vaccination with DUKORAL® from SBL Vaccines, which was given on days 0 and 6 (Fig. 1). Saliva (2 ml) was collected on days 0, 6, 16, and 66 in the morning and DUKORAL® vaccine specific salivary IgA concentrations got determined.

Questionnaires & scales

Trier Inventory for the Assessment of Chronic Stress (TICS), Visual analog scale for subjective stress perception (VAS), Symptom Check List (SCL-90), Recovery-Stress Questionnaire (EBF), Maslach Burnout Inventory (MBI-D), List of complaints (Ksb-S BL) and the Mental state scale (Bf– S).

Lung function & stress physiology

A computer-guided stress test was performed to measure the heart rate, respiration rate, and the skin conductance during a 3-min baseline phase, a 1-min stressor phase (optical and acoustical stressor) and a 4-min post-stress recovery phase. To determine the training effect a lung function (peak expiratory flow (PEF)) was performed.

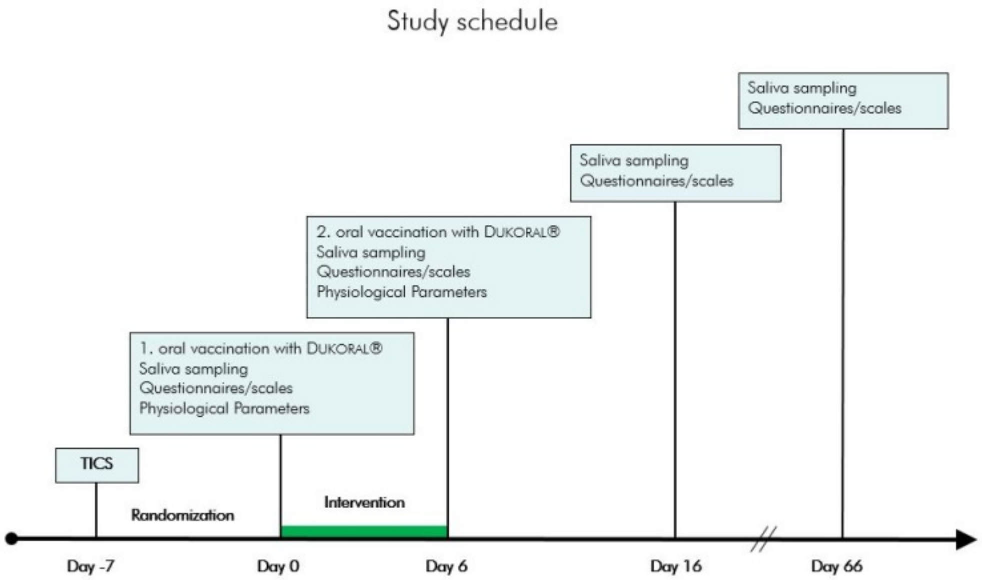

Figure 1: Study schedule. Schematic chronological process of the controlled clinical trial

Results

Specific sIgA

A comparison of IgA titers of both intervention groups (WF+ and WF–) with the non-intervention control group with a linear mixed model (LMM1) shows a strong statistical trend (p = 0.055) on day 16 of the WF+ group, compared to that of the CO group (Fig. 2). The strongest percentage increase at all time points can be found in the WF+ group. The specific impact of the waterfall ionosol was evaluated with another linear mixed model (LMM2) of the two intervention groups WF+ and WF–. The result indicates a significant increase of salivary IgA titers in the WF+ group on day 6 and day 66 (Fig. 3).

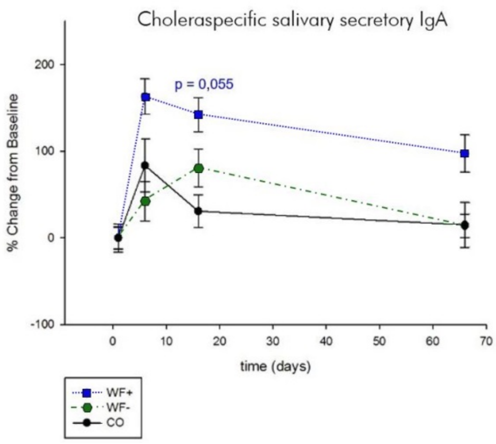

Figure 2: Antigen-specific salivary IgA levels of responders. Linear mixed model (LMM1) of both intervention groups compared to the control group. Data shown in percentage change (±SD) from baseline (pre-serum)

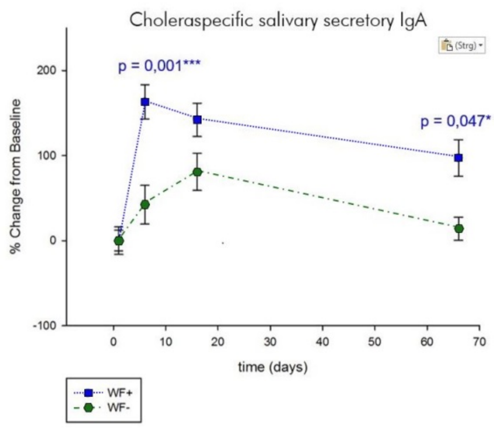

Figure 3: IgA levels of the two intervention groups (responder). Linear mixed model (LMM2) of the waterfall group (WF+) compared to the non-waterfall group (WF-). Data are shown in percentage change (±SD) from baseline (pre-serum)

VAS

The VAS assessing the subjective stress perception was applied on day 1 and day 6. A significantly lower stress level could be measured in the WF+ group after the intervention week on day 6, compared to the control group (p=0.000).

SCL 90

Linear mixed model analysis of the SCL-90 questionnaire revealed improvement in six of the ten symptom dimensions in both intervention groups after 6 days (compared to the control group). The data indicate a clear trend of a beneficial effect of the waterfall environment. Furthermore, on day 6, both the Global Severity Index assessing overall psychological distress, as well as the Positive Symptom Total which displays the number of self-reported symptoms, were significantly decreased in the waterfall group only, again indicating a waterfall-specific effect (p=0.009 and p=0.03).

EBF

The EBF questionnaire revealed less stress (p=0.068) and improved recovery (p=0.070) only in the waterfall group.

MBI-D

Measuring incidence and severity of burnout by means of the MBI-D elicited a significant improvement in the WF+ group in the category depersonalization, compared in the control group on day 66 (p=0.002). No differences could be measured concerning the other two components (emotional exhaustion, personal accomplishment).

Ksb-S BL

Reflecting constitutional changes during the trial, the WF+ group showed a significant positive long-term effect on day 66. Both intervention groups show a decrease of complaints on day 16 (p=0.011).

Bf– S

The mental state scale clearly indicates enhanced well-being short-term effects on day 6 (p=0.051).

Lung function & physiological stress test

Waterfall exposure had a significant positive effect on the PEF on day 6 (Fig. 4).
All signals of the physiological stress test decreased in the W+ and W– group after 1 week (Fig. 4). The results show the arithmetic mean [%] of the 4-min post-stress recovery phase, compared to a 100% reference line (mean of stressor phase). Results below 100% indicate the ability to reconstitute a parasympathetic physiological state within the 4-min post-stress recovery phase. The respiration- and heart rate was significantly decreased in both intervention groups. Skin conductance, indicating sympathetic activity was significantly reduced due to waterfall exposition.

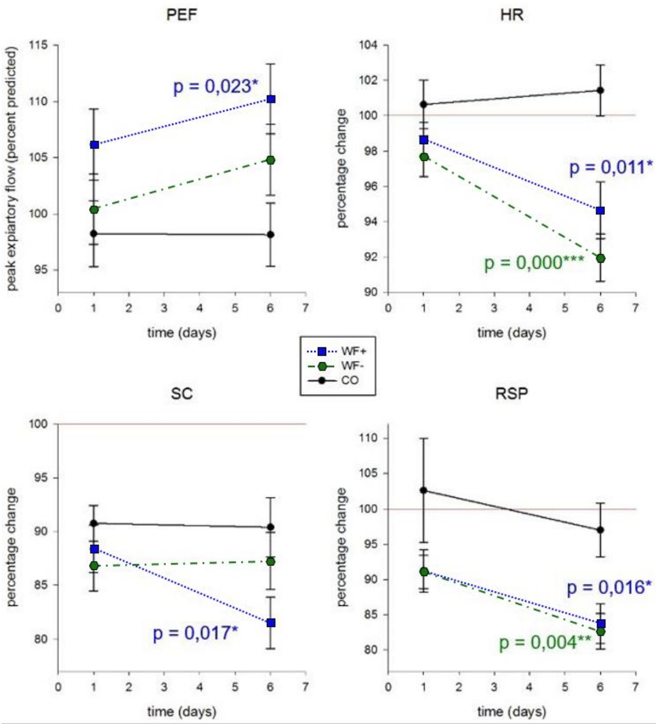

Figure 4: Lung function and physiological stress test. Linear regression analysis of lung function and peripheral signals of the physiological stress test. Means (±SD) of the PEF value is shown in percent of the predicted PEF, scaled on age, height, weight, gender, smoker (yes, no, former), and asthma (yes, no). Means (±SD) of the 4-min post-stress recovery phase shown in percentage compared to means of the 1-min stressor phase (100% reference,indicated as red line).

Discussion

Most investigated parameters were significantly changed with a 1-h/day exposure to the waterfall. The humoral immune response after oral vaccination was significantly improved by the additional waterfall exposure (GRAFETSTÄTTER et al. 2017). The specific microbiologic waterfall environment may directly affect the microbiota and thus be responsible for the observed effects on mucosal immunity.

Conclusion

The present RCCT provides evidence for an added value of a daily 1-h stay for 1 week in a waterfall environment in combination with green exercise and high-altitude climate therapy. Our data suggest to expand the applicability of this simple and cost-effective health provision for treatment of stress-related symptoms.

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Monitoring of Saharan Dust – Influence on aerosol composition and snow chemistry

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Abstract

Long-range transport of Saharan dust (SD) serves as a significant source of high particulate matter (PM) concentrations far away from the source region. High PM loads are relevant for climatic issues such as the radiation budget or cloud formation processes as well as for environmental issues such as acidity, ionic loads of precipitation and nutrient supply, but also for air quality issues and related topics such as human health. Extensive investigations and long-term studies of Saharan dust form the basis for further impact related studies.
We investigated the influence of SD on the aerosol composition as well as on high alpine snow chemistry and found a strong increase in aerosol mass and big differences in the aerosol size distribution with an increase of particle numbers in the coarse mode during SD-episodes. Besides our measurements of the snow chemistry underline the assumption that SD serves a high cationic input of especially Calcium as well as a high alkaline input, shown as an increase in the pH.

Keywords

Saharan Dust, air quality, snow chemistry, aerosol composition

Introduction

The Sonnblick Observatory, located in the Nationalpark Hohe Tauern, runs an extensive aerosol and snow deposition monitoring, providing an ideal data set to study the impact of SD. The occurrence of Saharan dust events (SDEs) is regularly identified based on optical aerosol properties (Coen et al., 2003). This, together with the observed aerosol mass, allows the computation of a "Saharan dust index" indicating a potential Saharan dust influence (Schauer et al., 2016). Besides, since spring 2016, the aerosol monitoring within the project DUSTFALL (funded by the Austrian Research Promotion Agency, FFG) comprises also a filter sampling of different particle sizes.
Complementary to this extensive aerosol monitoring, a 30 years long time-series (1987-2017) of the chemical composition of the annual winter accumulation snow is available from a glacier nearby the Observatory. It is well known, that the chemical composition of the snow is strongly influenced by long range transport of mineral dust (e.g. SD), markedly changing the cation concentration and the alkalinity of the snow cover, especially in such remote areas far off of human influence (e.g. Maupetit & Delmas, 1994).

The aim of this study is to investigate the influence of SD on the aerosol composition, in particular the chemical differences of the coarse (PM10) and fine (PM1) particles via the analysis of weekly aerosol filter samples of these two size fractions. Besides, the ecological issues of SD are investigated by evaluating the influence of SD deposition on high alpine snow chemistry of the last three decades from 1987 until 2016.

Methods

For the investigation of the aerosol composition during SDEs the particles are separated in two size fractions (PM10 and PM1). The PM10 fraction is sampled on quartz fibre filters via a Digitel High-Volume Sampler with a PM10 separator at the aerosol inlet, including the coarse and fine particle fraction. The PM1 fraction is also sampled on quartz fibre filters. Size segregation is performed by a low pressure impactor, installed at the whole air inlet available at the Observatory. Optical analysis of the filters comprises the measurement of transmitted light through the filter in the IR (880 nm) and UV (371 nm) using an OT-21 transmissiometer (Magee Scientific). The chemical analysis covers the measurements of soluble cations (Ca^{2+}, Mg^{2+}, NH_4^+, K^+, Na^+) and anions (SO_4^{2-}, NO_3^-, Cl^-) as well as the determination of sugars (mainly levoglucosan) via ion chromatography using standard protocols and the determination of organic and elemental carbon via a thermo-optical OC-EC Analyser (Sunset Lab) and the ESUAAR2 temperature program.

Snow samples of the whole winter accumulation snow cover were collected every year at the end of April, just before snow melt is likely to occur, in a 10 cm vertical resolution. Samples were kept frozen until the analysis in the lab where the pH, the conductivity as well as the ion composition (Ca^{2+}, Mg^{2+}, NH_4^+, K^+, Na^+, SO_4^{2-}, NO_3^-, Cl^-) via ion chromatography was measured. We identified Saharan Dust Layers (SDLs) in the 30-year long snow pack data set via a two-step approach based on Rogora et al. (2004). In a first step we identified alkaline layers via a pH higher than 5.6 and in a second step SDLs out of the alkaline layers were identified via a Ca^{2+} concentration of more than 15µeq/l.

Results and Discussion

Influence of SD on aerosol composition

The influence of SD on aerosol composition, in particular the chemical differences of the coarse (PM10) and fine (PM1) particles, is studied via the analysis of weekly aerosol filter samples of these fractions. Focus is put on two different episodes (Fig. 1), one without (02.06.2016-09.06.2016) and one with SD influence (21-07-2016-28.07.2016). Considering the first episode PM1 and PM10 samples feature almost the same colour due to a negligible influence of coarse particles. In contrast, during the second episode with SD influence, the larger PM10-filter has a brownish colour, whereas the small PM1 filter has a dark grey colour. As can be seen in the time series of the particle numbers of the two size fractions, a very high number of coarse particles was observed, whereas the fine particle mode does not really differ from the week before and after. More details become visible when chemical analysis is considered.

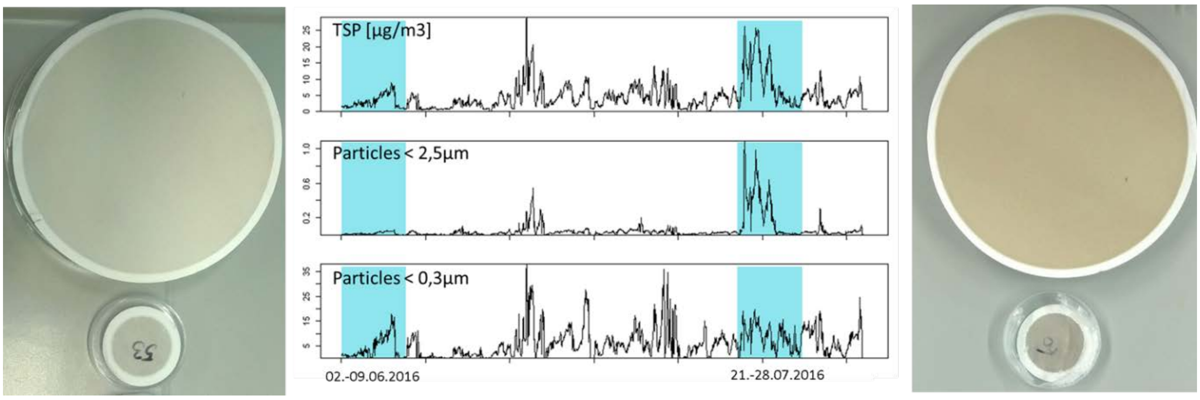

Figure 1: Time series of Total Suspended Particles (TSP) in µg/m3 and number of particles smaller than 2.5µm and 0,3µm in diameter. Filters of the PM10 (big filter) and PM1 (small filter) of the period from 02.-09.06.2016 (left) and of the period from 21.-28.07.2016 (right). Please check the digital conference volume for the true colour version of this figure!

Influence of SD on high alpine snow chemistry

Based on the two-step approach described above, we performed a retrospective identification of SDLs in high alpine snow packs of the last three decades from 1987 until 2016 (compare GREILINGER et al., 2016) to investigate the influence of SD on high alpine snow chemistry.

Fig. 2 shows mean deposition loads of every single ion for all years, separated in the contribution of SDLs and the remaining non-SDLs. Mean contribution of SDLs range between 5-6% for Cl-, NO3-, SO42-, Na+, NH4+ and K+ whereas for Mg2+ and Ca2+ a mean contribution of 16% and 28%, respectively, was found, although only 6% of all layers are identified as SDLs and contribute only 10% to the deposition load of all years.

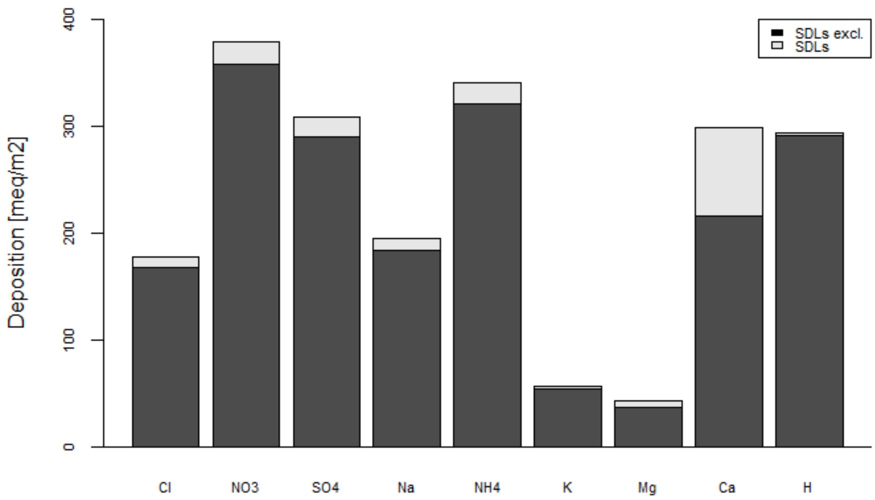

Figure 2: Mean deposition loads of all years in meq/m2 separated in the contribution without SDLs (black) and of SDLs only (grey).

The mean pH over all annual snow packs featuring SD input is 5.46. If layers, identified via the criteria described above, are excluded from the calculations, the mean pH remains in the same range with 5.39. In contrast the mean pH of SDLs only increases up to a mean pH of 6.11 (Fig. 3). Thus the pH in SDLs is 0.7 pH units higher than in other layers. SDLs alone show pH values corresponding to an 80% lower H+ concentration.

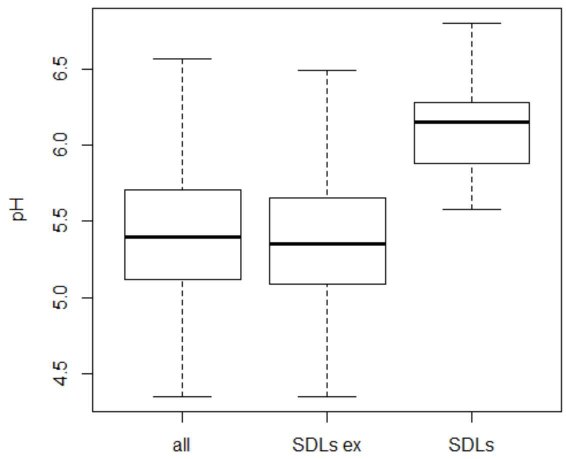

Figure 3: Mean pH values of all layers, layers with SDLs excluded and SDLs alone.

Conclusion

The aerosol filter sampling allows a differentiation between comparable small background aerosol particles, which is usually omnipresent, and the coarse air particles, which can be attributed to long-range transport of desert dust, e.g. from the Sahara, and reach the observatory episodically. These differentiation is of great interest to investigate the occurrence and intensity of SD transported to Austria and to improve the understanding how these episodes influence air quality issues such as exceedances of limit values of PM concentrations at lower elevations.
The investigation of the long-term snow chemistry data set and the retrospective identification of SDLs within the snowpack is very unique and allows conclusions on the impact of SD, not only on high alpine snow ecology, but also on additional ecological issues such as fertilization of surrounding ecosystems due to melt water run-off.

Acknowledgements

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Millennial scale variability of denudation rates for the last 15 kyrs inferred from the detrital ^{10}Be record of lake Stappitz in the Nationalpark Hohe Tauern, Austrian Alps

Nationalparks Austria Science Award 2017

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Keywords

Cosmogenic nuclides, denudation rates, alpine catchment, lake sediment core, climate impact, glacier activity, paraglacial cycle, transient landscape, Nationalpark Hohe Tauern, Austria

Summary

Reconstructing paleo-denudation rates over Holocene time-scales in an Alpine catchment provides an excellent opportunity to isolate and test the climatic forcing of denudation, disentangling its effects from tectonics or anthropogenic effects. We measured cosmogenic ^{10}Be on two sediment cores from Lake Stappitz (FRITZ & UCIK, 2001) in the Nationalpark Hohe Tauern (Austrian Alps) to derive a 15-kyr long record of the upstream Seebach Valley (Fig. 1).

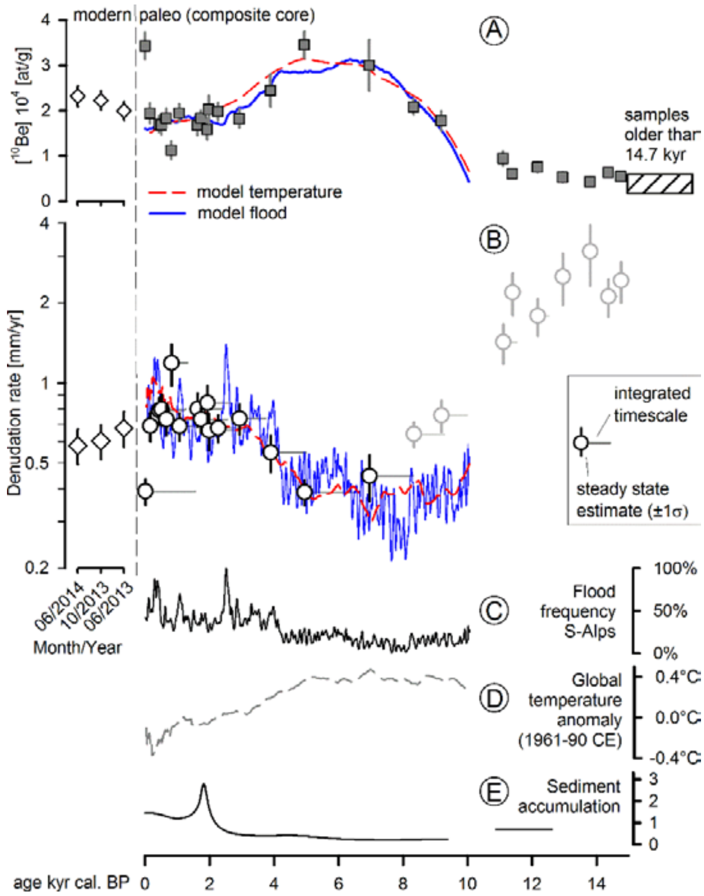

Figure 1: (A) 10Be concentrations from the core (gray squares) and the active stream (diamond shape) with the transient model output data using the climate records of (C) flood frequency (WIRTH et al. 2013) and (D) temperature (MARCOTT et al. 2013) as input denudation history (blue solid line and red dotted line, respectively. (B) steady-state denudation rates (white circles, shaded where they are not meaningful, see text). (E) Sediment accumulation rates derived from the age-depth model of the composite core.

Our study provides quantitative estimates of catchment denudation for the Holocene in an unprecedented temporal resolution (GRISCHOTT et al., in press). Due to the existence of the lake over the Holocene, the upstream Seebach Valley was isolated from baselevel (tectonic) changes and the high elevation minimizes anthropogenic impacts. The ^{10}Be record indicates significant, but temporally decreasing, mixing with low-dosed paraglacial sediments from 15 to 7 kyr cal BP. In the absence of perturbing glacial sediments after 7 kyr cal BP, the ^{10}Be concentrations can be converted to catchment-wide denudation rates (GRANGER et al., 1996).

Denudation rates significantly fluctuated over this time period and are related to the hillslope response of climate forcing. Lower hillslope erosion rates of ca. 0.4 mm/yr found between 5 to 7 kyr cal BP correlate with a stable climate, infrequent flood events (WIRTH et al., 2013) and higher temperatures (MARCOTT et al., 2013) that favoured the widespread growth of stabilizing soils and vegetation (NICOLUSSI et al., 2005). Higher hillslope erosion rates of ca. 0.8 mm/yr for the last ~4 kyr correlate with a variable, cooler climate where frequent flood events increase denudation of the less protected hillslopes. Overall our results suggest a tight coupling of climate and hillslope erosion in alpine landscapes as it has been observed in other parts of the Alps (ARNAUD et al., 2016).

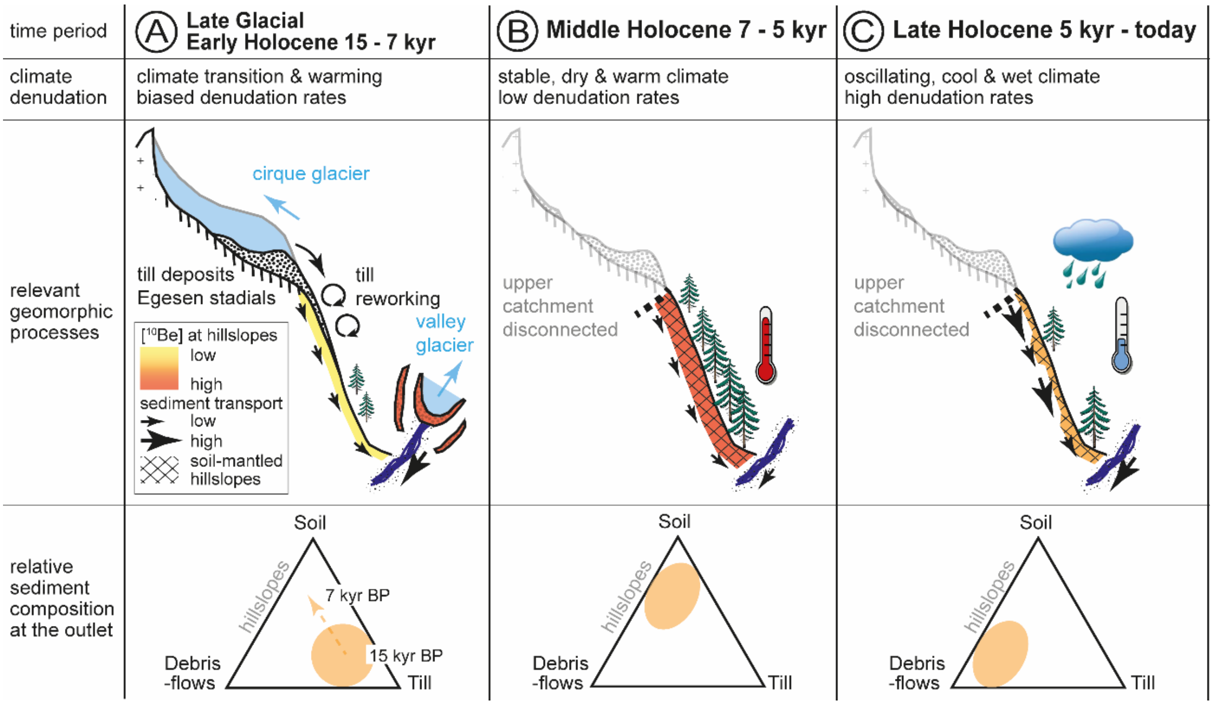

Figure 2: The environmental history of the Seebach Valley schematically explained in three distinct time periods between 15-7 kyr, 7-5 kyr and 5 kyr to present subdivided in climate and observed denudation rates, relevant geomorphic processes in the catchment visualized along a valley transect and the relative sediment composition at the outlet with the three major sediment sources 'soil', 'till', and 'debris-flows'. During the Late Glacial and Early Holocene (A), reworking of the glacial sediments and previously zeroed hillslopes leads to low 10Be concentrations of exported sediments. The Mid-Holocene (B) is characterized by rare flood events and warm temperatures leading to soil development and stabilization of hillslopes. Note, the upper half of the catchment is disconnected in terms of sediment transport. Later increase of the flood frequency and colder temperatures during the Late Holocene (C) leads to higher hillslope erosion and sediment flux.

Acknowledgement

This study forms part of R. Grischott's Ph.D. project, funded by a PhD grant from the SNF 200021_135317/1 granted to F. Kober. M. Hinderer and S. Wirth are thanked for rich and helpful scientific discussions. We thank the Nationalpark Hohe Tauern for fieldwork support. Both the Nationalpark Hohe Tauern and the Laboratory of Ion Beam Physics contributed to the AMS measurement costs. We thank J. Charreau and an anonymous reviewer for constructive comments which substantially helped to improve the manuscript. L. Hendriks helped to fix language issues which is acknowledged.

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How much wilderness is left in Europe's Wilderness Areas? A comparative analysis of selected wilderness areas in Central Europe

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Keywords

Wilderness, wilderness protection, Europe, non-intervention management, categorisation

Summary

The present thesis analyses various definitions of wilderness, as well as their applicability in Europe. The organisations behind these definitions work with different backgrounds and strategies, leading to a variety of interpretations what wilderness actually is, not just in theory but especially in the field.

The definitions in use in Europe categorise wilderness in two stages according to various factors, such as the extent of past and present human activities, time or size. The analysis of four selected wilderness areas in Central Europe, based on a self-developed categorisation framework, tries to find out if such a theoretical categorisation of wilderness and its dynamics can be applied in practise.

The four presented areas mainly differ in their history of usages and the consequences for nature arising from them. Despite of, for example, clear cuts for the iron production hundreds of years ago or decades of usage as a military training ground until the fall of the Iron Curtain, today all areas show characteristics of wilderness. This underlines the power of nature if it is granted enough time and space as well as no intervention in its processes. The arising challenges and conflicts coming along with wilderness protection, or rather non-intervention management, which is essential for it, will be addressed as well. Focus will be put on densely populated and economically heavily used regions such as Austria and Germany.

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The current situation of the River Enns fish fauna around the Gesäuse National Park

C. Gumpinger

Abstract

In two segments of the Styrian part of the River Enns the effectiveness of river engineering measures, implemented in the course of a LIFE-project, was evaluated by electrofishing. No improvement was detected - probably due to the small dimension of the rehabilitation measures that could not alter the overall bad ecological condition of the River Enns in Styria. This condition results firstly from channelization, but also from hydropeaking and periods with a surplus of fish predators. Improvement can only be gained by extensive restoration programs.

Keywords

river engineering, fish fauna, restoration measures, predators

Introduction

The River Enns is the longest river that has both its source and its mouth within the Austrian borders and covers a distance of over 255 kilometres. 120 kilometres of the watercourse are situated in the federal state of Styria, including the two reaches in which the present study was conducted. The investigations where performed as a post-monitoring program of a LIFE-project that dealt with morphological improvement measures in the River Enns and in the mouth of several tributaries.

The two studied reaches are distinguished by their morphology, the upper stretch 'U' – 'Paltenspitz to Gesäuseeingang' describing a very massively regulated und channelized river stretch that is deepened several metres and suffers from fine sediments deposited in the hyporheic interstitial and destroying this very important environment. The lower study reach 'L' – 'NP Gesäuse – Gofergraben to Johnsbachmündung' is much steeper, showing a more straightened natural river course. While stretch 'U' is regulated nearly along the whole range, the downstream stretch 'L' exhibits only short, punctual areas with rip-rap or other bank stabilizing measures.

Both investigated reaches are parts of SAC sites. Nevertheless, they both suffer from hydropeaking at hydropower sites in big tributaries on the one hand, and have not recovered from intensive fish-predating by cormorants in the middle of the 1990s.

Methods

Electrofishing with special boats was performed in both stretches in order to investigate the current status of the fish fauna. Both reaches were dealt with from the upper end of the stretch to the lower, fishing with an anode arrangement from boat, and additional habitat sampling with a backpacker generator.
The collected data were analysed and compared with data collected before the implementation of the measures in the years 1994, 1997, 1998, 2006, 2009 and 2015 (Jungwirth et al. 1996, Zauner 1999, Wiesner et al. 2008, Wiesner et al. 2010, Lumesberger-Loisl & Gumpinger 2015) in order to get an impression whether the LIFE-measures have led to a better ecological status of the river stretch with regard to the fish fauna.

Results

The electrofishing results showed that there is a large lack in species numbers, mainly in the upper stretch, and also in biomass. This phenomenon has been evident since the beginning of the investigations in 1994, resulting from river regulation and the vanishing of the historically extended floodplains that had led to the extinction of several specialised fish species. In the 'U' stretch, half the number of species that should be found there according to the Leitbild are missing. Those species that are still detectable appear only in small numbers and most of them show deficits in their population structures.
There has been no significant variation in the number of species nor in the number of individuals since the year 1996 when there was a drastic breakdown of the fish stocks as result of massive predation by cormorants. For the grayling (*Thymallus thymallus*) Zauner (1999) proved that numbers of individuals per hectare went down from 578 in the year 1994 to only eight after the year 1996. The same decline was found with the biomass of grayling, having dropped from 154 kg/ha to 2.4 kg/ha.
The development of the other fish species was similar, but not that dramatic. There was a significant breakdown of the fish stocks in the Styrian River Enns stretches in the year 1996, when due to a very cold winter many cormorants had moved upstream into these stretches that are several hundred kilometres away from the main cormorant stocks near the river Danube.

Data from the investigations of 1998, 2006, 2009 and 2015 show that fish stocks did evolve positively, but could never reach the status of 1994. It is the grayling that seems inapt of generating a good brood stock with enough parental individuals to re-establish a population rich in individuals.

Conclusion

Unto the mid-1990s the data show the effects of river regulation and channelization that become manifest in small numbers of species and the absence of specialist groups, mainly those living in adjoining waters, oxbows and backwaters.

In 1996, a very cold winter and the linked massive predation of cormorants led to a breakdown of the already tattered stocks of the remaining species. The fact that the grayling population had been reduced down to a few individuals can, on the one hand, be explained with the vulnerability of this species towards predators that, like the cormorant, hunt in the free water column. On the other hand one has to take into account that the populations of the other species – mainly rainbow trout (*Oncorhynchus mykiss*) and brown trout (*Salmo trutta fario*) – are supported by intensive stocking of the angling societies, which is not the case to that extent for grayling. As a consequence, not one single grayling must be permitted to be taken out of the ecological system – otherwise this species will undergo a catastrophic shift (SCHEFFER et al. 2001), which could make the species vanish from these river stretches.

Concerning the main goal of the investigation, which was to examine the effects of restoration measures, we have to conclude that there seem to be two main topics that have to be solved in order to ameliorate the ecological situation of the fish fauna in the two stretches:

Many more and much bigger morphological measures are needed. We can see first gentle effects of the measures that had been set until now, but we have to set measures that are able to create a much more original river-landscape with the potential for the river itself to initiate a dynamic development. On the other hand, the hydrologic regime, impaired by the hydropeaking mode of the upstream hydropower plants, has to be revised in a form that the flush and sink rates are reduced markedly.

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Adaptive management at the Ramat Hanadiv Nature Park, Israel: Expectations vs. Reality in a dry Mediterranean ecosystem

Liat Hadar & Avi Perevolotsky

Abstract

Ramat Hanadiv, a privately-owned Mediterranean Nature Park in Northern Israel, is managed according to the 'adaptive management' approach, followed by a long term monitoring program (LTER). Thirty years of applying active management in the park, aimed to conserve its biological assets among other goals, resulted in three main lessons: (1) Scientific knowledge is never sufficient, hence most management decisions are not objective but value-driven; (2) Highest ecological values exist in the most disturbed habitats; and (3) No park is an island! The neighboring community is and should be a central player in most management decisions.

Keywords

LTER, Adaptive management, Mediterranean ecosystem

Introduction

Ramat Hanadiv is a privately-owned Mediterranean Nature Park and memorial to the late Baron Edmond de Rothschild, operated for the benefit of the public by the Rothschild Foundation. The site covers~450 ha. of land perched on a plateau at the southern tip of the Carmel mountain range, overlooking the coastal plain and the Mediterranean Sea.

The Nature Park consists of open landscape abundant with indigenous fauna and flora and is perhaps the most investigated and carefully managed open space in Israel. It is managed according to the 'adaptive management approach', followed by a long term monitoring program (LTER). Within this framework, vegetation structure, diversity of selected biological groups, flag species and re-introduced species are monitored routinely as a basis for educated decision-making. Management operations include cattle and goat grazing alongside with plans for the management of rare, out-breaking and invasive species.

Thirty years of applying active management in the park, aimed to conserve its biological assets, revealed the complex interactions between objective scientific data and their interpretations and applied meanings. These ideas will be demonstrated by three case studies:

Case study 1: Managing the Park's gazelle population

Mountain Gazelles (*Gazella gazella*), an endangered species and a bio-indicator for ecosystem health, are considered charismatic wildlife that can play a role as a 'flag species' for conservation purposes. The park supports a local population of gazelles that is considered an important asset. To draw a management strategy for the population, field surveys for determining basic demographic parameters and population size of the local gazelles are conducted from 1987, and structured as part of the Park's LTER program from 2003. Surveys are conducted 4 times a month, along a 12 km fixed transect, and analyzed using distance sampling methods. The results show a decrease in predicted numbers followed by an increase in recent years (Fig. 1a). However, a closer look at the future generation reveals a decline in fawn numbers (Fig. 1b) and raises questions about other factors that potentially affect population size, such as change in methods and observer along the years and cattle presence (SHAMOON, 2015). Collecting long term demographic data appears to be a big challenge; despite the different methods used (direct, indirect, fecal transects, cameras) and the huge sampling effort invested over almost three decades, the applicable meaning of the data is still not clear. Moreover, the definition of gazelles as a 'flag species' is mainly value-oriented given that their ecological role, visibility and behavior are still not well understood.

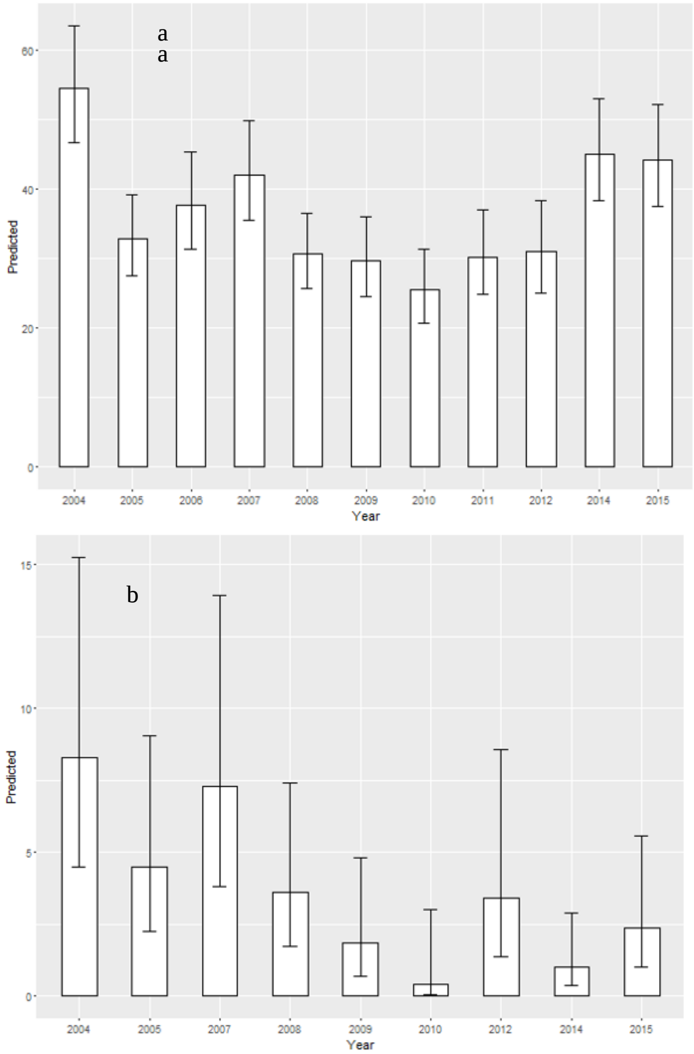

Figure 1: Gazelle population dynamics at Ramat Hanadiv 2004-2015 (predicted highest estimation for January) a). total population; b). fawns (SHAMOON, 2015).

Case study 2: Aleppo pine (*Pinus helepensis*) colonization in the park

The expansion of *P. halepensis* from plantations into natural sites is becoming a frequent occurrence across the Mediterranean zone of Israel and a source of debate among natural conservationists, foresters and landscape managers. This issue is strongly associated with ideology and management decisions, contradictory opinions and perceptions and a handful of emotions.

In Ramat Hanadiv, the continuous colonization of pines in the natural garrigue was recognized by the park managers in 2007 and assumed to be dynamic and management related. Its implications were projected to influence the park at the ecological, functional and landscape aspects. Intensive research was initiated to serve as a basis for objective decision making. The research goals were to assess and map colonization extent and population dynamics, with relation to three human related factors: afforestation, cattle grazing and fire.

Research findings were that density of colonizing pines was mainly determined by the proximity to planted pines and enhanced by cattle grazing (OSEM et al. 2010). The results confirmed that pine colonization is significant, dynamic and strongly related to human impacts. However, it originated different perceptions of the process and, accordingly, different management strategies. The ‘invasion scenario’ views pine colonization as an undesired human-dependent process and proposes to control it. Consequently, it focuses on the spatial dynamics and the ‘invasion front’. The ‘succession scenario’ represents a more pragmatic perspective that views *P. halepensis* as a native component of the pristine ecosystem and its colonization as part of natural succession. Hence, pine removal will only be performed in patches where colonization does not coincide with the park’s goals. A set of criteria was designed to support management decisions, including view-sheds of scenic observation points, fuel-break zones, patches of special natural and anthropogenic interest, wildlife activity and nesting sites, rare plant populations, research plots and hiking trails. A ‘no intervention zone’, as well as a ‘pine free zone’, was defined. Throughout the process, decision making was found to be complex as implications of intensive pine removal alongside difficulties in determining the desired landscape pattern and its relation to biodiversity and ecosystem functioning arose. The process highlights the role of research accompanying adaptive management and how management choices reflect fundamental perceptions and values.

Case study 3: Cattle grazing: 'friend or foe' of biodiversity?

The dominant vegetation formation in Ramat Hanadiv is a Mediterranean garrigue of heterogeneous density and structure (LEVIN et al. 2013). The inter-shrub patches are populated by a diverse community of herbaceous vegetation, extremely rich in species (an average of 12 species/0.25 m2 quadrate) and diverse in life-forms. Although Ramat Hanadiv covers only 0.016% of Israel's area, it conserves 636 species constituting ~23% of Israel's flora. Of these, 42 are defined as rare species, 35 are endemic, and 6 qualify as IUCN 'red' species. Several crop wild relatives grow in the park, including wild emmer wheat, *Triticum dicoccoides*.

Ramat Hanadiv's flora is monitored routinely as part of the LTER monitoring program in order to define the management that best conserves the local vegetation richness. Herbaceous vegetation data were analyzed at the community, functional groups and species level. Special attention was payed to the relationships between cattle grazing - a large scale, fire prevention management held in the growing season (November-June), and community diversity and composition. Throughout 14 years of monitoring, vegetation richness and diversity did not change significantly between sites, even when extreme management tools (heavy grazing, clearing) have been applied (Fig. 2). Moreover, highest richness values were found in the most disturbed, including heavily grazed, habitats (HADAR et al. 2013). In terms of the temporal dynamics, herbaceous community showed high variation in species composition between years, and extremely high decadal turnover rates (BAR-MASSADA & HADAR 2017). These results raise questions regarding the extent to which overall species diversity can serve as a practical management goal in species rich Mediterranean habitats, and to the meaning of conservation in the context of a constantly changing species composition. Ramat Hanadiv's 'species list' can be conserved only at the scale of the whole park, over long time and granted that spatial heterogeneity is preserved.

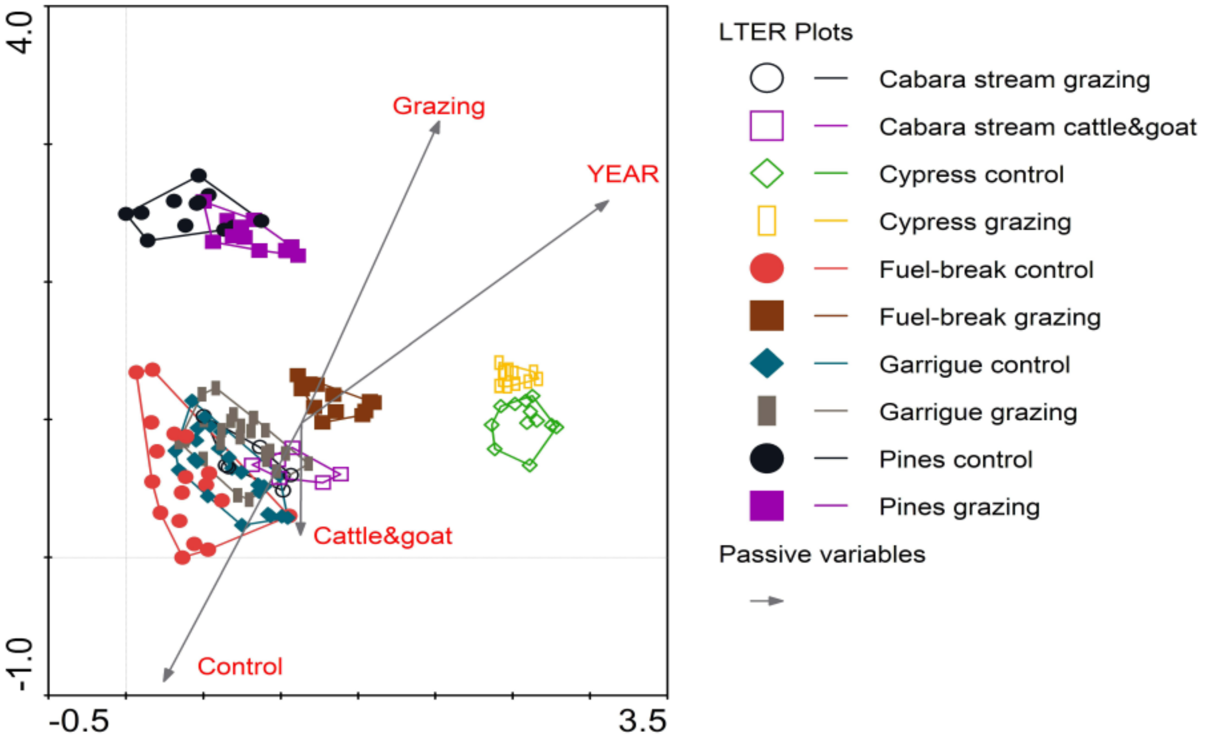

Figure 2: DCA showing site and management effects on plant species composition (HADAR et al., 2013)

Conclusion

In conclusion, thirty years of adaptive management in Ramat Hanadiv demonstrate the limitations of scientific knowledge and how most management decisions are not objective but value-driven; Furthermore, our experience emphasizes the need to develop scientific concepts that will provide better understanding how different perceptions and values affect interpretation of scientific knowledge and its application in management decisions. The human community is and should be a central player in most management decisions.

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Biodiversity and forest structures at the Zurich Wilderness Park Sihlwald

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Keywords

habitat availability, saproxylic species, dead wood, biodiversity monitoring

Summary

To understand biodiversity patterns and to improve conservation measures, detailed knowledge of the influencing environmental factors is needed. One of the most important factors is the availability of specific required habitats. Instead of looking into size and connectivity of habitat patches, the new habitat amount hypothesis proposes that only habitat amount in the local landscape affects species richness (FAHRIG, 2013; SEIBOLD et al., 2017). In forest ecosystems, dead wood plays a major role as habitat for hundreds of species that depend on it, so called saproxylic species (STOKLAND et al., 2012). This species guild is often used as an ecological indicator for near natural forests because saproxylic species are sensitive to the amount and quality of dead wood and other old-growth structures (LACHAT et al., 2012; NORDÉN et al., 2007). Considering this, the communities of saproxylic beetles, wood inhabiting fungi, mosses and lichens are investigated in the Zurich Wilderness Park Sihlwald.

The Sihlwald forest was used for timber production for over 500 years and is protected as a natural forest reserve since 2007. Therefore, the forest is still recovering from the intensive wood harvesting, which already stopped in 2000, and stands at the beginning of its development back into an old-growth forest. On the one hand, we want to understand how the forests history and development, which are reflected in the currently available forest structures, influence the present biodiversity. On the other hand, we want to draw a picture about a possible development. Therefore, we posed the following questions:

1. Which environmental factors are influencing the different species groups?
2. How does habitat availability (e.g. dead wood) in terms of quantity and distribution influence biodiversity and at which spatial scale can we find effects?

The four species groups (saproxylic beetles, wood inhabiting fungi, mosses and lichens) were investigated at 69 plots selected from the cantonal forest inventory. The plots were chosen along a gradient of dead wood amount and spatial connectivity. These gradients were calculated from a dead wood map, which was created with LiDAR-data and completed manually with 3D aerial photographs. The cantonal inventory provides information about forest structures and development at each plot, as it was carried out three times since 1981 and will be repeated in 2017. At each plot, wood inhabiting fungi, mosses and lichens were inventoried. Saproxylic beetles were collected with two flight interception traps installed on each plot.

For further testing of the habitat amount hypothesis, we use an experimental approach, where we control the size of the local habitat patch. At each plot four beech branch bundles of different sizes were installed. The bundles stay in the forest for one season and will be colonized by saproxylic beetles, before they are collected in autumn 2017 and reared in emergence traps for one year. With this experiment, we can study the effect of habitat amount and connectivity on dead wood colonization processes in different constellations: from high habitat amount and well connected to low habitat amount and isolated.

In total over 400 wood inhabiting fungi, 150 mosses and 130 lichens were recorded in the Sihlwald forest and their dependence on dead wood and old-growth forest structures is now analysed. Within these three groups, already some rare and highly specialised species, characteristic for old-growth forests, were found. The determination of the saproxylic beetles is still under way and the first results are expected for autumn.

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Nature therapy and green exercise as remedies for emerging civilization diseases

Arnulf Hartl

Keywords

green exercise, civilization diseases, nature deficit disorder, biophilia hypothesis

Summary

In the last few hundred years, there has been an extraordinary disengagement of humans from the natural environment: For the first time in human history, more of the world's population now lives in urban instead of rural Areas. The gap in natural exposure between our early evolutionary environments and modern life is growing tremendously. This physical disconnection from the environments in which we evolved has a diametric impact on our health and emotional well-being. A growing amount of health science studies show a significant correlation between increased urbanization and poor physiological and psychological health. Outdoor recreation in protected Areas is well on the way to becoming an important element of a healthy living and a remedy against the deficiencies of a modern life separated from nature. The present talk will give an overview on our own data on the potentials of nature-based interventions for the prevention and therapy of osteoporosis, chronic low back pain and cardiorespiratory fitness.

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Long-term monitoring of climate-sensitive cirques in the Hohe Tauern range

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Abstract

Quantitative monitoring data from high-alpine glacial cirques is extremely scarce. To reduce this gap, three long-term monitoring programs were established in the Hohe Tauern range: at the Kitzsteinhorn, at the Oedenwinkel, and at the Sattelkar. The selected sites differ in size, glaciation and lithology and are therefore addressed with different monitoring approaches. Research questions focus on glacial thinning, rockfall patterns and debris flow activity. For each monitoring site, the investigated processes are of direct relevance for nearby tourism, transport, or hydropower infrastructure.

Keywords

Glacial Cirques, Rockfall, Glacier Retreat, Debris Flows, Climate Change

Introduction

By scouring their beds and sapping their headwalls glaciers produce cirques, which belong to the most emblematic high-alpine landscape elements (BENN & EVANS 2010, SANDERS et al. 2012). Glacial cirques potentially react sensitively to climatic changes such as rising temperatures or an increase in the proportion of liquid precipitation (SCHERLER 2014). However, due to the lack of robust, long-term data, further assessment of the climate-sensitivity of high-alpine cirques and their role as a risk factor to lower lying catchment sections is subject to considerable uncertainty. For this reason, long-term programs to monitor changes of surface, subsurface, and atmospheric conditions have been started within this decade for three selected sites located north of the Hohe Tauern main ridge. Namely, these are (a) the Kitzsteinhorn, (b) the Oedenwinkel, and (c) the Sattelkar (see Fig. 1a, Fig. 1b). The three selected locations cover areas in and immediately around distinct glacial cirques and are situated in an altitudinal range between 2.100 and 3.450 m asl. The consequences of recent climate warming have had considerable, multifaceted impacts on critical infrastructure situated in direct proximity to the investigated cirques (transport, tourism, hydroelectricity). In this contribution, the three sites, related research questions, and some preliminary results are described in more detail.

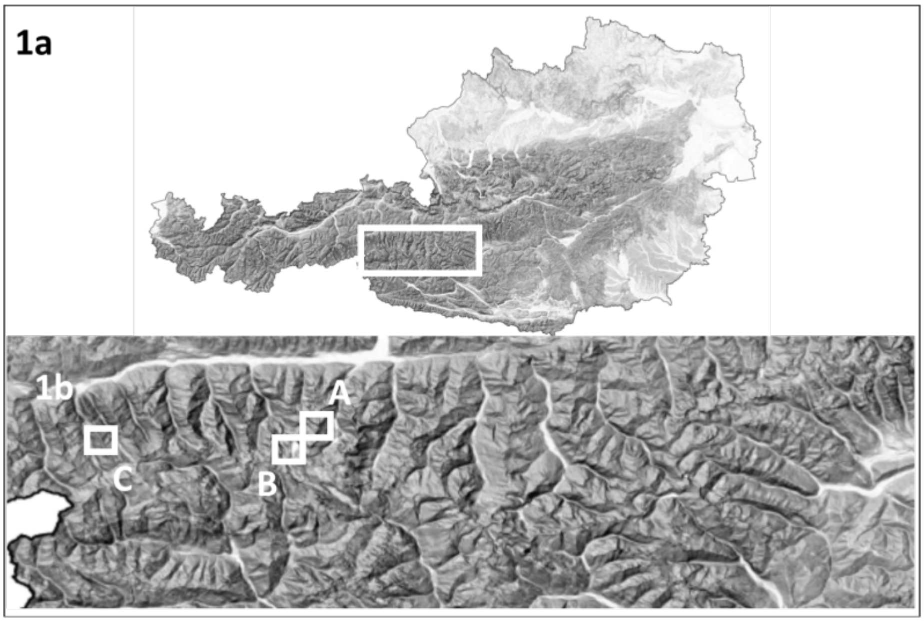

Figure: 1a: Location of the Hohe Tauern Range. Figure: 1b: Location of the three monitored cirques: (A) Schmiedingerkar (Kitzsteinhorn), (B) Oedenwinkelkar, (C) Sattelkar. Copyright GEORESEARCH.

Monitoring Site I: Kitzsteinhorn

The Kitzsteinhorn site covers the Schmiedingerkees cirque, which mainly consists of calcareous mica-schist. Pronounced glacial thinning in recent years caused a significant increase in rockfall activity from fresh bedrock surfaces, which has affected the local tourism infrastructure (up to 1 Mio. visitors per year). To reduce the scientific gap between laboratory evidences on rock **sample** scale and field observations on rock **mass** scale, an extensive Open Air Lab (OpAL) was established in 2010. Since then, the monitoring was constantly expanded and has now become one of the best instrumented long-term monitoring site for permafrost and mass movements in the Alps (please refer to contribution of KEUSCHNIG and HARTMEYER in this volume for more details on the Kitzsteinhorn monitoring).

Local cirque walls are investigated within an extensive terrestrial laserscanning (TLS) campaign since 2011, which revealed the striking impact of glacial thinning on adjacent headwalls: around 80 % of the detected rockfall volume was triggered from areas located less than 20 m above the current surface of the Schmiedingerkees glacier. Overall, more than 400 rockfall release zones were identified, the total rockfall volume exceeded 2.400 m³. To investigate poorly understood frost weathering and rockfall preconditioning in cirque walls, the project **GlacierRocks** (funded by the ÖAW – Austrian Academy of Sciences) will establish the worldwide first research site for long-term monitoring of stability-relevant processes inside a randkluft system. First components of the innovative randkluft monitoring have been installed in 2017 and will include permanent microseismic arrays, borehole temperature measurements in bedrock and glacier ice, and microclimatic recordings.

Monitoring Site II: Oedenwinkelkar

The Oedenwinkelkar extends from approximately 2.400 to 3.450 m asl. and is composed predominantly of granitic gneiss bedrock. The cirque is occupied by the Oedenwinkelkees glacier, which covers a total area of 1.8 km². The particularly pronounced debris cover in the ablation zone of the Oedenwinkelkees glacier is indicative of intense rockfall activity in the steep headwalls of the cirque. Continued glacial thinning is expected to cause increased rockfall occurrence in freshly exposed rockwall sections. Climate change induced modifications of the sediment transport regime directly affect the Tauernmoossee, a hydropower reservoir located immediately downstream of the glacier's proglacial area.

To study interactions between the Oedenwinkelkees glacier and its cirque walls, the project **CirqueMonHT** (funded by ArgeAlp – Arbeitsgemeinschaft Alpenländer) will establish an extensive environmental monitoring at the Oedenwinkel. Stability relevant temperature changes in bedrock surfaces exposed by recent glacier retreat will be monitored in various measurement transects. To monitor bedrock stresses, joint aperture changes will be recorded in selected locations. High-precision remote sensing techniques, such as laserscanning and UAV-based photogrammetry, will be used to localize and quantify rockfall release zones. Ice temperature and ice velocity measurements will be employed to analyze glacial ablation dynamics, enabling an accurate estimation of future glacier behavior close to the headwall. The meso-climate within the cirque will be recorded by several weather stations, allowing to assess the significant influence of topographic shading effects and local wind conditions.

The consequences of climate change usually become apparent only after long response times. Thus, a comprehensive understanding of increased rockfall activity in freshly exposed headwall sections requires monitoring periods of sufficient length. **CirqueMonHT** therefore explicitly strives towards a long-term monitoring of relevant processes at decadal scale and towards the integration of existing glaciological and hydrological datasets.

Monitoring Site III: Sattelkar

The Sattelkar site consists of a west-facing cirque made up of granitic gneiss bedrock. It is located in the Obersulzbach catchment, covering an elevation between approximately 2.100 and 2.700 m asl. The unglacierized slopes below the headwall are overcast with thick layers of post-glacial rockfall deposits, which contributed to the formation of a rock glacier. Since 2003, increased creep/slide rates have been observed in the deposits/rock glacier. In recent years heavy rainfall events repeatedly caused catastrophic debris flow activity from the Sattelkar. The triggered debris flows exceeded the cirque threshold, subsequent torrent activity endangered human lives and caused massive damage to transport infrastructure (railways, roads) in the Obersulzbach valley, as well as further downstream, in the main valley of the Salzach. To detect potentially hazardous future changes and to additionally infer information on the climate-sensitivity of the neighboring cirques (Ofenkar, Mitterkar, Steinkar), an extensive remote sensing and ground temperature monitoring campaign was started in 2015.

Conclusions & Outlook

Despite focusing on different processes, such as rockfall preconditioning, glacial thinning dynamics, and debris flow activity, all three programs investigate how sensitively different high-alpine cirques respond to recent climatic changes. The destabilization of cirque walls and the remobilization of material deposited in cirques does not only affect local infrastructure, it can also have negative short- to long-term cascading effects on lower lying catchment areas. However, the intensity and temporal behaviour of the responses is widely unknown, emphasizing the relevance of robust, long-term monitoring data from these harsh and inaccessible environments.

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Patterns of Wilderness – en route to compiling an inventory of the national processes in Gesäuse National Park (Ennstaler Alps)

Corinna Hecke, Michael Jungmeier, Daniel Kreiner

Abstract

In this paper, the authors examine the composition, patterns and succession of vegetation in four different ecosystems in Gesäuse National Park (Styria, Austria), that are characterised by certain disturbance regimes. The basic methodology for compiling an overall inventory of the region's natural processes is to be established in an attempt to describe the systems in terms of their spatial and temporal patterns using structograms and dynamograms. The detailed analysis will highlight the extent to which floodings, avalanches and mudflows contribute to local biodiversity. This confirms the importance of consequently protecting the natural processes in a manner consistent with an IUCN category II national park.

Key words

Wilderness, natural processes, succession, vegetation dynamics, vegetation patterns, national park research, nature conservation

Introduction

Natural processes play a crucial role in natural science definitions and descriptions of wilderness. As shown by JUNGMEIER et al. (2016), the Gesäuse National Park, which was set up in 2002, is particularly predisposed to natural process research. Natural processes should continue undisturbed in the core zone (currently accounting for 83 percent of the area). The Gesäuse mountains are characterised by high relief intensities. This causes a large number of gravitational dynamic processes such as avalanches, mudslides and rock falls. 'Wild water – steep rock' are slogans that are associated with Gesäuse National Park. Therefore, national park research also focuses on inventory compilation (STANGL 2011) and monitoring these areas (KLIPP & SUEN 2011, HALLER et al. 2013).

The investigation of natural processes in Gesäuse National Park can be traced back to the studies conducted by EGGER (1996). The syndynamic ecosystem concept developed by this author also provides the basis for this study. In the course of the investigations, four areas characterised by disturbance dynamics in Gesäuse National Park were to be documented to provide an answer to the following questions:

- How can natural processes be described and compared in a systematic manner (method development)?
- How can the significance of these processes be assessed from the perspective of biodiversity, natural protection and national park management (analysis)?
- What conclusions can be drawn to deal with natural processes relating to the European wilderness discussion (discussion)?

Methods

Vegetation mapping was based on a total of 47 plot studies in plant communities, 42 of which were carried out along 6 transect lines overall. A further 5 recordings were documented slightly outside the transect lines. Vegetation mapping was supported by high-resolution aerial photographs, which were taken with the Hexakopter E.C.O.pteryx. The UAV (unmanned aerial vehicle, commonly known as 'drone') aerial photograph material provided a unique portrayal of the small-scale patterns of vegetation (Fig. 1, gravel bars alongside and within the river Enns).

Figure 1: The aerial photograph was taken with a UAV, it shows one of the study sites at river Enns. Bed-load dynamics and flooding are crucial factors for zonation of vegetation in this area; E.C.O.pteryx/C. Hecke

The synsystematic nomenclature with brief descriptions in terms of ecological parameters and species follows GRABHERR & MUCINA (1993) and MUCINA et al. (1993). The preparation of natural processes stems from EGGER (1996). In the structograms, the spatial structure of the respective natural process is portrayed as abstracted patterns of the corresponding vegetation units. To analyse the temporal structure of a natural process, the (mostly obvious) temporal pattern of the process was generated from the spatial sample as a sequence of various vegetation units and illustrated accordingly in the dynamograms. The species in the individual vegetation units were counted in order to analyse biodiversity. An analysis of the plant life-forms according to GRIME (1979) and an analysis of indicator values according to ELLENBERG (1986) complete the picture of the respective natural process. Details on land survey methods can be gleaned from Jungmeier et al. (2016) and details on the respective land surveys per se from JUNGMEIER et al. (2014, 2015) and HECKE & JUNGMEIER (2017).

Results

Since 2014, four natural processes have been selected as part of the research project for detailed studies of disturbance dynamics. In the uninhabited regions of Johnsbach, just above the confluence of the Kainzenalblgraben in the Johnsbach, certain debris dynamics and floods determine the development and zoning of the vegetation. Disturbances are episodic and broadly reflect natural succession in a variety of ways, depending on intensity. A similar situation can be seen with the dynamic gravel bars along the Enns. In sections of the Enns that are free from river control structures, in areas such as Finstergraben and Räucherlboden, the natural processes are largely determined by debris dynamics and floods. The disturbance regime is comparable to that of Johnsbach. In the Kühgraben debris channel, water is also the defining system factor. However, the ditch is water-bearing only after heavy rainfall. There is a significant relocation of weathered material, essentially Dachstein limestone. Episodic erosion and deposits have formed patterns of stable and unstable debris fields, varying in age, which determine the way in which vegetation develops. In the Kalktal avalanche area, the ditches and channels under the Tamischbachturm are determined by avalanche events and the related disturbance dynamics. The avalanches are periodic but vary in intensity.

The spatial extent and zoning of the various natural processes are depicted in a structogram as shown in Fig. 2, citing the example of Enns. Taking Enns River once again as an example, the temporal component of disturbance dynamics is shown in the dynamogram in Fig. 3. The vegetation can be divided into different development stages arising essentially from an interplay of succession and disturbances.

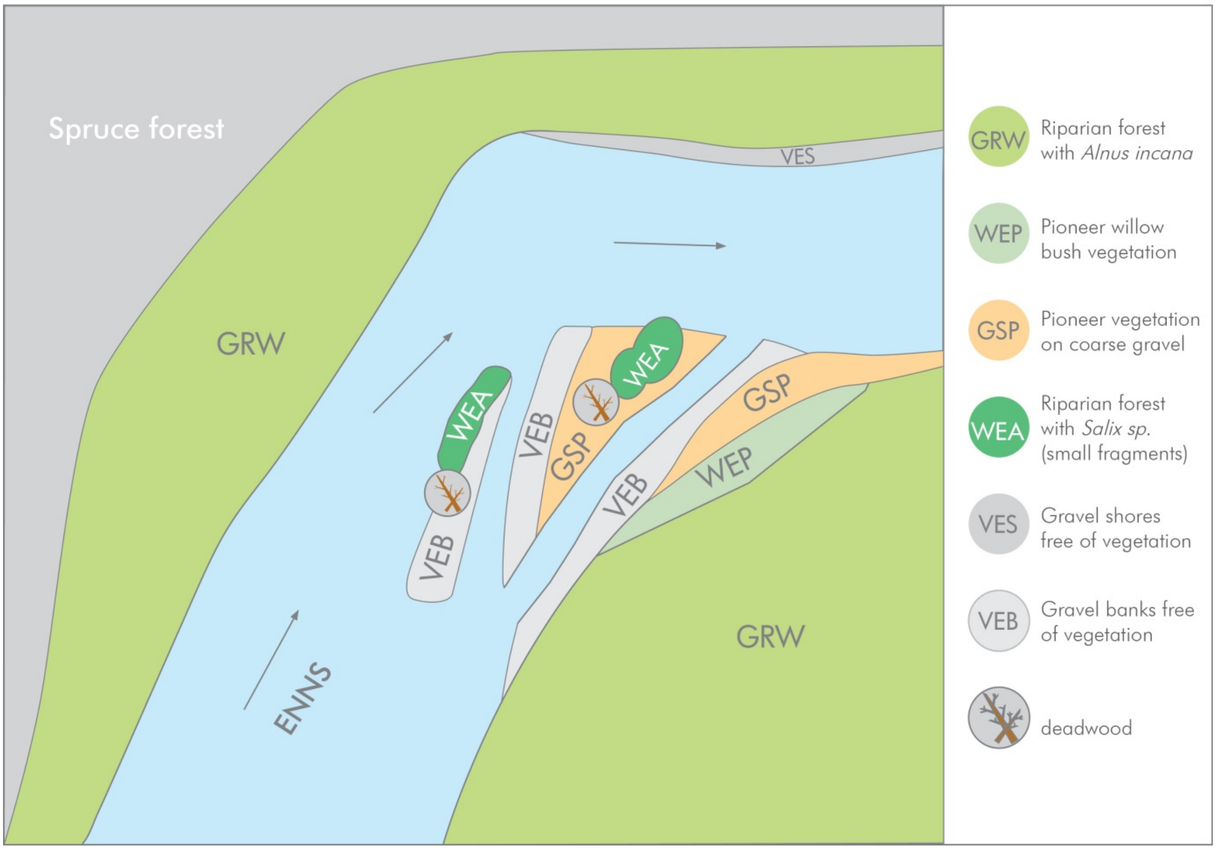

Figure 2: Structogram of dynamic habitats at study site river Enns. The chart illustrates the zonation of vegetation communities alongside river Enns; E.C.O./M. Fercher

Based on the structograms, the individual processes investigated can now be analysed comparatively. To this end, vegetation surveys are used to reach conclusions on the distribution of plant life-forms, number of species and site conditions in the respective processes. For instance, Fig. 4 shows the distribution of light-loving species according to an analysis of Ellenberg's indicator values in the disturbance systems. More detailed results are provided in the reports of JUNGMEIER et al. (2014, 2015 and 2016) and HECKE & JUNGMEIER (2017).

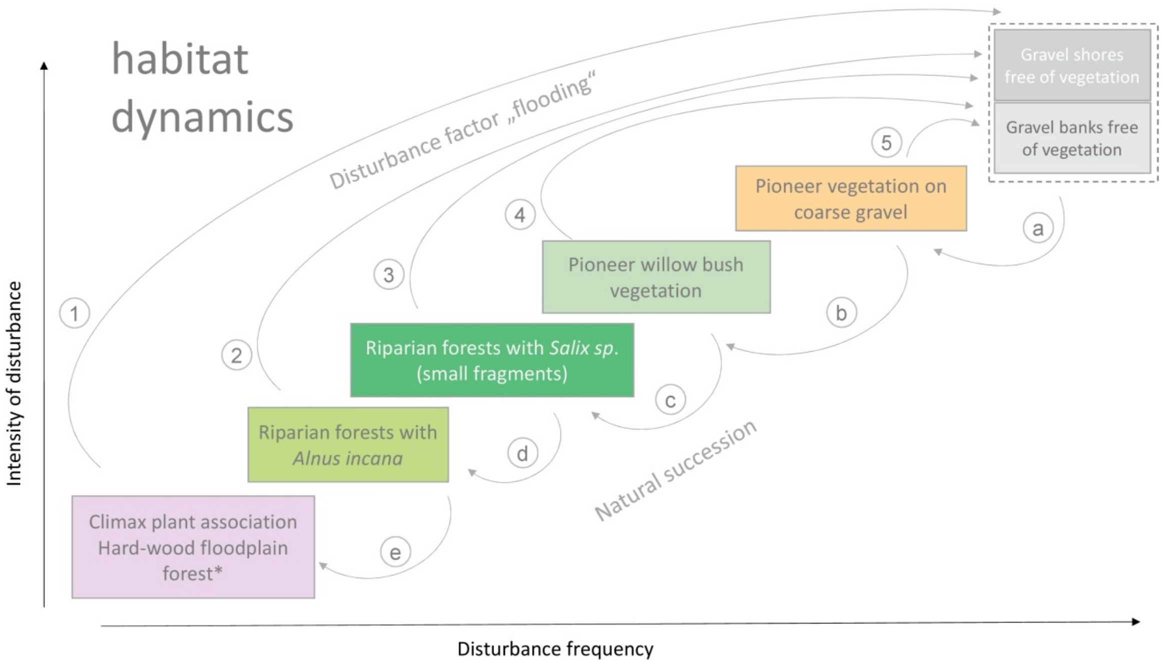

Figure 3: Dynamogram of dynamic habitats at study site river Enns. The chart illustrates how the temporal pattern of vegetation development is affected by disturbance dynamics and succession; E.C.O./C.Hecke

Discussion/Conclusion

An examination of selected natural processes reveals the complex spatial and temporal patterns which emerge through episodic and periodic disturbances. These are characterised by natural succession to the climax society and opposing disturbance regimens. The analysis shows that niches are formed in the resulting small-scale differentiation of habitats, leading to a significant increase in species. Only plant species were specifically studied but it can be assumed that this diversity is evident in animal species to a significant, if not greater, extent. Thus these natural process samples that characterise ‘wilderness’ are crucial factors in high biodiversity.
The applied method is used to test a procedure that allows natural processes to be detected and compared. Using this approach, the natural processes of an area, in this case the Gesäuse National Park, can be systematically recorded and will lead to a complete inventory. As regards the dynamics in largely disturbance-free climax plant communities, survey and presentation methods must be adapted. Based on corresponding surveys, a typology can be generated for the processes and the whole inventory *per se*. It is to be hoped that this inventory approach can be continued.

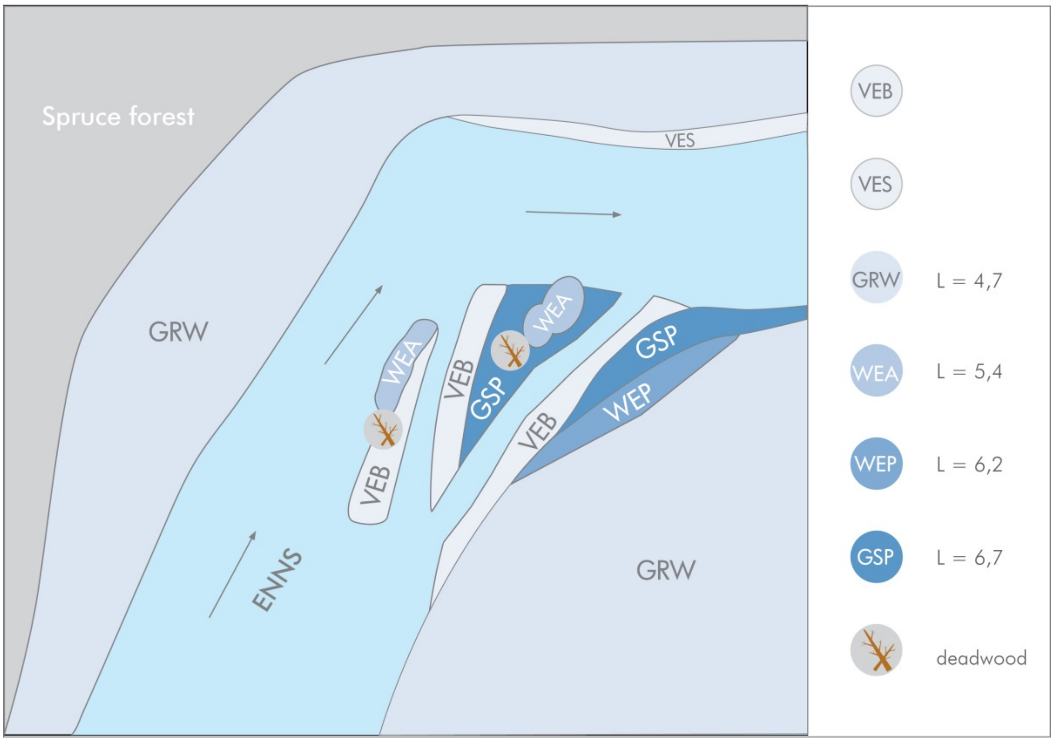

Figure 4: The structogram shows the average light values of the vegetation units according to the analysis of Ellenberg's indicator values. The scale is a 9-point scale representing a plant species preference for light intensity (1=deep shade, 5=semi-shade, 9=full light); E.C.O./M. Fercher

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How can Swiss Regional Nature Parks improve the functionality of the ecological infrastructure? Pilot-scheme in two Nature Parks in the Canton of Berne

Christian Hedinger & Andreas Friedli

Keywords

target species, target habitat, ecological infrastructure, connectivity, nature park

Introduction

In Switzerland, the term 'ecological infrastructure' has been anchored in the National Biodiversity Strategy and its Action Plans (SCHWEIZERISCHE EIDGENOSSENSCHAFT 2012). The implementation of the ecological infrastructure did only just begin with pilot-schemes such as the one presented here.

The government (Federal Office for the Environment, FOEN) assigned the Regional Nature Parks the role of pioneers for the establishment of ecological infrastructure. In the Parks, the government finances pilot-schemes to develop appropriate methods and analysis in 2016 / 2017, which can be implemented from 2018 onwards. Already now it is apparent, that the open framework conditions by The Federal Office for the Environment allowed the cantons and parks to develop a variety of projects with different means to reach their goals.

The Regional Nature Parks of Switzerland arise from regional initiatives. Even so the substantial participation of the affected communes in the sponsorship of the park is prerequisite. The operative aspects as well as the quality assurance of the park are regulated by a charter. Regional Nature Parks are of national importance as they feature high nature and landscape values. As the parks usually encompass whole communities, also less valuable areas can be found within its boundaries.

The following chapters present a possible approach and first results using the example of two Regional Nature Parks in the canton of Berne.

Methods

The base of the following work was formed by the collection of all existing knowledge and data available to the different participants of the project. The results of this step were more than 90 data layers such as:

- national and cantonal inventories and data on occurrence of habitats and species
- spacial planning (development concepts, protected landscapes,...)
- protected areas (forest reserves, game reserves, conservation areas, ...)
- surfaces of high quality within the agricultural land (land set aside for biodiversity)

The concept of target species and habitats was used as the basis for the choice of actions. All species and habitats of national priority were evaluated according to their importance within the park boundaries. The experts assigned the park specific responsibility for a certain species or habitat, if their occurrence in the park was remarkably higher than in other regions of the country. The result of the subsequent dialog with the park institutions was a list of target species and habitats. The working hypothesis postulated, that the role of the ecological infrastructure should not only be to provide overall habitat connectivity, but most of all to maintain and promote these target species and habitats.

The packages of measures developed by the experts based on the ecological requirements of the target species and habitats. In close collaboration with the park officials a plan of action is developed incorporating all evaluation criteria such as different players in the park and priorities.

Results

<u>Ecological infrastructure on the level of landscape</u>

The assessment of the current state shows a high density of potentially valuable areas. Not all of them, however, do yet have the required quality and long-term protection. The comparison of areas with long-term legal protection with areas of high quality or potential show, there is great scope for future actions and optimisations.

Among the areas with long-term protection are forest reserves, legally protected objects of federal inventories or protected nature reserves. The areas of potential for ecological infrastructure are more variable, amongst them are areas set aside for biodiversity on the agricultural land, watercourse corridors or forest edges with high potential for special habitats.

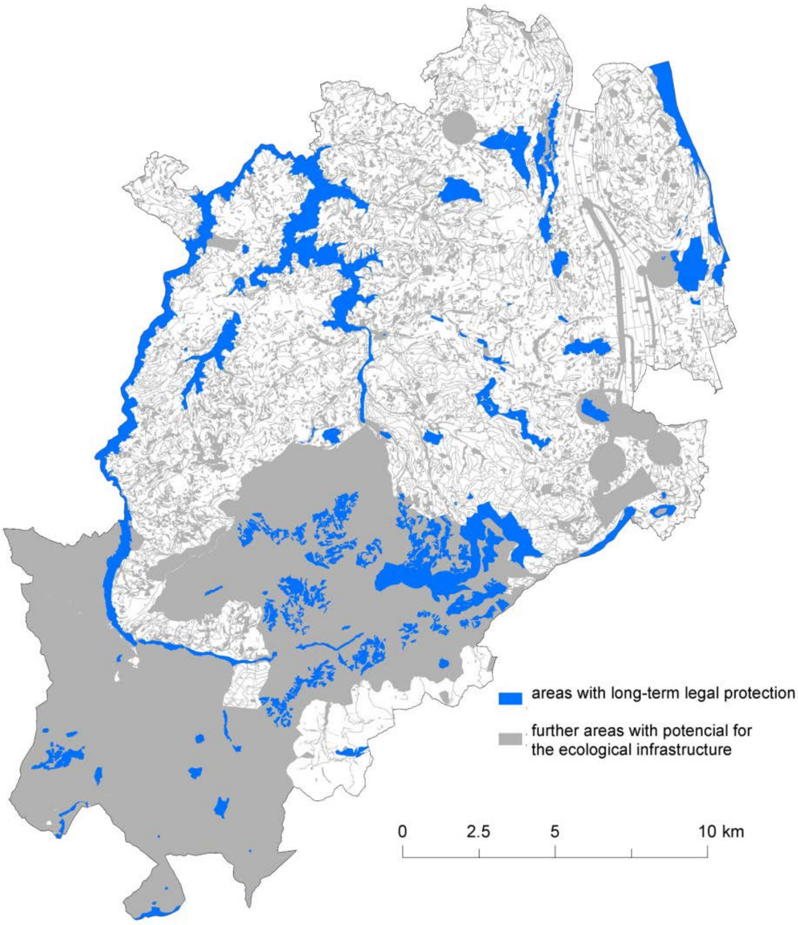

Figure 1: Areas with long-term protection and further areas with potential for the ecological infrastructure in the Regional Nature Park Gantrisch.

Through the geographical position of the Regional Nature Parks Diemtigtal and Gantrisch at the periphery of the intensively used land, they show an overall rather good habitat connectivity. Extensive actions are therefore not necessary. Nevertheless, a few deficits in the following fields on the level of landscape were located:

– Revitalisation of watercourses
– Amelioration of the edges of settled areas (improvement of permeability)
– Habitat connectivity in a intensively cultivated plane (the plane of Gürbe)

<u>Target species and habitats</u>

target species

				National Priority	Red List
Lichens	Lobaria pulmonaria	lung lichen	Echte Lungenflechte	4	VU
Bats	Rhinolophus hipposideros	lesser horseshoe bat	Kleine Hufeisennase	1	En
Bats	Myotis mystacinus	whiskered bat	Bartfledermaus	4	LC
Bats	Plecotus auritus	brown long-eared bat	Braunes Langohr	3	VU
Plants	Crepis praemorsa	Leafless Hawk's-beard	Trauben-Pippau	4	VU
Plants	Rosa chavinii, Rosa elliptica, Rosa sherardii	"rare wild roses"	Chavins Rose, Duft-Rose, Sherards Rose	3	VU
Moss	Cephaloziella varians	a liverwort	Arktisches Kleinkopfsprossmoos	4	VU
Reptiles	Vipera aspis , Vipera berus, Coronella austriaca		Aspisviper, Kreuzotter, Schlingnatter	2	CR
Birds	Bonasa bonasia	hazel grouse	Haselhuhn	1	NT

target habitats

			National Priority	Red List
Quellen	Cratoneurion, Cardamino-Montion		1	CR
Mires and Peatlands	Caricion fuscae, Caricion fuscae, Calthion, Sphagnion		3	EN
mesophile calcareous grasslands (low altitude)		Mesobromion	3	VU
nutrient-poor mountain grasslands	**grasslands of blue sesleria**	Seslerion	4	NT
	grasslands of rusty sedge	Caricion ferrugineae	3	NT
	mat-grass pastures rich ...	Nardion (only artenreich)	-	LC
woodlands	**Alluvial forests with Alnus incana**	Alnion incanae	2	VU
	Boreal bog conifer woodlands	Ledo-Pinion	2	VU
	Subalpine and montane Pinus uncinata forests with Swiss stone pine	Erico-Pinion uncinatae with Pinus cembra	4	LC
Sycamore-pastures			-	-

Table 1: target species and habitats for the Regional Nature Park Diemtigtal
Legend: National Priority (BAFU 2011, BAFU 2017b): 1 very high, 2 high, 3 medium, 4 moderate
Red List (BAFU 2011, DELARZE et al 2016): CR Critically Endangered, EN Endangered, VU Vulnerable, 4/NT Near Threatened, LC Least Concern
Where more than on species/habitat are summarized, the highest priority/status in the red list is listed.

Rare wild roses as an example for promotion and exploitation

The data basis of Info Flora (www.infoflora.ch) contained remarkable occurrences of a single wild rose of National Priority. In collaboration with the botanical gardens of Bern, volunteers have thus scanned potential areas for further occurrences of rare wild roses over the course of two field seasons. They found new sites as well as not yet registered species for this area. This enabled the experts to draw a spatial map of dimensions in terms of ecological infrastructure for this species:

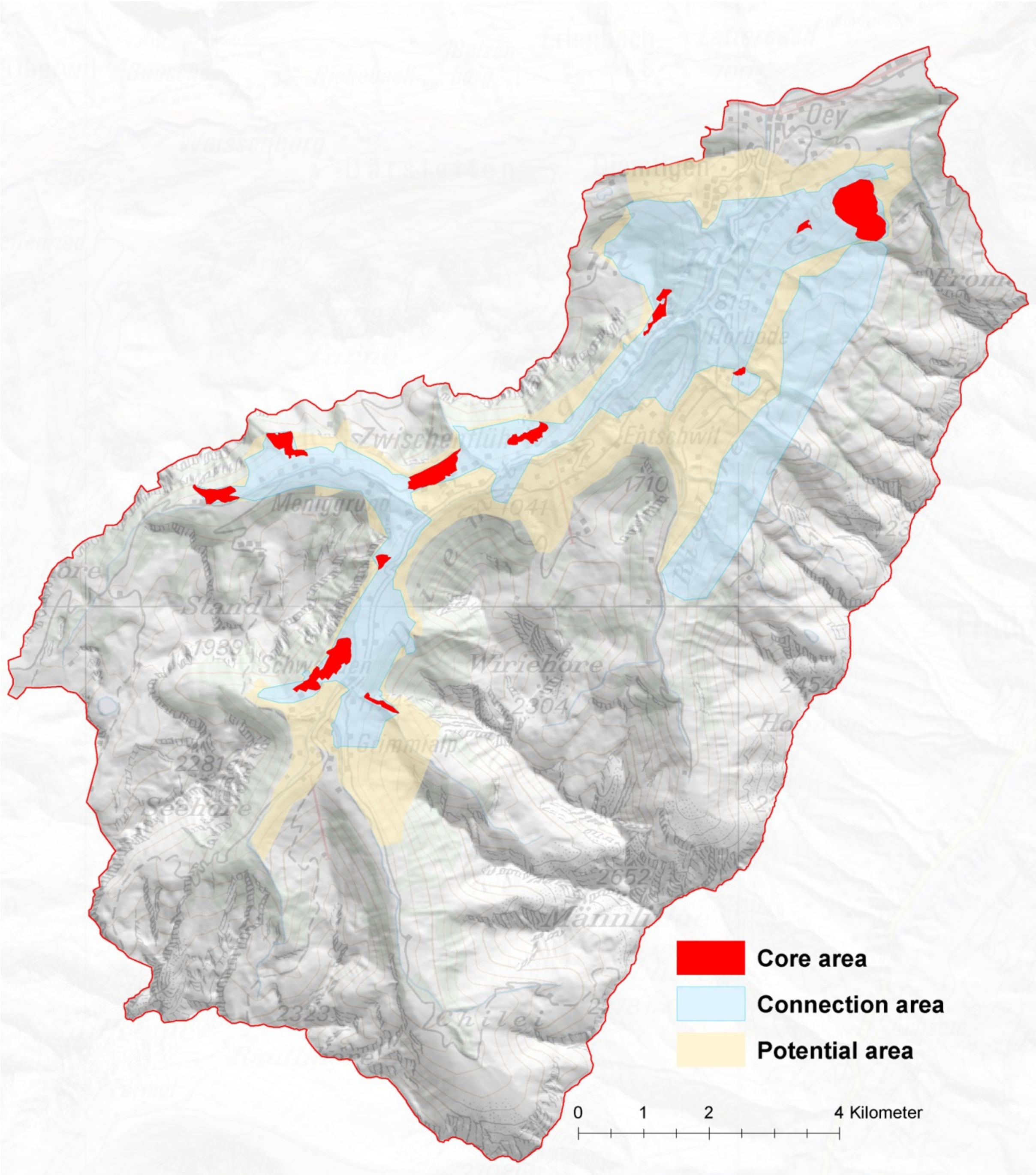

Figure 2: Wild roses in the Diemtigtal – a remarkable element of ecological infrastructure in this park.

The rose was made to an emblematic element for this park through a campaign including leaflets for park visitors and farmers. The park officials supported the farmers with work efforts to ensure the protection of wild roses through careful management of extensively farmed pastures. In parallel, a marketing opportunity was found for the exploitation of the rosehip. On a 'rosehip day' in autumn, everyone in the park can let their collected rosehips be cored with a special machine. Thus the regionally produced rosehip jam finds good sales.


a.

b.

c.

Figure 3: a: wild roses in an extensively farmed pasture; b: removal of shrubs by volunteers; c: processing of rosehips

Wild roses serve as mediator to bring the value of structural elements in extensively farmed pastures back into focus. With the adequate quality and quantity of these elements in pastures many other species can be promoted. This successful experience, however, cannot be transferred to many other target species, of whom much less is known. Also, the possibility to gain added value through products is probably an exception.

Conclusions

Regional Parks are welcome partners in the network of actors that care for nature values and their conservation. Through their close relationships with land managers and communes, they can provide the important connection between official agencies and people directly affected. The previous experiences are promising, particularly when the promotion of species and habitats can be linked with added economic value for the region. The establishment of ecological infrastructure is a chance as well as a challenge for parks to widen their spectrum of activities.

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Restoring fluvial landscapes – ecological effects of side-arm reconnection

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Abstract

River regulation works altered key ecosystem properties. An analysis of various restoration measures along the Upper Danube River to mitigate some of these alterations shows the effects of different reconnection measures on key ecosystem functions such as nutrient retention and plankton communities in different side arm and floodplain systems. Aspects analysed are to what extent pre-regulation conditions can be achieved, what critical constraints have been identified and what are the long-term perspectives of these measures to achieve an overall improvement of ecological conditions.

Keywords

hydrological connectivity, plankton, nutrients

Introduction

Aquatic and terrestrial parts of floodplains are key elements of riverine landscapes and are important areas for biodiversity, ecosystem functions and a multitude of services by for example controlling the regional water cycle and the retention of nutrients (HEIN et al. 2016, REBELO et al. 2013, SCHINDLER et al. 2014, WEIGELHOFER et al. 2015). Lateral hydrological connectivity, defined as the water exchange between floodplain water bodies and the river channel, is the key determinant of water related ecosystem processes such as nutrient turnover, sediment and water related processes (HEIN et al. 2004, WELTI et al. 2012).

While there is a wide appreciation of ecosystem services provided by riverine landscapes, there have been dramatic losses of area and reduction of the ecological functionality in remaining areas due to land reclamation and channel engineering in the past (HOHENSINNER et al. 2008). This resulted in an ecological degradation and in a reduced provision of several ecosystem services worldwide (TOCKNER et al. 2010). Thus, many remaining areas have been protected and to improve overall conditions restoration schemes have been implemented. As part of these activities, hydromorphological measures as one option have been designed and partly implemented to improve the hydrological connectivity of main channel habitats and floodplain water bodies in the Danube River (HEIN et al. 2016).

In order to quantify the ecological effects of hydromorphological restoration measures, we investigated several side arm restoration measures in the Danube Floodplain Nationalpark in the Austrian Danube. The aim was to analyse how the extent of side-arm restoration (the days of hydrological connectivity per year) control nutrient retention and planktonic processes in the water column of different side-arm systems. We expected that nutrient concentration follow closely the extent of connectivity, while plankton compartments show responses that are more complex.

Study site description and study design

The investigation area with several side-arm restoration projects was situated in the river floodplain stretch between Vienna and the Slovakian border (RECKENDORFER et al. 2005). In each side arm at one station, located in the middle of the side am, was sampled during water level conditions below mean water in 2014 and 2015 (Fig. 1). For the statistical analyses, 8 sampling dates per parameter and site were used. The parameters investigated were inorganic nutrients and different components of the plankton community. Methods followed detailed descriptions in HEIN et al. 2004 and BARANYI et al. 2002.

Results and Discussion

The comparison showed that phosphate concentrations in the water column during low water levels were significant lower in the side arm Regelsbrunn (lowest connectivity levels) compared to all other systems (Fig. 2). Notable in that respect was the low mean concentration in the Orth system, but high variability at the same time. In the Johler Arm the range of concentration was at the same level as in the Danube main channel. This points to the fact that at medium levels of restored hydrological connectivity a significant nutrient retention can still be observed. At levels of a permanent reconnection, the nutrient status of the side-arm is the same as in the Danube.

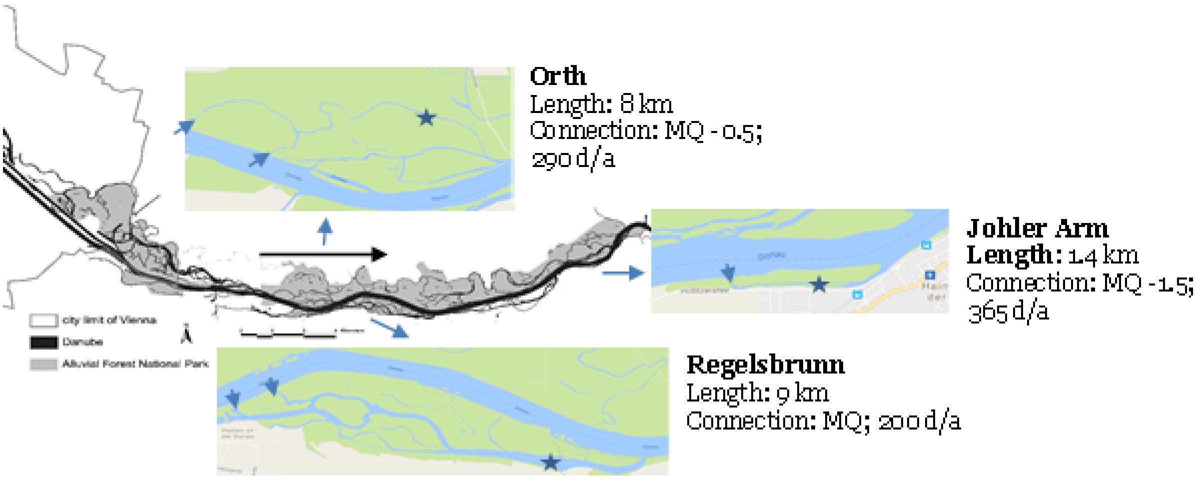

Figure 1: Map of investigation area, inserts investigated side arms. Stars mark sampling sites, arrows inflow areas. MQ: mean discharge in the river, connection: level at which side arm system is connected upstreams with the river main channel

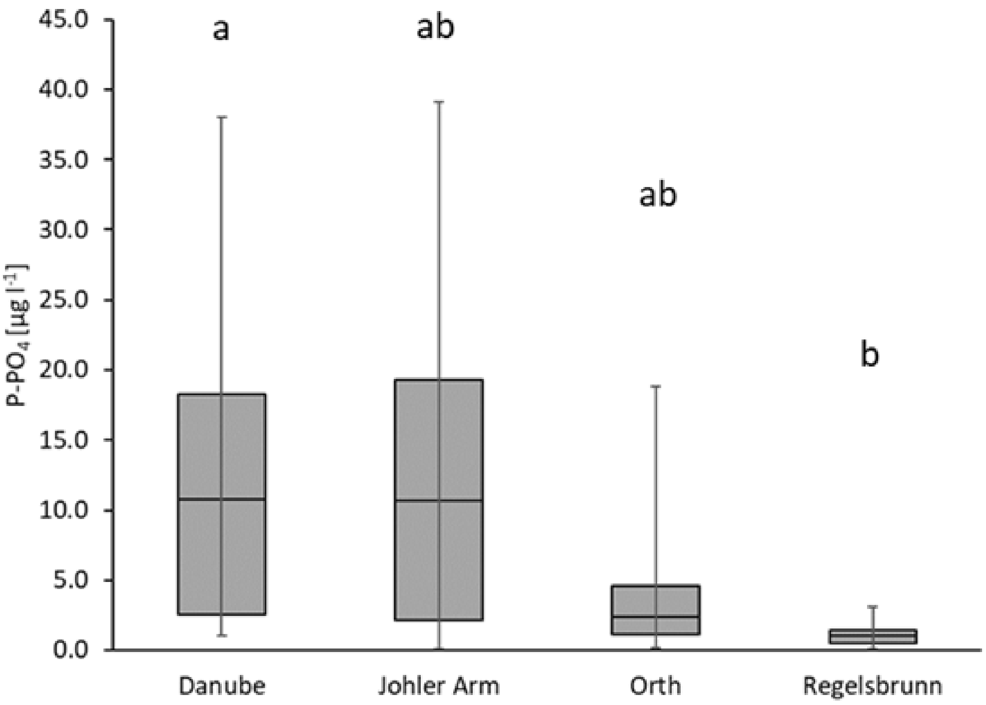

Figure 2: Boxplot of P-PO4 concentration in the water column; N = 8. Significance tested by Kruskal-Wallis one-way ANOVA = 0.027, letters indicate significant difference.

For plankton compartments, the following patterns were observed: Chlorophyll-a (Chla) as surrogate for phytoplankton biomass showed no distinct differences between river main channel and the restored side-arms, with mean Chla concentrations between 7 and 12 µg l^{-1} indicating medium productivity levels in these systems. Zooplankton abundance was low in the Danube, Johler Arm and Orth, while Regelsbrunn showed significant higher abundances (Fig. 3). Here the phases of disconnection are sufficient to increase retention times and allow a significant zooplankton development. The main groups have been rotifers and crustaceans (BARANYI et al. 2002). These differences in phytoplankton and zooplankton pattern point to a complex interaction of controlling factors, where highly connected systems are primarily controlled by abiotic factors, while medium connected systems show certain periods of dominant biotic control.

These results highlight that we do not observe gradual changes related to the amount of hydrological connectivity restored, rather than threshold responses, even for plankton communities. The same evidence can be provided for nutrient retention as an important ecosystem service showing comparable patterns, with still measurable nutrient uptake at medium connectivity levels. Thus, for the design of future restoration measures these findings can be applied to define realistic aims such as improved ecosystem services, or approaching riverine conditions for aquatic communities. Our results suggest that at medium connectivity levels nutrient retention can be optimized as frequent riverine pulses can be efficiently taken up by side arm communities, while permanent connectivity and lotic conditions lead to a dominant hydrological control of plankton communities.

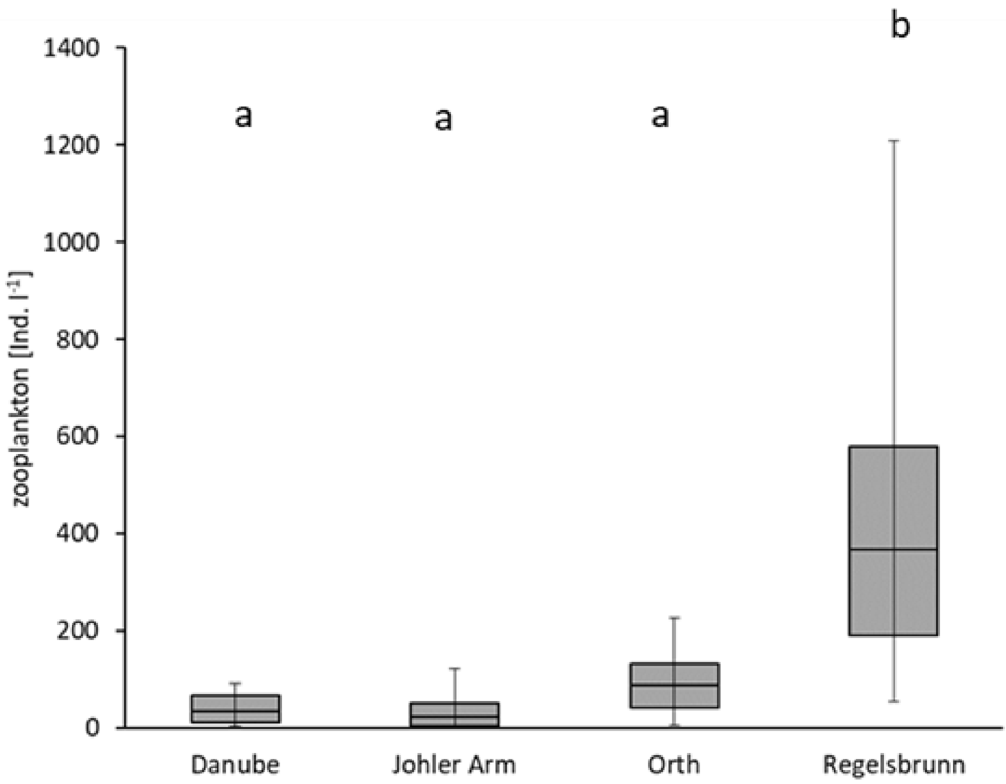

Figure 3: Boxplot of zooplankton abundance; N = 8. Significance tested by Kruskal-Wallis one-way ANOVA = 0.012, letters indicate significant difference.

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The use of crowdsourced (spatial) data in visitor management Discussed by the example of a visitor hotspot in Berchtesgaden National Park

Sabine Hennig

Abstract

Availability of (spatial) data is a key concern in visitor management. Crowdsourcing initiatives which involve the general public in data collection are considered a new source of data and information, and an alternative to traditional data collection approaches. But, how can visitor management benefit from crowdsourced data? Literature and Internet review as well as analysis of platforms and data reveal several advantages, but also challenges regarding the use of crowdsourced data. To benefit e.g. from crowd mapping platforms, GPS/ GPX sharing platforms, and multimedia sharing platforms certain skills must be build up among visitor managers. Moreover visitors must be motivated to contribute to crowdsourcing platforms in order to increase the amount of data available.

Keywords

visitor management, crowdsourcing platforms, multimedia, GPS tracking, spatial data, crowd mapping, geotagging

Introduction and research questions

Visitor management is a sub-domain of protected area management. Its objectives are:
1. to protect and improve natural resources in the context of visitor use,
2. to increase visitor enjoyment, and
3. to maintain and enhance the economic benefits that visitors have on a region.

Various strategies are applied to reach these goals. They refer to hard or restrictive actions such as prohibitions, limited access, and entrance fees, and, to soft actions based on the well-considered use of infrastructure, environmental education, and nature interpretation elements designed to guide, inform and sensitize visitors (see, e.g., HENNIG 2017).

For protected area management including visitor management to decide on appropriate measures the availability of data and in particular of spatial data is a key concern. Obtaining (spatial) data is often laborious and expensive. Due to the advances in information and communication technologies, the high Internet user penetration rate worldwide, and the steadily rising numbers of mobile Internet users, new approaches allow the general public to be involved in (spatial) data collection. These methods are an interesting addition to traditional data collection methods. In many domains, crowdsourced data is seen as an alternative method for obtaining and maintaining authoritative data (HERFORT et al. 2015). But, how can visitor management benefit from crowdsourced data and media and which challenges are related to the use of crowdsourcing applications? This is discussed by the example of a visitor hotspot in the German Berchtesgaden National Park (i.e. Alpine hut Kärlingerhaus at lake Funtensee)?

Study Area

The Berchtesgaden National Park is situated in South-East Germany, 30 km south of the Austrian city of Salzburg. It covers an area of 210 km^2 at an elevation ranging from 600 m a.m.s.l. (Lake Königssee) to 2,700 m a.m.s.l. (Watzmann Massif). Berchtesgaden National Park – established in 1978 – is the only German national park in the Alps. The main management objectives are nature conservation, environmental education, providing the public with requirements for recreation, and scientific research (BAYSTMLU 2001).

The region is one of the oldest holiday destinations in the Alps. To this day tourism and recreational use play a fundamental role in the region, and Berchtesgaden National Park is one of its main attractions (BAYSTMLU 2001). Over the last few years, in particular several days lasting hiking tours with overnight stays at Alpine huts have been receiving increasing attention. A main destination for this is the Alpine hut Kärlingerhaus at lake Funtensee (1,638m a.m.s.l.; 47° 29’44” N, 12° 56’ 14” O).

Methods

To gain insight into the use, potential, and challenges of crowdsourced data and crowdsourcing platforms different methods were applied. Based on the results of a literature and Internet review, crowdsourcing applications being of interest for visitor management purposes were identified and categorized. Using an especially elaborated list of criteria applications and data available were analyzed. The spatial focus was on the Alpine hut Kärlingerhaus and its surroundings.

Categories of crowdsourcing platforms and potential benefits for visitor management

Crowdsourcing platforms being of particular relevance for visitor managers encompass, among others, crowd mapping platforms, GPS/ GPX sharing platforms, and media sharing platforms.

Crowd mapping platforms allow the general public to add, i.e. provide spatial data on all kinds of infrastructure. Among existing initiatives OpenStreetMap (OSM; www.osm.org) is the world's largest public collection of spatial data. To describe features to be mapped, OSM provides a specific tagging system. It allows the user to describe recreational infrastructure and to characterize these features in detail (OSM Wiki). Benefits of using OSM refer e.g. to data's up to datedness, provision of data on elements that are hard to collect, and insight into people's individual perspectives and perceptions (HENNIG 2017).

On GPS/ GPX sharing platforms such as GPSies or Wiokiloc users publish tracks usually captured while performing certain outdoor activities such as hiking, biking, or ski-mountaineering (using a GPS device or a tracking app installed on a GPS capable smartphone). The created files (GPS/ GPX) are uploaded to the according platforms and attributes describing the track (e.g. degree of difficulty, beauty of scenery) might be added. Besides the tracks (download), track attributes as well as number and content of comments on the individual tracks might be a valuable source of information for visitor managers to gain insight into visitor hotspots and visitor preferences (see, e.g., MONTEIRO 2016).

On media sharing platforms (e.g. Flickr, Instagram, Twitter, Youtube, Freesound) users provide media such as photos, videos, and sounds. Information on the location (i.e. pair of coordinates, so called geotag) is added while creating/ capturing the media or by using specific applications (e.g. Geosetter). Regarding the use of geotagged media in the context of visitor management some examples can be found in literature. Thus, for instance, WALDEN-SCHREINER et al. (2016) and LUPP et al. (2016) used geo-tagged photos posted on photo-sharing platforms to collect data on visitors, their activities, preferences and needs.

In brief, the described crowdsourcing platforms provide attribute and spatial data relevant for visitor managers (Tab. 1). The data allows to gain understanding on visitors and their visits as well as knowing activities performed, sites visited and recreational infrastructure available.

Platform	Attribute data	Spatial data
Crowd mapping (e.g. OSM)	primary tag: feature type, secondary tags: feature characteristics	Mapped recreational infrastructure
GPS/ GPX sharing (e.g. GPSies)	Track characterization (quality, length, landscape, etc.), number of views/ downloads, comments, ratings	GPS tracks
Media sharing (e.g. Flickr)	Media content, comments, rating	Due to geotagging

Table 1: Data provided by crowdsourcing platforms

Availability and usability of crowdsourced spatial data regarding the study area

Regarding the visitor hotspot Alpine hut Kärlingerhaus extensive crowdsourced (spatial) data can be found on the different platforms. Nevertheless, there is room for improvement. This is outlined by some examples.

The OSM tagging system allows describing all relevant infrastructures regarding hiking trips (trails, Alpine huts, shelters, availability of drinking water, viewpoints, sign posts etc.). Despite this, the data hold in the OSM database remains inferior to existing authoritative data (see, e.g., management plan of the Berchtesgaden National Park; BayStMLU 2001). A pivotal benefit refers to tags reflecting visitors' assessment on infrastructure. Thus, for instance, by the tag trail_visibility it becomes obvious which trails (from visitors' perspective) are regarded excellent or good and which provide potential for improvement (based on the classification of the Swiss Alpine Club SAC; Fig. 1a).

On the GPS/ GPX sharing platform GPSies, more than 100 tracks related to the visitor hotspot Kärlingerhaus were uploaded by the users (to August 2017). Due to the data, insight into trails most popular to reach the Alpine hut Kärlingerhaus can be gained. Further, the data reveals which non-official trails are used (Fig. 1b). Track attributisation outlines that, on average, users consider the quality of the trails as good (rating: 4 out of 5 stars).

Moreover, the number of photos taken in the surrounding of the Alpine hut and uploaded to the photo sharing platform Flickr can serve as an additional indicator for the popularity of this site (compare Fig. 1a and 1c). The pictures themselves (incl. time of capturing the image) give insight on the fact that the Alpine hut Kärlingerhaus is also a popular visitor destination between Middle of October to end of May (not operating time of the hut, visitors stay in the so called winter room).

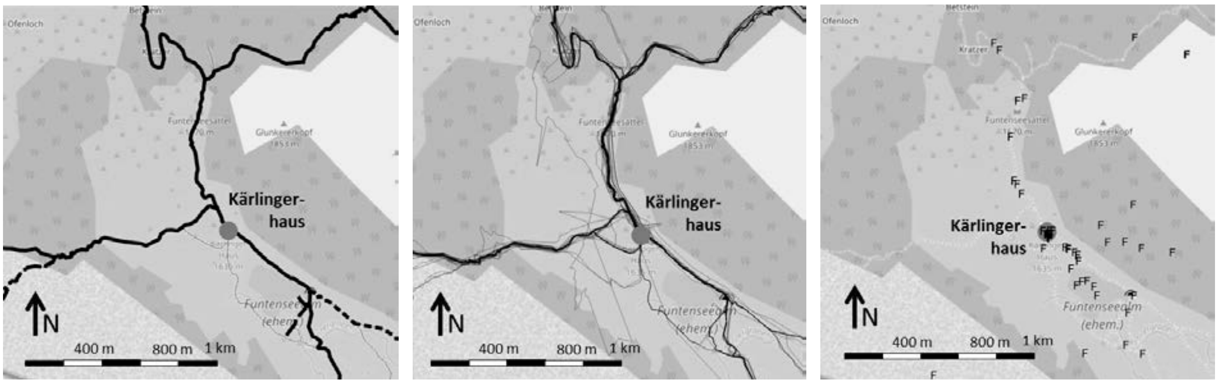

Figure 1: Examples regarding the availability of (spatial) data from crowdsourcing platforms regarding the Alpine hut Kärlingerhaus (a) OSM trail data: solid line: excellent/ good condition; dashed line: intermediate conditions, (b) GPS tracks on GPSies: solid lines. GPS/ GPX tracks, and (c) locations of Flickr photos: F location where photo was taken; (Basemaps: ©OpenStreetMap Contributors).

Discussion

Even though in literature a wide range of examples can be found outlining the use of crowdsourced (spatial) data, the incorporation of this data seems still be an exception in visitor management and mostly related to research activities. One reason among others might be that accessing crowdsourced spatial data still requires advanced GI geoinformatics skills. Apart from being able to handle GIS, among others, knowledge on the application programming interfaces APIs (regarding the different platforms) is important. In addition, to build up the required skills, visitor managers first and foremost must be aware of the possibilities and benefits of using crowdsourced data in visitor management.

Further, to increase amount of data available on crowdsourcing platforms, visitors (i.e. the general public) must be motivated to contribute on these platforms. As outlined in the context of citizen science, this requires for motivation strategies to have users add content (ENGELS 2015). Moreover, also the users must have certain digital, media and spatial skills. This is particularly relevant for adding data to crowd mapping applications (VOGLER & HENNIG 2013).

Conclusion and outlook

Crowdsourcing platforms are a rich source of different types of information including spatial and attribute data related to visitor activities and recreational infrastructure. Information is provided that otherwise is difficult to collect. But, to have more data available, visitors must be encouraged to contribute data. Further, it is important to build up GI skills among managers to enable them to leverage crowdsourced data. However, tools and methods to access, prepare and use data must become even easier to handle.

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Melting underground ice masses in Hochtor massif, Gesäuse National Park – documentation and implications for the water resources of alpine karst

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Abstract

Since 2002 hundreds of caves were surveyed in the Hochtor massif. Some cirques covered by large firn fields in 1920 are now snow-free revealing clusters of shaft caves. In some of them ice masses reached depths of hundreds of meters. During the last 15 years we observed a rapid subsurface glacier retreat in those places. This is seen as a dramatic signal of climate warming and contributes to a change of alpine landscape and biosphere. We expect adverse consequences for karst water resources in the Northern Calcareous Alps, which make a major contribution to drinking water supply in Austria.

Keywords

climate change, cave research, subsurface glacier retreat, ice caves, alpine karst, drinking water supply

Introduction

The Hochtor range in Gesäuse National Park belongs to the eastern part of the Northern Calcareous Alps. With an elevation of 2.369 m the summit of Hochtor marks the highest point, while the river Enns passes the massif in less than 600 m.a.s.l. In its upper, eastern and southern part the range is built of triassic Dachstein Limestone and Dachstein Dolomite. Despite of its rugged profile the massif is intensively karstified and penetrated by a large number of mainly vertical caves. The majority of precipitation drains the bedrock while the groundwater leaves the karst system in springs near the bottom of the surrounding valleys. Up to the 20th century the surface of glacially formed cirques was extensively covered by firn-, ice- and periglacial debris, as is documented in historic pictures and maps. Therefore the majority of shaft entrances, dolines and karrenfields in these areas had been hidden below this cover, and the massif was regarded as speleologically insignificant and poor in caves and other karst features.

2002 some members of VÖH and LVH Wien/NÖ[1] with good alpine climbing skills started investigations to document the existing karst features, especially the caves of this area, which had been nearly unexplored in respect of speleology (Fig. 1). Aside from numerous other surprising facts these explorations revealed extended subsurface ice bodies in the majority of shaft canyons in high altitude areas and cirques. Until recently those relicts of a colder climate in the past had blocked the vertical caves, but today, after the firn basins on the surface have disappeared. A rapid melting process can be observed which seems to be a further dramatic signal of climate warming.

The pristine alpine landscape of Gesäuse National Park offers the opportunity to monitor this natural process in an area nearly undisturbed by human activity. Monitoring results could be of high value for drinking water supplies in the neighbouring regions. On the other hand, the melting process of the underground ice is to some extent regarded as a consequence of man-made global warming which contributes to a change of alpine landscape, of the karst water system and the biosphere.

Methods

As far as the adverse circumstances (extremely steep terrain, weather conditions, episodic snow cover, little number of willing and fairly experienced volunteers) allow, a systematic documentation of caves and other karst features like karrenfields and dolines is driven forward. Following consistent standards all cave entrances get georeferenced and caves are mapped in scale 1:200 and 1:500 (vertical sections) respectively. Together with photo-documentations and verbal descriptions, these data are registered in the Austrian Cave Index as well as in the 'SPELIX' GIS database. The outcome as presented in this paper is one of the unexpected side-products of this systematic documentation. Becoming aware of the phenomenon, special attention has been directed to its influence on karst morphology and impact on karst water discharge.

[1] Verband Österreichischer Höhlenforscher (Austrian Speleological Association) and Landesverein für Höhlenkunde (Federal Association of Speleology)

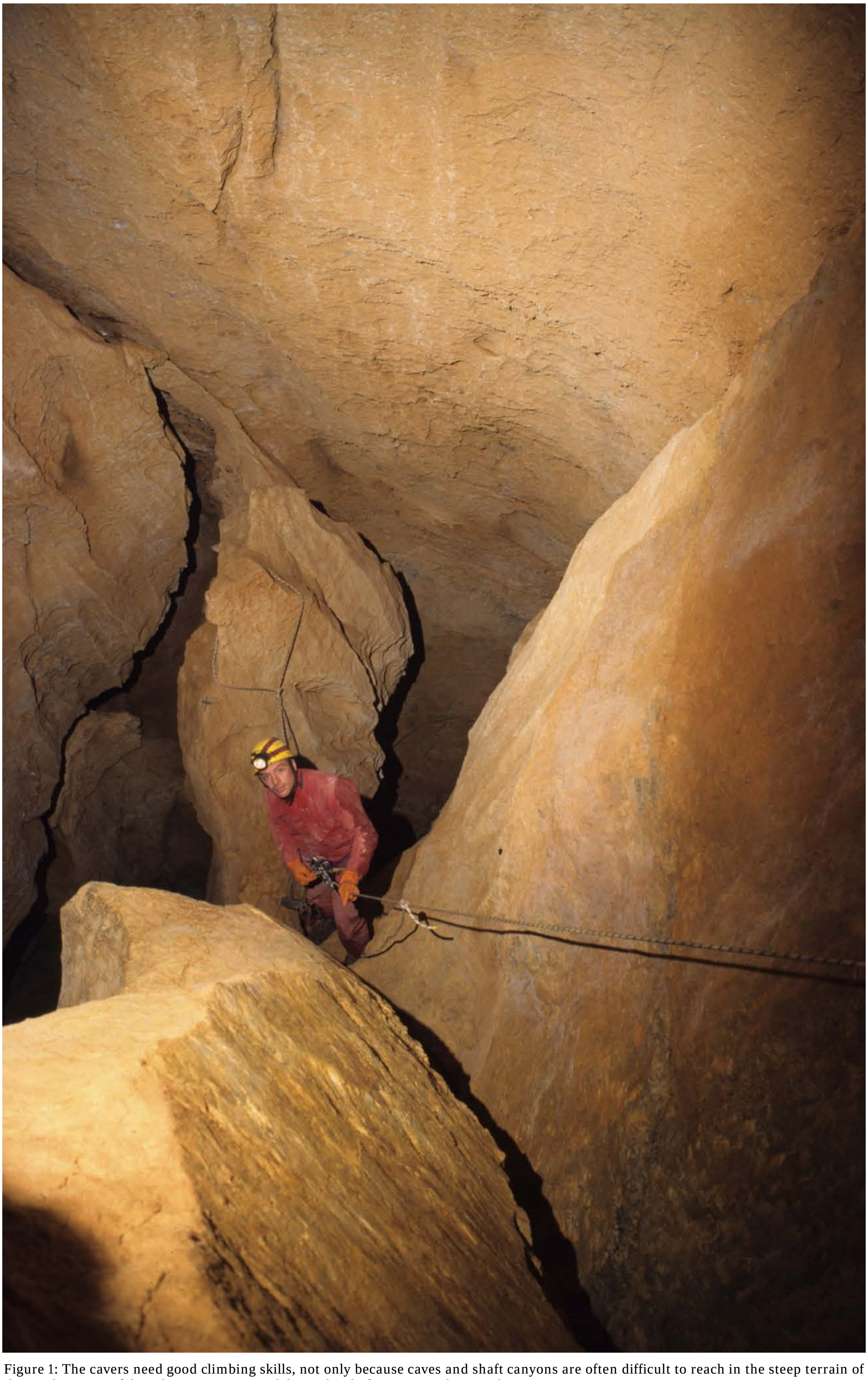

Figure 1: The cavers need good climbing skills, not only because caves and shaft canyons are often difficult to reach in the steep terrain of the Hochtor massif, but also to move up and down the shaft canyons. Photo: Eckart Herrmann.

Results

Annual field work resulted in the knowledge of more than 400 caves in the region. In the cirques of Schneekar/Schneeloch we discovered areas with more than 15 caves per hectare being accessible for man and many more dolines and blocked shafts (Fig. 2). But also in the other cirques like Roßkar, Seekar and Steinkar shaft entrances are abundant. The majority of these 'caves' is dominated by steep and winding canyon shafts, some of them leading into depths of more than 600 m, including giant single shafts of up to 170 m in depths and 30 m in diameter (Fig. 3). In contrast to other parts of the Northern Calcareous Alps, significant horizontal caves are only present at very low levels of Hochtor massif. The shaft canyons were formed in the underground by infiltrated meteoric karst waters and later became overcast by cirque glaciers and periglacial erosion in the side walls of the cirques.

Figure 2: In an area of the cirque called Schneeloch that was covered by a firn field up to the 20th century, there appears a high density of scree-covered shafts with melting ice bodies inside. Photo: Reinhard Fischer.

When field work began in 2002 we supposed numerous shaft dolines with only a few meters in depths being completely clogged by blocks. Scree slopes seemed to spread over bedrock in thick formations. But then we observed currently sinking depressions, and some years after the vanishing of firn fields we noticed that periglacial debris had built just a thin layer between the karstified bedrock and the firn cover. Subsequently we could find our way into deep shaft systems where we found remains of an expanded former ice filling, but only sparse remnants of debris. We detected stratified ice bodies (and fresh snow) down to 250m below the surface. (Besides, we discovered a block glacier in a cirque east of Hochtor peak, called 'Tellersack'). In places where debris still covers the rock surface the opening of new shafts or genesis of new dolines within a year could be observed accidently in some cases (Fig. 4).

Figure 3: The basis of a 170-m-step in the shaft canyon Schneekareishöhle, 250m below surface shows breakdown structures caused by former ice filling and freeze/thaw cycles. Photo: Michael Kopitsch.

Figure 4: In 2016 a currently formed doline in Schneeloch scree slope was found accidently. Photo: Josef Hasitschka.

Discussion

According to extreme densities of shaft canyons, a reasonable underground ice volume is supposed to be there, which still rests unrecognized in the karst underground but will probably disappear within the next years or decades. In contrast to glacier monitoring on the surface (and for some horizontal ice caves) no comparable long term observation on these shaft fillings is known.

In high alpine karst with bare bedrock the water storage capacity of epikarst is low. Therefore the inner mountain ice formation could play an important role to balance the discharge of karst springs, and a loss of cave ice could contribute to shortages in water supply during dry weather periods in summer. Without respect to the specific cave formation in the Hochtor range huge, but melting ice bodies in alpine shafts seem to be a widespread phenomenon (WEIßMAIR 1995, SPÖTL & PAVUZA 2016), also in karst massifs with important water supplies for parts of the Austrian population including major cities like Wien, Graz and Salzburg.

In many cases existing ice bodies contain datable organic substances like wood and bones. Respective radiocarbon datings from other parts of the Northern Calcareous Alps delivered ages reaching back to the holocene climate optimum (ACHLEITNER 1995, HERRMANN et al. 2010). It can be assumed, that during the quaternary climate fluctuations shafts opened due to melting ice plugs. The open shafts were covered by scree periodically, but they did not get filled up with debris.

Recommendations and future perspectives

Cave documentation is almost entirely done by volunteers. Scientific benefit should be taken as long as some people are willing to address themselves to this time-consuming, demanding and dangerous work. To get a better understanding of formation and origin of underground ice bodies observable stratifications should be recorded and radiocarbon datings should be done whenever possible.

Apart from the fieldwork it would be of great interest to compare dated historic pictures of the national park's stock of images and other accessible sources with the present surface status, to gain a more detailed picture of firn retreat and subsequent (re-)uncovering of karst phenomena. This was a detail task in the project 'Landschaft im Wandel' (Changing Landscape) which aims to describe the changes of the landscape in the Gesäuse National Park and its surrounding areas from the beginning of field mapping to the time of the founding of the National Park (HASITSCHKA et al. 2014). Finally, it should be mentioned, that up to now no continuous surveys of karst spring discharges were implemented at the springs in this massif; a cooperation with recognized institutions like Joanneum research is recommended. For scientific speleology a provisional estimate of the ancient and present underground ice mass in Hochtor range remains as open question.

Caves are natural archives of the past, and in this special case the retreat of snow and ice makes more and more alpine shaft caves accessible for human entry. Therefore surprising explorations can be forecasted – not only in terms of untouched ground but also in new scientific problems.

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Geocaching in Austrian National Parks

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Keywords

Geocaching, national park, impact, disturbance, Austria, GPS

Summary

Geocaching is a leisure activity that started in the year 2000 in the USA. Its goal is to find containers (so-called geocaches), that are hidden in cities or in natural areas, by the help of GPS-receivers or smartphones. The information required to find a cache, based on GPS-data, is uploaded to geocaching websites by the person who has hidden the cache. In the year 2000, the website *geocaching.com* was created explicitly for this purpose. In addition to other major websites, such as *opencaching.de* and *navicache.com*, there are also numerous smaller websites and databases dedicated to geocaching today. Since its beginnings, geocaching has evolved into a versatile hobby with increasing popularity worldwide. The most popular countries for this outdoor recreation activity are the USA, Germany, and Canada. But Austria also belongs to the top ten countries worldwide for the number of active geocaches (GROUNDSPEAK INC. 2013).

This development raises concerns from an environmental protection point of view, since geocaches are often located off-trail in protected areas (BROST & QUINN 2011) and since leaving the designated trails has the potential to impair the natural environment by negatively impacting vegetation and soil or by disturbing sensitive wildlife (HAMMIT & COLE 1998²; HÜPPOP 2005; INGOLD 2005; GUTHÖRL 2006²; PATUBO 2010). Given the ongoing popularity of geocaching, park managers and outdoor recreation researchers discuss the possible impact of, and ways for regulating, geocaching, especially in protected areas (REAMS & WEST 2008; BROST & QUINN 2011; PARKS CANADA 2017; FLORIDA STATE PARKS N.D.; STATE OF CALIFORNIA N.D.).

Against this background, this thesis examines the question to which extent geocaching is present in the Austrian national parks. This assessment gives an overview on the current situation, which is a valuable basis for developing any regulating measures, should they be considered necessary. For this purpose, an online research as well as GIS-based analyses were conducted to determine important parameters, such as the types of hiding places and their surroundings, the numbers of finds (period of recording: 1 June to 30 November 2012), and the distances of the hiding places from the nearest trails. In addition to the total number of finds logged for each cache during the period of recording (Figure 1), also the weekly number of finds was documented for each cache.

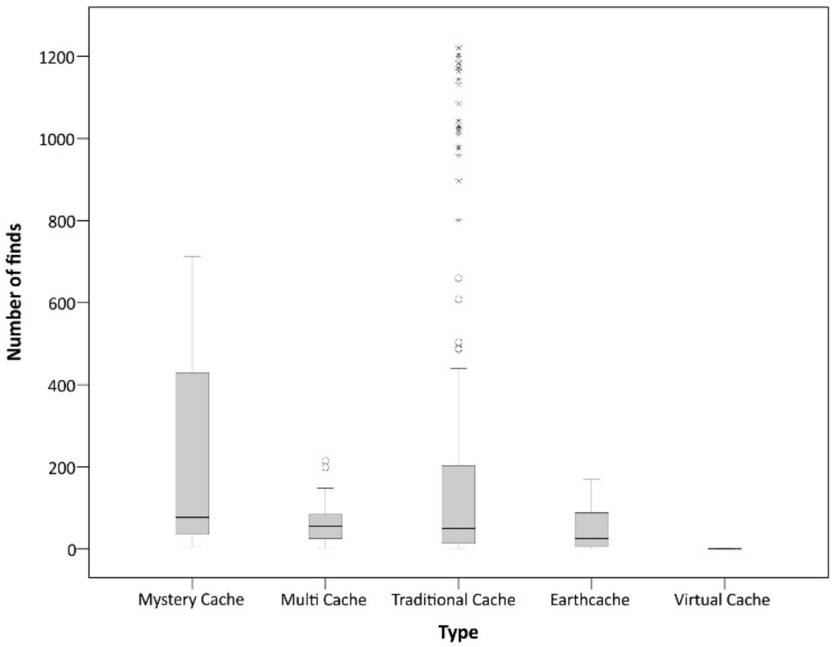

Figure 1: Number of finds in relation to cache types (N =259).

The results show that geocaching is present in all six Austrian national parks (IUCN Category II), but to rather varying degrees. It was also discovered that natural objects/structures are most commonly used as hiding places and that they are mainly located in natural areas. Regarding the distances of the hiding places from the trails and the numbers of finds, there are rather big differences between the individual national parks. At the same time, geocaches hidden in the same national park also show a wide range of results for these parameters.

In general, it seems to be necessary to keep an eye on the situation, respectively to take a closer look at it. This applies especially to the Donau-Auen NP, which is confronted with the highest number of caches and finds amongst all Austrian national parks.

A paper largely based on the results of this master thesis, but not exclusively limited to them, was published this year in the journal eco.mont:

HÖDL, C. & U. PRÖBSTL-HAIDER 2017. Geocaching in Austrian National Parks. Eco.mont 9(2): 42–51. doi:10.1553/eco.mont-9-2s42

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Evaluating the potential of protected areas to preserve biodiversity at large scales

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Abstract

The conservation value of protected areas can be measured in many ways. Here, we propose a concept that estimates the potential of large-scale protected area networks to preserve biodiversity. Our metrics of conservation value include species richness, rarity, the effect of area on species occurrence and differentiation diversity. With this approach we aim to improve protected area networks in terms of future conservation needs.

Key Words

Biodiversity, differentiation diversity, protected area, species rarity, species richness

Introduction

Environmental change leads to biodiversity loss at local to global scales. Protected areas are major conservation tools to prevent such loss. But most research on the performance of protected areas focus on local to regional scales (Orlikowska et al. 2016). In addition, the performance of PA networks depends on its large-scale configuration in space (Montesino Pouzols et al. 2014). Therefore, large-scale approaches are urgently needed to identify strengths and weaknesses of PA networks to efficiently protect biodiversity at all scales (Watson et al. 2014, Hermoso et al. 2016).

We suggest to assess the conservation value of PAs in different ways such as in terms of inventory diversity, differentiation diversity, species rarity and the species–area relationship. The methodological approach we propose is applicable for large-extent conservation assessments. Consequently, it is possible to identify PAs of high and low uniqueness values to evaluate current conservation efficiency and guide future conservation effort. Thereby, large scale management priorities can be defined.

Methods and Results

Since distribution data of species are variable in quality and mostly have coarse spatial resolution, we built a probabilistic approach for assigning each reported species to each PA (see also Araújo et al. 2011) by using chain rule probability theory. Based on that, we can estimate the uniqueness of PAs in terms of species rarity and differentiation diversity, and also calculate inventory diversity both directly and accounting for the species–area relationship (SAR). To measure conservation value in these ways, we propose to calculate about seven uniqueness indices (reported species richness, area-controlled surplus of reported species, rarity-weighted richness, average rarity, total dissimilarity, turnover dissimilarity, nestedness dissimilarity).

Discussion

A macroscopic perspective is necessary to guide effective conservation strategies (Araújo et al. 2011, Le Saout et al. 2013, Montesino Pouzols et al. 2014, Maiorano et al. 2015). Research effort has barely aimed to understand the potential of PA networks at international scale (Orlikowska et al. 2016), and most nature conservation funding has not been addressed to high conservation priorities (Hermoso et al. 2016). With our study, we propose a new perspective and simple analytical tools for decision-making and conservation prioritization at large scales. Funding strategies require transparent instruments to set conservation priorities for the spatial distribution of conservation effort (Hochkirch et al. 2013a, b; Maes et al. 2013, Kati et al. 2014, Linnell et al. 2015). Our novel approach allows PAs to be ranked, with respect to biodiversity components of conservation concern, and can be easily adopted for any data and PA type, and for other components of biodiversity.

Our method supports international conservation planning by demonstrating strengths and weaknesses of PA networks. We developed, for the first time, a range of measures of conservation value for PAs that include both richness metrics and dissimilarity values. Compositional dissimilarity is a crucial dimension of conservation performance of PA networks (Chiarucci et al. 2008) that is often neglected (Socolar et al. 2016). It is just another fundamental component of biodiversity that informs about complementarity, and is therefore highly relevant to multi-site considerations, such as to PA networks.

Conclusion

Biodiversity knows no country limits. Nature conservation needs international guidance. The uniqueness indices we propose can evaluate the performance of PAs with respect to species conservation. They can be easily adapted for other data from gene to ecosystem level. We encourage to apply these conservation tools at the international scope to also encourage national authorities to cooperate and support funding beyond national boundaries to improve nature conservation in future.

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Wintering birds in floodplain forests – Effects of vegetation structure and landscape composition on species assemblages

Barbara Hönigsberger

Keywords

bird species diversity, European mistletoe, vegetation structure, National Park Donau-Auen, riparian forest, winter

Introduction

This study explores the wintering bird community of floodplain forests in the National Park Donau-Auen. The national park was established in 1996 and stretches from Vienna, Austria to the Slovakian border. It contains the biggest semi-natural floodplain forest in Central Europe and one of the last free flowing sections of the Danube (MANZANO 2000).

Most of bird studies are conducted during spring season when migratory birds already arrived in their breeding area. Only few studies include the winter bird community (MANUWAL & HUFF 1987), but large differences are existing between breeding and wintering bird communities. For better protection and management strategies, it is crucial to understand the biology and behavior of birds as well as the ecological mechanisms which shape bird assemblages in nature. Hence, this study aimed detecting vegetation and landscape parameters which are responsible for shaping bird assemblages in a lowland riparian forest in winter.

Material and Method

Through 10-minute point counts, conducted between December 2015 and February 2016, bird assemblages were recorded and various vegetation parameters were estimated. The census points used for assessing bird assemblages were located at the northern shore of the Danube in the National Park Donau-Auen. Every census point was visited 3 times, only birds inside the 50-meter radius were used for further analysis. Plots were located north and south of the flood protection dam 'Marchfeldschutzdamm'. They were located at the intersection of 100 m grids established by the Österreichische Bundesforste AG and the MA 49 of Vienna in the framework of their forest inventory scheme. The points were filtered with ArcMap 10.2 (ESRI 2011) for the following criteria's:

1. max. 100 m away from paths (for good accessibility);
2. no forest margin within a 50-m radius;
3. >200 m apart from other points (for spatial independency).

Further, the plots were grouped by distance to next permanent water bodies using the following categories: <75 m, 75-150 m, 150-250 m and >250 m. In total 69 plots were used in this study.

Results

We used 34 bird species with 1934 individuals for further analysis. The most abundant bird species which was detected in all 69 plots were Great Tit with 506 individuals. Blue Tit was detected 320 times and Eurasian Nuthatch 303 times.

Species diversity

To find important habitat and landscape parameters which influence bird assemblages, we calculated generalized linear models for bird species diversity (Shannon Diversity Index).

The best GLM model included distance to open land, standing deadwood, proportion of grey alder in the canopy layer, number of mistletoes and number of fruits and seeds. In this model, only open land and mistletoes proved to significantly affect bird diversity (see Tab. 1).

Explanatory variables	**Estimate Std.**	**SEr**	***t* value**	***Pr* (>|*t*|)**
(Intercept)	1.8932	0.0472	40.077	<0.0001 ***
Openland	-0.0005	0.0002	-2.076	0.0420 *
st_dw	-0.0023	0.0012	-1.827	0.0725 .
alnus_incana	0.0071	0.0038	1.892	0.0632 .
mistletoes	0.0028	0.0006	4.927	<0.0001 ***
nr_fruits	0.0101	0.0057	1.781	0.0798 .

Table 1: Summary of the best model of sh_birds, Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Fig. 1 shows the importance of the environmental predictors for the best 100 models. The predictors mistletoe, grey alder and open land were in over 80% of the 100 best models present. The amount of deadwood and forest age were not significant but deadwood showed a negative effect on bird species diversity. No spatial autocorrelation was detected for the best model.

Further, the number of mistletoes on the south side of the dam is significant higher than north of the dam (Kruskal-Wallis test for equal medians: p= 0.0083).

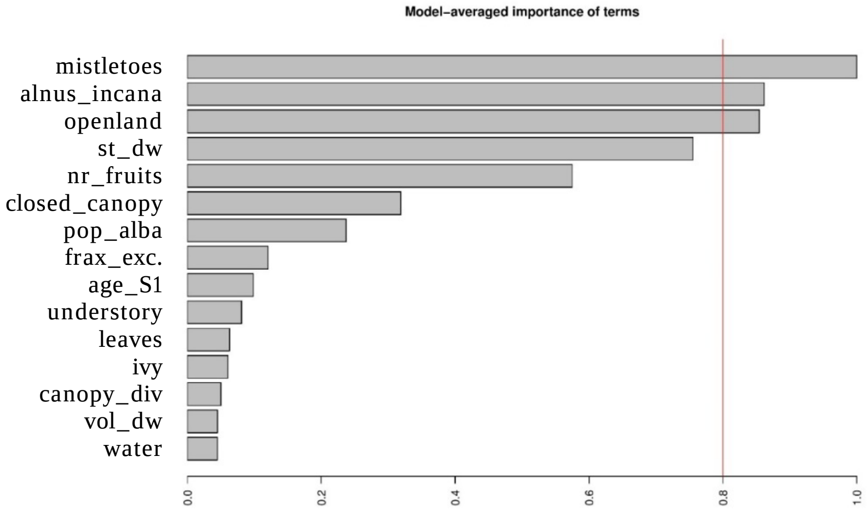

Figure 1: Model-avaraged importance of terms, red line at 80%

Species composition

The overall beta diversity for our 69 census points achieved a Sørensen dissimilarity of 0.93 (βSOR). The spatial turnover in species, measured as Simpson dissimilarity, was mainly responsible for the recorded beta diversity (βSIM= 0.89). Nestedness, measured as Sørensen dissimilarity, contributed sparsely (βSNE= 0.05) to overall beta diversity.

Bird species composition differed significantly between census points north and south of the dam (one-way ANOSIM: p= 0.039). Bird assemblages north and south of the dam are significantly different from each other and the variance within each group is smaller than between groups. Furthermore, more bird species were detected south of the dam (one-way ANOVA, p= 0.0182). Nonmetric Multidimensional Scaling (NMDS) was performed too. The occurrence of Eurasian Tree creeper seems to be strongly associated with the age of the canopy layer. Mistle Thrush and Jay are located near the arrows of the number of mistletoes and proportion of alder in the canopy layer. Height of canopy seems to be a good predictor for Long-tailed Tit and for Hawfinch. Chaffinch seems to correlate with distance to open land.

Discussion

Distance to open land, the proportion of alder in the tree layer and the number of mistletoe on the plot were the most important predictor for bird species diversity. Alder trees as well as mistletoes are important winter food sources and therefore it seems likely that birds prefer plots with a higher number of mistletoes and alder on it. Species diversity decreased with the distance to open land. This is an expected finding, because we assumed that the edge effect will be stronger developed in winter than in spring. ADRION (2016) did not find a significant relationship in spring. The edge effect explains the phenomenon that boundary habitats have a greater biodiversity than the adjacent bigger ecosystems (SCHAEFER 2012).

We could not find an effect from distance to permanent water bodies on the abundance of birds, therefore it seems likely that aquatic insects do not play a key role in winter nutrition. It seems likely too, that in the floodplain forest of the National Park Donau-Auen, habitat preferences of various bird species are stronger developed in winter than in spring. In addition, we found out, that bird assemblages north and south of the dam differed significantly from each other. Further, census points south of the dam were characterized by higher species richness than census points north of the dam. This is probably because alder only occurs south and mistletoes had higher numbers south of the dam. ADRION (2016) did not find a significant difference in bird assemblages north and south of the dam. This demonstrates that food supply plays a key role in bird distribution and assemblages in winter. In spring, various other food sources appear to be more important.

Deadwood and forest age

There was no significant relationship between the amount of deadwood and species richness or species diversity, although the number of standing deadwood was included in the best diversity model. Deadwood is often correlated with bird species richness because it provides habitat, feeding and overwintering sites for many insects as well as for birds (NILSSON 1979). In our study bird richness and diversity decreased with increasing number of standing deadwood. This irritating result was found by ADRION (2016) as well. WARINGER (2017) also found a negative effect of standing deadwood on Collared Flycatcher, normally a typical deadwood bird. The best explanation might be that, at the National Park Donau-Auen, the amount of deadwood is an indicator of former intense forestry management. We also could not find an effect of forest age on bird species abundance and diversity, although many studies documented a positive effect of old forest stands for overwintering birds (MANUWAL & HUFF 1987; DONALD et al. 1997; LAIOLO 2002; LAIOLO et al. 2003). This might be because the National Park Donau-Auen was established just 20 years ago, and so all investigated forest stands are remnants of the former intense forestry management. Due to these forestry measures implemented until recently, older stands may still lack typical features of mature forests.

Conclusion & Recommendation

Our study suggests that in the National Park Donau-Auen winter food availability is the strongest predictor for bird richness and bird diversity. It seems likely that mistletoes and alder trees are very important winter food sources in the riparian forest for many resident bird species. Aquatic insects as a winter food source are most likely neglectable. The former intense forestry management still influences the vegetation structure and the bird diversity. Most of the mistletoes parasite hybrid poplar stands and therefore these stands are very important winter habitats for many bird species. As a conservation recommendation for the national park this study suggests maintaining the formerly planted, highly infected hybrid poplar stands because of its importance for overwintering bird assemblages. Further, species richness was higher south of the dam, indicating that softwood forests provide better overwintering conditions for more bird species than hardwood forests. Therefore, it is recommended to preserve the softwood forest with its alder stands by stopping the fast succession from softwood to hardwood forest. This could be achieved by improving the hydrological connectivity of the floodplain forest with the water level of the Danube through the reconnection of side arms with the Danube.

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Sustainable regional development approaches in Alpine biosphere reserves - Farmers' perceptions

Adelheid Humer-Gruber

Abstract

The selected biosphere reserves focus on conservation of cultural landscapes, therefore Alpine farmers as managers of the land, play an important role in the model regions for sustainable regional development. Qualitative interviews with forty farmers in the UNESCO BR Salzburger Lungau und Kärntner Nockberge (AT), UNESCO BR Engiadina Val Müstair (CH) and UNESCO Biosphere Entlebuch (CH) give an insight on their opinion on the obligation of agriculture, nature conservation, BRs and why participation and cooperative approaches are essential.

This research should help to identify, strengthen or complete approaches for sustainable regional development in conservation sites in the Alps. Generally, the BR as shared platform for participatory concepts of various stakeholder groups for sustainable regional development is highly accepted and appreciated by the stakeholder group of farmers, once it's acknowledged as a long and slow process, which calls for numerous dialogues and relying on open minds amenable for mutual understanding.

Keywords

Biosphere reserves, agriculture, farmers´ perception

Introduction

The stakeholder group of farmers has been chosen as agriculture fulfils a high variety of essential functions like maintenance of the Alpine landscape, nature conservation and sustainable rural development. Farmers were asked where they see the duty of agriculture and the relevance of the biosphere reserve in their point of view. Since 1995 the concept of UNESCO (2016) biosphere reserves (BR) has been revised. People working and living in and around BRs should participate in decision making processes and be able to meet their economic, social, cultural and ecological needs. The management offices take over tasks of moderation and co-ordination, in a continuous process incorporating heterogeneous stakeholder groups. They serve as neutral point of contact for ideas from the community, to support them in sense of the common mission statement. The aim of this research is to identify to which extent BRs and nature conservation matters for farmers and where they see their role within this frame. What affects farmers' attitudes towards BRs and does it change over time? Further their point of view concerning improvements of development strategies and conservation measures are discussed.

Methods

Qualitative interviews with forty farmers in the UNESCO BR Salzburger Lungau und Kärntner Nockberge (AT), UNESCO BR Engiadina Val Müstair (CH) and UNESCO Biosphere Entlebuch (CH) were conducted between November 2014 and July 2015. In the course of personal conversations farmers were asked to share their opinion on the relevance of duties of agriculture, cultural landscape, nature conservation, biosphere reserves and knowledge transfer, with regard of agriculture in general or their farm in specific. Interviews, all performed in the local dialects, were recorded, transcribed, and combined with mind records and participatory observations. The analysis is carried out with the software MAXQDA (KUCKARTZ 2010). Addressed topics are elaborated and different positions were grouped and interpreted following principles of *grounded theory*. The focus of the sample selection along an adapted snowball sampling was on a high variety of farm sizes and farming systems (cf. HUMER-GRUBER 2017).

Results

As expected in mountainous research areas, all BRs cover high ranges of altitudes between 600-3200 masl, cattle are the most typical animal in the area (n=38). The high variety of other animals on the farm is a sign of small structures and diverse farming systems, which is of interest for nature conservation. Additional, due to market structures the ratio of organic farms is very high in some areas like Salzburg (50% organic farms) and Val Müstair (80% organic farms). Farms are family run, inherited over generations and in 17 cases more generations live on the farm, which emphasize the social functions. The interview partners (23 to 62 years old) were mainly male (n=32), corresponding to MAYR et al. 2016 as farming is men's business. Almost all farmers have an additional income and considerable fifteen farms (n=15) offer guest beds. Different obligations are identified whereof the most important are landscape maintenance and food production (n=38 resp.). Cultural and social obligation (n=31) are considered as an important task, mentioned are farms as family run operations, offering employment and settlement in rural areas. Nature conservation as a duty of farmers is mentioned by every second interviewed person (n=20). Some (n=15) see raising awareness of nature, agriculture and cultural knowledge as a task of their profession, as tourism and food advertisement impart an unrealistic picture of agriculture.

Discussion

In the initial phase, expectations on BRs are very high. BRs are not economic wonder pills for rural areas, and their success relies on the commitment and creativity of local communities. The single areas might be seen as a time lapse for a development process of BRs. BR Entlebuch evolved over more than 15 years, Val Müstair over seven years, while the Austrian BR was only designated two years before conducting the interviews. Fewer sceptical arguments are recognised in Entlebuch, which supports assumptions of an ongoing output of this research: expected negative impacts are often based on fears and apprehensions and over time they vanish (HUMER-GRUBER 2016). Gained positive experiences over a longer period are of major importance for a BR's success, because it equals peoples' participation, sharing ideas and empowerment.

Regional value creation and regional processing are central for BRs and for a successful participatory process balanced power structures are essential (WALLNER & WIESMANN 2009). Thematic round table sessions in the starting phase of the BR Lungau were appreciated. In the research areas in Austria and Val Müstair emigration is a major issue. BRs try to use the potentials in place to fight emigration of rural areas by regional value creation. The vivid agricultural community is a basis of a decentralised settlement. People should be able to earn a viable living (DARNHOFER et al. 2016) from farming in an area where agriculture with its surrounded economies is the most important livelihood. Good examples of sustainable development could be observed in all research areas.

Figure 1: The cultural landscape is shaped by agriculture, like here in the UNESCO Biosphere Entlebuch. (Foto: Humer-Gruber 2015).

Conclusion

This work shows that the BR has an influence on farmers and vice versa. To become a model region for sustainable regional development, it needs a strong community, which participates, discuss and brings up the courage to break new ground in their region to create a sustainable living, also for future generations. BRs support these participative structures.

The interviews with farmers show that support is given and motivation to participate is generally in place, although it is not always actively put into practice. An observant attitude of farmers has been reported from the initial phase in all research areas. Over time farmers became strong partners to the BRs management as seen in other examples. Experiences from BRs existing over a longer period give an insight that BRs have a huge potential to address farmers' concerns with support in product development, value added processing in the region, nature conservation training and awareness building, shared workforce, sustainable tourism or product marketing.
The BR is appreciated and highly accepted as a shared platform for participatory concepts, open to all stakeholder groups. Albeit BRs have to be acknowledged as a long and slow process, which calls for numerous dialogues and relying on open minds amenable for mutual understanding.

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Ecosystem Services and Pressures in European Protected Areas: Divergent Views of Environmental Scientists and Managers

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Keywords

Ecosystem services, protected areas, threats, environmental scientists, managers, abiotic, biotic, socio-economic, cultural, harmonization, effective management, remote sensing

Summary

In the last decades intense anthropogenic pressure caused serious threats to ecosystems, leading to degradation of habitats and environmental quality, thereby increasing the risk of loss of ecosystem services (ES). Protected Areas (PA) may help to counterbalance degradation and associated loss of ES.

In the EcoPotential project the state-of-art view was surveyed among environmental scientists and managers of PAs regarding the importance of various ecological, environmental, and socio-economic indicators for ES and pressures in their PA. Therefore, eight European PAs in mountainous areas, e.g. Kalkalpen and Gran Paradiso, and for comparison a few coastal PAs, e.g. Wadden Sea, were selected.

Environmental scientists predominantly indicated abiotic and biotic factors as being most important for ES and pressures, whereas managers proportionally indicated socio-economic and cultural factors more often.

Therefore, socio-economic and cultural factors (emphasised by managers) and abiotic and biotic factors (emphasised by scientists) need to be more integrated. Methods used worldwide for assessing the effectiveness of management in PAs may inspire the design of such an integrated framework. Moreover, in order to come to a concise list of variables for use in stakeholder engagement (incl. managers and policy-makers) these variables should be harmonised and preferably easy to measure, e.g. through Remote Sensing (RS).
In our presentation we will show the different views of managers and scientists, how we may harmonise variables, and examples on how social (aesthetic) ES may be measured by RS.

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Experimental Long-Term Evaluation of a Campaign to Reduce Freeriding-Wildlife Conflicts of Snow Sports

Marcel Hunziker & Eva Hubschmid

Keywords

Mountains, Alps, Switzerland, winter, visitor management, intervention, survey, field experiment, social science

Introduction

The appearance of outdoor recreation activities has increased significantly all over the world (MANNING & ANDERSON 2012) as well as in Switzerland (HUNZIKER et al. 2011). This development can lead to conflicts, in particular between snow-sports participants and native wildlife populations in subalpine areas (e.g. ARLETTAZ et al. 2007). The Swiss and Austrian campaign 'Respektiere deine Grenzen' so far successfully reduced such conflicts by positively influencing the respective behaviour of people who engage in ski-touring and snow-shoeing by means of information and sensitization (IMMOOS & HUNZIKER 2015).

However, it has been known that one group of snow-sports participants can hardly be influenced by such information campaigns, the so-called freeriders: skiers and snowboarders who use the transport facilities of ski resorts but ride down off the ski-runs (e.g. ZEIDENITZ et al. 2007). Thus, a specific freerider campaign, called 'respect wildlife', was launched in Switzerland, focussing on this group using its media and language.

Our study aimed at evaluating the effectiveness of this campaign. Furthermore, it aimed at comparing and understanding the influence of different elements of the campaign in order to enable future improvements of visitor-management measures focussing on targets groups not accessible by traditional information campaigns.
To reach these aims the following research questions were to be answered:

- How effective is freerider-specific campaign 'respect wildlife' regarding the desired wildlife-responsible behaviour of people who engage in freeriding in ski resorts?
- What are the significant influencing factors on the desired wildlife-responsible behaviour of the freeriders? What role do thereby play the different elements of the "respect-wildlife" campaign? What other factors, beyond the campaign, are also important?

Methods

To answer the research questions, surveys in ski resorts (i.e. handing out questionnaires that were returned by post) were conducted that only included freeriders (selected due to their visible behaviour, equipment and/or by an oral filter question).

Thereby, an experimental design was applied, i.e., surveys were conducted in a treatment area where the campaign was active on site as well as in a control area where no on-site measures were taken. In addition, the surveys were conducted in four waves (with increasing treatment intensity in the treatment area) during the skiing seasons 2013/14 and 2015/16:

- The first wave 2013/14 represented a pre-intervention state where no measures were taken at all, neither in the control nor in the treatment area.
- Wave 2, later in the season 2013/14, measured the effect of the first step of the campaign with a video clip shown at divers places in the treatment area (but not in the control area).
- Waves 3 and 4 (early resp. late in skiing season 2015/16) measured, on the one hand, the effect of additional measures taken during this season in the treatment area (further, even more 'freerider-attractive' video clips as well as reminding sign-posts at the boarder of wildlife reserves). On the other hand, these two waves also captured the effect of the long-term diffusion of the campaign's message since its start two years before.

Finally, the comparison of the treatment- and control-area measurements allowed to investigate the influence of other factors beyond the freerider-specific respect-wildlife campaign such as general related persuasion work elsewhere.

Results

The analysis of the survey results of the four waves in the treatment and control areas clearly showed that the respect-wildlife campaign positively influenced the (reported) wildlife-responsible behaviour of the freeriders (Fig. 1) as the treatment intensity (waves 1-4) and the location (treatment vs. control) turned out to be significant factors in ANOVA, and as the percentage of freeriders who knew the campaign also differed significantly between these waves and locations.

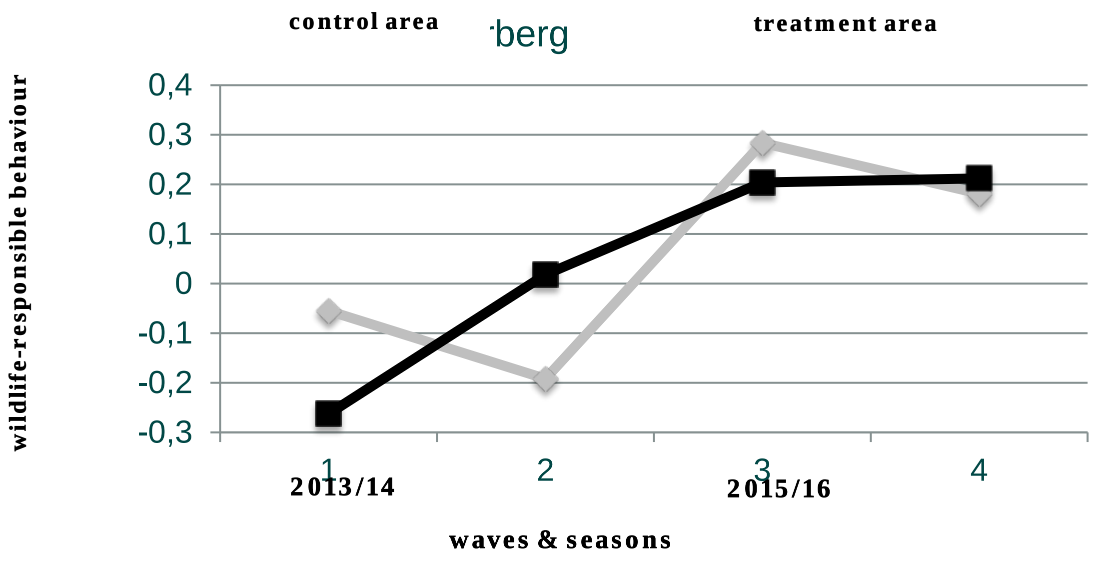

Figure 1: Reported wildlife- responsible behaviour (un-rotated factor based on two variables measuring reported behaviour regarding two respective rules) in the treatment (Laax) and Control (Flums) area in the Swiss Alps in four waves 2013/14-2015/16

However, as the reported behaviour as well as the knowledge of the campaign and further factors also improved in the control area, other factors than the perception of the on-site campaign itself seems to have influenced it. Diffusion of the campaign (which is welcome!) might have taken place, but there might have been other influences more. The latter was corroborated by the regression analyses we conducted. They revealed that some predictors of the reported wildlife-responsible behaviour, such as the attitude towards the behaviour, are not directly influenced by the "respect-wildlife" campaign.

Discussion and conclusions

The results support the value of specific target-group oriented on-site measures. They can influence the behaviour and related influencing factors in the desired way within quite a short period of time (i.e., within a skiing season). At the same time the results also demonstrate the value of general measures such as campaigns in the internet and other media. These are effective not only in a 'treated' area but more generally and show rather log-term effects (such as between 2013/14 and 2015/16 in our treatment and control areas). It is therefore highly recommended to apply both types of persuasion techniques, on-site and general ones, of course always in a target-group oriented way.

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From annual glacier mass balances towards a remote monitoring of near real-time mass changes

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Abstract

Traditional annual glacier mass balance measurements on four different glaciers situated in the national parks of Hohe Tauern (Austria) and Northeast Greenland are currently being intensified by a remote monitoring network that delivers mass balance data in an hourly to daily time step. The station network consists of ablation- and accumulations stations, automatic weather stations and automatic cameras. The near real time data shall be assimilated into an operational distributed glacier mass balance model that calculates the actual glacier mass changes. Both the measurements as well as the daily model output will be presented to a broader public within a web-based glacier information system. Here we present main results from traditional mass balance monitoring and selected results from the remote monitoring network.

Keywords

Glacier monitoring, climate change, glacier mass balance, automatic cameras, snow cover monitoring, snow cover model

Introduction

In the last decades Alpine glaciers have been losing mass in an unprecedented speed. However, quantitave information of the actual mass changes of glaciers is not available before the processing of the annual measurements during late summer. The aim of this research is to reduce this deficit of information by installing a widely automatic glacier measurement system, which is able to measure glacier mass changes in near real time on a daily or hourly timescale and to present the results to a broader public.

This remote monitoring network was designed for and installed on four glaciers that are currently monitored by ZAMG. All of the four glaciers are situated within National Parks: Kleinfleißkees and Goldbergkees on Sonnblick and Pasterze on Großglockner in the National Park Hohe Tauern (Austria) and Freya Glacier in the Northeast-Greenland National Park.

Annual glacier mass balance monitoring was initiated on Goldbergkees in 1988, on Kleinfleißkees in 1998 (e.g. SCHÖNER et al., 2009), on Pasterze after a break of 8 years in 2004 and on Freya Glacier in 2007 (e.g. HYNEK et al., 2013). Within the last years the glacio-hydrological monitoring at the glaciers near Sonnblick Observatory, Goldbergkees and Kleinfleißkees, has been extended to runoff monitoring, measurements of surface energy balance and chemical analyses of the winter snow pack.

Methods

Glacier mass balance monitoring on the four glaciers consists of annual or seasonal measurements of the spatial distribution of accumulation and ablation on the glacier and their spatial inter- and extrapolation over the whole glacier surface (ØSTREM & BRUGMAN, 1991). The time series of annual mean surface mass balances are then compared to decadal glacier elevation changes and if necessary homogenized using the methodology of ZEMP et al. (2013).

The remote monitoring of glacier mass balance uses mainly two different types of data, which are available online in near real time (delay from 10 minutes on Austrian glaciers to 1 day in Greenland). Glacier mass balance is measured on at least one point on the glacier surface by continuous logging of surface ablation and snow accumulation. To extend that information over the whole glacier surface, the spatial retreat of the seasonal snow line is measured by automatic cameras using the software PRACTISE (HÄRER et al., 2016). By assimilating all those data into a distributed mass balance model, the surface mass balance of a glacier can be monitored the best possible way in near real time. The model used for this purpose is based on the operational Austrian snow cover model SNOWGRID (OLEFS et al., 2013).

Results and Discussion

The glaciers in Hohe Tauern as well as Freya Glacier in NE-Greenland are constantly loosing mass in the current climate. Annual surface mass balance time series of all four glaciers are shown in Fig. 1. While the Austrian glaciers are losing approximately 1 meter of water equivalent every (w.e.) year (which corresponds to 1.1m of mean ice thickness change per year), Freya glacier is currently loosing 0.4 meter w.e./a. Including 2017 there has not been a single positive mass balance year since 2004 in Hohe Tauern. By analysing seasonal mass balance measurements we found that the amount of annual glacier mass balance in Hohe Tauern is determined by weather conditions in summer, while in NE-Greenland it is more determined by winter accumulation.

Results from recent decadal elevation changes confirm the picture of accelerating mass losses during the last decade. In Fig. 2 elevation changes of Pasterze are shown for 3 periods of time. The recent digital elevation model in 2015 covers only the glacier tongue, but still we can see an increase of ice thickness loss with mean values for the glacier tongue reaching from -1.8m/a between 1969 and 1998 to -4.3m/a between 1998 and 2012 and -5.1m/a between 2012 and 2015.

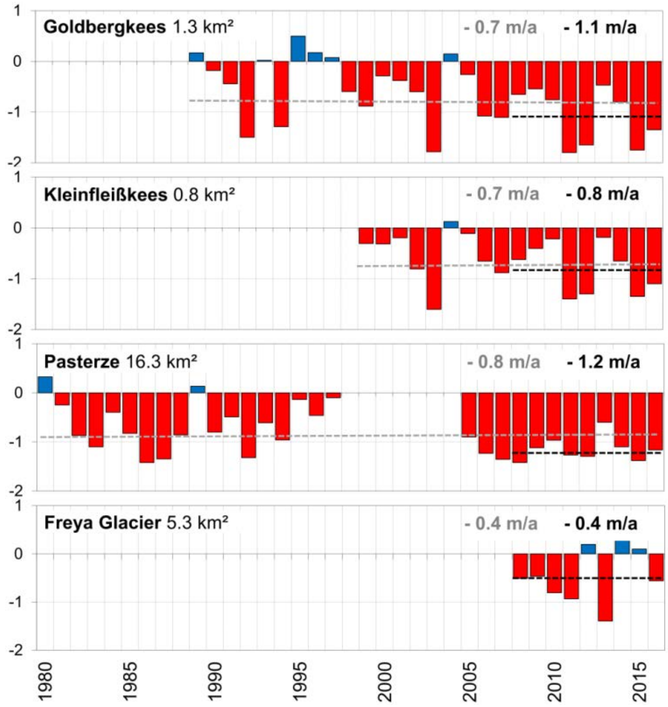

Figure 1: Time series of annual glacier mass balance of all ZAMG-monitored glaciers in Hohe Tauern (Austria) and on Clavering Island (Northeast Greenland). Plotted is the aerial average surface mass balance in meters water equivalent. Mean values are given for the total measurement period (grey) and for the last 9 years (black).

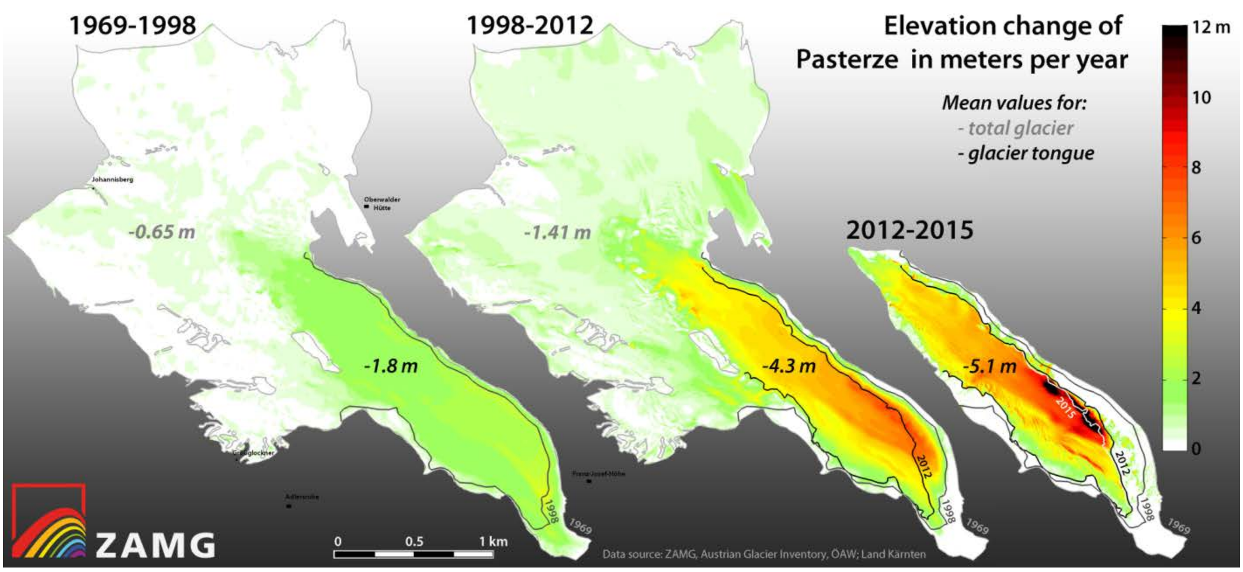

Figure 2: Elevation changes of Pasterze within the last decades show the recent acceleration of mass loss. Calculated using data from KUHN et al.,2009, Land Kärnten and ZAMG. **Please check the digital conference volume for the true colour version of this figure!**

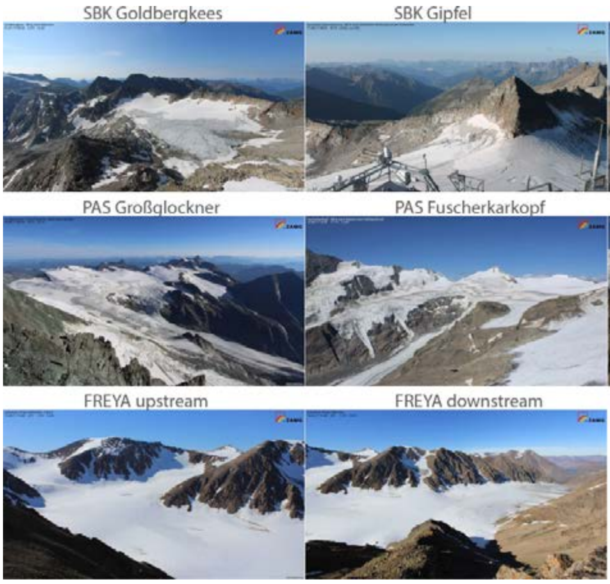

Figure 3: 10 webcams operated by ZAMG and University of Graz to measure snow cover, surface velocity and glacier retreat at the Goldbergkees, Kleinfleißkees on Sonnblick (SBK), Pasterze and Freya. The webcam pictures are freely accessible (photo-webcam.eu), except the 4 cameras on Pasterze (second row) that are located on the property of the Austrian Alpine Club (ÖAV).

Remote mass balance monitoring is based on three energy and mass balance stations (Freya, Lower Pasterze and Kleinfleißkees), two mass balance stations (Goldbergkees and upper Pasterze) and ten automatic cameras, that cover more than 95% of the total glacier area of the four glaciers. The glacier cams in Hohe Tauern are working all year round and deliver a picture every 10 minutes. The two cameras in the Arctic make pictures every hour and deliver one picture per day via Iridium.

The pictures are orthorectified and then the surface is classified into the categories ice, firn and snow to calculate the daily snow covered area fraction of the glacier, which is a good proxy for the mass balance state and a useful validation or calibration source for a distributed mass balance model. Examples of classification results for Kleinfleißkees during the ablation season 2015 are shown in Fig. 4. Until now the distinction between ice and brighter surfaces works automatically, but some manual interference in setting the right threshold is still needed to distinguish between snow and firn (snow that is older than one year).

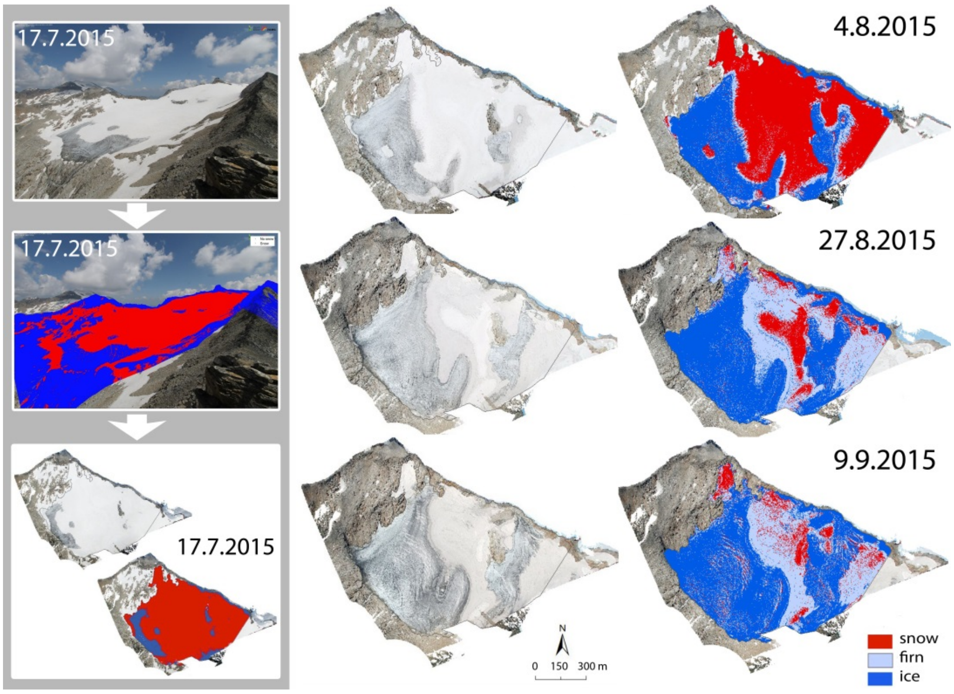

Figure 4: Webcam Kleinfleißkees: Results from Rojs (2016): Daily orthofoto production and surface classification (ice/firn/snow) using the photo rectification and classification software Practise (Härer et al., 2016)

Outlook

After completing the installation of an appropriate station network for a remote mass balance monitoring of all four glaciers we currently work on the assimilation of all data into an operational glacier mass balance model and on the visualisation of near real time data and model output via glacio-live.at and zamg.ac.at. In a next step it is planned to extend the operational glacier mass balance model to all glaciers of Austria.

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Effects of protection status, climate, and water management of rice fields on long-term population dynamics of herons and egrets in north-western Italy

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Abstract

The long-term population trends (1972-2015) of the herons and egrets breeding in NW Italy were analysed spatially and temporally in relation to environmental and human-related variables. *Ardea cinerea* and *Egretta garzetta* increased till 2000 but then began to decrease, mainly in the region of intensive rice cultivation, where the trend was likely driven by reduced flooding of the paddies, the main foraging habitat. Colony site availability is currently not limiting. These results are being applied to develop a strategy for the conservation of the colonies in the remaining wetlands of NW Italy.

Keywords

Grey heron, little egret, population trends, flooded rice fields.

Introduction

The breeding populations of herons and egrets in north-western Italy have sharply increased in the past decades (starting from 1980-1990) thanks to more favourable climatic conditions, the reduction of direct human-induced mortality, and the protection of colony sites (Fasola et al. 2010). Since 2000, the number has decreased in some areas, coinciding with a change in diet and with the diminished availability of flooded rice fields, due to the spreading of new agronomic techniques that include a partially dry cultivation of rice (Fasola & Cardarelli 2015). We took advantage of a long-term monitoring program carried out from 1972 on a guild of seven species of Ardeinae, and the availability of remote sensing images from 2000 (from which the fraction of flooded area in rice fields has been derived), to investigate the effect of changes in agricultural practices on the population dynamics of the two most abundant heron and egret species.

Methods

The nesting populations of seven species of herons and egrets (grey heron *Ardea cinerea*, purple heron *Ardea purpurea*, little egret *Egretta garzetta*, night heron *Nycticorax nycticorax*, great egret *Egretta alba*, squacco heron *Ardeola ralloides* and cattle egret *Bubulcus ibis*) have been monitored annually throughout north-western Italy (a breeding range of 57,600 km2, see Fasola et al. 2010 for details on census techniques) from 1972 to 2015. Each heronry was characterized by its protection status within a nature protection area ('protection' yes/no) and by the main foraging habitat ('habitat' rice fields / major rivers / small upland streams).

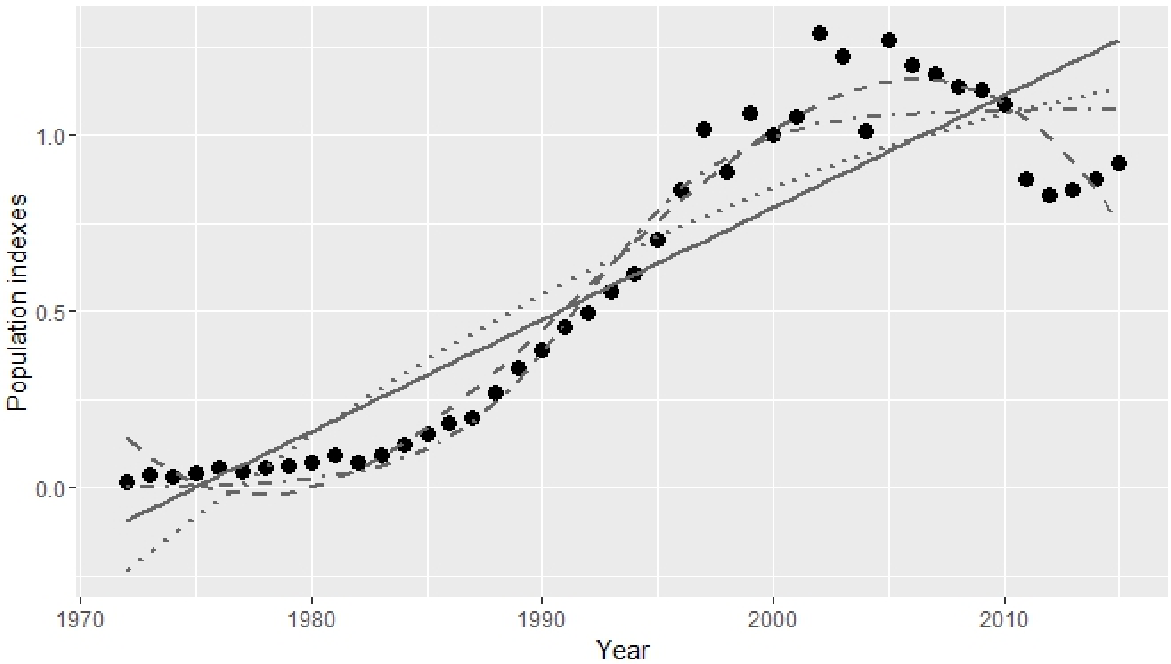
A method to estimate the presence of standing water in rice fields using MODIS satellite data (Ranghetti et al. 2016) was applied to estimate the fraction of flooded area from 2000 to 2016 within the total area covered by rice fields (rice district). In order to take into account the spatial variability of water management, the rice district was divided into ten sub-districts following the boundaries of irrigation areas, and ten time series of yearly flooding fraction were consequently computed (Ranghetti et al. 2017).

We estimated the long-term population trend of the two most abundant species, grey heron and little egret, by means of the TRIM software (Pannekoek & van Strien 2001) that allows the analysis of time series of counts with missing observations. We performed a series of models including different sets of covariates (protection, habitat, rice sub-districts) and we selected the best model using the Akaike Information Criterion (AIC). We then assessed the shape of temporal trend by fitting a series of models with 'year' as explanatory variable (linear, second-, third- and fourth-order polynomial, logarithmic, logistic, power and exponential), and again we selected the best model through AIC.

Results

The best TRIM model for grey heron included habitat and rice sub-districts, while the best model for little egret included protection and rice sub-districts. Both populations showed a marked increase until 2000-2006 and then a decrease. The overall trend is best described by a third-degree polynomial in both cases (Fig. 1).

The decreasing phase was more pronounced in rice fields (for grey heron, Fig. 2), in sub-districts with a lower average fraction of flooded area (for both species) and in protected areas (for little egret).



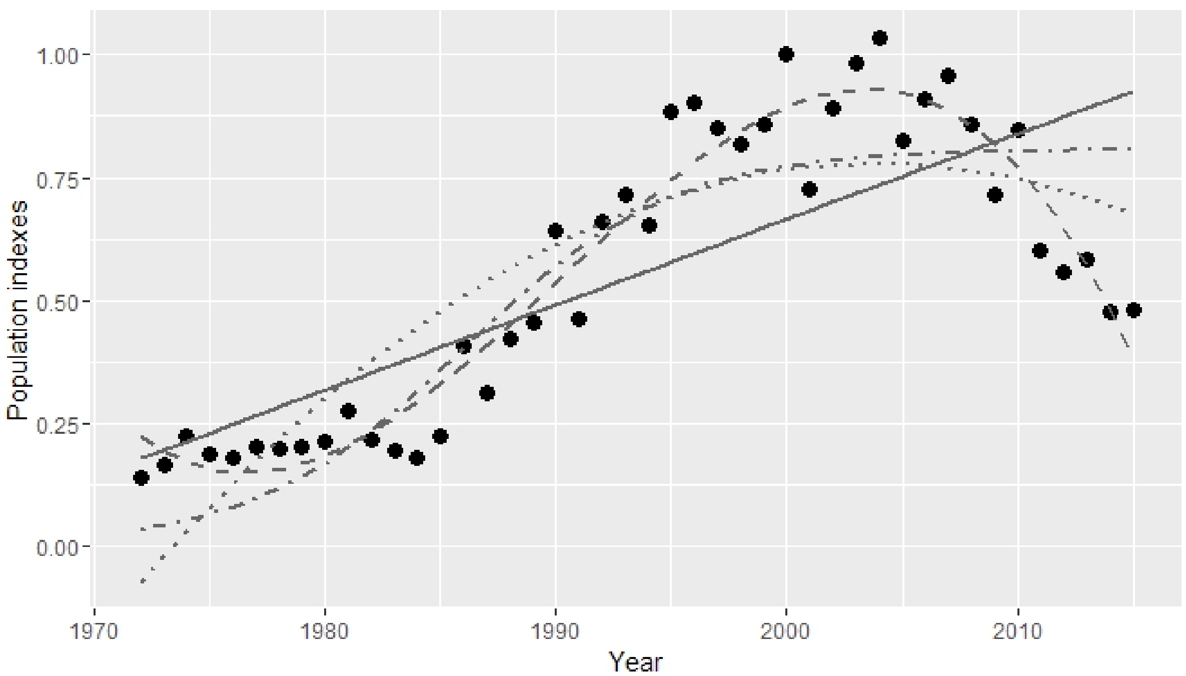


Figure 1: Fitting of some curves for temporal trend of a) grey heron and b) little egret populations. Solid line: linear; dotted line: quadratic; dashed line: cubic; dash-dotted line: logistic.

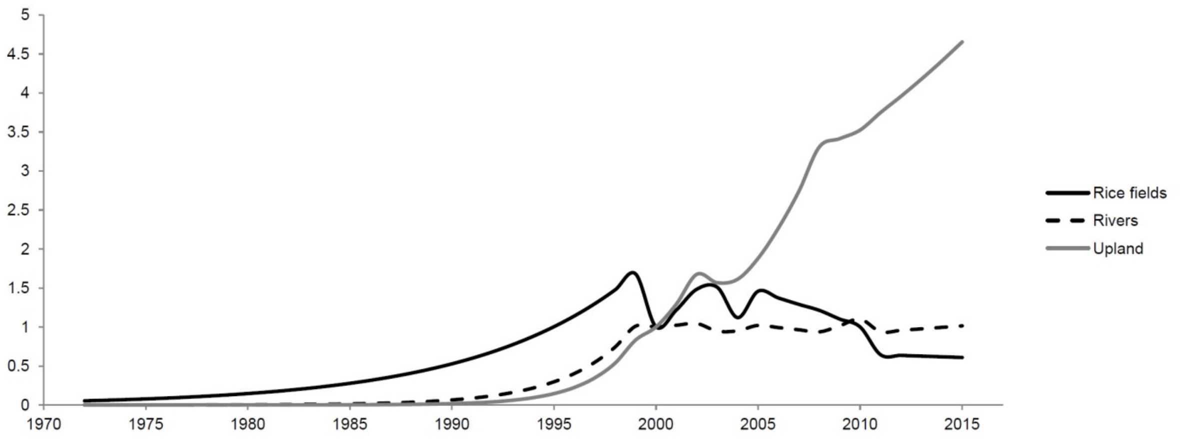


Figure 2: TRIM model indexes for grey heron for each habitat type.

Discussion

Rice fields remain the main foraging habitat for herons and egrets in north-western Italy, despite changes in prey types (FASOLA & CARDARELLI 2015) and a decrease in feeding success (CARDARELLI et al. 2017). However, the reduction in flooding of paddies due to the change in rice cultivation methods is likely driving the post-2000 decrease of their breeding populations in the rice fields area. On the contrary, the breeding populations foraging mainly in rivers and small upland streams remained stable or continued to increase (Fig. 2). Colony protection didn't seem to positively affect population trends after the species reached a full protected status.

The time series resulting from the best TRIM models has been used to analyse the effect of climate and fraction of flooded area in rice fields on the population dynamics of the two species. These results are being used to develop a sound strategy for the conservation of the colonies in the remaining semi-natural wetlands in NW Italy within the Action A.11 – EU LIFE 'GESTIRE 2020' in collaboration with Lega Italiana Protezione Uccelli and Regione Lombardia.

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Prokoško Lake – A monument to man

Haris Jahić, Muriz Spahić, Emir Temimović

Abstract

Natural resources are much diversified. This natural rarity, according to one object, in this case Prokoško Lake, situated in central Paleozoic morphostructures of Vranica in Bosnia and Herzegovina, gets different ranges of protection. They range from the lower taxonomic levels, to the higher, even though the natural habit of the lake, its basin and water quality are altered by anthropogenic activities. Lacustrine ecosystem experienced number of changes from the typical natural, when it was placed in the fifth level of protection as a nature park. When the natural landscape diversity ambient is replaced with anthropogenic lake, it was declared by a rigorous higher level of protection - natural monument. In the near past the same lacustrine system is 'protected' as the park of wilderness. The lake has lost its natural habit and became an anthropogenic lake, which we ironically call it a 'monument to man'.

Prokoško Lake is the highest lake in Bosnia and Herzegovina (1,636 m). F. KATZER (1902) postulated that the modification of a lake basin is occurred under the influence of Würm glaciers, as it confirmed in recent works by M. SPAHIĆ (2001). The lake was known by the indigenous sort of aquatic lizards *Triturus alpestris Reiser Werner* (1902). Due to human error by intrusion of salmonids in lake water, endemic species of lizards are completely disappeared.

Keywords

Prokoško Lake, Vranica, nature park, natural monument, park of wilderness, monument, endemic, triton.

Introduction

Natural state of Prokosko Lake is defined according to the earlier work of geologists, geographers – limnologists, hydro biologists and others. First scientific reasearch of Prokosko Lake is dating back to the beginning of the 20th century and can be considered as a benchmark for its natural condition.
The first geological study of the mountain Vranica which mentions, among others, the Prokosko Lake, comes from F. KATZER (1902) in the form of extensive work named Paleozoic of Vranica.
Significant scientific results of research on Prokosko Lake were given by D. PROTIĆ (1924-1926) in hydrobiologic and plankton-studies on the lakes of Bosnia and Herzegovina, which included Prokosko Lake as well, and which was published in the Journal of the National Museum of Bosnia and Herzegovina in Sarajevo.
Among other scientists who were important for the research of the Prokosko Lake and other mountain lakes in Bosnia and Herzegovina, it is important to mention J. CVIJIĆ (1899).
Complete and personal limnological research of natural lakes in Bosnia and Herzegovina was published in the limnological monograph of M. SPAHIĆ (2001), the author and promoter of these conclusions on Prokosko Lake.

Figure 1: Prokoško Lake – recent state

For the purposes of assessment of the genesis and evolution of natural conditions of Prokosko Lake, other than the palynological analysis of the coastal belt of Prokosko Lake and other mountain lakes in Bosnia and Herzegovina, Austrian cartographic and planning documents from the years 1884 and 1910 were used.

All forementioned and other works were the basis on which the current status of the lake was rated, with the purpose of evaluating its future perspectives. In addition, the paper deals with lake's natural condition, the state of anthropogenic pressing, legislation and legal issues of renaturalization of this aqual complex.

Retrospective settlings in the basin of the Prokosko Lake were documented using the mapping method, which included the analyses of periodically supplemented maps with cartographic content from the beginning of the last century to today. For this purpose, topo-graphic maps were used, first from the Austro-Hungarian era and then renewed topographic maps of the former Yogoslavia which were supplemented with modern cartographic content of each decade. Cartographic method has been supplemented by the modern methods which include aircraft method and cosmic detection. The last one is completely new and it provides numerical screening of new facilities and weekend facilities, which has replaced the old method. In addition to mapping method, analysis of the text was used, which dates from different time sections of last and the beginning of the 21st century. Mostly, it is about scientific papers and articles, scientific-popular texts and newspaper articles, which describe Prokosko Lake using text and images. All used methods have allowed a comparative analysis of the origins of anthropopressing on the natural-aqual complex of the Prokosko Lake.

The paper used the empirical field prospections as well, which were related to the geological, geomorphological, hydrographic, biogeographic, demographic and other geographical component contents. These prospections, especially from the first author of conclusions, refered to the comparative geographic component analysis of the development of natural-aqual complex since 80s of the last century. Paper includes other methods of which the most important are: interview, comparison, cartographic, historical and empirical method.

Natural state of the Prokoško Lake

The basin of Prokosko Lake is undoubtedly a tectonic depression, which has been modified during the tectonic history, and in the Pleistocene with the glacial modifications, as well as significant reshaping in Holocene caused by snow and debris avalanches, nival, fluvial and lacustrine modificators.

Limited glacial modifications are confirmed by the absence of rudimental fluvial-glacial sediments in the valley lowland levels of the valley of Jezernica. In addition, chaotic situated blocks around the lake, in the opinion of F. KATZER (1902), represent erosional limestone remains, although the mineralogical and petrographic analysis confirmed their origin from destructed Glavica hillsides.

All above mentioned indicates that the lake's basin is polygenetic, polyphase and polymorphic creation, which has evolved since the Pleistocene, when the lake water was accumulated in it. The youngest morphological members such as alluvial valleys, slope and nival delluvial, colluvial morpho forms, fluvial sediments and coastal sapropel bents belong to the holocene stage of natural self-development of the lake.

In addition, lake slopes are fluvially very active and are dotted with smaller river valleys. Since there is a case of a dissenting longitudinal profile of lake tributaries, their deep valleys in the lake are used for the transportation of drawn and suspended sediments. Draft and sediments, in the southwest part of the lake basin formed spacious accumulation flat area of 1500 m^2. In its pre accumulation stage, it was an integral part of the bottom of the Prokosko Lake, as suggested by the subsequent valley vertical articulation of lake tributaries.

Figure 2: *Triturus alpestris reiseri*

The negative natural processes that affect the natural evolution of the lake are fluvial sediments production from the immediate tributary area of lake and the regression of the lake's river. Lake's talus, alluvial and colluvial slopes are, fluvially, very unstable and dotted with small river valleys, inconsistent according to the longitudinal fairway, which end up in the lake. Through them, the flowing water does deep and lateral erosion and transports in the lake plenty of towed an suspended sediments, which rise the bottom of the lake and reduce its volume. On the other side, by the regressive erosion of the lake's river from its end to the lake's accumulation, the riverbed was continously deepened, which abstracted more lake water and resulted in a decline of its level, and thus the reduction of the volume of water accumulation.

Such evolution of the Prokosko Lake is confirmed by the past and present of Suho jezero, located near the borders of the accumulation wall, on the northwest side of the Prokosko Lake. Suho Lake doesn't have lacustrine function and through paleolimnic valley flows a steady stream.

Natural stage of lake's development had a diverse phytobenthos and herbal communities such as *Juncus articulatus carex leporina, Carex flava, Angelica silvestris, Juncus alpinus* et al. (SMLATIC, S. 1973). Herbal communities, especially those of the species *Carex*, from the coastal areas are spread into the coastal waters from which they are either floating or are attached to the shore. Once they had a limited extent, but today they are spred over the large areas.

Biodiversity during the natural exi-stence of naturalaqual complex Prokosko Lake is famous for its endemic species of water lizards named Raizerov triton (*Triturus alpestris Reiser*). Because of the natural diversity of indirect basin of Prokosko Lake and the presence of endemic Triton, it was protected by the law from the 1954, as well as some other lakes in Bosnia and Herzegovina and included in the level of protection rank: Regional Park of Nature.

Anthropogenic phase of development of Prokoško Lake

The beginning of the significant anthropogenization of the Prokosko Lake dates back to the times of intensive animal husbandry and grazing on Vranica, where transhumant livestock way was replaced by the constant summer stays of herders in the immediate basin of Prokosko Lake. This way of animal husbandry includes grazing on Vranica, and overnight stays of the cattle in the cattle pens and livestock herders in apartments and bacilli in the direct basin of the Prokosko Lake. From the cattle pens and livestock buildings, the organic sludge was transported into the lake and then accumulated at the bottom. In addition to the periodic presence of herders in the vicinity of Prokosko Lake, whose water was used for the cattle needs, the negative tendencies of anthropogenization of this natural-aqual complex include artificial ranching as well, which has arisen as a result of ichytiobiological research by the Institute of Fisheries of Republic of Bosnia and Herzegovina in 60's of last the century. These studies were focused on artificial intrusion of salmonid fish (Californian trout), which completely disrupted biological diversity with elimination of some living organisms from the lake water into the surrounding lake puddles, especially Raizerov triton (*Tritinus alpestris Reiser*). This made the natural aquatic biological balance endangered, especially the habitat of the endemic triton. Another negative effect for the Triton was the tendency of continuous income of organic waste, which was transported by the water from the immediate basin to the lake. Significant changes in the immediate environment of Prokosko Lake were created by the active presence of humans, when the folds and flats were substituted by the weekend-settlements, which were particularly pronounced at the beginning of the first decade of this century. In order to illustrate this trend we will use cartographic documents that clearly show the rural transformation from the early 20th century to today.
During the first cartographic representation of Vranica from 1902, in the immediate vicinity of The Prokosko Lake, there were registered only 2 objects. From that year forward, the number of cattle huts was increasing, so, according to the data from the renewed maps, in 1914, there were 6 cattle huts near the Prokosko Lake and in 1950 that number increased on 10 cattle huts.

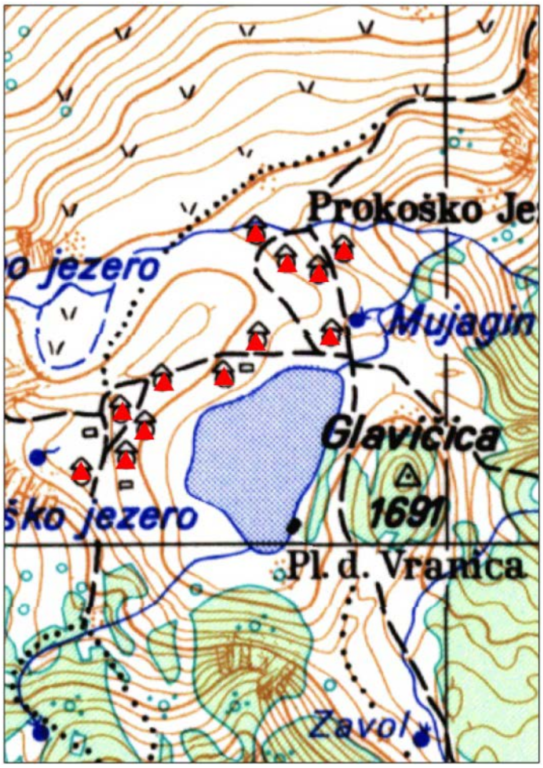

Figure 3: Prokosko Lake in 1960. (left picture) and 2015. (right picture). The difference of usurpation with occupied buildings is obvious, especially with weekend houses in todays situation. Despite the intense natural modification with anthropo pressing, the lake was declared a Monument of Nature in 2005 and thus included in the third category of protection. (right picture). In the middle of the last century when the immediate basin had, almost, natural habitat, with several livestock barns and apartments, which have neen used only in summer, this lake was declared only a Regional Park of Nature, which, according to today's nomenclature of protection suits the Nature Park and belongs to Fifth from Six categories of protection. (left image.)

Usurpation of the direct drainage basin of Prokosko Lake directly affected the modifi-cation of its natural state. From the group of negative tendencies, harmful, especially to the lake water is the production of organic sludge and waste from pens, barns livestock cottages and weekend-houses. The organic sludge and other sewage, which are the parts of incoming water in the lake, are deposited in the lake and stir the lake's water because of which it is opaque, and colloidal particles fall to the bottom of the lake, where they rott. The decaying process consumes a large amount of oxygen from the water, which is conductive to the coastal eutrophication of the lake.
Sapropelization and eutrophication are phytobenthos from which the coastal pleje (turfs) are made and coalesced with the lake's shore. They significatly reduce the surface of the lake and displace the lake's water through the lake's river. These proce-sses are seen on the first topographic maps from the beginning of the last century, when there were no observed coastal lacustrial plains of larger dimensions.

Figure 4: Prokoško Lake today. Artificial intervention in the riverbed of the lake's river, without legislative approval, raised the level of the lake, which will have unforeseeable negative consequences for its further development.

Changes to the coastline and its granularity are the processes that are noticeably taking place and can be visually registered after a decade. These changes are affected by the water balance as well, which shows the fluctuations of the water levels in the natural conditions, before anthropogenic interventions to a maximum of 0.6 m. These were regulated by the lake's river, which was stable with less regressive shifts caused by the cut.

The first disturbance of the lake river's riverbed dates back to the time of road construction across the river for the purpose od exploitation of forests and for the other needs, when the riverbed was artificially adapted. The latest interventions which were deliberately done in order to create a cofferdam to raise the level of the lake and its volume were undertaken without professional scientific expertise and monitoring works. They significantly changed limnic natural habitat because artificial level of the lake was increased by a maximum of 1.5 m. Artificial water level changed the natural regime, and the flood of the near lake plateau has incalculable harm to the functioning of this aqual complex.

Artificial interventions made on the lake and the anthropogenic usurpation of the lake basin contributed to the impossible naturalization of this aqual complex. We can talk about Prokosko Lake in the past tense only. Prokosko Lake by any criteria does not fulfil the conditions prescribed by international norms and standards for his appointment of monument of nature; its level of protection needs to be redefined to its recent condition to be able to take the necessary measures and actions to save at least some parts of its natural habitus.

Conclusions

Based on the presented analysis concerning the natural, slightly altered and completely altered state of indirect and, in particular, the immediate basin of the Prokosko Lake, it is possible to reduce concluding remarks in several points.

The beginning of the significant anthropogenization of the Prokosko Lake starts from the time of intensive cattle ranching on the mountain Vranica, which included summer stays of the herders in the immediate basin of the Prokosko Lake, which also was the water resource for the cattle. The negative tendencies of anthropogenization of this natural-aqual complex include its artificial ranching of salmonid fish in 60s of the last century. This completely disrupted biological diversity with elimination of the Raizerov triton (*Tritinus alpestris Reiser*) from the lake water in the surrounding lake puddles. The main earlier problems, and in particular the recent ones are the barns, pens and huts (both livestock and weekned ones) that were built in the immediate basin area, on the slopes from which the drains take the organic livestock and human faecal waste into the lake. Decay of organic sludge with oxygen consumption from the lake water has a beneficial effect on the coastal euthrophication of the lake. Sapropelization and eutrophication significantly affected the occurence of the coastal pleje (turfs), which are coalesced with the lake's shore. They siginificatly reduced the surface of the lake and displaced the lake's water through the lake's river. Changes to the coastline and its granularity are the processes that are noticably taking place and can be visually registered after a decade.

These changes are affected by the water balance as well, which shows the fluctuations of the water levels in the natural conditions, before anthropogenic interventions to a maximum of 0.6 m happened.

These were regulated by the lake's river, which was stable with less regressive shifts caused by the cut. The disruption of the lake's river riverbed was created by the road construction across the river for the purpose od exploatation of forests and other needs, when the riverbed was artificially adapted. The latest interventions which were deliberately done in order to create a cofferdam to raise the level of the lake and its volume were undertaken without professional scientific expertise and monitoring works and they significantly changed limnic natural habitat and at the same time increased the level of the lake by 1.5 m. Artificial water level changed the natural regime, and the flood of the near lake plateau has incalculable harm to the functioning of this aqual complex. Prokosko Lake has preserved its natural framework of evolutionary development until the beginning of the 60s of the last century, when as a natural rarity of this kind on Bosnia and Herzegovina, was declared a regional Park of Nature in 1954. According to the IUCN, the most relevant international organization for the nature protection, this protection rank belonged to the fifth of the six categories of protected areas. It implies a harmonious relationship between people and the natural environment, which allows the preservation of the natural aesthetic diversified values and biodiversity.

This level of protection was in effect until the January of 2005, when the Assembly of the Central Bosnia Canton changed the level of protection to the third, more rigorous category, and the Prokosko Lake was declared a natural monument. This category of protection under the IUCN includes in fact natural heritage of clearly defined area, which was by the Act of state administration put under the protection in order to preserve its original natural values.

When the two levels of protection are compared, where the first one was enacted in 1954, with which Prokosko Lake has been integrated into the fifth category of protection in a time when it had the original natural habitus with the other from the 2005., which changed the level of protection to the natural monument which belongs to the third rigorous level of protection although the natural environment suffered significant anthropogenic modifications. Therefore, it undoubtedly raises the question of how this could have happened? Answer to this question should be found in the professional background/feasibility study, which included a proposal for the category of protection, based on which the Prokosko lake was included in the rigorous ranking than that which preceded it.

In the Act which declared Prokosko Lake a monument of nature, sections that regulate measures and procedures for the revitalization of the lake from predominantly anthropogenic into the natural form so it could be treated by the predicetd level of protection, were not found.

In the Act on announcement of natural monument Prokosko Lake, scientifically unfounded elements of natural diversity were listed, by which this lake is different from other mountain lakes in Bosnia and Herzegovina. In addition, the number of flaws were made that have no scientific foundation, such as: *'...the borders of the natural monument are defined on the basis of the elements of river regime of water supply of the lake and geological composition of the terrain on which the lake basin was built'.; '...the mass of the basic colluvial rock material is downed to the lesser morphological head'; 'paralell direction'; 'geomorphological processes and forms presented with elements of limited karst morphosculpture of erosive and accumulative type'; '...many gravity forms of rock-fall in th form of chaotically distributed boulders are visible in the entire area of the immediate lake alluvial plain'; '...Prokosko glacier lake'.*

Other natural processes were not covered by the Act, and they should have been. It is not clear how were the protection zones defined. The Act provided the accompanying documents: The Plan for the Managemnt of the natural Monument Prokosko and Spatial plan of special purpose of the nature monument Prokosko. Both are not available to the public.

All actions that were done before and after the renaming of the nature park to the monument of nature around the Prokosko Lake, such as: unplanned construction of weekend-settlements, unplanned construction of infrastructure systems; especially sewage, coastal and lake's river rehabilitation, changes in the regime of water runoff and income and other interventions had no basis in Act on Water protection in Bosnia and Herzegovina. If we add to this the laws regulating the issues concerning water approval and water goods, all the deliberate actions made in direct and indirect basin of the Prokosko Lake on his renaturalization have no basis in the legislation.

Artificial interventions made on the lake and the anthropogenic usurpation of the lake basin contributed to the impossble naturalization of this aqual complex. We can talk about Prokosko Lake in the past tense only. Since prokosko Lake by any criteria does not fulfil the conditions prescribed by international norms and standards for its appointment to a monument of nature, its level of protection needs to be redefined to its recent condition to be able to take the necessary measures and actions to save at least some parts of its natural habitus.

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Supply of local products in Parc Ela – constraints and possible solutions

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Abstract

The aim of this Master thesis is to find out whether the farmers produce local products which are sold within the perimeter of the Parc Ela in Grison in Switzerland or not and why they follow the strategy they do. Further the processors like butchers and bakers within the Parc are asked about their strategy concerning using locally produced raw materials and products for their work. The constraints for the production or usage of local food products and the experiences with local products of different actor groups are tried to be found through qualitative interviews with farmers, local processors and gastronomes. Based on the results of the interviews possible ways of encouraging the supply with local products in Parc Ela are developed for the Management of the Natural Park.

Keywords

Local products, farmers, processors, gastronomes, constraints, Parc Ela

Introduction

The Master thesis is composed out of three main parts

<u>Theoretical part</u>

In the theoretical part the current state of knowledge about local products is described, important terms are defined and aspects of the wide subject of local products that play an important role in the thesis are explained. Regional products are products of which the provenance is known and can be recognized by the consumers (SAUTER & MEYER 2004). Another important aspect of regional products are the short distances between the place of production and the one of consumption (KÖGL & TIETZE 2010).
Further the policies of regional nature parks in Switzerland will be explained in this part.

The **research questions** for this part are the following:

– What's the importance of regional food supply (in general)?
– What are challenges and opportunities of regional food products (in general)?

The **hypotheses** that underlie this part are the following:

– The importance of regional products increases
– This is due to several reasons
– There are many opportunities and challenges related to regional products

<u>Empirical part</u>

The empirical part is the main part of the thesis. About 12 qualitative interviews are conducted with four persons in each actor group (farmers, processors, gastronomes). It is tried – as far as possible - to have an equal amount of people in each group that obviously follow a strategy of selling their products within the Parc (mainly direct marketing in the case of farmers), using local raw materials for their products (processors) and buying local products for their menus (gastronomes) and people who do not do that consequently. Through choosing the interview partners based on these criteria it should be possible to get an impression about the reasons why the actors chose the strategy they follow and about the constraints related to it.

The **research questions** for this part are the following:

– How is the supply of regional products within Parc Ela?
– What are obstacles to offer more local products in Parc Ela?
– From the point of view of farmers?
– From the point of view of processors?
– From the point of view of gastronomes?

The **hypotheses** for this part are the following:

- The agricultural policy does not provide enough incentives for farmers to do direct marketing.
- The processors and the catering industry use little local products / raw materials because they are comparatively expensive and the supply is not guaranteed in larger quantities.

Synthesis

The last part of the thesis is the synthesis. In that part it is tried to identify the constraints that hinder a wider supply of local products in Parc Ela based on the evaluation of the interviews. Based on the identified constraints it is tried to formulate recommendations of action for the management of the Parc Ela what they could do to encourage the supply of local food products in Parc Ela.

The **research question** for this part is the following:

- How can the management of the Parc Ela contribute to a wider range of offers of local products?

Methods

The theoretical part of the thesis presents the state of knowledge about the subject of regional food products. Therefore the method for the theoretical part is mainly desk research and literature research. The empirical part is made up of the qualitative interviews that are conducted with persons of different actor groups (farmers, processors, gastronomes). The approach for this part is therefore qualitative (interviews based on guidelines).

Results

The work on the thesis started in spring 2017. That's the reason why at the moment there are still no results available. The expected results are the identification of obstacles for the supply with local products in Parc Ela. Based on the identified obstacles recommendations of action for the management of Parc Ela how they could incentivize and encourage the supply of local products will be formulated.

Conclusion

The thesis tries to illuminate an aspect of life in the Parc Ela which is a Nature Park in Switzerland. Through encouraging the supply with local food products within the Parc the local economy and social connections can be strengthened. Also for the identification of the local population as well as of the tourists with the label 'Nature Park' that the area got in 2012, local products have a great potential. It could therefore be interesting for the management of the Parc to put more emphasis on that aspect of life in the Parc. Possible ways how that could be done should be shown up by this thesis.

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How hunting and legal regulations shape ecological connectivity in the alpine region

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Keywords

Hunting; legal framework; migration; ecological connectivity

Summary

The Research Institute of Wildlife Ecology (FIWI) is a project partner in ALPBIONET2030 – Integrative Alpine wildlife and habitat management for the next generation, a project co-financed by the European Regional Development Fund through the Interreg Alpine Space programme. This project seeks to analyze ecological connectivity impacts on the major wide-ranging game species in the context of the (predominant) hunting systems in the Alpine region.

The dispersal of wide-ranging wildlife species is dependent on ecological connectivity across natural and human induced barriers. Most of these species are considered game animals and are managed under various hunting systems. These hunting systems differ throughout the Alpine region, as they are subject to legislation and are influenced by regional traditions. Wildlife management strategies and applied hunting methods can strongly influence seasonal movement and spatial distribution patterns of game species.

Whereas the detection of changes in wildlife populations rest firmly on applied monitoring schemes, the ability to react and adapt management strategies is heavily dependent on legislative frameworks. Therefore, hunting systems may inherently constitute barriers to connectivity. We use spatial analysis including geodata such as administrative hunting management units, hunting ban areas, feeding areas and species distribution data in combination with habitat and barrier models to analyze the possible effects of the diverse hunting systems and hunting times on connectivity.

In a best-case scenario, we also want to integrate existing telemetry data sets in order to analyze spatial temporal behavior of Alpine ungulate species with regards to various previously developed barrier-models.

A recent collective publication of 35 European ungulate experts emphasized the growing need for science-based management of wildlife, as new challenges such as climate change will likely further aggravate wildlife conflicts (Apollonio et al. 2017). Modern wildlife management requires cooperative cross-border management and knowledge of the effects of key human interventions into wildlife populations.

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The Lab Above the Clouds
Sonnblick Observatory and Nationalpark Hohe Tauern

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Abstract

Established in 1886 the Sonnblick Observatory provides ideal characteristics for environmental research for more than 100 years now. Located in the core zone of Nationalpark Hohe Tauern a number of benefits arise for both, projects dedicated to well-defined research questions and the idea and aim to foster the awareness of natural heritage in the hearts of people. Here we want to focus on long term research related to atmospheric aerosols and the chemical composition of precipitation and highlight the potential of these data series for supporting the aims of national parks.

Keywords

air quality, wet deposition, atmospheric sciences, background measurements, long term trends

Introduction

The foundation and construction of the Sonnblick Observatory, i.e. the cooperation of Julius Hann and Ignaz Rojacher, is an early and extremely successful example of public science. Among a larger number of mountain observatories established that time, the Sonnblick Observatory is the only station located in a high alpine environment which survived without any breaks until today. Meteorology was the starting point, but very soon the Observatory was recognized as ‘Lab Above the Clouds’. Victor Franz Hess reported his experiments on cosmic rays already in 1928. In 1986 the new building allowed the extension of the monitoring and research activites in the fields of air chemistry and physics. Since 2016 the Observatory is accepted as a global GAW-station (GAW-Global Atmosphere Watch).

The Sonnblick Observatory is unique due to its position at 3106m asl without local pollution sources nearby, its direct and easy access to the surrounding environment, and the experimental possibilities offered by the onsite technical staff. Fig. 1 summarizes possible interactions of the environments (i.e. the atmosphere, the hydrosphere, the lithosphere and the biosphere) surrounding the Observatory.

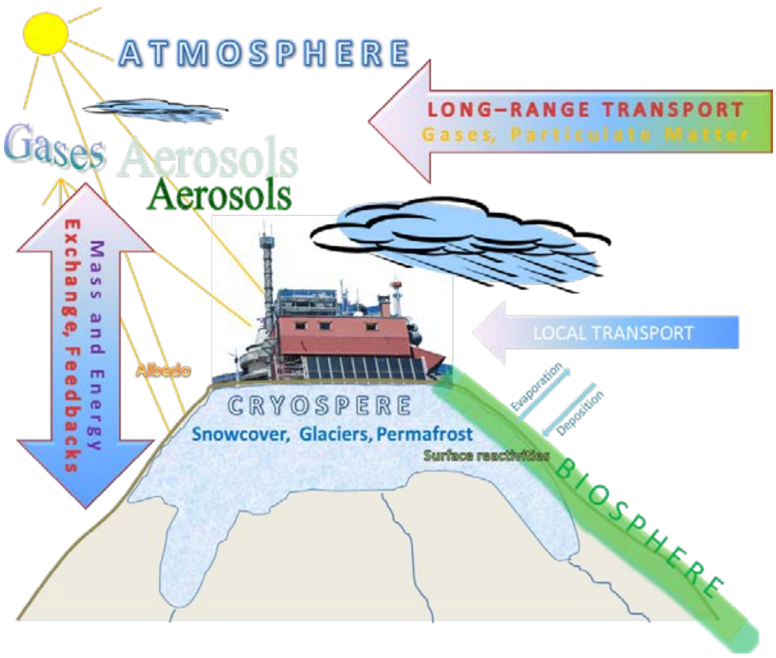

Figure 1: The Sonnblick Observatory at the interface between the atmosphere, cryosphere and biosphere (ENVISON-2, 2016)

The location of the Observatory within the core zone of Nationalpark Hohe Tauern creates mutual benefits regarding the intensity and variety of scientific research, the possibilities to offer environmental education, and the awareness of people to appreciate natural heritage.

Methods

Aerosol Measurements

Measurements of chemical composition (mainly inorganic ions, later also carbonaceous aerosols) based on filter samples date back to 1991, when a two year time series was conducted (KASPER & PUXBAUM, 1998). Later these measurements were continued on a campaign like basis. At present the activities within DUSTFALL (GREILINGER et al. 2017) extend the data set. Aerosol mass, number concentrations and size distributions, as well as optical properties of aerosol particles are determined since 2013 with continuously operating monitors. A brief description of the respective methods is given by SCHAUER et al. (2016). This sampling program is realized in cooperation of the ZAMG with Umweltbundesamt, the local government of Salzburg and Carinthia, the Climate and Air Quality Commission of the Austrian Academy of Sciences and TU-Wien (SONNBLICK OBSERVATORY, 2017).
Atmospheric aerosol particles influence the radiative balance and thus may induce both, warming or cooling of the atmosphere. By providing cloud and ice nuclei they are responsible for the formation of clouds and precipitation. Depending on their size aerosol particles remain airborne for several days and thus are subject to long-range transport. The remote location of the Observatory allows to investigate the impact of such transport events, which can be either of natural (e.g. desert dust, volcanic ash, fires) or anthropogenic (e.g. pollution episodes, fires) origin, without local influence.

Precipitation Sampling – Wet Deposition

Since 1987 wet deposition samples are collected daily with a 'Wet And Dry Only Sampler' – also called WADOS. Most of the year precipitation is in the form of snow. Only during some weeks in summer time rain is observed. Chemical analyses comprise inorganic anions and cations like sulfate, nitrate and ammonium. The trace gases sulfur dioxide, nitrogen oxides and ammonia, which are emitted by industry, traffic and agriculture, are precursors of these compounds. Emissions occur near the ground, but get transported to higher regions. Precipitation scavenges the pollutants and deposits them back onto the ground – thus cleaning the atmosphere. Additionally chloride and the basic cations sodium, potassium, calcium and magnesium are analysed. The determination of the pH-value (a measure for the acidity) and the electrical conductivity complement the data set (SONNBLICK OBSERVATORY, 2017).

Results and Discussion

The time the measurements of the chemical composition of precipitation samples at Sonnblick were started, the phenomenon of 'Acid Rain' urged scientists to have a closer look at the situation in high alpine environments. Usually concentration values in snow and rain samples collected at the Sonnblick Observatory are low. Still the high precipitation amounts can lead to deposition loads which are similar to conditions observed at lower altitudes. The measurements of major ions in aerosol samples complement this data set, as aerosol particles act as cloud condensation nuclei and thus are efficiently transferred into cloud water and precipitation by scavenging processes. Results of the aerosol measurements are exemplarily shown in Fig.2. Especially for sulfate a decrease of mass concentrations can be seen. This trend is in accordance with the reduction of sulfate concentrations in precipitation and snow samples determined at Sonnblick and other sampling sites in Salzburg (FIRMKRANZ et al. 2017, GREILINGER et al. 2016).

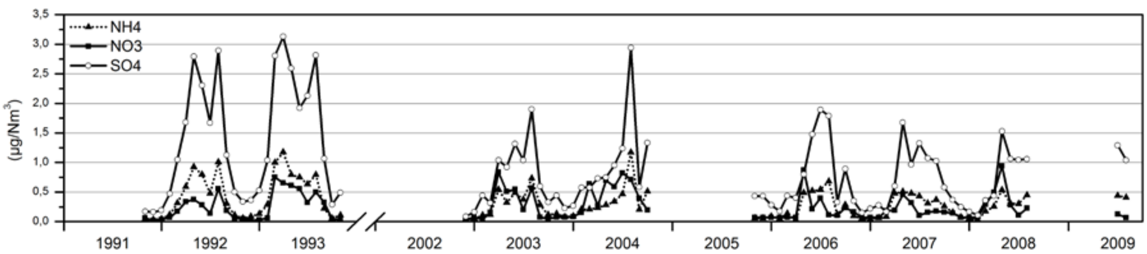

Figure 2: Temporal variation of monthly averages of selected inorganic ions in particulate matter (WINIWARTER et al. 2014)

The decrease of sulfate concentrations is caused by a reduction of emissions, due to the use of fuels containing less sulfur and the desulfurization of flue gases. Consequently the acidity of the samples decreased as well. Today the deposition of nitrogen containing compounds is in the focus of interest as no decreasing trends of total nitrogen (nitrate and ammonium) depositions are observed. The elevated input of nitrogen leads to eutrophication and influences biodiversity. Based on the available data sets joint research could include the impact of deposition loads on the biosphere in the alpine environment.

Other ongoing activities of atmospheric aerosol characterization and precipitation sampling are related to the monitoring of mineral dust, especially dust originating from long range transport from the Sahara (e.g. GREILINGER et al. 2017). Again a close connection to the nutrient input into the alpine environment glacial ecosystems and biodiversity is given.

Considering aerosol particles still airborne optical properties are relevant. Visibility is a parameter which is readily experienced by visitors of the Nationalpark Hohe Tauern. At the same time it is closely linked to airborne particulate matter concentrations. Here interesting possibilities exist to connect the monitoring activites at Sonnblick with topics of environmental education or citizen science.

Conclusion

Long term monitoring activities as well as campaign like projects conducted at the Sonnblick Observatory can be used as complementary information for research projects organized within the framework of the national parks but also for activities related to environmental education or citizen science.

Research at the Sonnblick Observatory is open for all topics. Within ENVISON, which is formulated for 5 years at a time, research foci are defined. Present foci are 'Outstanding events – analysis and forecast' and 'Aerosols and albedo and their interaction with snow cover and clouds' (ENVISON-2 2016).

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Open Wounds in Thin Skin: Soil Processes after Natural Disturbances

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Abstract

Natural disturbances are inherent drivers for ecosystem dynamics. Depending on type and severity, effects on soils, in particular on soil carbon dynamics may be pronounced and long lasting. The response is particularly severe in the Calcareous Alps, at sites with shallow Folic Histosols and Rendzic Leptosols. We describe effects of different agents (wind and fire), intensities, and severities of forest disturbance and regeneration patterns on soil carbon cycle at site/plot scale. Comparison of soil carbon stocks along chronosequences of stand replacing disturbances with adjacent stands indicate substantial carbon losses from the organic layer; in particular in case of regeneration slowed down due to ungulate herbivory. Soil CO_2 efflux measurements at a subset of the sites confirm that a temperature driven increase in decomposition of soil organic matter is the main cause of carbon loss from the system after disturbance. CO_2 flux measurements in the turbulent boundary layer of the atmosphere show that even after eight years post disturbance such a site can be a net source of CO_2. Advance regeneration surviving the disturbance retards decomposition and thus soil carbon loss due to its modulating effect on soil temperature. At the extreme end of the studied disturbance severity gradient, we investigated carbon dynamics at a site disturbed by a forest fire in the 1950s. Pronounced differences in feedback between re-establishing vegetation and soil lead to fine scale heterogeneity in soil carbon stocks.

Keywords

Calcareous Alps, forest soil, carbon cycle, CO_2 gas exchange

Introduction

Natural disturbances are inherent drivers for ecosystem dynamics and may occur at different spatial and temporal scales with different intensities (WHITE & JENTSCH 2001). They affect plant communities directly by disrupting ecosystem, community or population structure, as well as indirectly via changing resource availability, i.e. light, water and nutrients (PICKET & WHITE 1985). Soils are an integral part of terrestrial ecosystems and soil biota play an important role for ecosystem functioning. Natural disturbances affect soils in different ways: soil mixing due to forest windthrow or soil erosion at different scales creates regeneration niches. Fire may cause the loss of plant cover and organic soil layers. Pests alter the input of organic matter to the soil. While some disturbances can lead to a fundamental change of the overall site potential, e.g. via erosion, most disturbances, despite causing temporarily increases in resources, may leave the site potential unchanged (WHITE & JENTSCH (2001).

There is a trend towards changing disturbance regimes in European forests, probably related to climatic changes (e.g. SEIDL et al. 2014) as well as to an increased susceptibility of forest ecosystems due to altered structure and composition by previous management (SEIDL et al. 2011).

Soils developed from calcareous substrates, in particular from limestone and dolomite, are particularly sensitive to disturbance (REGER et al. 2015). In many forest areas of the Calcareous Alps historical records and ‘silent witnesses’ indicate severe soil losses due to former clearcut and grazing activities, also in nowadays protected areas like Nationalpark Kalkalpen (e.g. BAUER 1953).

Depending on the agent of disturbance, bare soil is exposed and prone to erosion. SASS et al. (2012) for example, found up to 200-fold erosion rates at burnt areas in the subalpine belt of the Austrian Calcareous Alps compared to unaffected locations. In such a situation, post fire vegetation regeneration may take 50 to 500 years. Retarded regeneration due to ungulate browsing after large scale windthrow events (PRÖLL et al. 2015) also may exacerbate humus losses (see Fig. 1, results). As Folic Histosols and Rendzic Leptosols consist predominantly of humus, such windthrow-induced changes result in a fundamental alteration of the site potential and have long term feedback effects on the carbon cycle.

In the following, we demonstrate the effects of different types (wind and fire), intensities and severities of forest disturbance and regeneration patterns on the soil carbon cycle at site/plot scale. We focus on forests of the montane and subalpine vegetation belt with shallow Folic Histosols and Rendzic Leptosols. Options for related research in wilderness areas are discussed.

Methods

Study 1: Windthrow effects on post disturbance regeneration and humus dynamics

The pilot study was conducted in order to investigate the effect of stand replacing disturbance (patch size > 1 ha) on natural regeneration and soil carbon dynamics (DARABANT et al. 2009). In each of three regions along a west-east gradient in the Austrian Northern Calcareous Alps (Lechtal Alps, Salzkammergut and Rax/Schneeberg), five to eight sites were selected along a disturbance chronosequence and were compared to adjacent more or less intact mature stands. PRÖLL et al. (2015) provide a detailed description of sites, their disturbance history and the sampling scheme. Soil morphology was described and undisturbed soil samples were taken to the lab for subsequent analysis of the carbon content. At all disturbed patches timber had been harvested and only residual biomass remained.

Study 2: Post-windthrow carbon cycle

In a selected chronosequence of study 1 (Rax) and in an additional chronosequence (Höllengebirge mountain range), soil CO_2 efflux and soil climate were measured in the units stand, gap and disturbed areas of different size and age. A detailed description of the methods is given in MAYER et al. (2014 and 2017a,b). Net ecosystem-atmosphere exchange of CO_2 was measured in the Höllengebirge chronosequence (MATTHEWS et al. 2017).

Study 3: Post fire plant-soil-feedback

At the extreme end of the studied disturbance severity gradient, we investigated carbon dynamics at a site disturbed by a forest fire in the 1950s. KALAS & BERG (2013) described vegetation succession at the fire site. They showed that 60 years post disturbance the vegetation community resembles an alpine grassland. SCHAUFLER (2014) described morphological soil characteristics and determined soil carbon stocks, stratified by vegetation cover (grasses, heather, larch, spruce, mountain pine) and in an undisturbed reference stand. In addition, soil CO_2 efflux and soil climate were measured in the respective units at the disturbed site.

Results & discussion

Study 1: Windthrow effects on post disturbance regeneration and humus dynamics

PRÖLL et al. 2015 found out, that despite high densities of germinants and small seedlings in the forest stands, recruitment establishment frequently failed on both disturbed sites and adjacent stands. Regeneration was insufficient on half of the disturbed sites and regeneration density did not increase with time since disturbance. Ungulate browsing was probably the main cause of regeneration failure. Fig. 1 shows the development of carbon stocks in the organic soil layer of the disturbed sites and adjacent stands.

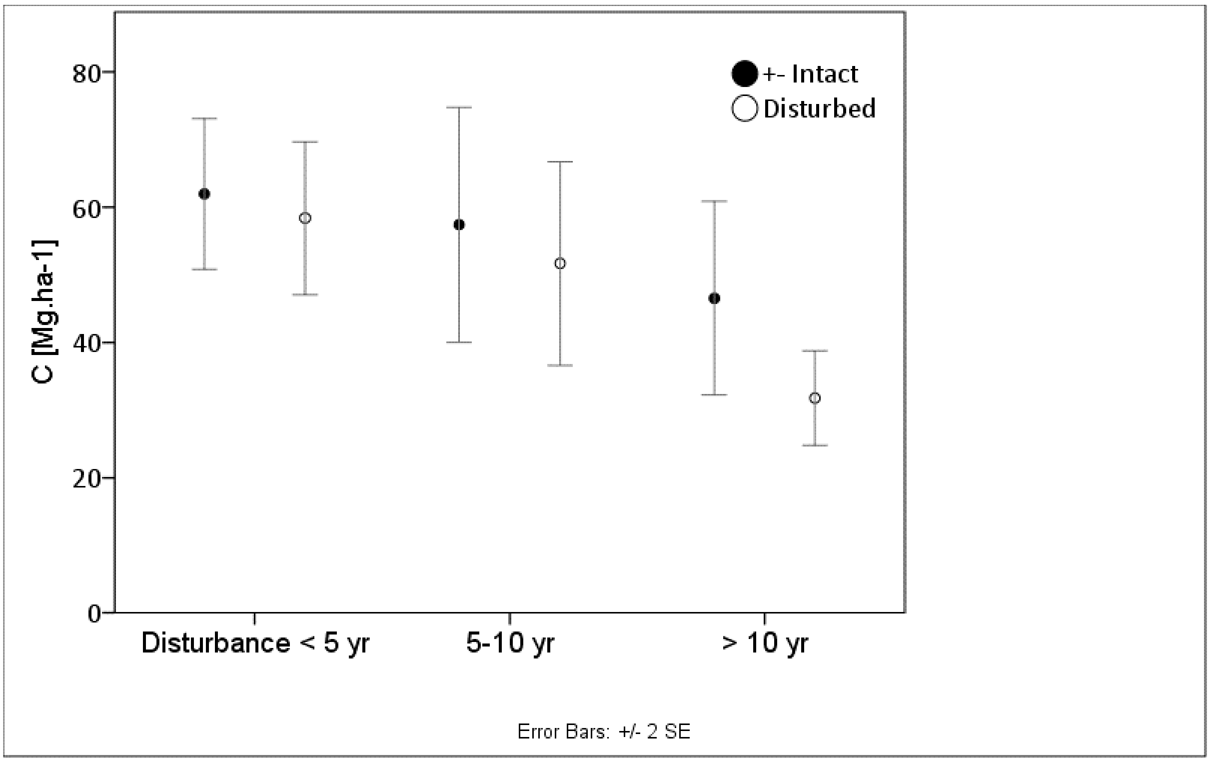

Figure 1: Mean carbon stocks in the forest floor of disturbed sites (different time since disturbance) and in adjacent stands in the Austrian Calcareous Alps.

There is a clear trend of decreasing carbon stocks in the organic layer over time, both at disturbed sites and, less severe in adjacent stands. In folic histosols and rendzic leptosols the organic layer is the main rooting space. Humus losses have therefore severe consequences for water and nutrient supply of the subsequent stands.

Study 2: Post-windthrow carbon cycle

In combination of a chronosequence and a direct time series approach MAYER et al. (2014) found that in the initial phase after windthrow soil respiration did not change compared to undisturbed stands, despite autotrophic respiration was low due to missing vegetation cover. In a later stage, with pronounced regeneration succession, soil respiration at the disturbed site increased significantly. MAYER et al. (2017a) found out that reduced autotrophic respiration at disturbed sites was offset by increased heterotrophic respiration compared to the intact stand. An increase of soil temperature was the main driver for the increase of heterotrophic respiration. The decline of soil organic carbon stocks was in the same order of magnitude as heterotrophic respiration. MATTHEWS et al. (2017) confirmed the negative net carbon balance of the disturbed sites even eight years post disturbance with Eddy covariance measurements. HOLLAUS et al. (2013) also found a substantial increase of bare rock surface and a decrease of soil thickness in the first phase post-windthrow on these south-exposed slope. In a follow-up study MAYER et al. (2017b) could show that established advance tree regeneration retards decomposition and thus post-disturbance C-losses due to its modulating effect on soil temperature.

Study 3: Post fire plant-soil-feedback

With a total of 3.7 kg C m^{-2} (in soil/litter, dead wood, charcoal and root stocks) the soils of recolonized patches at the fire-site have recovered by around 40% in relation to typical site potentials (reference site: 8.4 kg C m^{-2}). Heather shows the highest soil carbon stocks, comprising a total of 5.8 kg C m^{-2} belowground compared to 3.7 kg C m^{-2} for grasses, 3.5 kg C m^{-2} for spruce, 2.8 kg C m^{-2} for mountain pine and 1.8 kg C m^{-2} for larch). Plant-soil-feedback mechanisms are probably responsible for differences in litter input as well as differences in decomposition rates. In lab incubation studies, litter of heather shows lowest decomposition rates under standardized conditions. Soil temperatures and soil moisture in the field are considerable lower and less variable under spruce and heather compared to larch and grass. Less favourable soil climate together with low substrate quality for decomposers are probably responsible for the high soil carbon accumulation under heather and demonstrate its soil regeneration potential.

Figure 2: Vegetation succession in the subalpine belt of the Calcareous Alps 63 years after fire disturbance (©Katzensteiner).

Conclusion and outlook

The studies document the high vulnerability of mountain soils on calcareous bedrock. A projected increase in frequency and intensity of forest disturbances may have detrimental effects on the site potential and on the subsequent forest stands. As biomass was harvested at all of the sites after disturbance, except the one of the fire study, the role of deadwood for post disturbance soil development could not be investigated. In that respect, wilderness areas where deadwood remains after disturbance would provide an option for further research. Plant-soil feedback plays an important role in post-fire soil carbon dynamics.

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The Tyrolean Alps LTSER platform – connecting science and people

Sarah Kerle & Ulrike Tappeiner

Abstract

Facing serious global changes, Long-Term Socio-Ecological Research (LTSER) can provide valuable insights into human-nature interactions. This scientific knowledge is urgently needed and can be used for protected area management to address complex issues such as biodiversity loss. Within Tyrol large areas are under protection. The Tyrolean Alps LTSER platform currently consists of 9 research sites aiming to provide long-term data records and most sites are located within at least one protection category. A joint working strategy among scientists of the Tyrolean Alps (TA) LTSER platform and protected area managers could be very profitable for better area management.

Key words

Long-Term Socio-Ecological research (LTSER), protected areas, management, ecosystem services (ES), global change

Introduction

Global changes require advanced scientific approaches, extending the usual project duration of 3-5 years to longer periods. To observe how ecosystems respond to severe impacts such as climate change, biodiversity loss or resource depletion long-term observation and projection are urgently needed. Having this in mind, the first Long-Term Ecological Research (LTER) network was established back in the 70s in the United States aiming to provide long-term ecological data along with scientific expertise (LTER 2016). For Europe though, with its higher population density compared to the US and its long history in land-use, the initial idea had to be adapted as it became soon obvious that the society-nature interaction needs to be observed in a more comprehensive way (SINGH et al. 2013). This led to a 'next-generation network' (MIRTL et al. 2010). Within this network traditional LTER sites are combined with LTSER (Long-Term Socio Ecological Research) platforms allowing the incorporation of the social (human) dimension into the preceding concept. Thus, social, economic and historical usage aspects are combined with traditional long-term ecological research within the LTSER-concept (MIRTL et al. 2010). LTSER further aims to connect scientists from different kind of disciplines as well as local stakeholders in order to achieve best possible results for relevant issues. Hence, LTSER platforms can therefore act as valuable institutions bridging science and protected area management.

The Tyrolean Alps (TA) platform

In 2002 the Austrian Society for Long-Term Ecological Research was founded and some years later the Tyrolean Alps LTSER platform, next to the Eisenwurzen LTSER platform and other traditional LTER-sites within Austria, was build up.

The Tyrolean Alps are well known for their highly diverse ecosystems and landscapes which are especially sensitive to global change issues such as climate change or changes in land-use (e.g. EEA 2004). Due to the intricate structure and the feature of extreme living conditions of mountain habitats the area provides various ecosystem services to people. Ecosystem services are direct benefits to people derived from nature such as fresh drinking water, protection from natural hazards, timber supply, carbon storage, or natural pollination, to name but a few. Nevertheless, severe impacts coming from direct socioeconomic activities such as winter and summer tourism, changes in land-use and agricultural practice, hydropower generation, transport etc. affect ecosystem service provision. Not only for their extraordinary flora and fauna but also for their cultural heritage it is only reasonable that large parts of the Tyrolean Alps region are under protection. Hence, protection areas are central elements of the Tyrolean Alps.

The LTSER Tyrolean Alps platform consists of 3 clusters, i.e. 'Glaciers', 'Alpine lakes' and 'Gradients in the alpine area'. Within those clusters currently 9 LTER-Sites (Fig.1) are embedded. Among the sites are several glaciers, a glacier foreland, grasslands at different altitudes, two lakes, and a treeline site.

In Tyrol 8 different protection categories are in use: (Hohe Tauern) National Park, individual elements within a Protected Landscape, Nature reserves, Conservation areas, Special protected areas and Ramsar-Protected areas. Most research sites are located within at least one protection area category (Tab. 1).

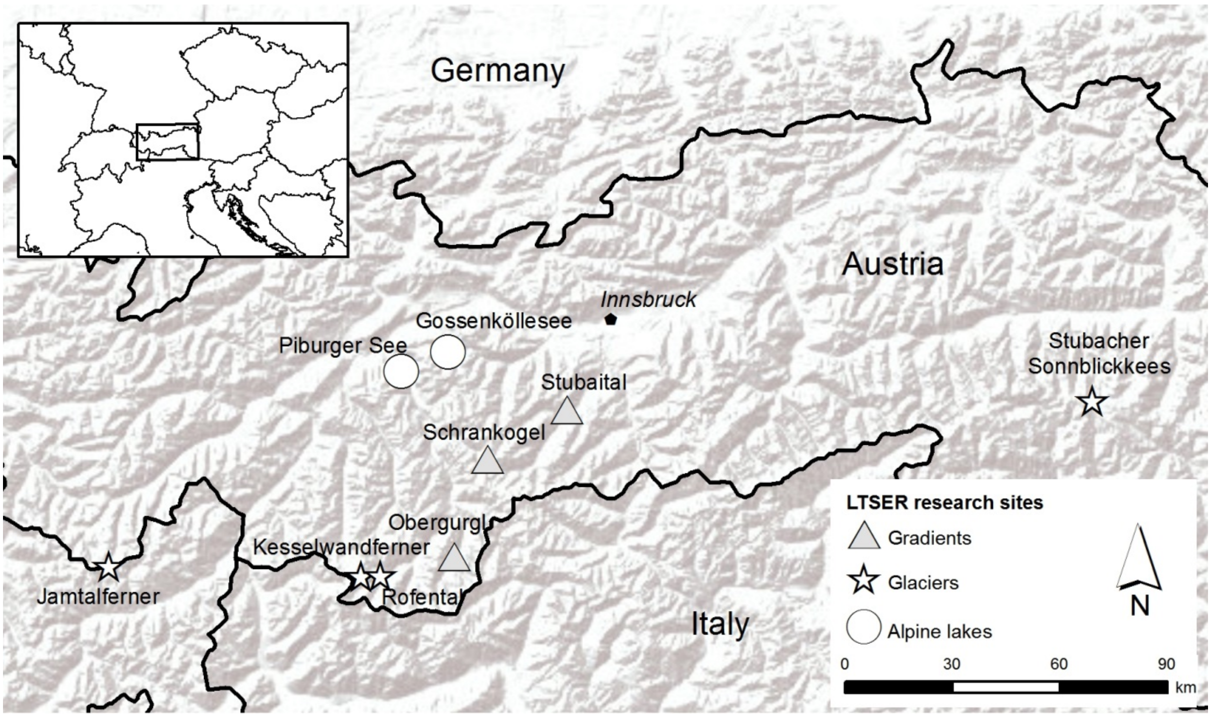

Figure 1: Map for the Tyrolean Alps LTSER platform: Research sites and their cluster affiliation. Source: LTSER & ESRI, USGS, NOAA; Map design: Johannes Rüdisser.

Cluster	**Research site including protection status**	**Main research focus**
Glaciers	Jamtalferner -	Mass and energy balance
	Kesselwandferner *Refugia, Natura 2000*	Ice velocity, mass balance
	Stubacher Sonnblickkees *Hohe Tauern National Park*	Mass balance, water budget estimations
	Rofental *Refugia, Natura 2000*	Cryospheric, atmospheric and hydrological processes
Alpine lakes	Gossenköllesee *Refugia*	Long-term alterations of alpine lakes, streams, catchments
	Piburger See *Nature reserve*	Hydrology, water chemistry, sediment, phyto- and zooplankton, zoobenthos, fish ecology, microbial food webs
Gradients in the alpine area	Obergurgl *Natura 2000*	Microclimate processes, colonization measurements, biodiversity and physical properties
	Schrankogel *Refugia*	Vegetation mapping, micro-climate, influence of global change drivers
	Stubai *Refugia, Nature reserve*	Greenhouse gas fluxes, productivity, water balance, N-cycling, C-sequestration, socio-economic studies

Table 1: The Tyrolean Alps (TA) Long-Term Socio-Ecological research platform: Hierarchical structure including protection status (italic) and main research focus. Source: adapted after KERLE & TAPPEINER (2017).

The TA LTSER platform provides databases on hydrology, permafrost biodiversity, demography, agro-economy, historical land-use changes, and tourism. This data records are fed into DEIMS, which is a central platform gathering relevant long-term data from LTER sites all over the world. This might be of special interest for protected area managers as this data is freely available and studies revealed that free data records coming from protected areas are rare (BERTZKY & STOLL-KLEEMANN 2009). In order to achieve the preservation objectives in protected areas, long-term data sets are needed for future scenario modelling, allowing the development of appropriate protected area management strategies, addressing complex issues such as biodiversity loss or the issue of invasive species. Moreover, science can help legitimate protected areas and their management.

Conclusion

Collaboration between scientists and protected area managers should be further strengthened (MÜLLER 2010) as both sites benefit from this transdisciplinary work. On the one hand protected areas are well suited for global research as severe direct human impact is prohibited, while at the same time external forces such as atmospheric changes interact with ecosystems. On the other hand managers can use scientific outcomes in order to achieve conservation goals and justify/improve protected area legitimacy. Hence, the TA LTSER platform, being an interdisciplinary and multi-institutional entity, could act as a bridging institution connecting science and protected area managers where outcomes could be applicable beyond platform boundaries.

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The Open Air Lab Kitzsteinhorn (OpAL) – Open Innovation in High Altitude

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Abstract

The Open Air Lab Kitzsteinhorn (OpAL) was established in 2010 and since then has grown into Austria's most extensive monitoring site for bedrock permafrost and high-alpine rockfall. Surface, subsurface, and atmospheric conditions are monitored based on a combination of borehole measurements, electrical resistivity surveys, terrestrial laserscanning, geotechnical recordings, and measurements at automated weather stations. We understand OpAL as an innovative pool of ideas and as a provider of valuable long-term data, open to everyone interested in investigating high-mountain environments and their response to climate change.

Keywords

Permafrost, Rockfall, Long-Term-Monitoring, Climate Change, High-Alpine Infrastructure

Introduction

Since 1880, mean annual air temperatures in Austria have risen by 2 °C, an increase that is more than twice as high as the average global warming of 0.85 °C during the same time span (APCC 2014). Rising temperatures have led to a dramatic retreat of alpine glaciers, and, far less visible, have caused significant degradation of high-alpine permafrost bodies (FISCHER et al. 2015, PERMOS 2016). Both, glacial thinning and bedrock permafrost warming, have a considerable destabilizing effect on high-alpine rock walls (WEGMANN et al. 1998, KRAUTBLATTER et al. 2013). However, quantitative data on the response of frozen rock faces to recent climatic changes is scarce (KENNER et al. 2011), leaving fundamental knowledge gaps and thus impeding adequate adaptation measures. Aggravating the situation, the temporal responses of frozen rock faces to recent warming can differ drastically, reaching from immediate effects to heavily lagged feedbacks that become evident only after long time periods (GRUBER et al. 2004). To grasp the full spectrum of responses, long-term measurements are therefore vital. The Open Air Lab Kitzsteinhorn (OpAL) has addressed this important issue by establishing a long-term monitoring in the summit region of the Kitzsteinhorn, which is briefly introduced in this contribution.

Objectives & Key Contributors

OpAL is focusing on the combined observation of surface, subsurface and atmospheric processes, to better understand the interaction between climate change, mountain permafrost, and the occurrence of rockfall. While many relevant rock- and ice-mechanical processes are well understood within the controlled and isolated confines of laboratories, the transferability of lab evidences to more complex, natural conditions remains problematic. By implementing an extensive high-alpine monitoring, OpAL strives to reduce the scientific gap between the rock **sample** scale and the rock **mass** scale, contributing to the lab character of OpAL.

The monitoring at the Kitzsteinhorn was initiated in 2010 within the research project MOREXPERT, guided by the alpS – Centre for Climate Change Adaptation (FFG funding). Since then, several committed partners provided substantial financial, logistical, and intellectual support, such as the Gletscherbahnen Kaprun, the University of Salzburg, and the Geoconsult ZT GmbH. Over the following years the monitoring was constantly expanded and has now become one of the best instrumented long-term monitoring sites for permafrost and rockfall in the entire Alps. In 2015, remediation measures to stabilize the cable car summit station were carried out under the lead of Geoconsult, strengthening the focus of the monitoring on high-alpine infrastructure safety. A year later the newly founded GEORESEARCH Forschungsgesellschaft was assigned with the lead of OpAL. Among other international networks, OpAL is integrated into the Munich Alpine Hazards and Mitigation Cluster (AlpHaz) and regularly provides temperature data to the Global Terrestrial Network for Permafrost (GTN-P).

Monitoring Structure & Key Results

The monitored area covers the entire summit pyramid of the Kitzsteinhorn, extending from the Schmiedingerkees glacier (2.950m) to the summit (3.203 m). Its isolated position and horn-type shape make the Kitzsteinhorn an ideal site to study responses to climatic changes. The monitored area primarily consists of calcareous-micaschists belonging to the Glocknerdecke (HÖCK et al. 1994). The local tourism infrastructure (cable car, ski lifts, ski slopes etc.) provides easy access and convenient transportation of measuring equipment, an essential prerequisite for an extensive long-term monitoring program.

The OpAL combines permanent surface, subsurface, and atmospheric measurements, which include five deep bedrock boreholes (up to 30 m deep) to measure permafrost temperatures, over 30 shallow bedrock boreholes (up to 1 m deep) to examine near-surface frost weathering dynamics, two permanently installed geoelectrical arrays to investigate subsurface thermal changes provided by Geolog2000 and the Geological Survey of Austria, a network of passive seismic sensors to detect acoustic emissions triggered by rockfall, numerous laserscanning positions to identify rockfall detachment zones, crackmeters and automatic rock anchor load plates to register deformations along bedrock fractures, and several fully automated weather stations that record changes of meteorological conditions (see Fig. 1).

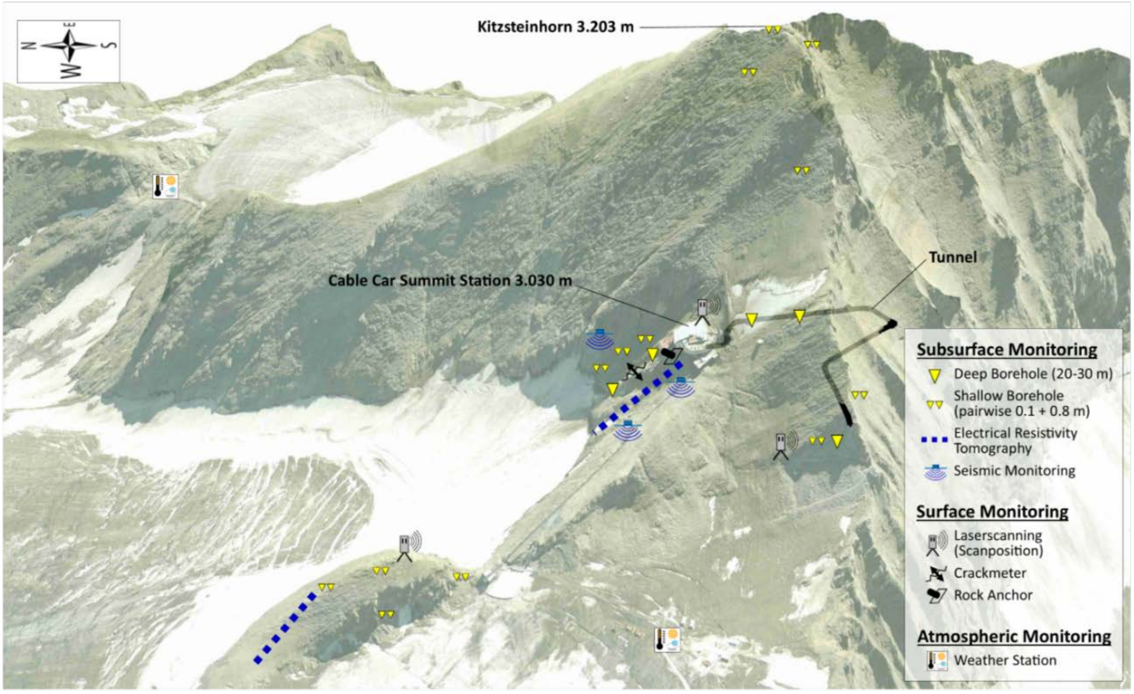

Figure 1: Overview of the long-term monitoring installations in the summit region of the Kitzsteinhorn. © GEORESEARCH

Data from deep boreholes (20-30 m) located at 3.000 m a.s.l. demonstrate permafrost core temperatures of -1.8 °C for north facing rock slopes and warmer temperatures for other slope aspects. The south-face of the Kitzsteinhorn is permafrost-free, as evidenced by measurements performed in the interior of the summit pyramid ('Hanna-Stollen') and by near-surface temperature measurements.

Electrical Resistivity Tomography (ERT) measurements are carried out along two profile lines on north-facing rock slopes. ERT data is well-suited to differentiate between frozen and unfrozen subsurface regions and is furthermore capable of identifying fluid flow in fractures. ERT measurements conducted during snow melt in June suggest that meltwater, seeping through open fractures, might have a strong and sudden destabilizing effect, despite the presence of subzero bedrock temperatures (KEUSCHNIG et al. 2016).

To detect changes occurring at the rock surface extensive terrestrial laserscanning (TLS) surveys were performed. Analysis of the TLS data obtained from 2011 – 2016 displays the dramatic impact of glacial thinning on adjacent headwalls: around 80 % of the detected rockfall volume was triggered from areas located less than 20 m above the current glacier surface. Overall, more than 400 rockfall release zones were identified, the total rockfall volume exceeded 2.400 m³. With continuing warming, the significance of rockfall from deglaciating headwalls as a considerable threat to man and infrastructure is expected to grow throughout the foreseeable future.

Conclusions & Outlook

By combining data on external forcing (climate), internal responses (rock temperatures) and surface changes (rockfall), the Open Air Lab Kitzsteinhorn provides valuable insights on the correlation between climate warming and rock mass destabilization in high-alpine rock faces. GEORESEARCH understands OpAL as an innovative pool of thoughts and ideas, open to everyone interested in high-mountain research and open to new and interdisciplinary contributions. In this context, OpAL has already evolved into an important platform for partner projects which contribute their own research questions and at the same time utilize the existing monitoring infrastructure (e.g. SeisRockHT, GlacierRocks). In the future, GEORESEARCH plans to further strengthen OpAL's role as a provider of valuable information for scientists as well as the interested public.

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Identifying crucial factors for nest survival and predation in a northern lapwing *Vanellus vanellus* population in the Lake Neusiedl – Seewinkel National Park

Markus-Leander Khil & Christian H. Schulze

Keywords

pasture, nest, predators, nest loss, hatching success, artificial nests, defense,anti-predator defense, conservation, colony size

Summary

In the last decades, lapwing populations decreased dramatically all across Europe due to shifts in land use and agricultural intensification. Knowledge of the threats to a species is essential to design appropriate conservation measures. Nest loss and insufficient productivity in the remaining habitats have been main causes for declines in the lapwing.

In this study, the causes for and the factors determining nest loss in the lapwing in the Neusiedler See – Seewinkel National Park were investigated in the spring and summer of 2014.

Clutches were recorded and monitored until they hatched or failed and the fate of each nest was assessed. Additionally, data on vegetation and ground humidity at the nest sites were gathered to test for effects of habitat variables on hatching success. Nest temperatures were recorded through temperature data loggers to record if diurnal or nocturnal predators were involved in nest predations. Artificial nests were deployed at the study site and monitored until they were predated. The results were also used to demonstrate the strong anti-predator defense of lapwing colonies. Trail cameras monitored artificial nests to reveal potential predators.

59% of the nests were predated during incubation. Only 2.5% of failed nests did so due to other reasons than predation. Nest survival probabilities differed significantly between different colony sizes (> 5 nests: 55%, 2-5 nests: 14.8%, solitary nests: 3.5%). Colony size was the only statistically valid predictor for nest loss probability. Vegetation cover, sward height and ground humidity at the nest site, as well as rainfall did not prove to be significantly related to nest loss. Predation risk of artificial nests was negatively correlated with the distance to the next four lapwing nests.

According to nest temperature logger data, nocturnal/mammalian predators were the main predators of lapwing nests. On the other hand, all predations of artificial nests recorded on trail cameras were carried out by corvids. Hence, artificial nest exposure experiments can be unreliable when aiming to identify important predators.

Our results emphasize the importance of sufficiently large areas of suitable habitat, where lapwings can develop colonies, where nests have a significantly higher hatching success than solitary nests on small habitat patches.

Figure 1:Adult female northern lapwing

Figure 2: A nest of a lapwing at the study site

Figure 3: Mean nest predation probabilities ± SE (box) and 95% CI (whiskers) predicted by a GLMM for solitary nests, nests in small (2-5 nests) and large colonies (> 5 nests).

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Survival in little? Refugia of high-elevated plants in the Spanish Sierra Nevada

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Keywords

Grasslands, isolation, global warming, alpine tundra.

Abstract

Climate change is a serious threat to high-elevated plant species. There are three possible strategies to survive if they cannot exist in their inherent habitats any more: Upward shift, use of phenotypic plasticity ore movement to small-scaled local still suitable microhabitats. Furthermore, high-mountain plants are still exceptionally endangered since they are already at their ecologic limits. We analyzed future shift strategies based on possible climate scenarios considering current and future climate conditions. The study was conducted at the Spanish Sierra Nevada National Park as part of the ECOPOTENTIAL project.

Introduction

Plants at high-elevated mountains are in particular sensitive to temperature changes (KÖRNER 2003) and disproportionately high endangered in cases of fast environmental changes. Elevational gradients represent quit often strong environmental gradients – in the Spanish Sierra Nevada an increase in precipitation and a decrease of temperatures. Mountainous species seem to be limited at their elevation, upwards by increased environmental extremes, downwards by competition of more widespread species (GHALAMBOR et al. 2006). In the case of environmental changes and competition of upward-shifting species, a species at a certain elevation has several strategies to avoid extinction: (1) niche differentiation from upward-shifting species (e.g. by using phenotypic plasticity and resp. or finding micro-habitats (SCHERRER & KÖRNER 2010)) or (2) even migrate upward to find suitable, environmental similar conditions (GÓMEZ et al. 2015).

In the Sierra Nevada are plant species migrations more likely since the slopes of the Sierra Nevada are not very steep (PAULI et al. 2003). Besides climate conditions seems the yearly snow cover important: Snow protects plants during winter from frost. Moreover, snowmelts play a crucial role for the water supply during summer (PAULI et al. 2003).

We are interested in the influence of both, changes temperatures and snow cover on alpine plants of the Sierra Nevada. We investigated vascular plant species, in particular endemics, and checked their current temperature conditions to find future similar locations. We estimate their risk to get extinct based on the accessibility of future refugia.

Material and methods

We investigated vascular plants above the treeline, along an elevational gradient from 2,000 to 3,000 m a.s.l. at the southern slope of the Mulhacén in the Sierra Nevada National Park. Pseudo-abundances were calculated by presence-absence data of subplots of a hexagonal plot design (JURASINSKI & BEIERKUHNLEIN 2006). We used a local flora of Blanca et al. (2009) to identify the plants and to sort them to different classes of endemism.

We used WorldClim to get current and future spatial temperature data (HIJMANS et al. 2005). We used the CCSM4 rcp 8.5 scenario for future temperatures. All data were reprojected to the local UTM resolution. Distances between current and future temperatures were calculated as proposed by HAMANN et al. (2015).

Results

Our results show, that endemic species in the Sierra Nevada might be endangered due to environmental changes like global warming (Fig. 1 & 2). Especially arctic-alpine endemics (Fig. 2) and, from the Sierra Nevada endemics, those with the lowest temperature niches are highly endangered since there will be no refugia anymore.
We found for the highest elevations the largest distances to areas of the same temperature regime as found there today (Fig. 3).

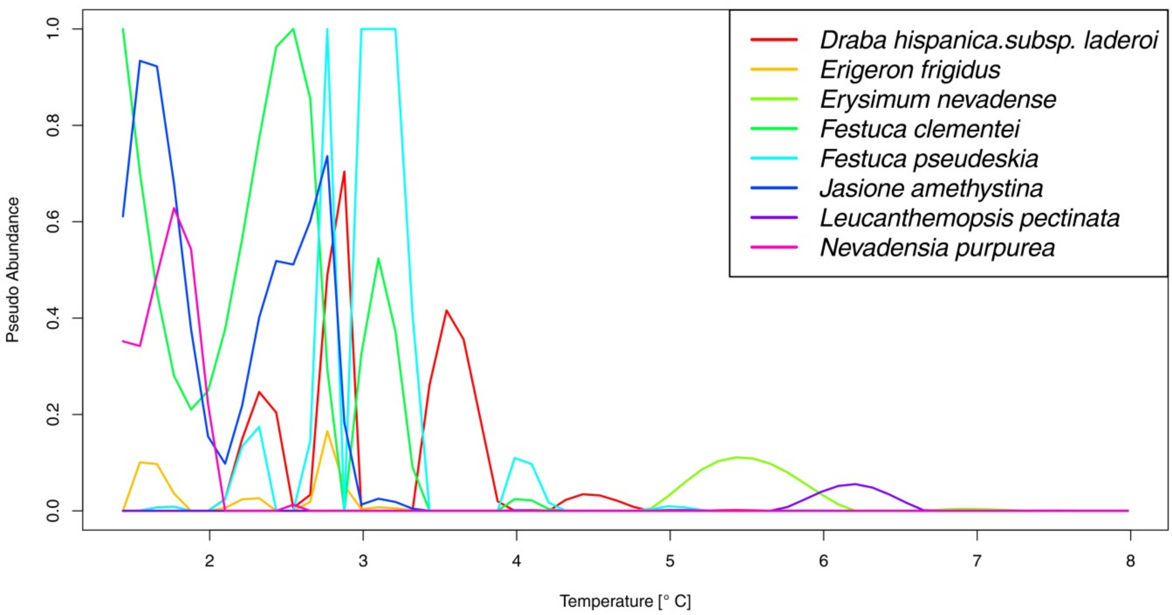

Figure 1: Pseudo-abundances of some Sierra Nevada endemits along the temperature gradient.

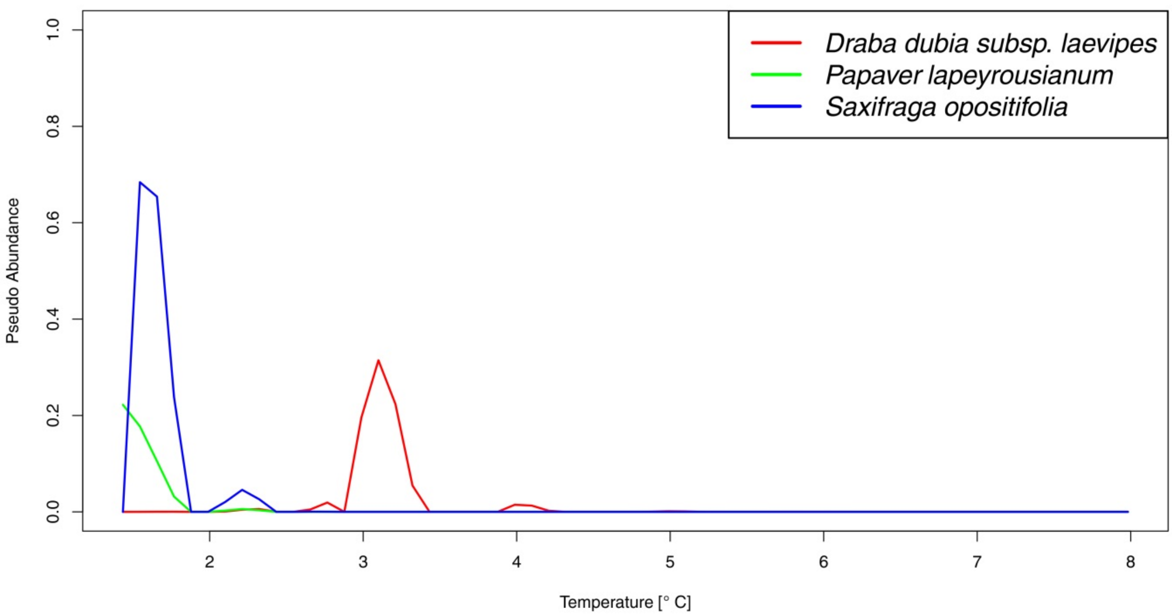

Figure 2: Pseudo-abundances of Arctic-alpine endemits along the temperature gradient.

Discussion

Endemic species in mountainous areas, especially in the Mediterranean area, are in particular threatened by global warming. Potential future refugia can be identified by distances to similar environmental sites. There is no substitute for the high-elevated summits of the Sierra Nevada.

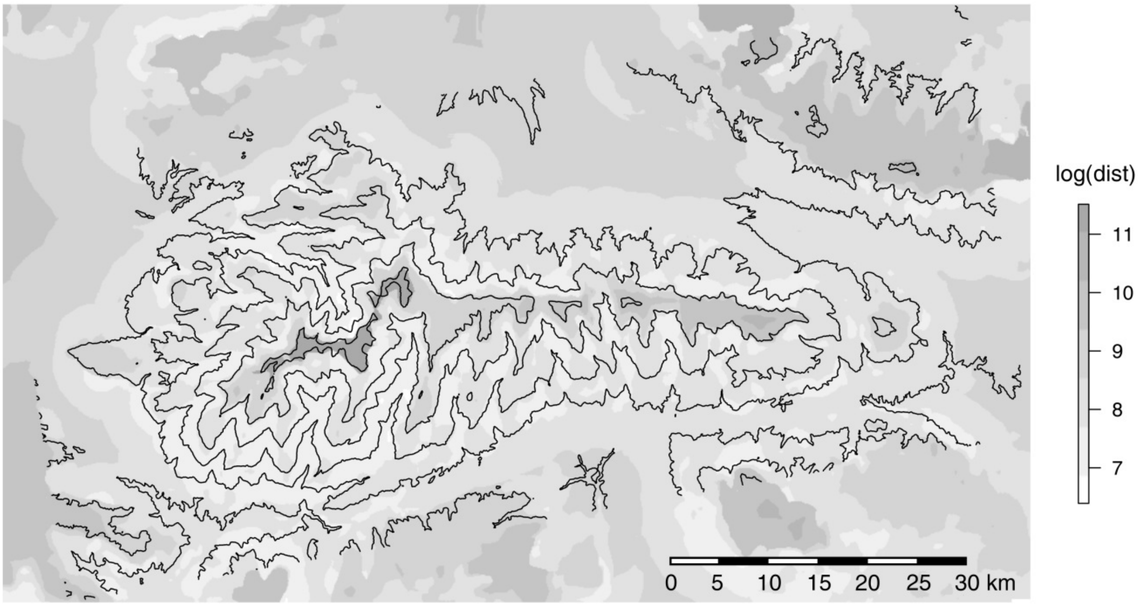

Figure 3: Nearest distances between current areas and future areas with unique temperatures. Isoclines are elevational steps in 250 m intervals.

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An improved bedload management for the Danube River in the Donau-Auen National Park. An application of the 'principle Sisyphus'

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Abstract

The Danube River east of Vienna has been strongly affected by bedload deficit due to human impacts. The river is incising, the connectivity between channel and side-arms and floodplains is decreasing. In 1996 a first stage of a bedload management was implemented. However, this was not sufficient to stop degradation. In recent years a concept for an optimized bedload management has been developed, including the recirculation of bedload and the addition of coarser, less mobile gravel, thus the problem should be solved. However, the question emerges whether a permanent artificial bedload supply of such an extent and over unlimited duration can be truly compatible with the idea of a national park.

Introduction

In general, natural alluvial rivers are supposed to be in a state of dynamic equilibrium, or, at least, in a quasi-equilibrium (LEOPOLD & MADDOCK, 1953). However, human impacts in the form of river engineering, the construction of barrages (dams) and hydropower plants and maintenance operations (such as dredging) often have strongly disturbed the sediment balance of rivers. Due to a deficit of bedload, which is a very common problem, many river reaches have become subject to severe bed degradation (e.g. PETTS, 1980; WILLIAMS & WOLMAN, 1984), which can also be called a 'hungry water effect' (KONDOLF, 1997).

The Danube east of Vienna

Such problems are also relevant in the Danube River between Vienna and the Austrian-Slovakian border, which is the 'artery' of the Donau-Auen National Park. It was originally an anabranching river system with a mean width of the active zone of about 4600 m (HOHENSINNER et al., 2008) and a bankfull width of about 800 m (HOLUB, 2012). In the second half of the 19th century the project reach was straightened, concentrated into one main channel and channelized. The banks of the Danube were fixed by riprap, thus erosion can only take place in form of channel incision; most side arms were separated from the main channel by artificial levees, and parts of the floodplain were narrowed by a flood protection dyke (KLASZ et al., 2013).

In the second half of the 20th century about 80% of the Austrian Danube reach were impounded by ten hydropower plants. The last of it, Vienna-Freudenau (river-km 1921, which is directly upstream of our study reach) was put into operation in 1997. The project reach remained a free flowing river, but due to the retention of bedload (bedload deficit) in the upper parts of the river basin (impoundment chains) and some of its tributaries the bed degradation is ongoing, with incision rates of about 2 cm/yr in most parts of the project reach (KLASZ et al., 2013, 2016), see Fig. 1, and the hydrological connectivity between channel and side-arms and floodplains (frequency and duration of floodplain inundation) is decreasing permanently (TOCKNER et al., 1998; KLASZ et al., 2013).

The nucleus of bedload-management in this river reach

As a consequence of the hydropower plant at Vienna-Freudenau and following a water law based decision a first stage of a bedload management was implemented. The basic requirement was to avoid additional bed degradation by this hydropower plant. Thus the operating company (Verbund Hydro Power: VHP) has dumped an average of ~190'000 m^3 gravel per year downstream of the barrage to compensate for the effect of this hydropower plant (SCHIMPF et al., 2009; KLASZ et al., 2013), and this artificial bedload supply will be continued as long as the hydropower plant is in operation. Thus it was (and will be) possible to maintain a stable riverbed in the upper part of the reach, directly downstream of the barrage. However, this artificial gravel supply is not sufficient to cover the complete bedload transport capacity of the river (which is supposed to be about 350'000 m^3 per year, averaged over longer time periods; KLASZ et al., 2013), thus the channel incision could not be stopped completely until now, see Fig. 1 (MW-differences in the time period between 1996 to 2010).

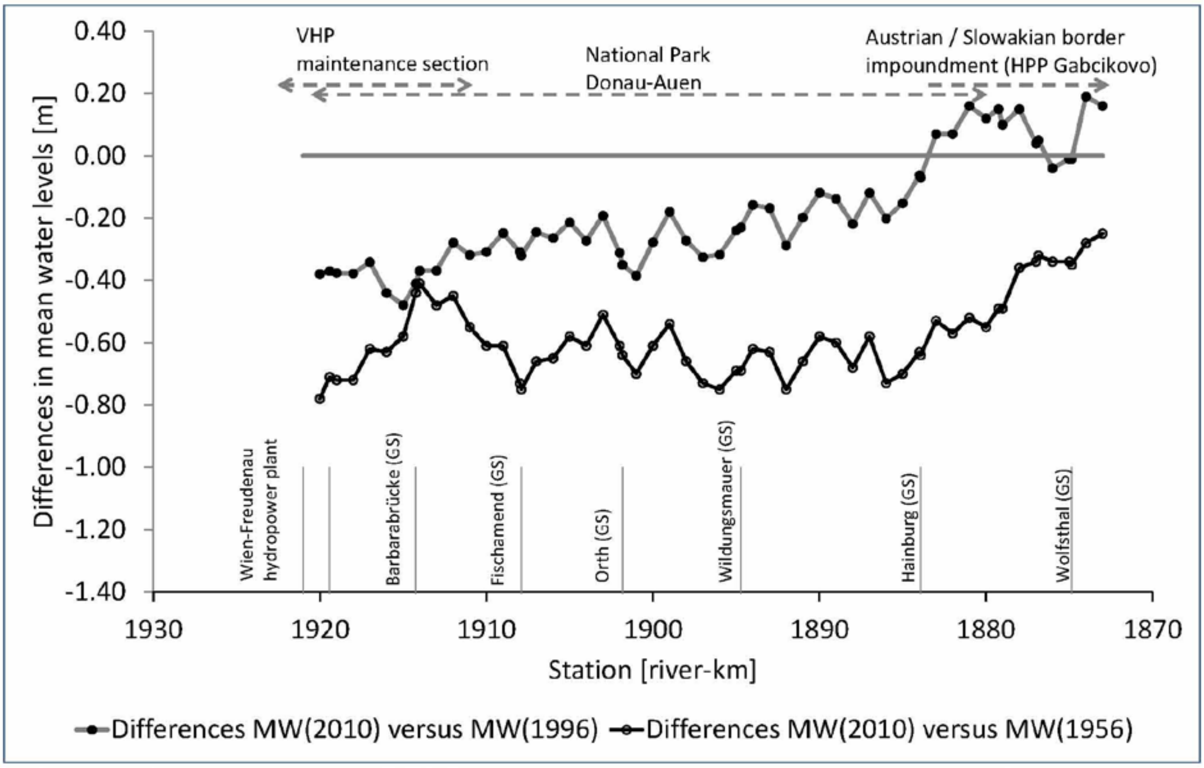

Figure 1: Differences (temporal changes) in mean water levels (MW) in the longitudinal section, MW(2010) and MW(1996) relative to MW(1956); data sources: Bundesstrombauamt (1959), Wasserstraßendirektion (1998), viadonau (2012). GS=gauging station; HPP= hydropower plant.

Concept for an optimized bedload management

The described incision is unacceptable from ecological point of view and within the national park. Thus, a concept for an optimized bedload management has been developed (KLASZ, 2014), including the recirculation of bedload, the addition of coarser and less mobile gravel and a monitoring program (including an efficiency control of all technical measures), see Tab. 1.

River management tools:	Important elements:
increase of the amount of gravel supply (up to the transport capacity) mainly in the upper parts of the section	bedload recirculation (from a bedload trap at the downstream end of the reach or from the downstream reach, which is impounded by the hydropower plant Gabcikovo)
	compensation of abrasion loss by coarser gravel and cobble fraction (e.g. 16/120 mm)
reduction of bedload transport capacity	coarsening of grain-size of bed material in order to decrease the intensity of transport (granulometric bed improvement)
	side-arm reconnection
	(slight) bankfull widening by riverbank restoration
additional local measures	local scour control (local bed armoring)
Monitoring, evaluation, efficiency control	river bed surveys (repeated cross-sectional suveys or multibeam survey; analysis of bed changes)
	measurement and analysis of mean water level / reference low water level (analysis of water level changes)
	bed material sampling (analysis of grain-size distribution curves)
	control of grain-size of added material (gravel / cobble)
	optional: bedload transport measurements by basket sampler and artificial tracer stones (radio-tracking)

Table 1: Tools of an optimized bedload management (from KLASZ, 2014)

The basic and simple idea of bedload management in a degrading reach is to fully compensate the bedload deficit by gravel augmentation ('artificial bedload supply'). In our context this results in a refilling of erosion zones downstream of the barrage, see Fig. 2. This concept was first developed by Felkel for the free flowing Rhine River downstream of Iffezheim (FELKEL, 1970, 1987), and this program is successfully running since 1978 (GÖLZ, 2008). It should be mentioned, that such an alternative for our river reach has been already investigated in the 1980^{th} (ZOTTL & ERBER, 1987), and it was found to be feasible, however it was eliminated from further consideration, because it was thought be far away from a sustainable solution, and another alternative was proposed (dumping of a layer of large gravel and cobbles, grains large enough to ensure 'static stability').

A central issue is the availability of large amounts of gravel with suitable grain-size distribution. Until now, most of the added gravel was obtained from the Danube River at Krems, which is about 80 km upstream (bedload output from the free-flowing Wachau-section into the impoundment of the Altenwörth hydropower plant), transported by barges and dumped by hopper barges). This part of bedload management (M1 in Tab. 2) can be seen as an artificial bedload bypass through the impoundments of three upstream hydropower plants (Altenwörth, Greifenstein, Vienna-Freudenau) by barges (Fig. 2). However, this source of gravel is limited. Of course, there are several gravel-pits in the Vienna Basin (within a distance of 10 to 60 km from the project reach), but this material is quite expensive, gravel is a limited and valuable resource, and furthermore, it could only be transported by trucks to the river, which would be associated with severe environmental stress (including CO_2-emissions (equivalent) of ~4.6 kg CO_2e per m^3, provided a transport distance averaged 30 km and specific CO_2-emissions of ~90 g/t.km).

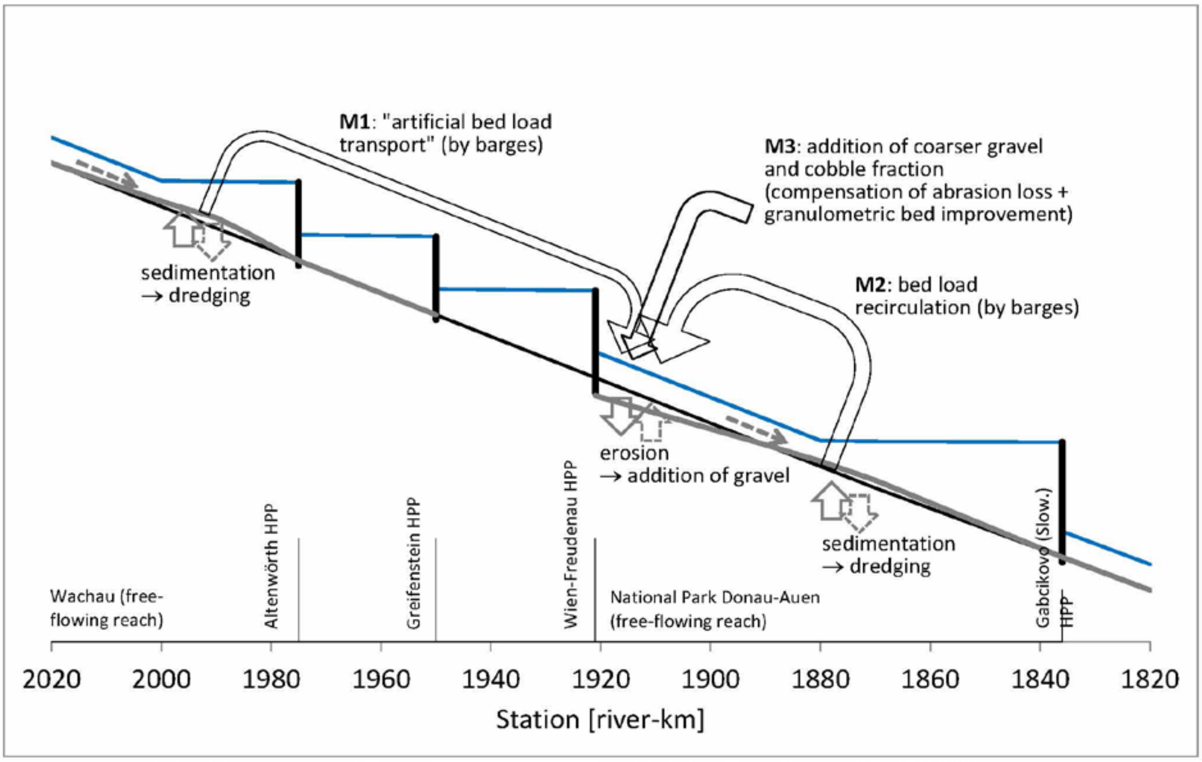

Figure 2: Schematic diagram, longitudinal section, Danube River, impoundments upstream and downstream of our project reach, including the key measures of bedload management east of Vienna (M1, M2, M3); HPP= hydropower plant.

Considering the special situation of the river reach (a relatively short free-flowing section between a hydropower plant upstream and another hydropower plant downstream, Fig. 2), the recirculation of bedload is the most obvious and cost-efficient solution (M2 in Fig. 2 and Tab. 2). The bedload output from our reach is deposited in the impounded section of Gabcikovo (since 1992), which will incrementally reduce the flood protection level for Bratislava; therefore these sediments have to be removed anyway. The gravel should be dredged at a bedload trap at the downstream end of the reach, afterwards it will be transported by barges to the upstream end of the free-flowing reach and dumped by hopper barges (Fig. 3).

Bedload transport is associated with abrasion, grains are getting smaller on their way downstream (between river-km 1920 and river-km 1880 the median diameter D_{50} declines from ~27 mm to ~19 mm, KLASZ et al., in prep.), thus this abrasion loss should be compensated by a coarser gravel and cobble fraction (M3 in Fig. 2 and Tab. 2, grain-size distribution: see Fig. 4). The mobility of coarse grains is lower than those of smaller ones; thus, by coarsening of the surplus material (more than the compensation of abrasion loss would require), the efficiency of artificial bedload supply can be improved, that is, the amount of needed material can be reduced ('granulometric bed improvement'). As coarser gravel and cobble fractions (such as 16/120 mm) can only be provided by gravel-pits, which means, that it is more expensive, there is a trade-off between costs and the reduction of mobility, and this optimizing may require further trial and error procedure. Coarsening of bed material below barrages (or dams) can also occur without augmentation of coarser material, leading to an armor layer (KONDOLF, 1997) and in this context it can be understood as a self regulation or adjustment process. In our river reach the potential of self-generated coarsening is not sufficient (as such an armour layer with maximum grain size diameter D_{max}~120 mm and a medium diameter $D_{50,D}$ of ~58 mm is too small to resist flows larger than ~1-year-floods; ZOTTL & ERBER, 1987).

The amounts M1, M2 and M3 for different temporal perspectives are given in Tab. 2.

component	present state	medium term scenario (initial stage)	long term scenario	Remark:
	~ 350'000 m^3/a ([a]	~ 350'000 m^3/a	~ 330'000 m^3/a ([d]	bedload transport capacity
M1 =	~ 190'000 m^3/a ([b]	~ 190'000 m^3/a	~ 80'000 m^3/a ([e]	~0/240 mm (D_{50}~25…30 mm) ([f]
M2 =	~ 50'000 m^3/a ([c]	~ 140'000 m^3/a	~ 230'000 m^3/a	0/120 mm (D_{50}~20…25 mm) ([g]
M3 =	0	~ 30'000 m^3/a	~ 40'000 m^3/a	16/120 mm (D_{50}~55 mm) ([h]
effect:	no balance, incision	balance, small excess		

[a]) … estimated value based on hydrographic findings (Klasz, 2014; Klasz et al., 2016);
[b]) … arithmetic mean, period: 1996 – 2010 (Klasz et al., 2013, 2016);
[c]) … recirculation by dredged bed material from maintenance dredging (viadonau); equivalent surplus volume (Klasz et al, in prep.), arithmetic mean (period: 2009 – 2016), resulting from a mean annual dredging volume of ~160'000 m^3/a and a mean upstream transport distance of ~6 km (see Sect. 5);
[d]) … slight reduction (estimation) by coarsening of bed material, widening the (bankfull) channel, and similar measures; Klasz (2014);
[e]) … taking into account, that the bedload output from the Wachau-section is about 60'000 … 100'000 m^3/a (estimated value), anyway less than 190'000 m^3/a; higher value for dredging in the past were obtained because there were larger deposits from the time before 1996;
[f]) … estimated grain-size distribution;
[g]) … grain-size distribution from bed material sampling (Zottl & Erber, 1987);
[h]) … grain-size distribution in order to compensate abrasion loss and to reduce mobility of surplus material, that is, to increase its efficiency, see Fig. 4 (Klasz, 2014);

Table 2: Components (amounts) of bedload management from KLASZ (2014, modified); M1= bedload (gravel) from upstream (at Krems, dredging in the upper part of the impoundment of hydropower plant Altenwörth); M2= recirculation of bedload (from the downstream end of the free-flowing reach); M3= additional gravel supply, coarser gravel and cobble fraction;

There are additional possibilities to reduce the bedload transport capacity of the channel (especially by channel widening and the reconnection of side-arms); however, the potential to optimize bedload management by such measures is relatively small, as they may worsen conditions for inland navigation (a decrease in available navigation depth at low water).

All measures should be implemented and integrated in an adaptive management framework (LINKOV et al., 2006), that is, monitoring, evaluation (efficiency control), modeling (planning) and implementation should form a feedback loop, including adaptive learning both as basic principle and surplus value.

Figure 3: Artificial gravel supply by hopper barges; process of dumping.

Current situation

In the study by KLASZ (2014) it is argued, that an increase of gravel augmentation related to the hydropower plant operator (VHP, see Sect. 3) should be decided and ordered by the water authority (considering the effects of the impoundments of all other hydropower plants upstream of Vienna and the cost-by-cause-principle) and based on Austrian Water Act (§21a, amendment of approval). Recently a working group was formed by the Austrian Ministry of Agriculture, Forestry, Environment and Water Management in order to discuss such open questions.

Since 2009 a first stage of bedload recirculation has been implemented by viadonau (waterway company for the Austrian Danube) as dredged material usually is transported and dumped some kilometers upstream (averaged over the period 2009-2016 about 160'000 m^3/a of dredged bed material has been transported ~6 km upstream; SIMONER, 2016; KLASZ et al., in prep.); in 2015 and 2016 these recirculations have been increased (SIMONER, 2016); however these measures are not regulated by law (until now) or contracted, which means, they could be stopped at any time. All in all we are close to a solution, but the problem is not yet solved completely.

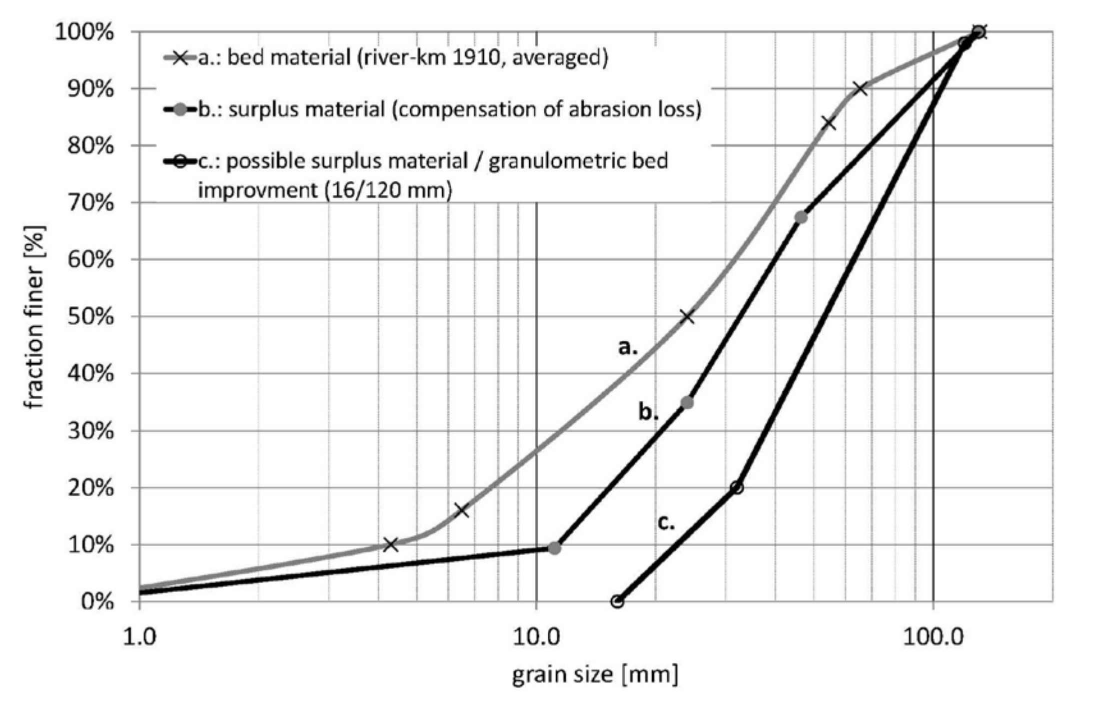

Figure 4: Grain-size distribution of bed material ('a.') and possible surplus material ('c.': a coarser gravel and cobble fraction, e.g. 16/120 mm, compensation of abrasion loss and additional coarsening, to decrease the intensity of transport); the grain-size distribution 'b.' exhibits minimum coarsening, to compensate for abrasion only; all data from KLASZ (2014)

Sisyphus, rolling stones forever. A basic question

'Maintenance', as an ongoing activity, is a necessary and unavoidable consequence of manmade technical measures and infrastructure, but not an inherent principle of 'nature'. In river management, maintenance can be understood as an indication of an existing deviation of the given state from a dynamic and natural equilibrium state. From conservation point of view, technical maintenance measures should not take the lead in the search for a solution, on the contrary, to minimize or to exclude human impacts.

In the case of the considered Danube River reach the situation is rendered even more difficult as the National park Donau-Auen has not been established in an area of 'untouched nature' (wilderness) but rather in an area that is subject to substantial pressure from many human influences in the area. This is particularly true for the Danube River reach itself which – connecting two large and growing cities (Vienna and Bratislava) – is burdened by the continuous river bed degradation, a legacy of the past, and by the current demands of river navigation and flood protection.

When intending to solve the existing problems, a fundamental dilemma becomes obvious: it is, that the desirable ecological improvements can only be achieved by permanent human interventions, that is, by an activity in accurately the sense of maintenance. Furthermore, the question emerges whether a permanent artificial bedload supply of such an extent and over unlimited duration ('rolling stones forever') can be seen to be truly compatible with the idea and requirements of a national park.
We cannot make a final judgement on that issue.

In 1942 Albert Camus wrote an essay, 'The Myth of Sisyphus'. Sisyphus has duped the gods, has put Death in chains. His punishment (rolling up a large stone up a hill, only to have it roll back down as soon as he reaches the top) will never end. There is no meaning. There is no sense. However: *'[…] I leave Sisyphus at the foot of the mountain! One always finds one's burden again. But Sisyphus teaches the higher fidelity that negates the gods and raises rocks. He, too, concludes that all is well. This universe henceforth without a master seems to him neither sterile nor futile. Each atom of that stone, each mineral flake of that night-filled mountain, in itself forms a world. The struggle itself toward the heights is enough to fill a man's heart. One must imagine Sisyphus happy'* (CAMUS, The Myth of Sisyphus).

Acknowledgment

This contribution is a spin-off of a study on bedload management in this river reach (KLASZ, 2014), which was funded by the Nationalpark Donau-Auen. We would also like to thank Markus Simoner (viadonau – Österreichische Wasserstraßengesellschaft mbH., head of team waterway management) for providing data and information on waterway management activities of viadonau and Roland Schmalfuss (Verbund Hydro Power GmbH) for data and information on bedload supply related to the hydropower plant Vienna-Freudenau and both colleagues for helpful discussion.

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Naturalness and conservation status of forest habitats in the National Park Hohe Tauern Salzburg (Austria)

Ralf Klosterhuber & Harald Vacik

Abstract

National Park Hohe Tauern is a protected area under the European Framework for nature conservation Natura 2000 and is internationally acknowledged by the IUCN. The protected area comprises the border region of the countries Carinthia, Tyrol and Salzburg along the Central Alpine crest covering 1.200 km² altogether. The proportion in Salzburg is 805 km², 16% of it covered by forests.

Knowledge about the natural tree species composition, the naturalness and the conservation status of the forest habitat types was scarce. For this reason the National Park Administration set up a project to address these issues in 2014 and to derive information about nature conservation tasks for the upcoming planning period.
The project was conducted by WLM Office for Vegetation Ecology and Environmental Planning (Innsbruck) and the Institute of Silviculture / University of Natural Resources and Life Sciences, Vienna

Keywords

Natura 2000 forest habitats, naturalness, indicators for conservation status

Introduction

The Natura 2000 site National Park Hohe Tauern in Salzburg comprises 13.800 hectares of forests. Based on a terrestrial sampling survey on forest vegetation, ecological site conditions, tree species composition and land use influences (i.e. forest management, grazing, game, tourism) the state of the respective habitat types could be investigated. 160 sample plots were examined, 30 among them were established as permanent monitoring plots for future assessments.

The project outputs are maps of the potential natural forest types derived from an empirical site model as a reference data basis for naturalness assessment. In comparison with the actual tree species composition based on a false color image interpretation the actual forest habitat types could be assigned. By intersection of both maps the degree of naturalness of the forest stands could be derived. The latter is key indicator for the naturalness assessment and the conservation status respectively.

This data basis allows conservation object oriented management activities as well as setting up research activities in the context of ecosystem development in relation to climate change, ecosystem services and biodiversity.

The research questions to answer:

- Mapping the potential natural forest types
- Mapping the actual forest habitat types based on a FCIR image interpretation
- Inference of the area-wide naturalness of tree species composition
- Forest habitat type description in a kind of ecological portfolio as a reference for National Park and forest management
- Assessment of the conservation status of forest habitat types based on a plot survey of 160 samples, 30 of them established as monitoring plots
- Assessment of the degree of forest function fulfillment according to the National Forest legislation
- Analysis of the degree of exploitation through forestry and pasturing
- Definition of nature conservation issues
- Proposal of management activities for the protection and development of the forest habitat types in the park area

Methods

The potential natural forest communities (e.g. potential forest types) was inferred by applying an empirical ecological site model based on terrain forms, geology, altitudinal belts and hygric positions in a GIS environment: The forest types are defined according to soil-specifics and vegetation characteristics. Forest types on acid soils, base-rich soils and calcareous soils were distinguished and correlated with the forest communities of Austria (MUCINA et al.1993).

The actual forest habitat types were inferred from actual tree species compositions derived from an FCIR image interpretation overlaid by the specific potential forest types. By defining thresholds for obligatory tree species in a respective habitat type the naturalness of the stands could be derived.
The conservation status of the habitat types was determined by applying the national guideline for assessing the conservation status of Natura 2000 habitat types (ELLMAUER 2005) concerning habitat specific indicators for tree species composition, structure, influences through pasturing, forest management, tourism and game (Table 2) on the basis of 160 sampling plots which were randomly distributed over a 200 m Grid net for the survey around the Park area.

The degree of exploitation by forest management was assessed via a GIS based model taking into account the distance to forest roads and terrain suitability for specific cutting and transportation techniques. Pasturing of the forest stands was derived from terrestrial mapping of pastures in the park area courtesy of Umweltbuero GmbH.

Results

The naturalness of the tree species composition of the forest habitats and the conservation status was assessed on the forest groups level for practical reasons. The natural forest groups are physiognomic and ecological units specified by principal tree species (Table 1) and are regarded to be a suitable level for conservation and forest management issues.
The naturalness of tree species composition could be mapped area-wide (Fig. 1), the conservation status was inferred statistically on the basis of 160 sampling plots (Fig. 3).

Forest group	%	**Forest group**	%	**Forest group**	%
Dwarf Pine shrubs	15,1	Subalpine Spruce forests	25,6	Beech forests	0,0
Green Elder shrubs	19,2	Montane Spruce forests	0,1	Sycamore forests	0,5
Stone Pine forests	9,6	Fir forests	19,0	Grey Alder forests	2,8
Larch forests	7,4	Spruce-Fir-Beech forests	0,3	Birch forests	0,2

Table 1: Natural forest groups and relative area (%) in the National Park Hohe Tauern Salzburg

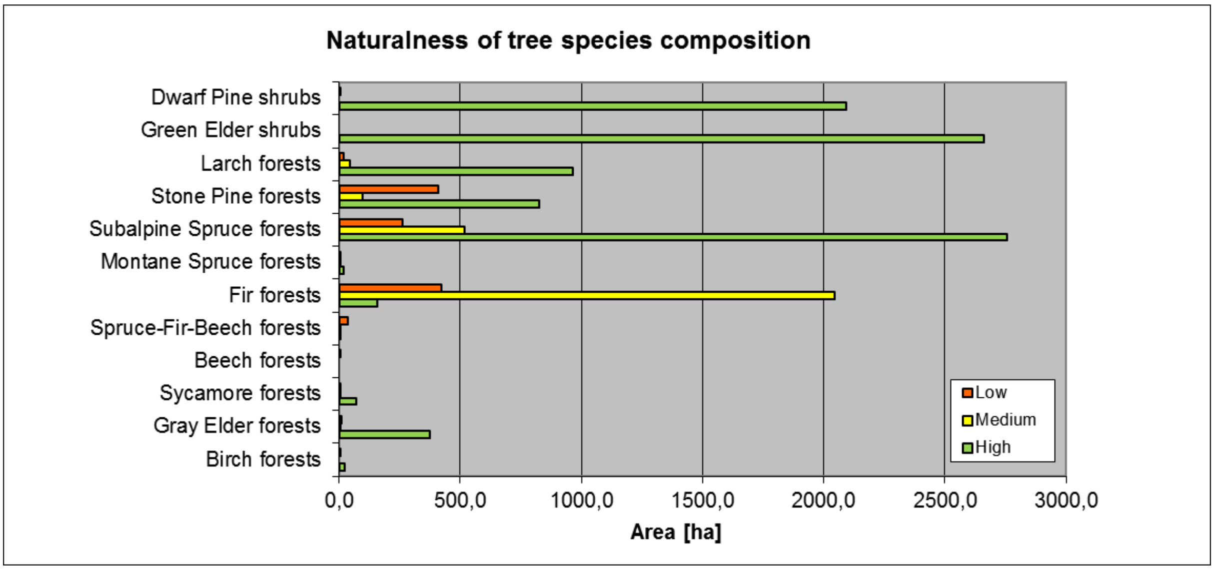

Figure 1: Absolute Area of Naturalness of tree species composition in the forest groups for the National Pak area

The naturalness of tree species composition was assigned in 3 levels: High – full correspondence of potential tree species composition and the actual abundance in the stand (ELLMAUER 2005). Medium – one obligatory tree species is missing or shift in proportions by 1 degree. Low – potentially dominant or subdominant species missing or not abundant.

The following indicators (Table 2) are considered for the conservation status of the habitat types in the levels A (excellent), B (good), C (intermediate/limited) for the Natura 2000 site.

Reflecting the indicators tree species composition and dead wood together with game influence determine the largest threats to the conservation status. About 25 to 31% are in limited state (see Fig. 2) On the other hand appropriate tree species composition can be found on 2/3 of the plots – mostly (94%) among Subalpine Spruce forests. The latter also show the most negative influence by game (36%) which does not impact the conservation status as much as in the Fir forests. The reason is that there are always enough Spruces for regeneration whereas Firs are affected considerably and extinguished for ages if there are no seed trees in the neighborhood.

Indicator	Description	Indicator	Description
Cover (FG)	Area of the stand covered by the habitat type	**Structure (St)**	Occurrence of stems of a least diameter per area
Tree species composition (BA)	Occurrence of natural tree species of the habitat type in the actual stand	**Forestry exploitation (Nu)**	Degree of lumbering
Dead wood (TH)	Volume of dead wood over a certain diameter per area	**Disturbance (SZ)**	Disturbance due to grazing indicated by specific plants
Influence of game (WE)	Damage on branches, stems caused by game	**Hydrological impacts (HY)**	Artificial alteration of water flow along rivers

Table 2: Indicators for the conservation status

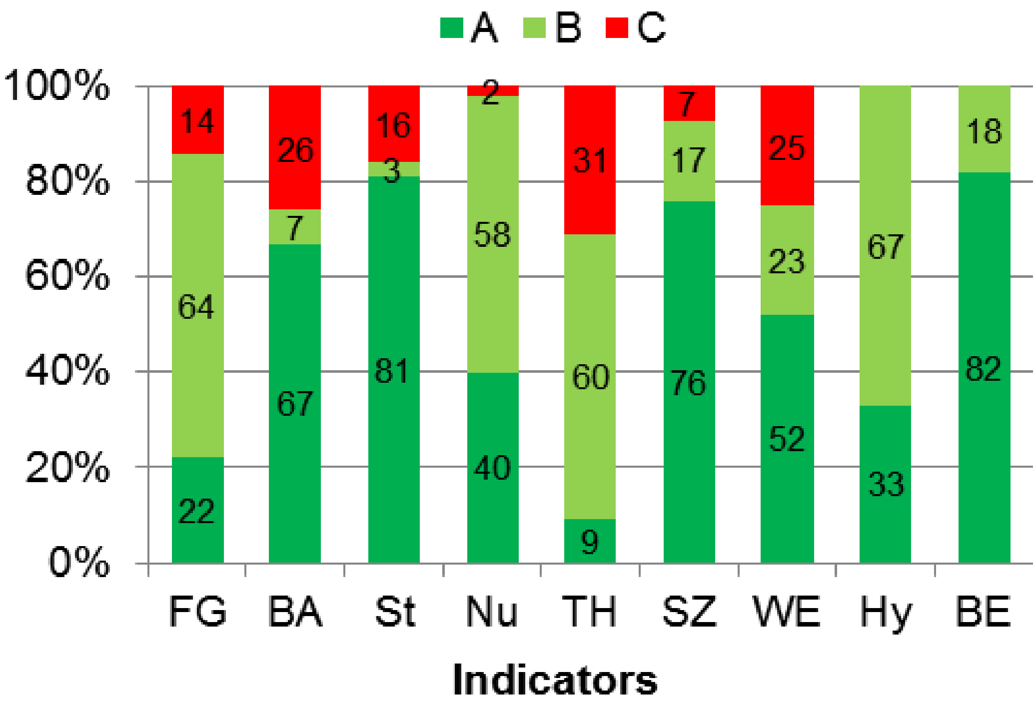

Figure 2: Overall assessment of the indicators for the conservation status suggested by Ellmauer (2005)

Reflecting the forest groups the conservation status is rather different. Stone Pine forests comprise most of the plots with excellent status, Subalpine Spruce forests show the fewest samples with limited conservation status. The deficits are strikingly significant among the Fir forests due to the missing Fir as the essential tree species. 84% are in limited status. The reason can be identified through the vast exploitation of the forests in former times for mining and salt production. Recently high game stocks prevent the sensitive young Firs from establishing in the stands. Despite the Kötschach valley near Gastein European Fir is missing or restricted to relicts. To re-establish Fir in the National Park will be the challenge for future forest and Park management. Globally there are about the same proportions of the respective 3 conservation states. (Fig. 3)

Discussion

The statistical results of the conservation status gives insight into the influences and threats on the forest habitat types derived by the indicators examined on 160 plots. The indicators allow to identify the impacts on the habitats and consequently the measures to be taken in order to improve this status or conserve it as demanded by the Natura 2000 legislation of the European Union. The samples are not sufficient to derive impacts on the forests for a single valley, specific zones or even on stand level but they give an overall insight in what is favorable for naturalness of the habitats and what is not.

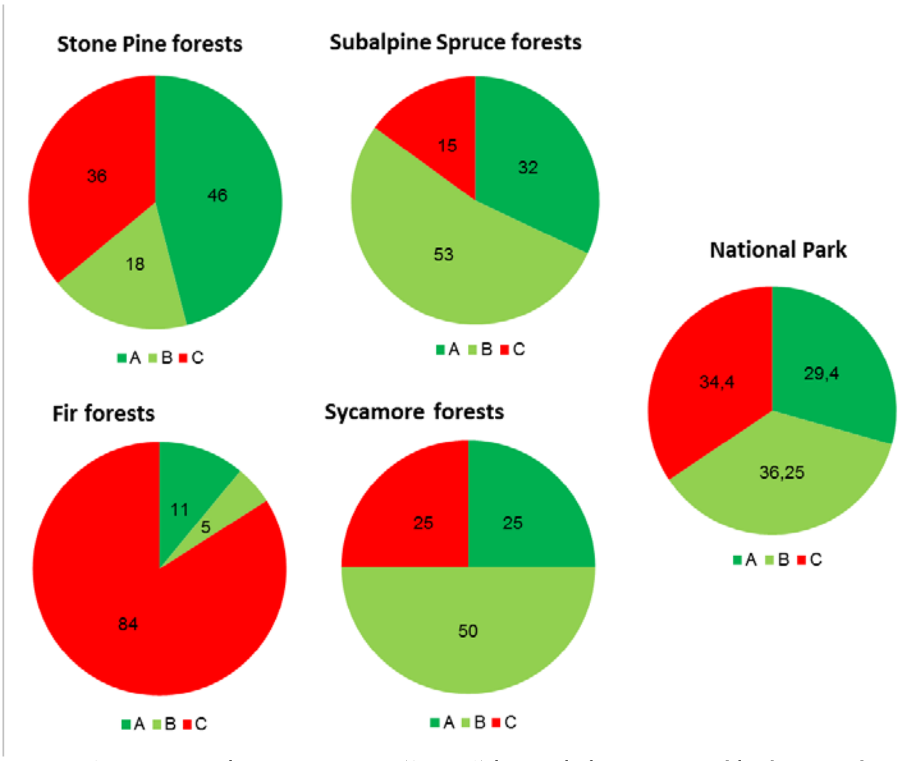

Figure 3: Percentages of conservation status (A, B or C) for specific forest groups and for the National Park out of a sample of 160 plots

Conclusion

The analysis of the conservation status is a kind of traffic light to watch and to consider action to be taken for an appropriate management of the respective habitats. The monitoring plots were designed to repeat the terrestrial survey in 15-20 years time in order to monitor the change of impacts reflected by the investigated indicators.

In addition it is recommended to set up activities in the most affected forest habitat types – so to say to put an eye on the remaining Fir forests in Kötschachtal, and on the seed trees and stands in Untersulzbachtal, Habachtal, Hollersbachtal and Seidlwinkltal.

A second priority is the conservation of rare and prioritory forest habitat types (European Commission 1992) such as the Sycamore forests (habitat type 9180 Tilio-Acerion forests) on screes and in ravines and the Gray Elder forests along rivers and on erosive slopes (habitat type 91E0) which nevertheless show a significant occurrence in the National Park Hohe Tauern Salzburg. Consequently Salzburg and the Park administration have the responsibility to keep or restore them in an excellent conservation status.

The maps and GIS data on the conservation issues provide the geographical information for management activities. The portfolios for the forest type groups convey the essential information on how to treat the respective habitats appropriately according to conservation and forest management objectives.

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Seasonal patterns of food use of wild boar (*Sus scrofa L.*) in a Central European floodplain forest

Elisabeth Knapp & Christian H. Schulze

Abstract

Wild boar populations are rising all over the world. This also counts for the Donau-Auen National Park (DANP). The aim of this study was to analyze seasonal and spatial changes in wild boars' diet in the DANP, the largest remaining floodplain forest in Central Europe. We analyzed the stomach contents of 242 wild boars shot in the DANP for regulation reasons. Plant matter (e.g. crops) proved being the most important food, while animal diet was negligible. Diet composition most likely was affected by management measures and/or human disturbance. A more natural feeding behavior of wild boars could only be achieved when reducing baiting. However, this may reduce regulation success, resulting in a population increase with potential negative impacts (e.g. on floodplain forest vegetation, increased crop raiding).

Key words

Diet, Donau-Auen National Park, Protected Areas, Wetlands, Austria

Introduction

Wild boars are omnivorous generalists, opportunistic and very flexible in their food selection. Hence, the food found in wild boars' stomachs often reflects the availability of food items. Consequently, there are seasonal differences in food use. Wild boars can also have a strong impact on animal species of high conservation relevance.

The aim of this study was to quantify seasonal changes in wild boars body condition and spatio-temporal differences in diet use in the DANP. Therefore, we analyzed stomach contents from 242 wild boars shot in the Donau-Auen National Park (DANP) between February 2015 and February 2016.

<u>Our hypotheses are:</u>

(H1) Adult wild boars show seasonal changes in body condition due to seasonally changing food availability.
(H2) Diet composition and diet breadth of wild boars varies between the seasons.
(H3) Wild boars' food composition and diet breadth are affected by management measures differing between study sites.
(H4) The high density of wild boars in the DANP might represent a potential conversation problem due to negative effects on the native herpetofauna.

Methods

The study was conducted in the DANP east of Vienna, Austria. We defined six study sites with almost the same size, two in the Viennese part (Lobau) and four in the Lower Austrian part of the national park. In total 242 wild boars' stomach contents have been analyzed (Lobau: n = 144; Lower Austria: n = 98). As no wild boars were shot in the Lower Austrian part between February and October, comparisons between stomach contents of wild boars between the Lobau and the Lower Austrian part of the DANP only consider the period November 2015-January 2016.
The fullness of the stomachs and the percentage volume of food items were estimated in percentage. Body condition was quantified for all adults by regressing body mass on body length. The residuals from this regression were used as an index of body condition.

Results

<u>Seasonal changes in stomach fullness and body condition</u>

Fullness of stomachs differed between months but was not related to body weight. Body condition proved being significantly affected by seasons. A distinct peak of higher body condition was found in October and November.

<u>Seasonal Changes in diet composition and diet breadth</u>

Food composition differed between all seasons. In winter Levin's Index of diet breath was highest followed by autumn. Plant material (94% mean relative volume) represented the most important food matter of wild boars' diet (Tab. 1).

Food category	Spring	Summer	Autumn	Winter	Total	Frequency
Plant matter	**94.2±12.1**	**93.3±9.4**	**94.6±9.2**	**93.3±13.8**	**94.0±11.5**	**100.0**
Maize/Crop	36.1±33.8	40.9±33.9	38.3±33.9	27.4±31.8	36.8±34.1	81.1
Grass/ Herbaceous Pl.	38.3±34.1	31.8±31.2	25.8±28.8	29.9±31.0	33.3±31.3	88.8
Fruits/Nuts/Beechnut	6.7±18.0	9.2±21.2	12.0±20.8	14.3±26.6	10.7±21.6	37.8
Root Tuber	11.0±24.9	8.0±22.7	12.2±26.4	19.7±31.5	9.0±21.9	23.1
Acorn	0.6±4.1	2.1±7.2	3.8±10.5	–	2.3±8.4	11.2
Mistletoe	0.4±1.8	0.3±1.9	0.5±2.2	0.4±1.4	0.5±2.0	6.3
Root	1.0±4.1	0.9±4.0	2.1±5.9	1.6±3.0	1.5±4.7	16.8
Animal matter	**4.7±11.0**	**5.6±8.0**	**3.5±6.9**	**2.7±5.4**	**4.4±9.3**	**44.1**
Vertebrate	1.3±5.4	0.7±2.8	0.8±3.0	1.3±3.3	1.1±4.3	18.2
Bird	–	–	–	0.5±2.7	0.1±1.3	1.4
Amphibian	–	–	–	0.3±1.8	0.1±0.8	0.7
Carrion	1.3±5.4	0.7±2.8	0.8±3.0	0.6±1.5	0.9±4.1	16.1
Invertebrate	3.4±7.3	4.8±7.8	2.7±6.5	1.3±4.0	3.3±7.0	32.2
Snail	2.9±6.3	3.6±6.4	1.7±4.5	0.4±1.8	2.4±5.5	25.9
Earthworm	0.2±1.0	0.8±2.6	0.7±2.5	0.5±2.0	0.6±2.1	10.5
Terr. arthropod	0.3±1.1	0.4±1.9	0.3±1.8	0.3±1.8	0.3±1.7	8.4
Other matter	**0.8±4.4**	**0.8±4.4**	**1.6±5.7**	**4.0±10.9**	**1.5±6.1**	**8.4**
Soil	0.6±3.7	0.6±3.7	1.3±5.3	3.4±10.5	1.3±5.9	7.7
Other	0.3±2.4	0.3±2.4	0.3±2.3	0.6±3.5	0.1±1.7	0.7

Table 1: Mean relative volume (%) of food types in different seasons in stomach contents of Viennese wild boars.

Regional differences in food use and food composition

Animals shot in the Lobau in November 2015 until January 2016 had slightly different stomach contents than wild boars shot in the Lower Austrian part during the same period. Further, the Levin's Index of wild boar diet breadth was higher in Lower Austria than in Vienna.

Discussion

Our study shows a great seasonal variation in fullness of stomachs and body condition of wild boars, indicating better food availability in the autumn and winter months, hence perhaps reflecting the mild winter during the study year. In other studies the mean stomach content was greatest in summer (e.g. Poland: GENOV 1981). No relation between stomach fullness and body weight and body condition respectively could neither be found by our nor by other studies (ASAHI 1995; CELLINA 2008). Wild boars' body condition differed significantly between seasons with a distinct peak in October and November. That wild boars were capable of maintaining a relatively high body condition in our study area even during the winter months may have been also caused by the warm and mild winter 2015/2016.

In our study seasonal changes in food use were visible especially in the consumption of fruits, acorns and root tubers and in the use of animal food. Crops including maize were the most important food types found, occurring in 81 % of the analyzed wild boar stomachs in the Lobau with the highest amount in summer. For wild boars maize is a very attractive food source (GENOV 1981), hence it is used often for supplementary feeding. To control the wild boar population, maize and other crops are also used in the DANP as bait by hunters. In our study we had a very low standardized Levin's Index value year around (Ba about 0.2), indicating a small diet breadth all over the year (MASSEI et al. 1996).

Food compositions during late autumn and winter differed between the two federal states was identified. In Vienna crop, including maize and wheat, are used for baiting and hence represented the most important food items. In Lower Austria grass and herbaceous plants are most important, while maize and other crops played only a subordinate role in wild boars' diet. A possible explanation could be that in Lower Austria, contrary to Vienna, more than the half of the shot wild boars were not hunted with baiting. Additionally, the results of the standardized Levins Index of the study sites in Vienna was under 0.2, while the study sites in Lower Austria reached a value of Ba>0.2.

Wild boars can have negative effects on the native herpetofauna (JOLLEY et al. 2010; KRULL & EGETER 2016) and can represent important predators of bird nestlings and nests (CARPIO et al. 2016; OJA et al. 2015; SENSERINI & SANTILLI 2016). In contradiction to results of other studies these food types did not contribute substantially to the diet of wild boars in the DANP. In 242 analyzed stomachs only one frog and two times remains of birds were found.

Our data indicates that a more natural feeding behavior of wild boars in DANP could only be achieved when reducing baiting. However, this may reduce regulation success and subsequently may result in an increase of the wild boar population. Considering the potential negative impact of higher wild boar densities in the DANP (e.g. on the vegetation of the floodplain forest) and an increase of crop raiding individuals in agricultural areas adjacent to the park border, further studies evaluating different scenarios are urgently required before modifying the current management measures to control the park's wild boar population.

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Park-labelled products as a tool for innovation and regional development

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Keywords

label, labelled products, protected area, park, innovation, economic development, conservation, Biosphere Reserve

Summary

Protected areas and their management bodies are increasingly confronted with exigencies that go beyond their traditional scope of activities: Besides nature conservation, they are expected to contribute to social and economic development in their regions (BORRINI-FEYERABEND et al. 2013). This trend drives protected area managements from unifunctional conservation approaches to multifunctional approaches with measures offering intended positive outcomes for nature, society and economy equally. These changing requirements apply to Nature parks and UNESCO Biosphere Reserves in particular, but also to National parks and UNESCO world heritage sites (hereinafter parks).

A traditional, well established and successful approach to foster development in parks is nature-based tourism. Its economic impact is well documented, e.g. for National parks worldwide, the economic impact is estimated at US$ 600 billion per year (BALMFORD et al. 2015), for UNESCO Biosphere Reserves in Germany, the impact ranges from US$ 6 to 275 million per year (Job et al. 2013). Tourism can, hence, contribute to the livelihoods of many people in and adjacent to these regions. This development approach has, however, a clear economic focus and is therefore rather unifunctional, i.e. cultural and natural assets being the object but not the subject of the measures implemented.

Figure 1: Park-labelled products originating from the UNESCO Biosphere Reserve Entlebuch. © UNESCO Biosphäre Entlebuch and Coop Schweiz.

A different and more recent approach to foster regional development is sought by labelling products originating from a park (Fig. 1). They are sold in- and outside of the park-region to customers that are willing to pay a surcharge for products with known origin and quality. In the park-region, these products can have multiple positive implications:

1. The additional sales volumes achieved through the labelled products lead to an economic added value in the park-region that translates into jobs: For the UNESCO Biosphere Reserve Entlebuch (Switzerland), the only available data so far, park-labelled products generate a remarkable gross added value of US$ 5.8 million in 2014, corresponding to 4% of the jobs in agriculture and forestry or to ca. 1% of all the jobs in the park-region (KNAUS et al. 2017). For the UNESCO Biosphere Reserve Rhön (Germany), KRAUS et al. (2014) further found a strengthening of the regional added-value chains induced by park-labelled products, i.e. producers use a higher share and hence increase the demand of intermediate inputs originating from within the park-region.

2. Triggering the demand for intermediate inputs and raw material in the mostly rural park-regions safeguards farms and small forestry businesses that form still an essential part of the rural life and culture. Hence, by stimulating the economy, park-labelled products also adopt a social or cultural function.

3. Producing goods with resources from the park will on one hand side preserve the type of goods being traditionally produced in the park-region and hence safeguard to some extent the cultural heritage. On the other hand side, innovations refining traditional products will smoothly transform them to novel types of products that may be more compatible to current and future customer preferences opening up additional market opportunities.

4. By implementing strict standards in their production (e.g. organic or wildlife-friendly farming), park-labelled products can have a direct influence on land use practices of farmers, foresters, etc., and hence, can contribute to conservation or sustainability goals of the park itself.

5. Persons involved in the production of labelled products develop a close network and solidarity between each other and establish a deep attachment to their products supporting both regional identity and social values (KRAUS et al. 2014).

These various implications show that park-labelled products entail many positive effects for economy, nature, culture and society, and hence, offer the potential for a true multifunctional development approach (KNICKEL & RENTING 2002) as requested above. Establishing successfully park-labelled products is, however, a complex and lengthy task. It requires a continuous process, supported by the park-management, that builds up trust, credibility and identity among the producers and the customers (KNAUS et al. 2017). Furthermore, the products need to be successfully placed on the market, and the consumers need to know and believe in the positive aspects of the product, which requires solid PR and education (KRAUS et al. 2014). Promoting labelled products can have disadvantages as well, i.e. through a higher dependence of producers on local suppliers or through longer transport distances of intermediate inputs that are not available in the right quality in the park-region (KRAUS et al. 2014).

Nevertheless, taking into account the multiple positive impacts of park-labelled products for nature, economy and society, as well as their potential as a positivistic medium for communication with stakeholders inside and outside the park, they can be considered as a truly advantageous tool for parks and their managements.

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Development of Hybrid Poplar Stands in the Donau-Auen National Park (Austria)

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Abstract

Hybrid poplars (*Populus ×canadensis*) are mainly the cross product of the native *Populus nigra* (male) and the North American *P. deltoides* (female). Since the 1860's these trees have been planted in the area of the Donau-Auen National Park. Advantages of *Populus ×canadensis* trees are their resistance against diseases, their fast and erect growth as well as their tolerance of water deficiency and their good propagation properties. Certainly hybrid poplars represent a danger for the biodiversity of the national park: Because of the fact that one parent is native in the Austrian flora, hybrids of *Populus ×canadensis* and *P. nigra* can occur under natural conditions. Up to ten percent of *P. nigra* seedlings already contain hybrid poplar genes. Other risks are the high infection rate of *Viscum album* and the interspecific competition. Hybrid poplars were introduced to Austria after 1492 and are therefore classified as neophytes.

Usually *Populus ×canadensis* are harvested 30 to 40 years after planting, which isn't the case here since the national park was established in 1996. Since then the hybrid poplar stands have been left on their own. The developments of these stands were observed with vegetation relevés (method after Braun-Blanquet) and tree inventories.

In this study 100 plots were observed to describe the development trends of the hybrid poplar stands.
The results show that older plantations contain more (native) species and less (invasive) neophytes. The hybrid poplar stands can be classified in two vegetation groups. The second one is richer in species and could be the product of the abolishment of forestry.

This study suggests to leave the hybrid poplar plantations as they are. They seem to develop in the direction of natural forest stands.

Keywords

Populus ×canadensis, hybrid poplar, development, national park, floodplain forest, neophyte

Introduction

Populus ×canadensis, family *Salicaceae*, is the crossing product of *Populus nigra* (male) and the North American *P. deltoides* (female) (Heinze 1998; Vanden Broeck et al. 2004; Zsuffa 1973). These plants were firstly cultivated in France (the first description of a hybrid was written in 1775; Zsuffa 1973). Since 1860 the hybrid poplars were planted in the area of the Donau-Auen National Park (Jelem 1974). In the 1970's the Regelsbrunner Au had a very good reputation as a very excellent hybrid poplar forest enterprise. Usually *Populus ×canadensis* were used after 30 to 40 years (Eichelmann 1995).

Since the establishment of the Donau-Auen National Park the hybrid poplar stands were left as they were. Just some management for a faster re-establishment of native tree species was done. The so called 'Keimzellen' (germination cells) are clear-cuttings with max. 0.5 ha which were planted with native and typical tree species (e.g. *Populus alba*, *Fraxinus excelsior*, *Quercus robur*). Through this method around 20% of the hybrid poplar stands could be eliminated from 2002 until 2010 (Oitzinger & Kovacs 2010).

Today around 13% (Lower Austria) and 11% (Vienna) of the area of the Donau-Auen National Park still contain *Populus ×canadensis*.

Problems with this tree species are the fact that they are neophytes, the interspecific competition and the high degree of *Viscum album* growing on them. The largest problem though is the introgression with the native *Populus nigra*.

Methods

The sampling points were located along the inventory monitoring points of the Austrian Federal Forests (Österreichische Bundesforste – ÖBf). Via GIS (ArcMap 10.3; © Esri 2015) points where the hybrid poplars had a minimum content of 80% of the tree species were selected. Of 119 sampling points in Lower Austria and seven sampling points in Vienna 79 sampling points in hybrid poplar stands were randomly chosen and vegetation surveys were done. The inventory monitoring points of the ÖBf were located via GPS in the field and plots of 20 x 20 meters were surveyed (vegetation with Braun-Blanquet values (Tremp 2005), tree inventory (height, BHD, vitality) as well as the amount of dead wood). With GIS the distances to the next water body, path and 'Keimzelle' were measured. The same procedure was done with 21 'Keimzellen' in Lower Austria.
The data from the field and the GIS were analyzed using SPSS 22 (© IBM 1989, 2013) and JUICE 7.0.102 (© L. Tichý 1999-2010; Twinspan and indicator values according to Ellenberg).

Results

In total 79 hybrid poplar stands and 21 'Keimzellen' were surveyed. The division into stand age and percentage of *Populus ×canadensis* content is shown in Table 1.

	0%	**80%**	**90%**	**100%**	**sum**
0-15 years ('Keimzellen')	21	0	0	0	21
20-39 years (AC 1)	0	2	2	8	12
40-49 years (AC 2)	0	3	17	13	33
50-59 years (AC 3)	0	7	8	8	23
60-81 Jahre (AC 4)	0	0	2	9	11
sum	21	12	29	38	100

Table 1: Distribution of the difference age classes (AC) and the percentage of hybrid poplars of the 100 sampling points.

According to the different age classes it could be shown that in higher age classes (age class 2 to 4) more species occur. This increase is due to native plant species. Native species rise from an average value of 13.33 (SD = 4.99) to 17.73 (SD = 7.09). Neophytes increase less (age class 2: 2.85 in average (SD = 1.20); age class 4: 4.18 (SD = 1.40)). If just the age classes 2 and 4 are compared neophytes reduce to a difference of -0.40 (significance proven with a Kruskal-Wallis one-way analysis of variance: $p = 0.006$) and native plant species higher to a difference of +2.23.

This can be shown even better, if you have a look at the coverage of native and non-native plant species. The neophytes in the shrub layer decrease from age class 2 (average: 17.42%, SD = 20.71) to age class 4 (average: 7.55%, SD = 11.59). The development of the neophytes in the different age classes is shown in Figure 1.

The Shannon-Wiener index (diversity index) was calculated and has a significant increase with the age classes (Spearman's rank correlation coefficient = 0.244; $p = 0.030$). The older the plantations the higher was the biodiversity of the forest stands.

The TWINSPAN analysis divided the *Populus ×canadensis* stands into two groups.
Group 1 (includes 17 sampling points, 6 subdivisions) had only hybrid poplars in the tree layer 1. There is almost no second tree layer and the herb layer had a very low diversity (mainly consisting of *Urtica dioica*, *Rubus caesisus*, *Phalaris arundinacea* and *Phragmites australis*).

The second group (Group 2) had often *Fraxinus excelsior* and *Populus alba* in the tree layer 1, the tree layer 2 is more often present. The herb layer is more divers and also woody plants reproduce here.
The difference in the amount of plant species in the two groups is in average 17.35 and 19.50 in group 1 and 2, but this result was not significant (Mann-Whitney U test: $p = 0.373$).

Significant differences between the two groups can be shown in the different layers: The species amount for example is significantly higher in group 2 (Mann-Whitney U test: $p = 0.003$).

The indicator values according to Ellenberg showed significant difference in the humidity and light parameters. Hybrid poplar stands in group 2 are shadier and drier than the forest stands in group 2. Hybrid poplars from group 2 are less vital (Mann-Whitney U test: $p = 0.019$).

‘Keimzellen’ were divided into two age classes (established before 2010: 12 sampling plots and after 2010: 9 sampling plots). The most interesting results here are the differences in the amount and coverage of species (native and non-native) and the correlation with the indicator values according to Ellenberg.

‘Keimzellen’ established before 2010 had a higher number of species (26.67 in average compared to 22.42), but also a higher number of neophytes (4.44 in average compared to 3.67). In the tree layer 2 and in the herb layer these results were significant (tree layer 2: Mann-Whitney U test: p = 0.030; herb layer: Mann-Whitney U test: = 0.044).

Correlations between the number of native plant species and the indicator values according to Ellenberg showed significant results: The lighter the ‘Keimzelle’ is, the more neophytes occour (Spearman's rank correlation coefficient = -0.526; p = 0.014).

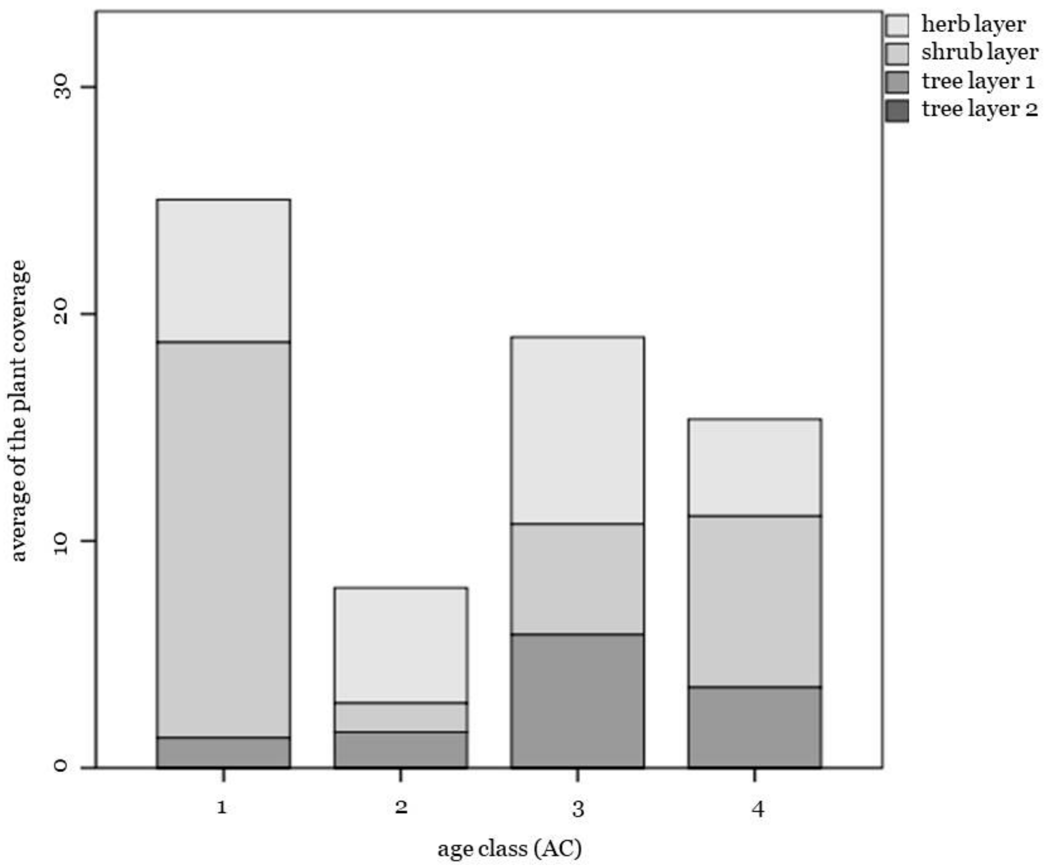

Figure 1: Coverage of the neophytes in the different plant layers and age classes.

Discussion

The older the hybrid poplar stands are, the richer they get in species diversity. This increase is due to the higher number of native plant species. The number of species is less than in other studies (DELARZE & CIARDO 2002; ZERBE 2003). That hybrid poplar stands are generally poorer in the number of plant species is also shown by HÄRDTLE et al. 1996 (in BARSIG 2004), DIETRICH (2011) and STARFINGER & KOWARIK (2011). The increase of the Shannon-Wiener index shows that this increase is due to an equal increase of more than just a few species.
DIETRICH (2011) showed similar results according to the neophyte occurrence: Neophytes don’t appear more often in hybrid poplar stands.

According to the two groups of hybrid poplar forest stands it can be said that the more abundant group 2 forest stands are more divers in species, shadier and drier than the sampling points in group 1. Group 1 has similarities with other *Populus ×canadensis* stands – *Urtica dioica*, *Rubus* sp., *Phalaris arundinacea* for example are very common plant species in these kind of plantations (HIMMLER & RÖMMLER 2001 in BARSIG 2004; ZERBE 2003). Group 2 could be the result of the protection of natural processes in the Donau-Auen Nationalpark.

The influence of ‘Keimzellen’ according to the reproduction of tree species in hybrid poplar stands was not shown. Therefore, the planted trees in the ‘Keimzellen’ might be too young to reproduce now. The number of species decreases while the number of neophytes increases with the age of the ‘Keimzellen’.

Conclusion

Due to the results it can be said that non-intervention is a good way to cope with hybrid poplar stands. The vitality decreases, the number of native and typical plant species increases with the age of the plantations. The opposite is the case in the managed 'Keimzellen'.

The fact that the introgression with the native *Populus nigra* is not higher than is was in 2005 (GNEUSS 2005; Micek 2017), as well as the non-intervention philosophy of the national park, tightens this strategy too.

Therefore the recommendation for the Donau-Auen National Park is to leave the stands as they are and let nature conquer back the space for the natural vegetation.

German Download available at:
https://infothek.donauauen.at/fileadmin/Infothek/2_WissenschaftlPublikationen/21_WissenschaftlicheReihe/10414_NPDA_39_2015_Knoll_Bestandsentwicklung_Hybridpappelforste_NP_Donau-Auen.pdf

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Abstract

The Austrian Man and the Biosphere (MAB) Programme is financed by the Ministry for Science, Research and Economy (BMWFW) and administered by a National Committee established at the Austrian Academy of Sciences (ÖAW). The MAB Committee, responsible for Austrian biosphere reserves (BRs), was endowed with a separate research budget from its start in the year 1973. This budget allows the Committee not just to identify research gaps in BRs but to fill them with appropriate research projects. Overall, the Committee, has funded countless research projects in the four decades of its existence.

Keywords

Man and the Biosphere, UNESCO, biosphere reserves

MAB National Committee

In 2013, the Austrian MAB Programme, funded by the Federal Ministry for Science, Research and Economy (BMWFW) and coordinated by a national committee at the Austrian Academy of Sciences (ÖAW), celebrated its 40th anniversary, making it one of the longest existing national MAB committees (Köck 2014).

From the start, the National Committee was endowed with a separate research budget. This budget allows the committee not just to identify research gaps but to fill them with appropriate projects. The committee, made up of acclaimed scientists, plus representatives of ministries and federal organizations, the Austrian UNESCO Commission and NGOs, monitors the Austrian research scene, analyses research needs, formulates new research strategies and encourages as well as funds research projects. The Committee advises and supports biosphere reserve managements on scientific and technical issues and provides the link to the MAB Secretariat in Paris. It is also responsible for any submission to UNESCO of an area as a biosphere reserve as well as for enforcing the UNESCO standards.

The evolution of the MAB Programme made a revision of the 'National Criteria for BRs in Austria' necessary. Ten years after the launch of the criteria catalogue in 2006 the Austrian MAB Committee has updated the catalogue in line with the new MAB Strategy 2015-2025. In December 2015 the updated version of the National Criteria was adopted by the members of MAB Committee (http://www.biosphaerenparks.at/index.php/en/national-criteria).

Biosphere Reserves (BRs) in Austria

Until 2014 Austria had a total number of seven BRs (including four pre-Seville sites). However, after non-successful 're-designing' initiatives for the four 'first-generation' sites, the Committee decided to remove four BRs ('Gossenköllesee' and 'Gurgler Kamm' in 2014; 'Untere Lobau' and 'Neusiedlersee' in 2016) from the World Network of Biosphere Reserves (WNBR) because of their non-compliance with the Statutory Framework of the WNBR (Köck & Arnberger 2017). At present, Austria has three well-functioning BRs which comply with the Seville Strategy.

<u>BR Großes Walsertal</u>

(approved 2000)
Size 19.200 hectares
Population: 3,400
Zonation: 20 % Core zone, 65 % Buffer zone, 15 % Transition area

<u>BR Wienerwald</u>

(approved 2005)
Size 106.645 hectares
Population: 815.000
Zonation: 5 % Core zone, 19 % Buffer zone, 76 % Transition area

BR Salzburger Lungau und Kärntner Nockberge

(approved 2012)
Size 151.969 hectares
Population: 34,000
Zonation: 5.6 % Core zone, 37,8 % Buffer zone, 56,6 % Transition area

Research

For the last 15 years, the Austrian MAB Committee has focused its research increasingly on studies in and for national BRs. Since 2005 some 3 million euros have been invested in research projects. In October 2016 the MAB Committee has launched a new call for research projects including cooperative projects with foreign partners.
Currently five research projects are being funded:

– A. KRATZER (University of Innsbruck): Experimental networks for sustainability: Urban Biosphere Reserves as engines of transitions (ENESUS)
– T. WRBKA (University of Vienna): Biosphere Reserve Integrated Monitoring based on Social and Environmental ecosystem services (BRIMSEN)
– R. EDER (University of Natural Resources and Life Sciences Vienna): Perception and Reality of Recreational User Conflicts in the UNESCO Wienerwald Biosphere Reserve (UserConflicts)
– P. PETRIDIS (Institute of Social Ecology Vienna): Samothraki as a Biosphere Reserve: Securing continuity of science-civil society collaboration in a systemic design (SamoMAB)
– C. R. VOGL (University of Natural Resources and Life Sciences Vienna): Lessons Learned for the Management Policy of the Biosphere Reserve 'Oxapampa-Ashaninka-Yanesha' (Peru) based upon the inhabitants' local knowledge and available global scientific knowledge (AGROBIO-K_NOW)

Two of these new projects include cooperation with BRs or BR candidates in Peru, Brazil, Greece, United Kingdom and Spain.

An additional MAB research project is funded through the ESS research initiative:

– T. FRANK (University of Natural Resources and Life Sciences Vienna): Alpine landscapes under global change - Impacts of land-use change on ecosystem services and human health and well-being (Healthy Alps)

Nearly all project reports from research projects funded by the MAB National Committee are published online in successful cooperation with the Austrian Academy of Sciences Press. At present, some 28 MAB project reports can be downloaded from the homepage of the Austrian Academy of Sciences Press (http://epub.oeaw.ac.at/Projektberichte). Moreover, numerous scientific papers are created within research projects funded by the MAB National Committee and published in scientific journals and in books. A selection of the open access publications can be downloaded here: http://www.biosphaerenparks.at/index.php/en/selected-open-access-papers.

Additional Activities

The Austrian MAB Committee financially supports various research-related UNESCO-MAB activities, e.g. additional MAB Young Scientist Awards and the production of the MAB Activity Reports 2013 - 2014 and 2015 – 2016 (CÁRDENAS TOMAŽIČ et al. 2015, 2016). The Committee also produces acclaimed books, e.g. the White Paper of Austrian BRs, Inspired by Diversity (LANGE 2005), the award-winning volume on Austrian environmental research, Planet Austria (KÖCK et al. 2009), the Austrian contribution to the 40th anniversary of the international MAB programme, Biosphere Reserves in the Mountains of the World: Excellence in the Clouds (AUSTRIAN MAB -NC 2011), the book on Chilean BRs, Reservas de la Biosfera de Chile Laboratorios para la Sustentabilidad (MOREIRA-MUÑOZ. & BORSDORF 2014), as well as the cookbook of Austrian BRs, A Connoisseur´s World – The Austrian Biosphere Reserves (KÖCK et al. 2011, 2013), which also won an award (KÖCK & GRABHERR 2014).

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Wilderness preserved? Representation of wild land within Austria's network of protected areas

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Abstract

Based on previous studies we present a spatially explicit wilderness assessment for Austria. Using GIS-techniques, we have identified areas which still show features typical for wilderness and wild areas, here collectively referred to as 'wild land'. A total of 586,178 hectares (7% of the national territory) qualifies as wild land, all of it is located in the Alps, mostly at high altitudes. There are 39 patches larger than 1,000 hectares, adding up to 473,503 hectares. Only 40% of the remaining wild land enjoys effective protection, especially in National Parks and in the Tyrolean 'Quiet Areas'. We therefore propose 1.) a significant expansion of 'Quiet Areas' to provide basic protection to the remaining wild land and 2.) the establishment of additional wilderness areas (IUCN protected area-category Ib) to secure the wildest and most valuable patches.

Keywords

wilderness, wild areas, protected areas, gap analysis, Austria

Introduction

In recent years, wilderness preservation and restoration have received increasing attention in European nature conservation (Wild Europe 2013, Sylvén & Widstrand 2015, Pereira & Navarro 2015, Bastmeijer 2016). Ongoing, fundamental changes in land use, rapid urbanisation, dwindling spatial resources and a deepening gap between modern agriculture and forestry on the one hand, and biodiversity conservation on the other, have led conservationists to a higher esteem for landscapes and ecosystems that are still predominantly shaped by natural processes. The natural heritage of Europe is no longer perceived as consisting exclusively of man-made cultural landscapes: the importance of remaining wild lands is acknowledged as well. A prerequisite to the preservation of wild lands is their identification, and therefore wilderness mapping exercises are currently conducted throughout Europe, at various spatial levels (Carver & Fritz 2016). Building on previous studies of the Austrian wilderness potential (Plutzar et al. 2016, Kohler et al. 2016) we present here results from a recent, refined analysis (Enzenhofer 2016). Our focus in this paper is on the representation of wild land in the Austrian network of protected areas.

Methods

Our study relies on the idea of a 'wilderness continuum' – a term first coined by Nash (1973), which was later on developed into a formalized concept by Lesslie & Taylor (1985). The continuum approach allows to rate individual locations with regard to the degree of anthropogenic impact and to calculate a quantitative wilderness quality index. Using a Geographic Information System (GIS) we combined a set of input data reflecting anthropogenic land use, including land cover (Kuttner et al. 2015), traffic system, power plants and high voltage lines (OSM 2014, WWF 2009), isolated buildings and alpine huts (OSM 2014), skiing areas (Umweltbundesamt 2008), naturalness of forests (Grabherr et al. 1998) and mountain pastures (BMLFUW 2016). By combining weighted distance decay models with local index assignments we derived a spatially explicit wilderness assessment for Austria, with a spatial resolution of 25 meters (details in Enzenhofer 2016). We then classified the continuum results using the Jenks algorithm (ESRI 2013), resulting in 6 distinct classes reflecting the degree of naturalness: 1) very unnatural, 2) unnatural, 3) altered, 4) slightly altered, 5) close to nature and 6) very close to nature. For the purposes of this study, class 6 can be equalled to 'wild land', that is potential wilderness and wild areas as defined by Wild Europe (2013). In order to assess the current degree of wilderness protection in Austria, we have finally intersected these areas with the existing network of protected areas.

Results

The extent of wild lands in Austria amounts to a total of 586,178 hectares, corresponding to 7% of the national territory. Their distribution is very uneven: only 5 of the 11 Austrian ecoregions have any wild lands left, and all of them are found within the Alps: 77% are located in the ecoregion ‘Central Alps’, another 13% in the middle and western parts of the ‘Northern Alps’. The altitudinal distribution is very much biased towards the highest zones: wild lands in the alpine and nival altitudinal zone (> 2,000 m a.sl.) account for more than 64% of the total.
Accordingly, Austrian wild lands consist mostly of rocks (30%), subalpine scrub- and heathland (27%), alpine grasslands (19%), conifer forests (13%) and glaciers (6%). Within the 9 Austrian federal provinces, Tyrol is by far the ‘wildest’, it harbours almost 56% of all wild land. Most wild land still occurs in sizeable blocks: there are 39 coherent patches larger than 1,000 hectares, with a total extent of 473,503 hectares (=5.6% of Austria, Fig. 1). The largest patch is located in the western part of the Hohe Tauern and the adjacent portions of the Zillertal mountain range, it extends over almost 132,000 hectares; the second largest in the Ötztal range covers 73,000 hectares.

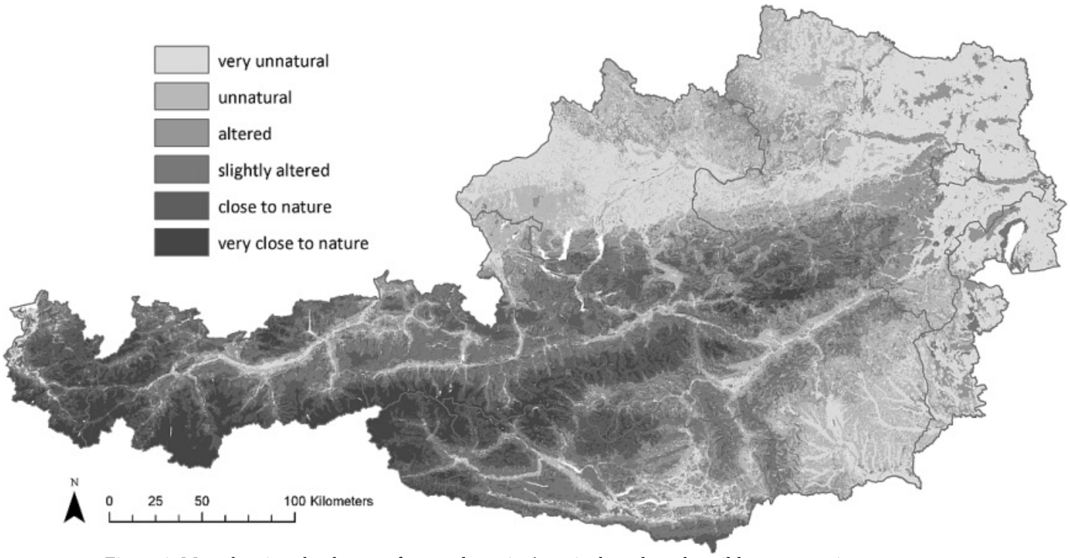

Figure 1: Map showing the degree of naturalness in Austria, based on the wilderness continuum concept.

Regarding its protection status, little more than a third of all wild land is found within Natura 2000 areas (Tab. 1), a fifth enjoys national park status, and a remarkable 15% are located within so-called ‘quiet zones’ - a type of protected area aiming at the preservation of undeveloped mountain landscapes, which so far has only been implemented in Tyrol. Nature reserves and Biosphere reserves play a comparatively minor role. The only two Austrian wilderness areas (Dürrenstein and Sulzbachtäler) secure just a fraction of the wilderness potential. Note however, that the figures in Tab. 1 cannot be added up, as the various categories of protected areas are often overlapping. Also, regulations in Natura 2000 areas and Biosphere Reserves are often not sufficient to protect wilderness values. Correcting for all overlaps and insufficient protection results in a figure of just 40% effectively protected wild land. Regarding the share of wild land within the different types of protected areas (Fig. 2), it becomes evident that wilderness is of importance especially in national parks and ‘quiet zones’.

Type of Protected Area	Hectares	% of total Wild Land
Natura 2000 Areas	210.361,3	35,9
National Parks	122.974,3	21,0
"Quiet Areas"	87.767,6	15,0
Nature Reserves	37.469,8	6,4
Biosphere Reserves	29.408,4	5,0
Wilderness Areas	7.674,3	1,3

Table 1: Representation of wild land within the Austrian network of protected areas (Wilderness Areas includes the recently established Wilderness Area Sulzbachtäler, which is not yet recognized by IUCN).

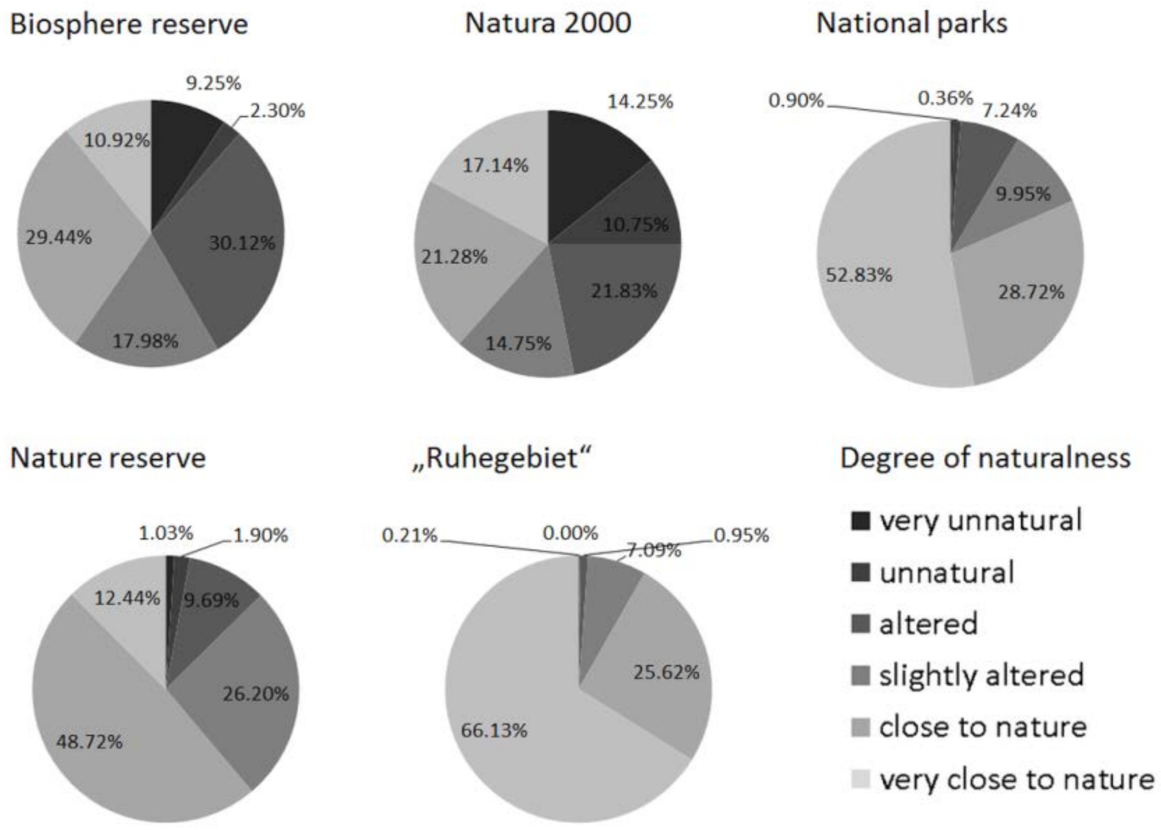

Figure 2: The distribution of the six naturalness classes in the network of protected areas

Discussion

Almost two thirds of the Austrian national territory belongs to the Alps, which many people in Central Europe perceive as a stronghold of wilderness. But much of the mountain landscape is no longer wild, only 7% of Austria can still be classified as such, according to our analyses. Thus, wild land is already a scarce resource. Its preservation should be of some concern to nature conservation, since even remote places at high altitudes have recently come under pressure: from skiing resort-developers trying to compensate for the lack of snow at lower elevations; from hydro- and windpower development; from intensification trends in forestry and the continuing expansion of the forest road network; from the construction of protective infrastructure, aiming to secure increasingly urbanized valley floors against natural disasters; from intensification of mountain pastures, etc.. Although the Austrian tourism industry heavily relies on images of intact alpine landscapes, truly intact nature is already rare.

The existing network of protected areas in Austria is obviously not sufficient for effective wild land preservation, so additional protection must be provided. To this end, we propose a two-fold strategy: 1.) Provide basic protection to most of the remaining wild lands (ideally the full 590,000 hectares, but at least to the 470,000 hectares in the 39 coherent blocks) through the establishment of additional ‘quiet zones’. Such zones would secure basic wilderness qualities by preventing large scale and landscape-altering development projects; but they would not restrict low-intensity forms of land-use, like traditional mountain pasturing, small scale forestry, hunting or hiking tourism. 2.) Establish additional wilderness areas (IUCN protected area-category Ib) in the wildest and most valuable tracts of wild land. The Austrian Biodiversity Strategy (BMLFUW 2014) states that by 2020+, 2% of the Austrian national territory should be devoted to the protection of natural processes, among others through the establishment of ‘areas with wilderness character’. A recent analysis (Kohler et al. 2016) has shown that currently 1.2% of the national territory (located in the core zones of national parks and wilderness areas) already conform to the above goal. To reach the 2% benchmark, another 0.8% (=67.000 hectares) must receive strict protection. This is certainly an ambitious goal, but one commensurate to the challenge of saving Austria’s ‘last of the wild’.

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Ecological connectivity in the Alps and beyond - a long term challenge

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Abstract

The alpine area is a particular challenge for ecological connectivity planning. Nevertheless ecological connectivity is a key element for nature protection also in this mountain area. The identification of strategic alpine connectivity areas allows focusing the efforts towards the most promising areas. Beyond planning aspects, the topic comprises further facets linked to its social (ex. Stakeholder involvement), political (effects of legal framework to connectivity implementation) and economic (ex. green economy) dimensions.

Keywords

Ecological connectivity, Alps, Protected areas, Nature Protection, EUSALP

Ecological connectivity as multi-dimensional approach

The perception that nature conservation in the Alpine region needs to be addressed at a transnational level has gained ground in the past decades. In this regard, the issue of ecological connectivity assumes a key role. The topic was taken up by the Alpine Convention, non-governmental initiatives and the European Union specifically as part of its Interreg Alpine Space Programme and, since 2015, within the EU Strategy for the Alpine Regions (EUSALP). In comparison to other mountain regions, the Alps therefore benefit from a broad range of different institutions and initiatives and a growing network of actors (HEDDEN-DUNKHORST 2017).

Since the first overview about individual initiatives on ecological connectivity in the alpine countries in 2004 (ALPARC 2004) and the first attempts to start pan-alpine activities on this issue (Ecological Continuum Initiative, ECONNECT, recharge.green,...) in 2005 (KOHLER 2016) the range of topics in this context has also significantly increased.

If the first concepts linked to ecological connectivity where principally focused on the nature protection aspects defining ecological networks for various species or of different habitat types (BENNETT 2004, BENNETT & MULONGOY 2006), recent development broadened the frame of the approaches including gradually aspects of climate change, ecosystem services, human wellbeing and economy. The latest concept of green infrastructure of the European Commission is therefore defined as '*strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services such as water purification, air quality, space for recreation and climate mitigation and adaptation. This network of green (land) and blue (water) spaces can improve environmental conditions and therefore citizens' health and quality of life. It also supports a green economy, creates job opportunities and enhances biodiversity*' (EUROPEAN COMMISSION 2013).

This diversification of topics can also be observed in the alpine context. The first large international project in the Alps ECONNECT (2008-2012) focused on the identification of barriers and the development of methodologies to map ecological connectivity in the Alps but also included to analysis of legal barriers to connectivity implementation (FÜREDER et al. 2011).

The project Rercharge.green highlighted the interrelation between biodiversity conservation and the development of renewable energies in the Alps (BALEST et al. 2015), whereas greenAlps strongly focused on policy and planning aspects of ecological connectivity in the Alpine area (SVADLENAK-GOMEZ et al. 2014). The contribution of implementation measures in favor of ecological connectivity to an alpine green economy where highlighted by GreenConnect (KOHLER 2017).

Links to the EUSALP territories

Since 2015 the creation of the European Strategy for the Alpine Regions adds also a new geographic challenge to the alpine activities on ecological connectivity. Indeed, ecological connectivity is the topic of the Action Group 7 (AG7 - To develop ecological connectivity in the whole EUSALP territory). The cooperation with the territories around the Alps, especially also the metropolitan areas of the larger city located around the Alps, is a particular challenge that offers a series of interesting perspectives.

An analysis of land use impact and that of the main transit and transport axes on ecological connectivity in and around the Alps (PLASSMANN et al. 2016) clearly demonstrates that the most important challenges are not within but outside of the Alps. Indeed, only the most populated and fragmented inner Alpine valleys have an impact on connectivity comparable to that of the very important barriers in areas surrounding the Alps.

This statement leads to the acknowledgement that the future challenges to Alpine biodiversity have to be evaluated, at least partially, in regions outside of the proper Alpine space. It is not realistic to regard the Alps as an autonomous functioning entity when considering its biodiversity. The conservation of the enormous diversity of life within the Alps as well of fauna and flora depends largely on the management of those areas on the outer edge of the Alpine range that are economically intensively used. Of greatest concern here are the large flood plains of important European rivers like the Po, the Rhône and finally the Rhine and the whole riverine system of the Danube.

The important peripheral Alpine cities such as Marseille, Lyon, Torino, Milano, Geneva, Zurich, Munich, Venice, Ljubljana, Graz and Vienna have a significant impact on ecological fragmentation through their relative dispersal of human settlements, their con-urbanisation and satellite towns needing transport and energy infrastructure, as well as via their large footprints of economic activities (industry, commercial areas,...); the Alpine surroundings are like a continuous belt of towns with some more or less important hot-spots of settlements.

Even if Alpine connectivity still seems to be functioning in large parts of the Alps, this connectivity increasingly resembles a tenuous thread loosely linking a series of habitats, as connections to the surrounding European landscapes and mainly neighbouring massifs like the Jura, the Central Massif, the Apennine and the Carpathians are more and more disrupted. In any case, Alpine biodiversity will not survive in the long term if they are completely isolated from the outside, inaccessible for any kind of gene exchange. The growing disconnection in very large parts of the Alpine surroundings needs to be addressed through adapted measures. Especially the west (Rhone valley – France), the south (Po plain – Italy) and the east (axis Trieste – Ljubljana – Maribor) face major barriers. The northern part of the Alps seems more open to connectivity for its surroundings.

The cooperation with EUSALP offers the possibility to include new, central stakeholders such as for example issued from the private sector or from the administrations of the larger metropoles in the periphery of the Alps. Their involvement allows treating certain dimensions of the topic in a more comprehensive way, for example concerning effects of seasonal daily or weekend tourism coming from the urban areas towards the mountain regions for leisure and sport activities.

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A new classification of endemic species of Austria for nature conservation issues

Christian Komposch

Abstract

Endemic species are the biological treasure of every country. They show a restricted distribution and thus are often endangered. Responsibility for the protection of these species is high. Despite these facts they are widely neglected in nature conservation work. The new categorization presented here comprises 14 categories and combines a biogeographic basis with nature conservation demands.

Zusammenfassung

Endemiten sind der biologische Schatz des jeweiligen Landes und der exklusive Beitrag zur weltweiten Biodiversität. Sie besitzen eine kleinräumige Verbreitung und sind daher oftmals gefährdet. Die Verantwortlichkeit zum Erhalt dieser Arten ist hoch. Dennoch erfahren diese hochrangigen Schutzgüter in der fachlichen Naturschutzarbeit kaum Berücksichtigung. Die neue Kategorisierung der Endemiten umfasst 14 Kategorien. Sie basiert auf einer biogeographischen Grundlage und wird naturschutzfachliche Anforderungen gerecht.

Keywords

endemics, biodiversity, areas, protection, nature conservation, Austria, Alps

Introduction

"Nothing in biology makes sense except in the light of evolution." (DOBZHANSKY 1973)

Endemic species represent the exclusive contribution of a given region to the overall worldwide biodiversity. They are the most interesting topic of faunistics and biogeography and the biological treasure of every country. Endemics show a restricted distribution, reaching up to local endemics occurring in, for example, a cave system or a mountain massif. They are highly adapted to special climate conditions, habitats and structures. Furthermore they are sensitive to environmental changes and impacts. Therefore it is obvious that endemics have a high risk of becoming extinct. It might be expected that endemic species are protected by law and enjoy a high awareness in nature conservation matters. This paper deals with the large gap between this expectation and reality.

The currently used categories "endemic and subendemic to Austria" (RABITSCH & ESSL 2009) are appropriate to reduce the large number of endemic species to a workable size, which could be published in one book weighing less than 5 kilograms. In terms of nature-conservation issues this approach leads to a negligence of numerous rare and endangered taxa from Alpine-endemic ones up to local endemics. A new suggestion for categorization aims to reflect the phenomenon of endemism on a wider basis, facilitating the consideration and protection of all valuable endemic species in nature conservation work.

A new classification for endemic species

Endemism can be described as a phenomenon of time. We make a distinction between older (palaeoendemic) and younger (neoendemic) taxa. An accepted threshold value for this differentiation is about 1.9 million years. In other words, all neoendemics have developed during the last ice age.

Considering endemics, we first of all have to define the geographic area of the taxon. The borders can be natural (e.g. the Alps, Northern Calcareous Alps) or political (e.g. the national territory of Austria or the federal country of Carinthia). So long as these geographic units are clearly defined, the endemics are as well. If parts of the autochthonous population(s) and habitats are outside of these units, we must talk about subendemism – and require a definition for these distribution patterns.

To their credit, Wolfgang Rabitsch and Franz Essl have coordinated the Catalogue of Austrian endemic and subendemic species (RABITSCH & ESSL 2009). These authors chose a definition of subendemic if 75% of a given species' area is situated inside the national borders of Austria. This 75% borderline is merely an arbitrary value. The advantage of this astonishingly high percentage is a reduction of the assemblage of endemics to a smaller, manageable amount. The big disadvantage of this value is that several endemic species from the Eastern Alps fall through the sieve – probably half of the relevant species! To be absent in the Catalogue (“Endemitenkatalog”) means to be absent in several scientific and nature conservation evaluations. In such cases these endangered species, their areas and habitats are often the forgotten losers among protected species.

The new categorization (Table 1) recognises 14 categories and is an attempt to combine biogeographic basics with nature conservation demands. It is also an extended approach, which compensates this deficit to a wide degree.

endemism-category I	**endemism-category II**	**Deutsche Bezeichnung**	**definition**
a Austrian-endemic	a.1 locally endemic	Österreich-Endemit: Lokalendemit	100 % in Austria AND less than 10 localities (populations) OR total area less than 1.000 km²
	a.2 regionally endemic	Österreich-Endemit: Regionalendemit	100 % in Austria AND total area less than 10.000 km²
	a.3 nationally endemic	Österreich-Endemit: Nationalendemit	100 % in Austria AND total area more than 10.000 km²
b Austrian-subendemic s. str.	b.1 locally subendemic	Österreich-Subendemit im engeren Sinn: Lokaler Subendemit	> 75 % in Austria AND less than 10 localities OR total area less than 1.000 km²
	b.2 regionally subendemic	Österreich-Subendemit im engeren Sinn: Regionaler Subendemit	> 75 % in Austria AND total area less than 10.000 km²
	b.3 nationally subendemic	Österreich-Subendemit im engeren Sinn: Nationalendemit	> 75 % in Austria AND total area more than 10.000 km²
c Austrian-subendemic s. l.	c.1 locally subendemic	Österreich-Subendemit im weiteren Sinn: Lokaler Subendemit	25-75 % in Austria AND less than 10 localities OR total area less than 1.000 km²
	c.2 regionally subendemic	Österreich-Subendemit im weiteren Sinn: Regionaler Subendemit	25-75 % in Austria AND total area less than 10.000 km²
	c.3 supranationally subendemic	Österreich-Subendemit im weiteren Sinn: Überregionaler Subendemit	25-75 % in Austria AND total area more than 10.000 km²
d. Eastern-Alps-endemic		Ostalpen-Endemit	endemic to the Eastern Alps and in general total area less than 25 % in Austria
e. Alps-endemic		Alpen-Endemit	endemic to the Alps and in general less than 25 % of its area in Austria
f. Alps-subendemic		Alpen-Subendemit	Main-distribution in the Alps with further populations in adjacent/related mountains (Dinardis, Apennin, Carpathians, Central-European Mittelgebirge) and in general less than 25 % of its area in Austria
g. Boreo-alpine species		Boreo-alpine Art	Disjunct distribution in the Alps and the boreal deciduous forests
h. Arcto-alpine species		Arkto-alpine Art	Disjunctive distributed in the Alps, Central-and Southern European mountains and the arctic tundra (e.g. THALER 1976)

Table 1: Categories and definitions of endemic species with the reference area of Austria. The total area is defined as the smallest possible polygons including all localities. (sensu IUCN).

The pragmatic solution used by conservationists has been to define range-restriction, sometimes called “local endemic” species, using an arbitrary threshold of < 50,000 km². Range restriction is also an integral part of the criteria used by the IUCN to identify and classify species in danger of global extinction – known as the IUCN Red List (www.redlist.org) (LADLE & WHITTAKER 2011).

The Endemics-Catalogue of Austria lists in total 548 species for the fauna and 200 for the flora; the hot-spot of endemic species is the Gesäuse National Park with the sum of 70 endemic taxa within one grid-square (RABITSCH & ESSL 2009). “*Die deutliche Häufung von Endemiten in den nordöstlichen und südöstliche Alpen wurde schon früh erkannt.*“ (NIKLFELD et al. 2008). The South-Eastern Calcareous Alps (Karawanken, Steiner Alps, Karnische Alps) has dozens of endemic species, shared between the countries Austria, Slovenia and Italy, which reach a value of “only” 30 or 50 % of their area in Austria. This problem has been pointed out already in the endemics-catalogue by KOMPOSCH (2009: 491 ff.): “*Die Südalpen oder Südöstlichen Kalkalpen sind … der „Verlierer“ der 75 % Areal-Rahmenbedingung dieser Studie. Die Südalpen mit ihren zahlreichen Massifs de Refuge am Rand der würmeiszeitlichen Vergletscherung sind nicht nur aus arachnologischer Sicht das mit Abstand bedeutendste und diverseste Endemitenzentrum Mitteleuropas.*“

The new categorization of endemism proposed here (Table 1) allows a more detailed consideration and more precise analysis options. Regarding the spider fauna, 46 species are listed in the catalogue. At least 37 species with distribution patterns making them Austrian subendemics s.l. according to the definitions in Tab. 1 had to be excluded. A similar picture can be seen for the harvestmen: 11 species benefit from the definition of RABITSCH & ESSL (2009), but at least 8 additional subendemic species s.l. were omitted. The total for endemic and subendemic species for Austria is herewith more than 1,000 species; the definitive number is not known at present. A recent calculation for two endemism-hot-spots show total numbers of 165 for the Koralpe (Steirisches Randgebirge; Carinthia and Styria) and 180 for the Gesäuse National Park (Ennstaler Alps; Styria) (ÖKOTEAM 2016; KREINER & KOMPOSCH 2018). A survey of the endemics of the Karawanken would lead to a total value far beyond 200 species.

Acknowledgements

Endemic species undoubtedly need greater attention and protection by law. The first step is a comprehensive and more detailed approach towards the new categorization as presented here in this paper. The lists of protected species in Austria (Artenschutzverordnungen and habitats/birds directive) still contain at the present many more mammals, amphibians, reptiles, diurnal butterflies, etc., even if they are not endangered and show a European or Palaearctic distribution. Endemics deserve our care although they are mostly not big, colourful or “sweet looking”. The new categories address much better the responsibility for protection of endemic species for a federal country, a nation or the European Community.

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Dianthus plumarius subsp. *blandus* – Distribution and Habitat Features

Walter Köppl & Iris Oberklammer

Abstract

The pink carnation *(Dianthus plumarius* subsp. *blandus)* is a narrow endemic in the Northern Limestone Alps. The plant prefers dolomitic lime scree habitats. The pink carnation grows and performs best on open, sunny, but well water-supplied scree habitats. Within the Nationalpark Gesäuse populations were mapped in 2014 and 2015. Relevées were collected using the Braun-Blanquet method. The pink carnation is essentially associated with the plants of Thlaspietea rotundifolii, Asplenietea trichomanis and Seslerietea albicantis.

Keywords

Dianthus plumarius, population mapping, vegetation types, scree habitats

Introduction

Dianthus blandus is an endemic found only in the Northeastern Alps in Styria, reaching from Dachstein to the Gesäuse mountains. It appears on limestone and dolomite gravel slopes in various succession stages from almost open ground over mountain pine bushland to open red pine forests. The Gesäuse region itself is characterized by limestone mountains with steep, unstable gravel slopes with torrent creeks running down to the Enns river. Especially due to snow melting in spring and thunderstorms during the summer strong movement and shifting of sediments occurs. The habitats filled with scree, gravel and sand are very dynamic and instable. Only areas of low inclination on the side of the streams show more stable conditions, which enable plants to grow there for longer periods of time, ranging from weeks and months to years or even decades.

In the course of a master thesis (KÖPPL 2016) and additional field work (KÖPPL & OBERKLAMMER 2015) distribution and habitat choice of the endemic *Dianthus plumarius* subsp. *blandus* (in short: *Dianthus blandus*) were investigated in the National Park Gesäuse. To describe the phytosociology and the habitat choice of *Dianthus blandus* 53 Braun-Blanquet relevées were collected. Before this investigation knowledge of distribution and habitat features of *Dianthus blandus* was fragmentary. For the first time, a detailed distribution of populations was documented.

Methods

Distribution

To investigate the current distribution of *Dianthus blandus* in the National Park Gesäuse, an extensive search was carried out during the main flowering season in May and June 2015. As a means of documentation, two GPS-devices (Garmin 60CSx, Garmin eTrex) were used for setting waypoints at each location of *Dianthus blandus* individuals or clusters. For data transfer 'MapSource' (Garmin) was used. Afterwards all waypoints were transferred to 'ArcGis' (Version 10.3) and displayed on 'OpenStreetMap' and orthophotos of 'Digitaler Atlas Steiermark'. Due to occurring irregularities in terms of accuracy the method was adapted to drawing population borders on printed orthophotos during field work (KÖPPL & OBERKLAMMER 2015) and digitalizing them using ArcGis. Finally, the square measure of the distribution areas was calculated for subpopulations and populations.

Phytosociology

The phytosociology of vegetation types inhabited by *D. blandus* was determined by collecting and evaluating 53 relevées using the Braun-Blanquet method from 1964. In 48 of these areas *D. blandus* was present. Five of them were chosen without the plant to allow better comparison of vegetation compounds. All together the variability of 'carnation-habitats' was well documented. Vegetation data was entered in 'Turboveg' (HENNEKENS & SCHAMINEÉ 2001), then exported to 'Juice' (TICHY 2002) and data was processed with 'Twinspan-analysis' (HILL 1979).

Habitat features

Out of this data habitat features were worked out.

Results

Distribution

Dianthus blandus could be found ranging from 590 m a.s.l. close to the river Enns up to approximately 1200 m a.s.l. in Gseng. The main distribution was found in the montane zone between 600 and 800 m. It has settled within the National Park in 10 populations with at least 92 sub-populations. A population was defined by geographical extension and connectivity. Populations were separated by others by at least 200 meters. All pink carnations within such an area were considered as belonging to one population, however with some substructure resulting in several subpopulations.

Exceptions from this classification were made in Hinterwinkel and eastern Haindlkar, where populations were further outspread. See also Fig. 1 (Distribution: Populations of *Dianthus blandus* in the National Park Gesäuse).

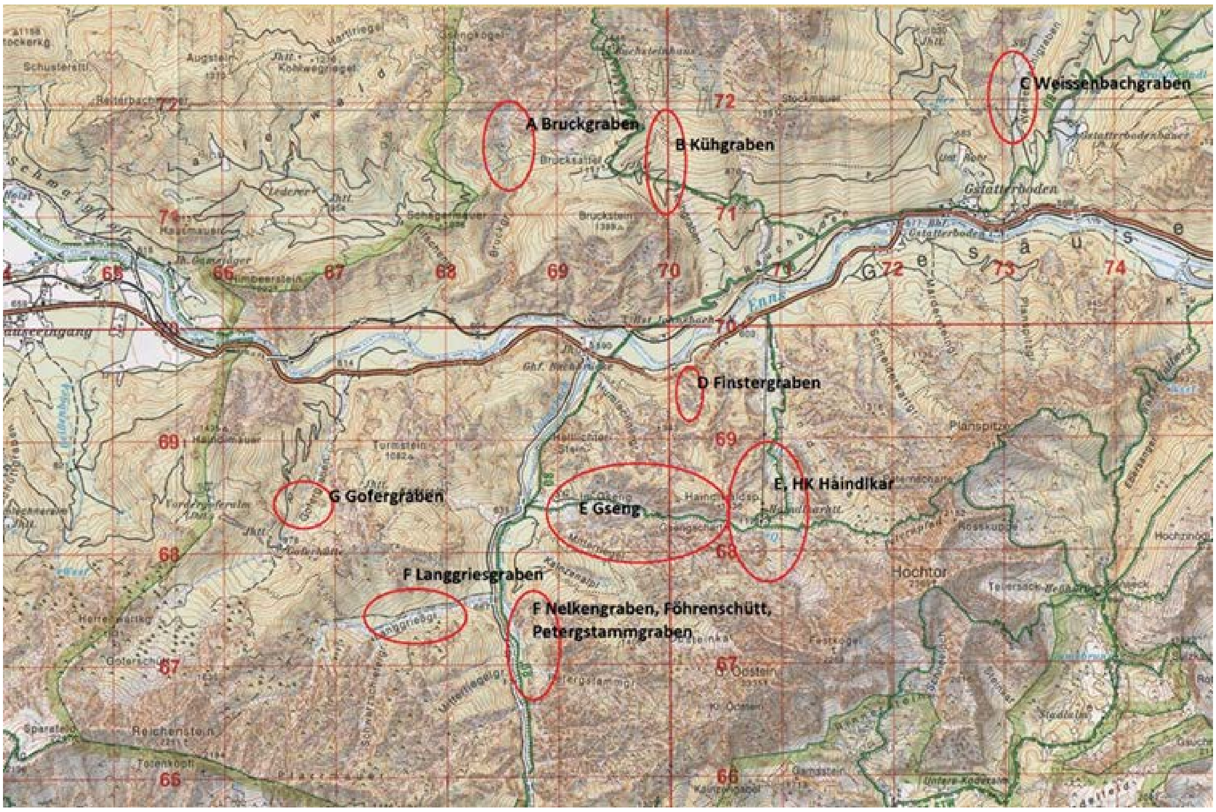

Figure 1: Distribution: Populations of *Dianthus blandus* in National Park Gesäuse

Areal extent

Population areas were calculated by summing sub-population areas (Tab. 1). Altogether Carnations inhabit 11.350 m² of area within the National Park borders (KÖPPL & OBERKLAMMER 2015).

Population	**Sub-populations**	**Areas in m²**
A Bruckgraben	**6**	**500**
B Kühgraben	**4**	**300**
C Weißenbachgraben	**5**	**800**
D Finstergraben	**10**	**400**
E Gseng	**24**	**3500**
E HK Haindlkar	**14**	**1000**
F Langgries	**12**	**1300**
F Nelkengraben	**6**	**1500**
F Petergstammgraben	**10**	**1600**
G Gofergraben	**1**	**450**

Table 1: Populations, Sub-populations and Areas of *Dianthus blandus* in Gesäuse

Phytosociology

Dianthus blandus was found mainly in **Thlaspietalia rotundifolii** (Petasiteum niveii) with *Petasites paradoxus, Rumex scutatus, Silene vulgaris* subsp. *glareosa, Linaria alpina* and *Campanula cespitosa*. In **Asplenietea trichomanis** (Potentillion caulescentis) and in **Seslerietea albicantis** (Caricetum firmae) with *Carex firma, Dryas octopetala, Primula clusiana*. These scree habitats, montane to subalpine grasslands, and dry forest are species rich and tend to mix. Succession can change these habits to **Erico-Pinetum prostratae** and **Erico-Pinion sylvestris**.

Habitat features

Carnations were most abundant at the fringe from open scree slopes to more stable conditions. Germination seems to take place best on open habitats with good water supply. Most of germination and establishment seems to happen there. But within an observation period of three years many of these places were destroyed by floodings.

As to be seen in Langgriesgraben (Fig. 2), habitats can be some way off the open gravel fields and situated in more stable parts. Here we find all succession stages to pine forest.

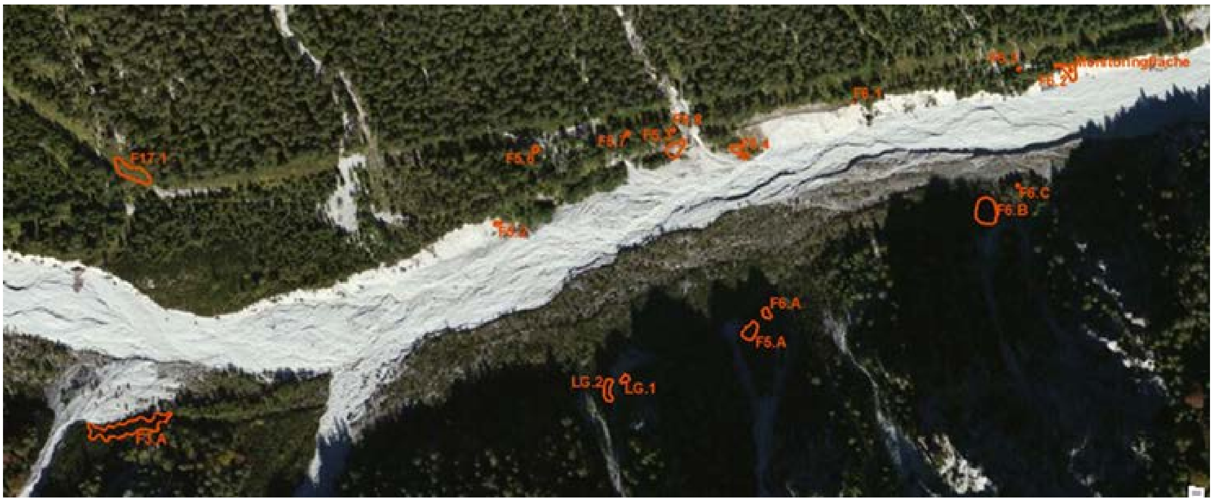

Figure 2: Langgries: Sub-populations and habitat choice

Discussion

Especially the field mapping work has increased the knowledge about *Dianthus blandus*` distribution and choice of habitats within the National Park Gesäuse. The already known spot occurrences could mostly be confirmed and have been investigated further. The populations have proven to be larger than expected and consist mostly of several subpopulations.

Some of the subpopulations could not be reached because of the steepness of some sites. Some may not have been found due to inaccessibility. At least one unknown population was found in Gofergraben, south of the river Enns. During field work it became obvious that many seemingly suitable habitats were not populated by *Dianthus blandus*. Based on the observations we conclude that the meta population dynamics are small on the scale of populations and occur rather on the scale of subpopulations. Subpopulations could stay stable by local recruitment from seeds, and using offshoots, which can also result in local short distance migration.

Conclusion

Dianthus plumarius subsp. *blandus* has gained some attention during the past few years and knowing details on the distribution, habitat features and phytosociology of this flagship-endemic is important for its survival. An ongoing monitoring will hopefully provide further insight into its performance. Genetic research is recommended. At present the population is not endangered.

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Comparative, long-term ecosystem monitoring across the Alps: Austrian Hohe Tauern National Park, South-Tyrol and the Swiss central Alps

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Abstract

To assess potential impacts of on-going environmental change on alpine biota, a long-term ecological monitoring program was launched in the Alps. Plant, invertebrate and microbial responses will be assessed across sharp snow-melt gradients several hundred metres above treeline in five study regions. This contribution summarizes the conceptual framework and explains the practical aspects of this research.

Keywords

LTER, long term ecological research, microclimate, snow, plants, animals, microbes, high elevation.

Why long term monitoring?

Plants, animals and microbes track environmental conditions so that certain organismic assemblages (communities) emerge at a certain location that reflect 'natures' long-term answer to that given environment. For several reasons, such assemblages may not have reached at theoretical equilibrium between organismic demands and environmental provisions:

1. environmental changes may proceed faster than all or some key organisms can follow (e.g. short distance dispersal limitation, life history constraints),
2. regular disturbances (fire, herbivory, human land use) may interfere with undisturbed community-environment interactions (climate 'tracking'),
3. the right taxa may not be available regionally (e.g. long distance dispersal limitation), or
4. communities never reach an equilibrium with their environment, because of succession, that is, one assemblage creates conditions (e.g. soil conditions) that facilitate the gradual establishment of a new community, and so on.

Currently, humans induce a number of environmental changes that have no analogy in the relevant geological past, such as the continuous rise of CO_2 concentration above its last million year mean of approximately 240 ppm to the current close to 410 ppm, the steady reactive nitrogen deposition which exceeds 'pre-industrial' background rates by at least ten-fold, or the anthropogenic rise of near-ground ozone concentrations, with the first a universal and the two others regionally varying drivers. Climatic change (rising temperature and maximum vapour pressure deficit, altered precipitation regimes) have parallels in the geological past, but the current rates of change are quite exceptional. Finally, these changes act upon a landscape that experiences more anthropogenic land use pressure at global scale than ever before (with regional exceptions).

Changes in plant and animal communities and their microbial partners in response to environmental change are often hard to evidence and explain, because the changes are (1) commonly slow and thus, can not be identified by our senses, and (2) because several environmental changes may co-occur or even interact, making it difficult to isolate cause–effect relationships. This is where long-term observations come into play, both in otherwise undisturbed ecosystems or in long term experimental manipulations (FREPPAZ et al. 2012). If cleverly designed, such long-term observations may not only evidence changes in organismic communities, but also permit distilling the key drivers of these changes, provided the suite of potential influences is known or is specifically co-monitored.

In this contribution, I will briefly summarize the conceptual framework of a terrestrial monitoring program in the central Alps that aims at evidencing responses of organismic communities to climatic change in cold environments. A complementary aquatic program will include alpine lakes and small creeks that drain catchments in which the terrestrial permanent plots are nested.

Ecosystems in which life is adapted to cold conditions may be expected to show faster changes than those in already warm areas. However, topography is a strong modifier of temperature, creating warm niches in otherwise meteorologically cool terrain because of solar ground heating that interacts with slope, exposure and degree of shelter (SCHERRER & KÖRNER 2009). Yet, topography also affects snow distribution, and thus, causes sharp gradients of the lengths of the growing season over very short distances. Many species reach their range limit within a few meters across such snow cover gradients (Fig. 1). These gradients of species distribution and range limits may be seen as mirroring trends that might otherwise be observed over large elevational gradients.

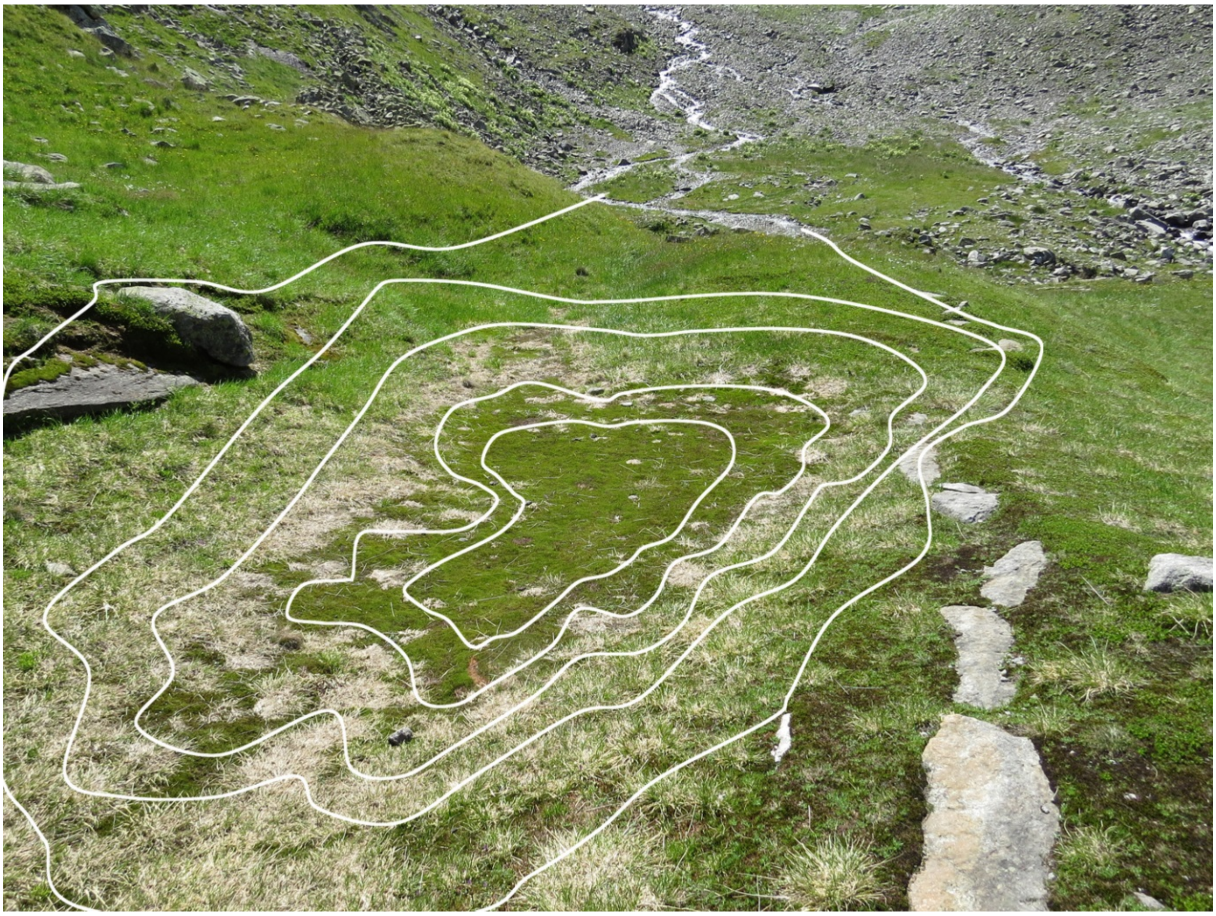

Figure 1: Alpine snow-beds are topography driven snow accumulation areas which exert very steep gradients in the length of the growing season. Transects across such snow duration gradients provide 'experiments by nature' that permit exploring causes of species range limits. The isolines of snow melt date are indicating 'life zones' that may range (over a few meters) from locations where angiosperms are absent to the most luxury life conditions for a given elevation.

The Austrian National Park Hohe Tauern has launched this monitoring program under the motto 'life at the limit', assuming that high mountain terrain will exert ultimate constraints to life at one point (line) across the climatic gradients exhibited in mountainous landscapes (low temperature species range limits). These limits will differ for species in response to several temperature-related factors such as absolute minimum temperatures in winter, spring or summer, the lengths of the growing season, the temperature during the growing season, either individually or in combination. This distinction between different facets of the action of temperature is critical (KÖRNER & HILTBRUNNER 2018). It had been shown for montane forest trees that species specific flushing phenology in interaction with freezing resistance, during or shortly after the flushing, and the duration of the remaining season (permitting tissue maturation) explains the species specific elevational and latitudinal range limits of taxa (KÖRNER et al. 2016). Data of this sort are not yet available for alpine taxa.

Above the treeline, it becomes near to impossible to obtain data about the actual thermal life conditions (and thus, the associated risks) of plants and animals, given that macro-climatological conditions (weather station data) do not scale to life conditions near the ground (SCHERRER & KÖRNER 2011). Hence, these life conditions need to be measured in order to explain plant and animal responses. Currently, climatic range limits of alpine taxa and the decisive underlying mechanisms are not known. Growth chamber conditions cannot mimic the actual alpine life conditions, most importantly, soil conditions and the ever variable microclimate. Hence, such tests must be undertaken under field conditions.

Where is the monitoring located?

'Experiments by nature', that is, sharp climatic gradients in the field, provide the most promising test conditions. Such gradients are often created by snow duration in so-called snow-beds as depicted in Fig. 1. Species are reaching range limits over a distance of a few meters that would otherwise be seen across kilometres of climatic contrast along elevation gradients. The central role of topography (snow melt regimes in particular) for life at alpine elevations is well established (an early account by AULITZKY 1963; later works by GALEN & STANTON 1995, KUDO et al. 1999, SCHERRER & KÖRNER 2011, SEDLACEK et al. 2015). Another advantage of such snowmelt gradients is that they can be replicated within a given macroclimatic, geological and biogeographic setting.

The monitoring program aims at capturing 'species at their limit' at multiple sites across the Alps. Locations are ca. 150 to 450 m above the regional climatic treeline (3 to 6 transects per site, each 7-10 m long and 3 m wide, with the central 1 m strip remaining undisturbed for photographic monitoring; Fig. 2). Monitoring sites were established in 2016 in the Hohe Tauern National Park, north and south of the main divide of the Alps, in Carinthia (Seebachtal 2300 m, Ankogel), Tyrol (Innergschlöss near Matrei, 2350 m), and Salzburg (Untersulzbachtal, 2380 m), with additional sites in northern Italy (Oberettes 2690 m, Matschertal, Ötztal-Alps) and in the Swiss central Alps (near Furka Pass 2460 m). The dominant vegetation under favourable growth conditions at all these sites is a *Carex curvula* heathland (the optimum reference along the snow melt gradients), with often only a few or no flowering plant species left at the centre of such snow-beds ('pessimal' end of the gradient).

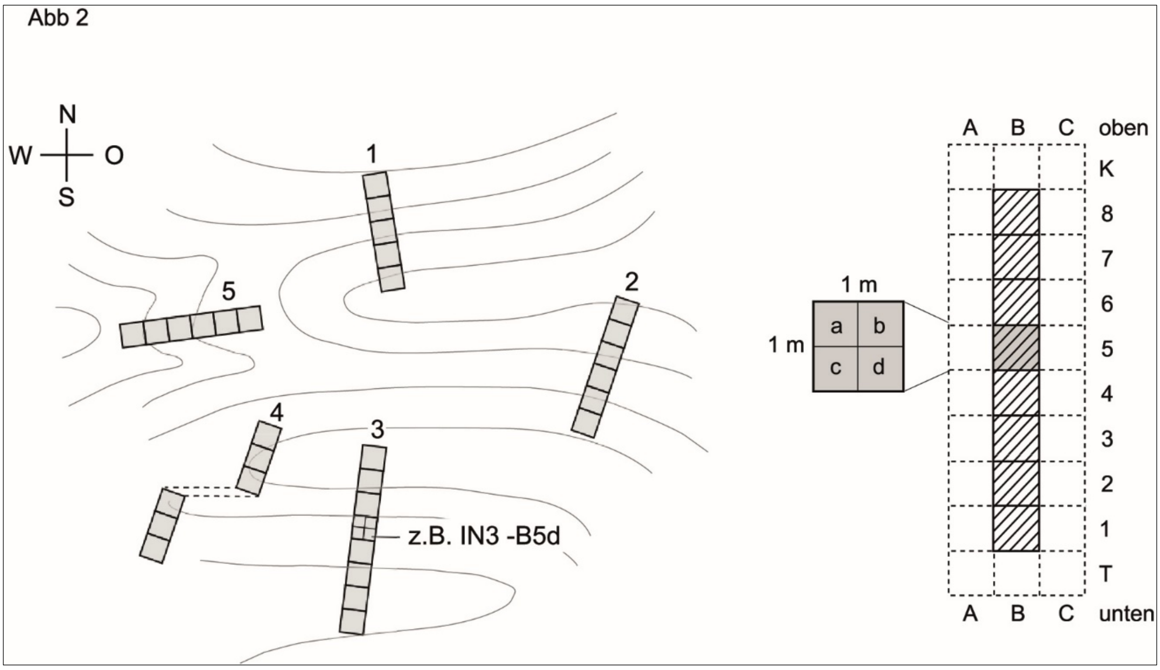

Figure 2: The study design of the monitoring program exemplified for one site with 5 snow-melt gradients (transects). Each transect consists of 3 parallel 1 m strips, with the center strip (B) serving for a photogrammetric documentation and non-destructive plant species census (no sampling). Strips A and C will be sampled following a protocol that prevents re-sampling the same subplot. For simplicity, the map illustrates the B strips only.

What is monitored?

This program aims at assessing plant, animal and microbial species diversity in exactly the same permanent quadrats placed along a micro-topography gradient. Life under optimal climate (long 'warm' season) for the given elevation will be compared to life under least favourable conditions at the same elevation (extremely short, but not necessarily less warm conditions during the snow free period). Climatic warming may change snow duration (the date of release from snow), but it will not change the spatial patterns of snowmelt (FRIEDEL 1961, KÖRNER 2003). A similar program focussing on summits and their floristic changes over time has established a global network (GLORIA) that revealed substantial increases of plant species numbers for most European summits at decadal resolution (GOTTFRIED et al. 2012, PAULI et al. 2012).

The data collected as part of this new monitoring program include:

1. environmental conditions (temperature in the top soil near the meristems of all graminoids and many herb taxa), snow duration, soil physical parameters (water content – what potential responses, grain size distribution, pH and basic soil chemistry including ^{15}N signals in the soil organic fraction),
2. plant and soil animal (invertebrate) species identity and abundance (various techniques including photographic records of permanent plots, Berlese samples),
3. soil microbe spectra (molecular techniques),
4. wild animal presence (ungulates, predators; using automatic cameras).

The associated aquatic program will monitor water chemistry, planktonic and benthic biodiversity. The basic idea of coordinated monitoring by standard protocols follows the LTER concept (Long term ecological Research; VANDERBILT & GAISER 2017) and as discussed in an earlier attempt for elevational gradients in the Alps (Becker et al. 2007).

When will the monitoring take place?

Since many of these cues undergo rapid variation, high temporal resolution is critical in order to prevent misinterpreting inter-annual peculiarities of weather conditions (Fig. 3). The data by WALKER et al (1994) are a good example of such variation for above ground plant biomass that fuels the trophic chain, including aquatic systems. Given the work load and costs, the timing of the terrestrial census is adjusted to specific tasks:

1. fast and continuous records, all year (soil temperature and snowmelt regime)
2. wild animal monitoring during the growing season of each year (10" intervals during daylight)
3. annually at peak season (defined by phenology) above-ground plant biomass
4. presence and abundance of plants, animals and microbes will be assessed at one (non-destructive, photo-monitoring) to several year intervals (e.g. five to ten years for soil organisms), also below ground plant biomass will assessed with longer intervals (because of its destructive nature).
5. air dried soil samples and above-ground plant biomass (dried at 80 °C) will be archived for multi-decadal re-visitation.

We do not expect rapid changes, but changes that materialise over decades or even centuries. Therefore, the assessment is highly standardised, locations are permanently marked, plot sizes are normed. This should permit future generations of researchers to perform re-assessments by applying identical protocols on the very same, replicated test sites. In addition, the archived soil and above-ground plant biomass samples (ca 40 samples per site from 20×20 cm sampling area) will be archived for future inspection and application of novel (e.g. molecular) methods. These archives will be located in a regional museum, given the needed institutional continuity, and will be accompanied by documents that explain all codes and applied procedures (protocols).

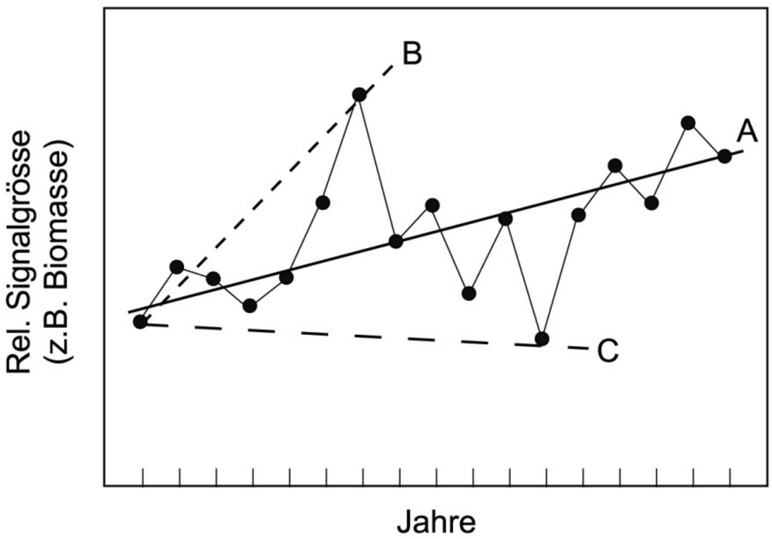

Figure 3: The problem of temporal (inter-annual) variation in ecological long-term monitoring research. Since signals may differ substantially from year to year, multi-year census intervals may reveal misleading long-term trends.

The problem of phenology

Because different plant and animal species start their season at different calendar dates, though most commonly in the same sequence in a given year, seasonal timing of the assessment is key. It would be near to impossible to standardize (adjust) sampling time for each 1 m^2 permanent quadrat for identical developmental (phenological) stage. So the common sampling date per site will have to remain a compromise. Our criteria for the yearly assessment date is that the climatically most constrained micro-habitats along such snowmelt gradients had a chance to reach full plant canopy development. Since typical snow-bed taxa exert opportunistic phenology, that is, they enter the seasonal developmental cycle whenever snowmelt permits, the beginning of the assessment must be at a time that accounts for the 'seasonal late comers'. Otherwise we would compare mature states at the edge of the snow-bed and premature states in the core of it. Since the latest snow melt in the test areas is commonly between the second and third week of July, the second week of August has been found to be a good compromise, for a time window during which the edge populations did not yet enter seasonal senescence, while populations in the snow-bed centre stopped growing and mostly completed flowering. The onset of fruit dispersal by *Gnaphalium supinum* in quadrats close to the 'pessimal' end of the transects is a good pheno-marker.

In contrast to the opportunistic life strategy of snow-bed taxa, plant species at the edge of the snow-bed, often on ridges, would be at risk if they adopt an entirely opportunistic phenology strategy (the may lack snow cover during late winter and flush and flower at the 'wrong' time, that is too early, and thus, may undergo freezing damage (BABTIST et al. 2010). Such taxa often use photoperiod as a reliably environmental cue (KELLER & KÖRNER 2003). Snow melt gradients may thus, run into a mismatch between adaptive (genetically contolled) phenology and melting date in case of a rapid climatic change - an area currently explored by MATTEODO et al. (2016), CARBOGNANI et al. (2016). The net consequence of such microclimate effects is likely to be a change in species distribution, as explored in our long term monitoring. There is evidence that snow-beds have already undergone changes that find an expression in changed species distribution and species abundance (BAHN & KÖRNER 2003).

Current state of monitoring

Permanent plots were established in 2016, when the thermal site characterisation started, with the first year-round data now permitting a comparison of edge and center conditions across snow-beds as well as across sites (NEWESELY et al. 2018, this volume). These data also permit nesting life conditions at the test sites in a pan-European assessment of ground temperatures in alpine grassland (KÖRNER et al. 2003). The terrestrial group performed the sampling for the base-level ecosystem assessment in August 2017 (Fig. 4, Fig. 5), with all samples and data as listed above now under processing.

Figure 4: A sample of a single transect at the site Innergschlöß, at 2350 m elevation. Mobile meter-grid nets assist sampling teams to locate permanent quadrats and the sub-quadrates nested in each grid window. Such grids also serve the photo-documentation of permanent quadrats in transects.

A large number of automatic cameras is monitoring wildlife (and domestic animal) abundance in the test areas at different elevations since July 2017. These data are essential to estimate natural and domestic herbivory pressure. Sites that have a history of domestic animal grazing (largely sheep; Innergschlöss, Furka and Oberettes) will be equipped with 25 x 25 cm ground baskets (3 cm mesh) from 2018 onwards to prevent grazing, and thus, also permit quantifying biomass losses to ungulate grazing. In 2017 these sites were fenced in the weeks before biomass harvesting. The aquatic group has all installations in place. At some sites such data are already available for several years (see FÜREDER 2018, this volume).

The way this monitoring program is conceptualized will ensure that the data not only meet the public interest in learning about climate-change influences on high elevation biota, but that the data collected also meet high scientific standards that will permit advancing high elevation biology and ecology. Environmental monitoring should always produce good science, to double-justify public spending and academic engagement. Such well replicated and standardized assessments will also permit scaling beyond the boundaries of small regions, and thus, will attract the wider conservation science community and environmental policy.

Figure 5: An example of plant biomass analysis for an 'optimum' quadrat and for a quadrat close to a snow-bed centre. Sampling of plant biomass at peak season (20 x 20 cm squares in the second week of August) and biomass sorting are done in such a way that all above ground plant dry matter that had accumulated in the current season (even if it had already senesced during that season) is included. This way, 'accumulated' seasonal dry matter becomes a proxy of annual above ground net primary production (NPP). Because of in-season biomass losses (e.g. by herbivory or seed distribution) the 'true' NPP will always be slightly higher. Below ground plant biomass, invertebrate and microbial samples are harvested from the same spot by means of soil cores. Mosses, lichens and woody structures from dwarf shrubs are disregarded, because growth in these tissues cannot be attributed to the given season. Note the graminoid (grasses, sedges, rushes) dominance at the favourable end of the transect and the herb dominance near the 'pessimal' end. Fueling the food web, NPP is one important starting point to explain invertebrate and microbial communities across these sharp climatic gradients.

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Ecosystem Services: Contribution of Natura 2000 Network in the economy and society of Crete

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Abstract

The aim of this study has been to map the benefits provided by the ecosystems within the Natura 2000 (N2k) network of Crete and assess its importance to the island's society and economy. GIS were utilised to create an integrated platform (Clearing-House Mechanism, CHM) consisting of the most relevant and up to date data for quantitative and qualitative evaluation Ecosystem Services (ES) at regional and/or national scale. Spatial and non-spatial data were merged to provide indicators of provisioning ES. Spatial data produced led to estimates of the contribution of Natura 2000 Network areas in Crete's primary sector, in relation to demography and employment patterns. Maps were further utilised to inform, communicate and raise awareness for the importance of the N2k network to the society and economy of the island.

Keywords

Ecosystem Services, Natura 2000, Clearing-House Mechanism, GIS, Greece, Crete, primary sector, employment, demography

Introduction

Natura 2000 (N2k) Network plays a key role in the conservation of the unique and endangered biodiversity in Europe. Moreover, it aims to protect the provision of benefits from ecosystems to both the society and the economy at local, regional, national and international (EU) level 'via the flow of ecosystem services (provisioning, regulating, cultural and supporting services)' (MAES et al. 2012; TEN BRINK et al., 2011, 2013).

A large number of methodologies, platforms and models have been developed by the scientific community for estimating the benefits and services provided by ecosystems (e.g. InVEST, natural capital project). Despite the availability of data banks (e.g. at European scale) more detailed national surveys and useful datasets are often neglected in ES modelling efforts. Exploration and cataloguing of existing data sources at national scale as well as data integration in a common (GIS) platform is the first step towards the assessment of ES at finer scales. The case of Crete constitutes one of the first attempts in Greece.

The purpose of this study was the implementation of a Clearing-House Mechanism (CHM), a platform consisting of the most common, up-to-date and useful data for quantitative, qualitative evaluation and mapping of ES indicators. The CHM and the associated database for Crete aims to improve efficiency and accuracy of future studies and offer a pilot example of mapping of ES provided by the 53 N2k sites of Crete (NYKTAS 2016). GIS has played a central role as the core of the CHM platform.

Methodology

Both geographical and non-geographical data relevant to the quantification of ES at regional and national level were catalogued and included in a ES CHM-GIS database. Data were made available through various agencies and sources such as the Hellenic Statistical Authority (HSA), the Ministry for the Environment and Energy, the European Environmental Agency (EEA), the Joint Research Centre (JRC) etc. Some of the most relevant data includes the following:

1. Corine Land Cover map (2000).
2. Vegetation type maps at national scales,
3. Land Capability and Land Resources Maps,
4. Soil and geological surveys,
5. Priority species and habitats range and distribution
6. Important areas for birds, as well as auxiliary data e.g. administrative units, waterbodies, road network, cities, towns and villages, monuments etc.

Spatial datasets included the EUNIS Habitat Classification of Crete in 2 levels (10 & 61 classes) from EEA. Supplementary recent high-resolution satellite images (RapidEye, 2016, 5m) were acquired to assist interpretation and future LC/LU assessments.

Important non-spatial data for the assessment of ecosystem services include census data collected by the HSA. The annual special statistical survey on agriculture and livestock farming in each Municipal Community (MC) of Crete (2010 census) was used in the present study. Information on the area covered by several types of crops, the number of fruit trees, agricultural and livestock production, livestock capital, as well as certain data on inshore fishing was the basis for the assessment and comparisons in the present study. Additional valuable information that links ecosystems with society and economy is related to the demography and geographical distribution of the island's population. The data used in this study refers to each MC in Crete and is related to the population, the employment numbers, as well as the workforce allocation per sector (2011 census) (NYKTAS 2016).

Processing of data involved merging of spatial and non-spatial (i.e. census) data, leading to a geographical representation of key provisioning ES, as well as social and economic indicators at MC administrative unit scale. Out of 205 different agricultural and livestock products, 24 were selected to be used as indicators of provisioning ES. Additionally, 6 demographic and employment indicators were included. The geographical dimension gained by linking GIS, demographic and agricultural-livestock census data, enabled various comparisons to be made between the areas of N2k sites in relation to the rest of Crete (NYKTAS 2016).

A methodological choice that had to be addressed in the course of this study is related to the borders of the MCs not coinciding with those of N2k sites. In that respect, the assumption made also for data processing is that ecosystems of N2k Network provide services and benefit communities within their borders, as well as closely neighbouring communities. Therefore, it was decided that all MCs that have at least 1% of their area within a N2k site were included in further processing (NYKTAS 2016). Provisioning ES for MCs intersecting N2k site borders were proportionally included in calculations using MCs mean value. In this way, the results would be more representative of the area designated as a N2k site.

Supplementary information was gained from Level 1 EUNIS Habitat Classification at European scale. Area distribution in each ecosystem type was calculated, as well as the proportion of each type within the island's N2k Network. The GIS software version used in the study was ArcGIS 10.2. Statistical data was merged with the polygons of the MCs and comparisons were performed in spreadsheet (NYKTAS 2016).

Results

Outputs of the present study include:

1. the percentages of the main ecosystem types in Crete and the proportion of each type within N2k Network (Tab. 1),
2. estimates of 24 indicators of provisioning services (Tab. 2) and
3. 6 indicators of population and employment (Tab.3). Comparisons were made between the areas within or close to N2k sites of Crete in relation to the rest of Crete.

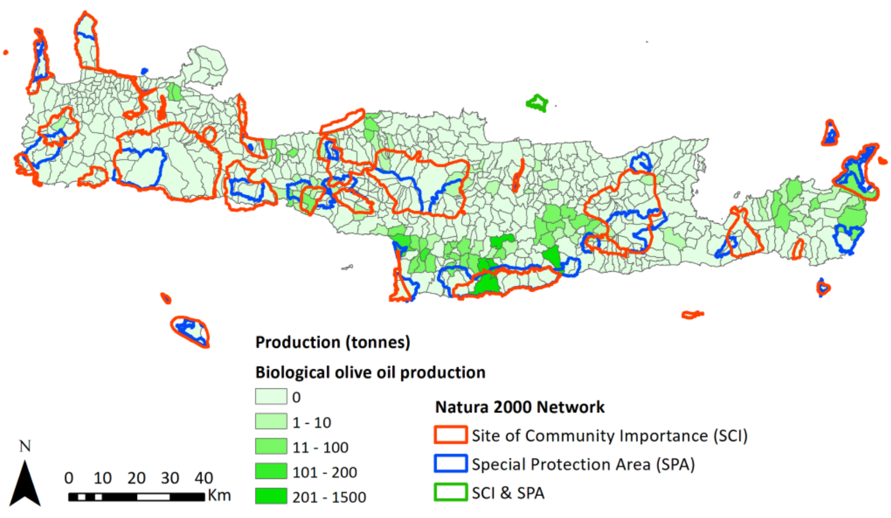
In total, thirty-one (31) maps were created: one map depicting the types of ecosystems in Crete, twenty-four maps of the geography of the primary sector in Crete, two demographic maps and four maps related with employment patterns in each economic sector.

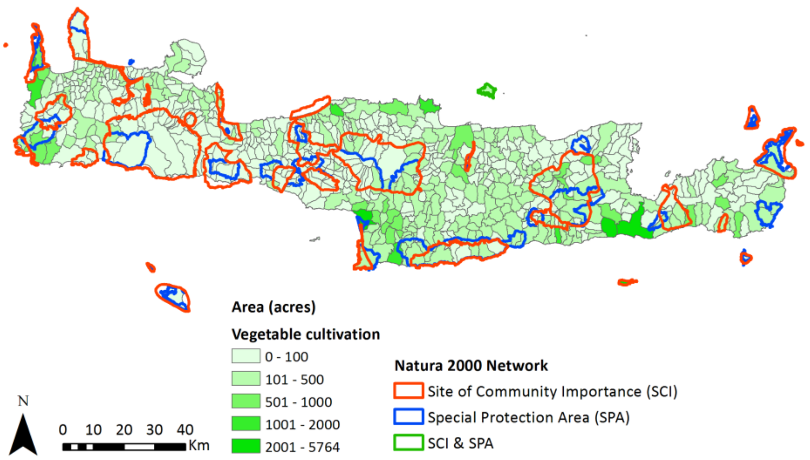
Ecosystem Type	Crete (ha)	% of Crete's area	% of habitat in the Natura 2000 Network
Marine			
Coastal	23707	2.8	46
Fresh water	144	0	44.4
Grassland	216122	26	37.8
Heathland and shrub	211765	25.4	40.1
Woodland and forest	253302	30.4	20.6
Sparsely vegetated land	27199	3.3	78.4
Cropland	88386	10.6	15.2
Urban	11858	1.4	5.2
Total	832483		

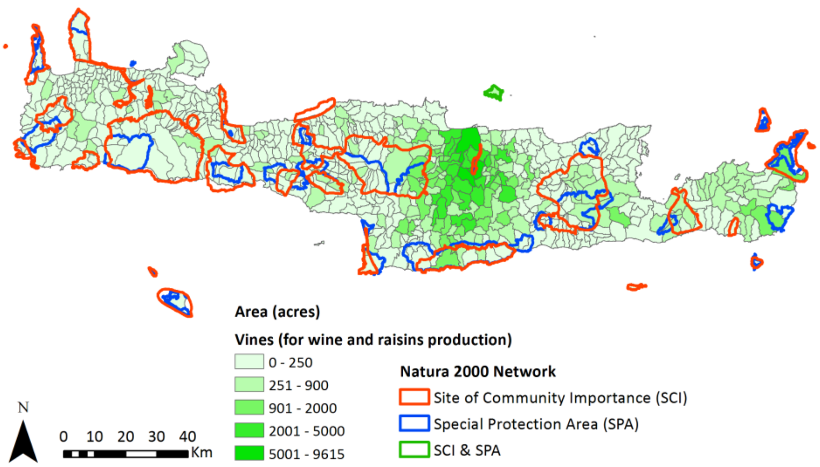
Table 1: Ecosystem types of Crete (EUNIS Level 1); proportion of island's total area and within N2k Network.

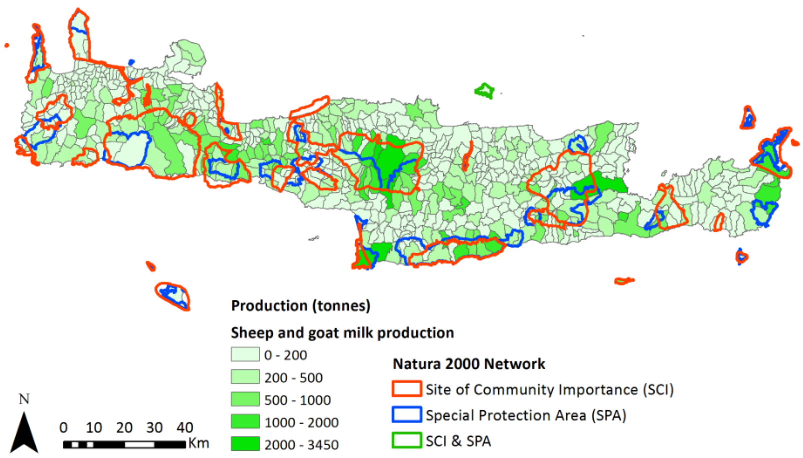
Indicators of provisioning services provided by agroecosystems	% within the Natura 2000 Network	% outside the Natura 2000 Network
Total area of big scale crops (cereals, legumes, fooder)	24	76
Total area of arable land	23.5	76.5
Total area of vegetable cultivation	23.5	76.5
Olive oil production	19.8	80.2
Tree cultivation area	22.7	77.3
Vines (for wine and raisins production)	16.8	83.2
Local and European beehives	44.3	55.7
Sheep and goat milk production	33.5	66.5
Sheep meat production	32.6	67.4
Goat meat production	34	66
Firewood production	22.2	77.8
Quantity of olive oil produced in the oil factories	16.7	83.3
Quantity of biological olive oil produced in the oil factories	27.8	72.2
Cheese and dairy production	40.9	59.1
Sheep wool production	36.4	63.6
Goat hairs production	49.5	50.5
Honey production	47.4	52.6
Wax production	55.2	44.8
Hides and skins from small animals	21	79
Hides and skins from large animals	3.8	96.2
Fisheries	19.1	80.9

Table 2: Geographical distribution of agricultural & livestock production in Crete (Source: HSA, 2010).





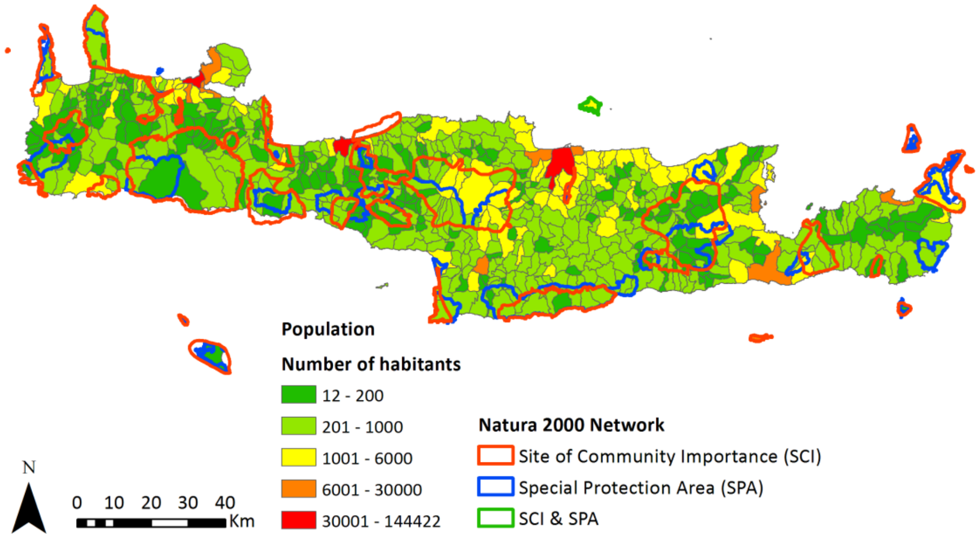


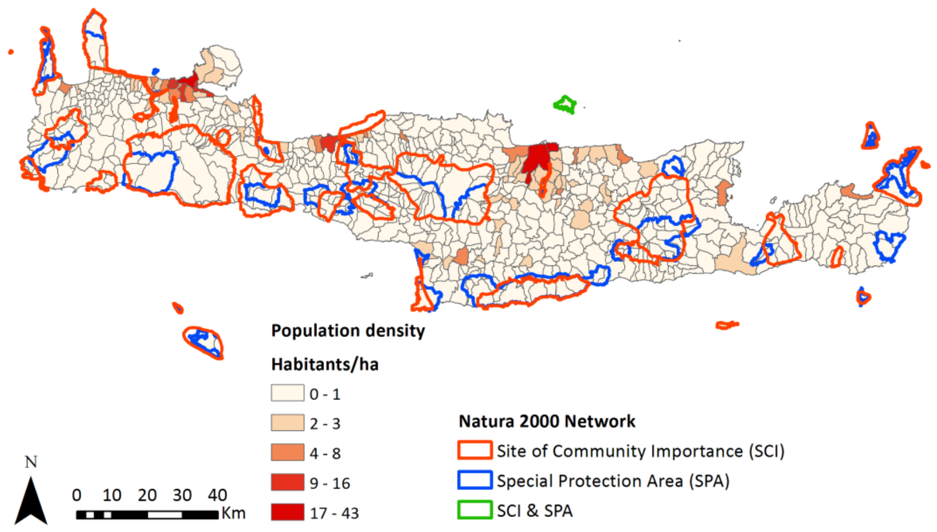


Figures 1-4: Four examples of provisioning ES depicted in map form: 1) biological olive oil production, 2) vegetable cultivation, 3) vine crops & 4) sheep & goat milk production (Source: HSA, 2010).

Indicators of population and employment	within the Natura 2000 Network	outside the Natura 2000 Network
Distribution of population	7%	93%
Population density (hab/ha)	16.8%	103.8%
% of economically active population (% of economically inactive population)	37% (63%)	44% (56%)
% of economically active population in primary sector (% of economically inactive population in primary sector)	35.7% (64.3%)	10.8% (89.2%)
% of economically active population in secondary sector (% of economically inactive population in secondary sector)	9.7% (90.3%)	12.5% (87.5%)
% of economically active population in tertiary sector (% of economically inactive population in tertiary sector)	46.9% (53.1%)	60.9% (39.1%)

Table 3: Geographical distribution of population & employment in Crete (Source: HSA, 2011).





Figures 5-6: Geographical distribution of population & population density in the MCs of Crete.

Conclusions

The terrestrial part of N2k network covers 31.8% of the total area of Crete, while the mountainous areas represent 50.1% of N2k sites area. The allocation of ecosystems within N2k is balanced with regards to natural habitats, whereas cropland and urban areas are underrepresented as expected. Even though sparsely vegetated areas occupy only 3.3% of Crete, a high proportion of them (78.4%) are included in the N2k network (Tab. 1). Protection of mountainous areas reflects the importance of these habitats for many endemic and rare species, as well as the key role of those areas in Crete's water resources management.

The results of agricultural and livestock production demonstrate a notable production derived from the primary sector within or close to N2k sites. Livestock production in particular stands out. Despite that only 7% of the population of Crete lives within the protected areas (Tab. 3), sheep and goat milk production *(Map 4)*, as well as cheese and other dairy production ranges from ~33% to ~41% in N2k sites. Similarly, sheep and goat meat production in N2k sites represents about 33% of the island's total production (Tab. 2). Crop fields (excluding tree crops) cover 10.6% of Cretan land, while 15.2% of them is found within the N2k Network (Tab. 1).

Basic agricultural products such as cereals, vegetables, fruits and grapes, support Cretan economy and are produced in significant quantities within protected areas (24%, 23.5%, 22.7% & 16.8% respectively). Organic and conventional olive oil production within N2k Network is 60.5% και 35.3% respectively *(*Fig. 1-3, Tab. 2*)*. These numbers are noteworthy given the importance of olive oil production and export to Crete's economy.

More than 20% (120 out of 578) of MCs have at least part of their land within N2k Network. Population numbers and density within N2k sites (Fig. 5-6, Tab. 3) are low especially when compared to the production of the primary sector in those areas. With regards to the employment, the economically active population in the areas outside of N2k Network of Crete is the 44% of the total population as opposed to 37% of the population of the rural areas of N2k Network, most possibly related to the aging of the population in those areas. The population within or close to N2k sites that works in the primary sector is 35.7% of the total active population as opposed to 10.8% outside of the protected areas (Tab. 3). All the above emphasize the threat from further depopulation of rural areas of Crete and its detrimental effects in Crete's primary sector and overall economy.

Discussion

The preliminary findings of the present study for the island of Crete highlight the importance of a CHM and GIS for the evaluation and monitoring of the ES provided by N2k Network. GIS is an essential tool for collating and visualizing various indicators depicting the significance of N2k Network to the society and the economy of the region. Spatially explicit outcomes of this study could provide policy directions for the sustainable management of the areas within and outside N2k Network. Furthermore, outcomes have been an indispensable input for the production of educational and instructive material raising public awareness regarding the importance of the N2k network in Crete.

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A tourism toll road in the biggest central European National Park – a paradigm? Or an antagonism? And what about the inhabitants' expectations? – An Example from the Hohe Tauern National Park.

Alexandra Kruse & Peter Strasser

Abstract

In the Austrians high mountains, we find a paradigm: A tourism toll road with more than 800.000 visitors a year embedded in a National Park, IUCN category II. Both, park and tourism attraction attract visitors one for the other and both have advantages through their proximity and close cooperation. One can even say, one was and still maybe is the reason for the other.

Keywords

Sustainable planning and management, participatory planning

Introduction

The Großglockner High Alpine Road (GGHAS) is a high-alpine touristic toll-road in Austria, embedded in the Hohe Tauern National Park, the biggest protected nature area in central Europe (IUCN category II). Built in the early 1930ies, it is both prototype and best preserved example of a historical scenic mountain road and provides a spectacular experience for more than 800,000 visitors per year.

Since its opening, the same comprehensive management and preservation concept on the basis of sustainability will be applied in close cooperation with the National Park service as well as with the surrounding municipalities. Since 2015, the road is protected as national monument. The protected area includes the entire route between the two toll gates up to across the passes, both access roads, the essential buildings as well as moveable heritage objects such as, for example, the rotary snow ploughs. Its maintenance measures are implemented according to a comprehensive care concept in consideration of sustainability. This concept has been developed and implemented back in the 1930s by the road's architect, Franz Wallack. In 2017 the road was proposed as UNESCO cultural World Heritage property.

Methods/Results/Background

The **Großglockner High Alpine Road** (GGHAS), a high-alpine touristic toll-road in Austria runs through the **Hohe Tauern National Park**. While the street represents a human monument with dense traffic, the National Park (IUCN category II) serves as a refugium for high Alpine fauna and flora.
Plans for the Großglockner High Alpine Road date back to 1924 and were realised between 1930 and 1935. The road represents both prototype and best preserved example of a functioning historical scenic mountain road in Europe. It is the only road, which, since its opening as a toll road, is operated according to the same comprehensive management, marketing, and preservation concept. Its management- and maintenance-concept served as model for other toll-roads, like the Silvretta High Alpine Road (Silvretta Hochalpenstraße) between Tyrol and Vorarlberg. Planned and built as a toll road in a protected and largely untouched high-mountain landscape, it aimed at offering visitors a spectacular driving *and* landscape experience. '*Early engineers and surveyors in the United States, such as Robert B. Stanton, saw no contradiction between the beautiful railroad and grandiose landscape.*' (MAUCH & ZELLER 2008:6) This principle was the fundament of the American Scenic Highway – and it swept over to Europe where so far, only railroads had been used to open the land to the public. The main idea of Wallack was to open the view into the high alpine nature – by offering after each turn a new impression. The engineer himself described aim and ambition as follows: ‚*Die Straße sollte sich nicht nur harmonisch in das Landschaftsbild einfügen, sie sollte gleichzeitig auch möglichst viele schöne Aussichtspunkte direkt berühren. Diese im Interesse des Fremdenverkehrs und der Touristik gelegene Forderung sollte der Leitstern der ganzen Trassierung sein*[1].' (WALLACK 1949:30). A still increasing number of tourists from all over the world visit the GGHAS every year to enjoy and experience of the Hohe Tauern landscape.

The driving factors of tourism and the landscape perception, as found with the GGHAS, constitute a new construction theme, a concept, which has since then been copied many times in other places or has served as a model, f. ex. for the German Alpine Road, the Susten Pass Road in Switzerland, and the Vienna High Road in Austria. Still today, delegations from all over the world come in order to learn about the technical and engineer's features as well as the management and maintenance concept.

[1] 'The road should integrate itself not only harmonically; it should at the same time directly touch on as many beautiful vantage points as possible. This claim in the interest of tourism and its administration shall be the guiding principle of the whole alignment.'

Since 2015 the protected area – as protected under the Austrian Monuments Protection Act - includes the entire route between the two toll gates up to across the passes, both access roads, the essential buildings as well as moveable heritage objects such as, for example, the rotary snow ploughs, which date back to the early years of the GGHAS. Its maintenance measures are implemented according to a comprehensive care concept in consideration of sustainability. This concept had been developed and implemented back in the 1930s by the road's architect, Franz Wallack.

The **Hohe Tauern National Park**, the largest protected area in central Europe with nearly 2,000 km² and with 300 peaks over 3000 m in altitude, contains the region around Austria's highest mountain, the Großglockner (3,798 m) as well as the Pasterze, with approximately still 8 km the longest glacier in the Eastern Alps. The park was established in 1983. One of the most well-known features is the so called 'Tauern Window' which offers a unique view of the earth's geological history. It comprises an approximately rectangular region extending from the Brenner in the west to the Katschberg Sattel in the east (approximately 176 km) and from the Salzach Valley in the north to the Matrei / Möll Valley line in the south (approximately 30 km). In this area, kilometre-thick layers have already been eroded from the Alps (rocks that once were part of the African continental plate), which provide us a window-like view of the lower layers of rock (and the clearly much younger rocks of an ocean floor). In Großkirchheim, for example, the rocks of both large geological units can be observed on the slopes of both sides of the Möll Valley. This allows us to experience within walking distance both the European and the African continental plates almost simultaneously.

The park, classified under IUCN II category, comprises the Pasterze and numerous further glaciers, the Krimml Waterfalls, several glacial valleys and alluvial fans, as well as extended tundra areas and forests. Among the flora of the Alps, especially Swiss Pines grow along the tree line; above subshrub, mainly alpenrose but also the endemic saxifraga rudolphiana, up to nival level at about 2,800 m (9,200 ft). The fauna includes chamois, Alpine ibex and red deer, as well as griffon vulture and the golden eagle. The formerly extinct bearded vulture and the Alpine marmot have been successfully reintroduced.

Figure 1: Every year after the re-opening of the GGHAS, a wondrous view is offered to the drivers and users of the road and the landscape is hidden in the snow. (Source: A. Kruse 2016)

The Großglockner High Alpine Road is not only a touristic highlight of the Eastern Alps and an excellent vantage point for the highest peaks in Austria, but also includes unique geological rock formations. In fact, there is hardly another point in the Alpine region that has natural geological rock formations of vastly different eras, including those created by humans that can all be observed directly in a relatively small area. For this reason, the 'Tauern Window' is intended to be positioned as an Educational Centre for the Anthropocene by 2018.

As since the beginning, the experience of nature and landscape had been the driving forces for the construction of the GGHAS, the administration of the National Park is a member of the steering group of the proposed World Heritage Site. Both partners agree on their ecological responsibility and have therefore agreed to achieve the following results:

– Through the management of tourism along the Großglockner High Alpine Road and in its surroundings, we have shared responsibility for one of the largest protected areas in Europe: Hohe Tauern NP. Sustainable commerce in a highly sensitive, high alpine natural area sets clear norms and limits for the company.
– Unique Experience of High Alpine Nature: However, the uniqueness of this landscape and of the national park idea also make it our job to bring the experience of high alpine nature to a broad audience in an environmentally friendly way through the Großglockner High Alpine Road. In particular, this includes educational and cultural facilities.
– Safeguarding the Future: We see ourselves as keepers and savers of the Großglockner High Alpine Road monument's future, and of the facilities and businesses belonging to it. We strive towards actively developing our services further to move the Austrian — and in particular the regional — tourism industry forwards as best as we can. Our expertise in the ecological management of the Großglockner High Alpine Road and our work for the national park idea is used by our affiliates and also for additional tasks.' (Guiding Principles of the operating company Grohag)

This is demonstrated not only by cooperation, common education facilities, and sustainable management including waste management but also by e.g. financial cooperation and investment in environmental protection research.
Apart from the two large players, there are also several small municipalities, living from a certain extent from tourism – winter and summer tourism. As it is their aim to extend tourism, this would mean - with regard to the winter season - the construction of e.g. new slopes and/or lifts, with regard to summer tourism the prolongation of the duration of onsite stay, from day to several days tourism. The most important selling points of the region are the GGHAS and the NP – as every slogan, every local brand and marketing concept underlines. Most recently another 12 local enterprises have been awarded by the Hohe Tauern NP Region with the Carinthian Quality label (https1)

Discussion/Conclusion

As demonstrated above, the co-existence of a Tourism road in the heart of a National Park is not seen as being problematic – because from the beginning, the road was developed in order to valorise the landscape and the nature, to protect and to maintain it – for the visitors of the road. Therefore, both components are in a way dependent on each other. That the road and National Park are considered as a unit in one way or another, has been underlined by the fact, that both elements had been submitted jointly in 2002 as a mixed site to the UNESCO World Heritage List. Due to several formal reasons, the nomination had been withdrawn by the Austrian State Party during the nomination procedure (PAULOWITZ 2015).

Figure 2.: The street is literally embedded in the landscape – often hard to recognise – each turn opens a new experience, a new landscape view. (Source: A. Kruse 2015)

However, the inhabitants' expectations of this special region are at first place to have a bigger share at the tourism activities. More than 800.000 tourists visit the GGHAS each year – only during summer times, as the road is closed in winter. However, due to the conception of a DRIVING site, most people come by car (>187.000) or motorbikes (appr. 90.000). Although there is a growing number of cyclists (around 24.000[2]) – also due to the increasing number of e-bikes - these tourists cannot yet be considered as the main group. And more important, as they come, drive and leave, most of them do not stay in the villages at both ends of the GGHAS. To increase the number of bus tourists (with a concept of a 2 days stay by offering further visits or events) seems not to be an option, because the road was developed and is appreciated for a driving experience, which will be limited when the number of busses increases. A solution could be a time management, which restricts for certain hours access for cyclers, others for busses and so on.

Winter tourism is completely detached from the road – which is, at several points, not even perceivable. However, it is unlikely that the National Park authorities and administration will cooperate to extend slopes or agree to the construction of new ski lifts

Generally speaking the inhabitants of the neighbouring municipalities of Heiligenblut am Großglockner and Fusch an der Großglocknerstraße are satisfied with the situation, as they appreciate the advantages of living in-, respectively with the National Park and the GGHAS. Nevertheless they are quite attentive towards any changes and eventually upcoming further restrictions. Therefore, several hearings have been organised while preparing the candidacy for inclusion in the UNESCO List of World Heritage. A local stakeholder group with farmers and landowners is following the activities considerately. A dialogue has been established and will continue in order to inform on a regular basis and in order to let local stakeholders participate in planning and development strategies.

Figure 3: Citizens information events at Heiligenblut am Großglockner (right) and Fusch an der Großglocknerstraße, together with the Municipality of Rauris (left). Source: A. Kruse 2016

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[2] All numbers based on Grohag counted in 2015. The visitor statistics exist since the beginning of the road in 1935.

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Fluvial landscapes – an important ecological dimension within European protected areas

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Abstract

This presentation aims to give an exemplary overview about fluvial landscapes covered by protected areas across Europe. The main data sources about protected areas are the Natura 2000 data and the World Database on Protected Areas. Briefly, fluvial landscapes are an important ecological dimension within European protected areas, though there are spatially differences in frequency across Europe.

Keywords

Natura 2000, RAMSAR, WDPA

Introduction

In general, fluvial can be described as '*of or pertaining to rivers, produced by the action of a river or stream*.' In the broadest sense, fluvial landscapes include all landforms and biologic communities that are affected by the flow of water, sediment, and organic materials within the hierarchically branching network of river corridors. Fluvial landscapes comprise active and former river channels, off-channel water bodies, confluence environments, wetlands, floodplains, terraces, riparian vegetation, subsurface patterns of hyporheic flow and all habitat associated organisms. The fluvial landscape can thus be understood as a spatially dynamic entity, formed, and altered over time, by hydroecological processes related to a specific catchment (BENDA et al. 2011).

The IUCN (2017 a) defines protected areas as: '*A protected area is a clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values*.'

Protected areas can be categorized in several ways. Regarding the management objectives, the IUCN proposes following categories: Ia Strict Nature Reserve, Ib Wilderness Area, II National Park, III Natural Monument or Feature, IV Habitat/Species Management Area, V Protected Landscape/ Seascape, VI Protected area with sustainable use of natural resources (IUCN 2017b).

Another classification system may be e.g. the type of protected area as legally/officially designated or proposed: **Regional** - Protected areas designated or proposed at the regional level, **National** - Protected areas designated or proposed at the national or sub-national level, **International** - Protected areas designated or proposed through international conventions (PROTECTED PLANET 2017).

Several protected area frameworks are already implemented. At the spatial scale of European Union (EU) for example, the aim of the Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (Habitat Directive, adopted on 21 May 1992) is to promote the maintenance of biodiversity, taking account of economic, social, cultural, and regional requirements (EC a). Both Habitat Directive and Bird Directive (EC b) establish the EU wide Natura 2000 ecological network of protected areas.

On the international level, important frameworks are e.g. UNESCO-MAB Biosphere Reserves, Ramsar Sites, or World Heritage Sites. Under the Convention on Wetlands of International Importance, called the Ramsar Convention, the contracting parties are committed to: work towards the wise use of all their wetlands; designate suitable wetlands for the list of Wetlands of International Importance (the 'Ramsar List') and ensure their effective management; cooperate internationally on transboundary wetlands, shared wetland systems and shared species (RAMSAR CONVENTION 2017). The Convention uses a broad definition of wetlands and includes also running waters.

This presentation aims to give an exemplary overview about fluvial landscapes covered by protected areas across Europe.

Methods

The main data sources about protected areas are the Natura 2000 data (EEA 2017 a) and the World Database on Protected Areas (WDPA) (IUCN and UNEP-WCMC 2017). The Delineation of Riparian Zones data set (EEA 2017 b) was used as (visual) support for on-screen-selecting exemplary protected areas of fluvial landscapes. The Interpretation Manual of European Union Habitats (EC 2013) gives indication of habitats relevant to fluvial landscapes.

Results

The Interpretation Manual (EC 2013) compiles 17 habitats in the section **Freshwater Habitats – Running water**: 3210 Fennoscandian natural rivers, 3220 Alpine rivers and the herbaceous vegetation along their banks, 3230 Alpine rivers and their ligneous vegetation with *Myricaria germanica*, 3240 Alpine rivers and their ligneous vegetation with *Salix elaeagnos*, 3250 Constantly flowing Mediterranean rivers with *Glaucium flavum*, 3260 Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation, 3270 Rivers with muddy banks with *Chenopodion rubri p.p.* and *Bidention p.p.* vegetation, 3280 Constantly flowing Mediterranean rivers with *Paspalo-Agrostidion* species and hanging curtains of *Salix* and *Populus alba*, 3290 Intermittently flowing Mediterranean rivers of the *Paspalo-Agrostidion*, 32A0 Tufa cascades of karstic rivers of the Dinaric Alps. Further water-dependent habitats in fluvial ecosystems are 91E0 * Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion*, *Alnion incanae*, *Salicion albae*), 91F0 Riparian mixed forests of *Quercus robur*, *Ulmus laevis* and *Ulmus minor*, *Fraxinus excelsior* or *Fraxinus angustifolia*, along the great rivers (*Ulmenion minoris*), 92A0 *Salix alba* and *Populus alba* galleries, 92B0 Riparian formations on intermittent Mediterranean water courses with *Rhododendron ponticum*, *Salix* and others, 92C0 *Platanus orientalis* and *Liquidambar orientalis* woods (*Plantanion orientalis*), 92D0 Southern riparian galleries and thickets (*Nerio-Tamaricetea* and *Securinegion tinctoriae*), 9370 * Palm groves of *Phoenix*). Further habitats typically for standing waters (e.g. *3130* Oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletea uniflorae* and/or *Isoeto-Nanojuncetea*, 3140 Hard oligo-mesotrophic waters with benthic vegetation of *Chara spp.* or 3150 Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition* - type vegetation amongst others) may also situated in fluvial landscapes, but aren't included in this analysis.

Running water is here defined as sections of water courses with natural or semi-natural dynamics (minor, average and major beds) where the water quality shows no significant deterioration (EC 2013).

At the end of year 2016, the Natura 2000 network database incorporates 27527 protected areas, thereof 9135 sites cover one or more habitat types related to running waters. 8745 of these protected areas are connected to the Habitat Directive. About 49 % of the sites are within the Continental biogeographic region, followed by the Mediterranean (16 %), Atlantic (10%), Alpine (9%) and Boreal (8%) biogeographic region (see Fig. 1).

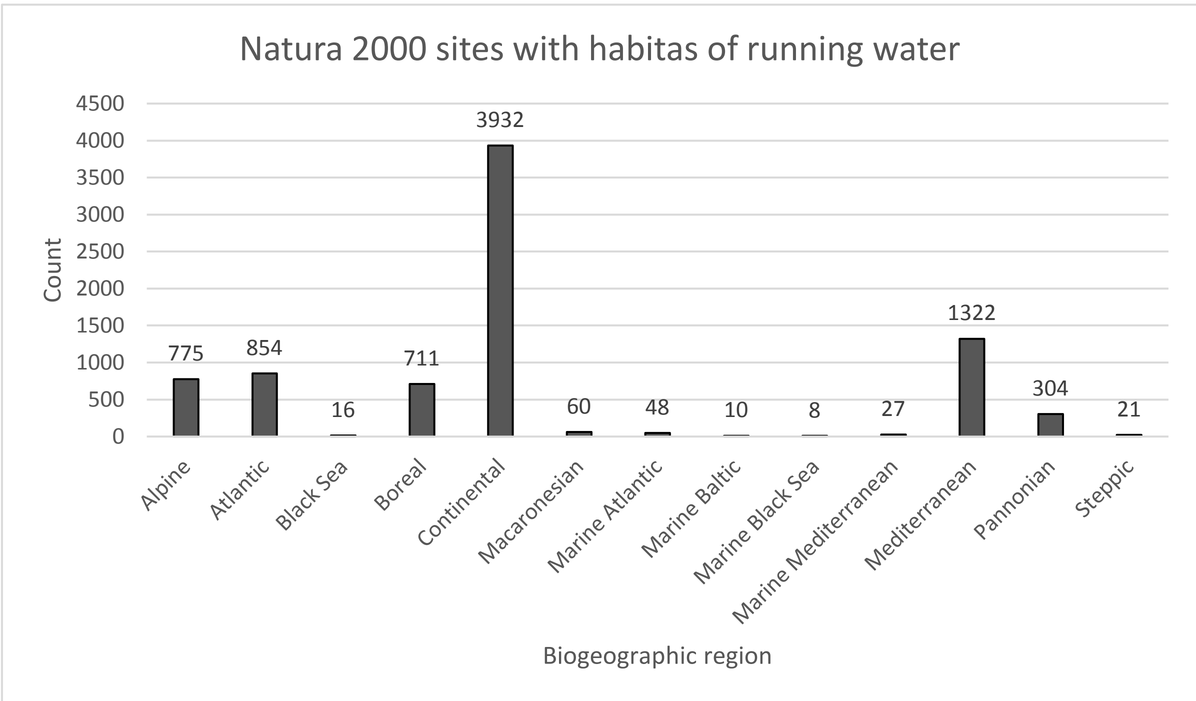

Figure 1: Natura 2000 sites with habitats of running water in the European biogeographic regions

Several of these protected areas implemented after the Habitat Directive are explicitly dedicated to running waters and their fluvial landscapes and covers large river sections. Examples are e.g. Durance (FR9301502 Steppique Durancien et Queyrassin, FR9301589 La Durance), Ticino (IT2080002 Basso corso e sponde del Ticino), Isel (AT3314000 Osttiroler Gletscherflüsse Isel, Schwarzach und Kalserbach), Isar (DE8034371 Oberes Isartal, DE7537301 Isarauen von Unterföhring bis Landshut) or Mura (AT2213000 Steirische Grenzmur mit Gamlitzbach und Gnasbach, SI3000215 Mura, HR2000364 Mura). Otherwise a high portion of these 8745 protected areas covers only parts or sections of running waters and their fluvial landscapes.

Some of them have more than one conservation/protection label, e.g. protected area according to the Habitat Directive like AT1204000 Donau-Auen östlich von Wien and AT1202000 March–Thaya-Auen (both dedicated

additionally whether as a national park or as a transboundary Ramsar site, i.e. Trilateral Ramsar Site Floodplains of the Morava-Dyje-Danube Confluence) or AT3309000 Tiroler Lech (includes also a regional Nature Reserve).
In Austria, more than 60% of all ascertained floodplains are part of the Natura 2000 network, that are 60.213 ha (LAZOWSKI & SCHWARZ, 2014).

Selecting the Ramsar sites out of WDPA by the Delineation of Riparian Zones data combined with quick visual correction shows that about 70 protected areas according to the Convention of Wetlands cover running waters and (parts of) their fluvial landscapes.
Spatial filtering for the Balkan region, the WDPA data compiles 462 protected areas for these non-EU countries (Albania, Bosnia and Herzegovina, Kosovo, Macedonia, Montenegro, and Serbia); a spatial selection by the Delineation of Riparian Zones combined with quick visual correction shows about 50 sites covering running waters and (parts of) their fluvial landscapes. The main protection categories are here: Landscape of Outstanding Qualities, Managed Nature Reserve (category IV IUCN), National Park, National Park (category II), Natural Monument, Protected habitat, and Ramsar Site.

The Kopački rit, a known and large fluvial landscape in the Balkan region, is shared by EU and non-EU-countries. Several protected areas with different categories cover river and fluvial landscape; the categories are here Nature Park, Nature Reserve, Ramsar Site, Site of Community Importance (Habitats Directive), Special Protection Area (Birds Directive), Special Reserve. Otherwise, high-value (near) natural rivers in the Balkan region, e.g. Vjosë (Albania), are not under any protection.

Delineation of Riparian Zones data is not available for East-European non-EU countries like Belarus, Georgia, Moldova, Russia, or Ukraine; thus, a quick visual selection of the WDPA data in GIS was performed. In this European region, some rivers and (parts of) their fluvial landscape are protected as e.g. Managed Resource Protected Areas, Ramsar Sites, Regional Landscape Parks, Managed Reserves, or other protected areas on national level with IUCN category IV.

Discussion/Conclusio

In summary, fluvial landscapes are an important ecological dimension within European protected areas. There are spatially differences in frequency across Europe, with a high density in the EU.

Within the EU, Habitat Directive and Bird Directive are important legal drivers to include running waters and their fluvial landscapes in the protected area network Natura 2000. These directives are mainly focused on conservation and sustainable land use. In addition, on the international level, the Convention on Wetlands of International Importance is another important framework to implement protected areas spanned over fluvial landscapes, with focus on a wise and sustainable use.

Different protected areas categories cover fluvial landscapes, resulting in a variety of various legal, conservation and management/land use implications: from high level National Parks, over Managed Resource Protected Areas to Nature Parks more focused on rural development. A small portion of these sites, mostly of them in the EU, are labelled by more than one category.

Regarding the spatial envelope of protected areas along running waters and fluvial landscapes, a heterogeneous pallet of implementations can be observed; from including the entire running water and fluvial landscape to involving only a section of these ecological entities into a protected area. As fluvial landscapes are dynamically embedded into their surroundings, spatial extent and envelope of the protected areas influence the options of management and sustainable use and thus the successful achieving of the conservation targets.

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Local trophic cascading impact of wolves on tree regeneration in summer and winter areas of ungulates

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Abstract

Wolves can change the abundance and the spatio-temporal use of habitats of wild ungulates and thus have an impact on the browsing of tree regeneration. In the Calanda region of Switzerland, ungulate browsing was monitored in tree regeneration inventories before, during and after wolf settlement. Within the core zones of wolves the deer density and browsing on tree saplings decreased but not in frequently used zones that were within winter areas of deer. Trophic interactions are supposed to be complex because of the influence of forestry, hunting and wildlife protection areas.

Keywords

Canis lupus, ungulate browsing, herbivory, forest regeneration, red deer

Introduction

The wolf (*Canis lupus* L.) currently returns to its original distribution areas in central Europe. Since about 1995, it has been migrating from Italy to Switzerland. In the region around the mountain range of Calanda (Canton of Grisons) the first couple of wolves in the modern time of Switzerland settled down in 2012 and reproduces each year.

The wolf will change the interactions between the organisms, as wolves eat wild ungulates like chamois (*Rupicapra rupicapra* L.), roe deer (*Capreolus capreolus* L.) and red deer (*Cervus elaphus* L.) to meet their energy needs as a large, year-round active carnivore. This reduces the species abundance of the prey species and can affect the frequency and distribution of browsing on tree regeneration (RIPPLE & BESCHTA 2012). Besides such direct, numeric effects of wolves on the abundance and demography of their prey populations, functional effects through mediated behaviour of wild ungulates are reported. For example, the presence of wolves can affect the spatio-temporal use of wild ungulates (KUIJPER et al. 2013). This in turn affects the vegetation development and the tree regeneration indirectly (GÄRTNER & NOACK 2009). The group size (BARJA & ROSELLINI 2008) and the food selection of the wild ungulates (CHRISTIANSON & CREEL 2008) can also change in the presence of wolves, and thus the browsing pressure on the site increases or decreases locally. As forest ecosystems in central Europe are strongly influenced by hunting, the trophic cascading impact of carnivores on forests may be limited (RATIKAINEN *et al.* 2007). Thus, trophic interactions between predators, herbivores and forest regeneration are complex, multi-layered and difficult to anticipate.

In a first phase of wolf recolonization in a region with still a low density of wolves, the functional effects as changes in the spatio-temporal use of habitats and resources are considered to be dominant because the wild ungulates attempt avoiding to become a prey (KUPFERSCHMID & BOLLMANN 2016). Later, in phases with higher wolf densities and in particular in wolf core areas, numeric effects on the abundance of prey species should become more obvious. Since the spatio-temporal habitat use of prey species is not only influenced by the occurrence and abundance of large predators but also by forestry, hunting practises and wildlife protection areas, a gradual decrease in the browsing level cannot be assumed in general.

In this study I used regeneration assessment areas that were installed previous to wolf settlement i) in the core area of the wolf pack, ii) in areas used by deer and wolves in winter and iii) in areas with only sporadic presence of wolves. The aim of this pilot study was to compare the regeneration density and browsing intensity over time to see if there was a large and thus measurable effect of wolves on tree regeneration.

Methods

In order to control the influence of ungulate browsing on tree regeneration, the canton of Grisons established regeneration assessments in different areas with 14-25 circular sampling plots on a rectangular grid with a fixed distance of 100 m. The plot radius varied between 2 and 9 m and the plot centres were permanently marked. Each plot was sampled in autumn by the cantonal authorities in various years (1996, 2007/08, and 2013/15). Thereby, the amount of tree regeneration was counted in height classes (10 cm till 130 cm height) and it was noted if the terminal shoot was browsed. For this study, seven sites were chosen with regeneration of *Abies alba* that also had silver fir trees in the canopy.

Four sites were situated in the Calanda region:

- 2 sites in the core area of the wolf pack located in a summer area of red deer (hunting area Felsberg)
- 2 sites with frequent wolves in winter located in a winter area of roe and red deer and belonging to the wildlife protection area of ‘Chimmiwald’ (hunting area Untervaz).

Three sites were situated in the nearby Prättigau region:

- 2 sites with infrequent wolf presence located in a winter area of red deer, one of them belonging to the wildlife protection area of ‘Eggwald’ (hunting areas Vorderprättigau or Seewis)
- 1 site with infrequent wolf presence located in a summer area of red deer (hunting area Seewis).

The sites were resampled by students in early spring before budburst in 2016 (Calanda) or 2017 (Prättigau). Ungulate density was approximated in each area by taking the number of ungulates culled by hunting per year and forest area (red and roe deer) or area (chamois) within each hunting district and calculating the Ungulate Density Index (following MOTTA 1996) as UDI = 1/5 roe deer + 1/4 chamois + red deer. Analysis was done separately for each tree species with the R 3.3.1 (2016), function ‘lm’ of the package lme4. For the number of saplings browsed on their leader shoot in percentage of all saplings, i.e. the browsing intensity, additional subset analyses per each region were carried out.

Results and discussion

The region Calanda with frequent wolves and deer in a winter area had significantly less tree regeneration (apart from more beech saplings, probably due to lower elevation of one site) than the region Calanda with deer in summer (Tab. 1). The values varied over time with more regeneration of the preferentially browsed tree species *Abies, Acer* and *Sorbus* after compared to before wolf settlement (Tab. 1). An increase in UDI tended to have a negative influence on *Acer* and *Abies* sapling density. Generally, the models explained rather poorly, indicating that some major factor explaining tree regeneration density is missing in the models.

	Acer pseudoplatanus	*Fagus sylvatica*	*Sorbus aucuparia*	*Abies alba*	*Picea abies*
Browsing intensity	-0.0021±0.0014	-	0.0015±0.0008	-	-
Basal area	*-0.0709±0.0275*	**-0.4319±0.0816**	**0.0558±0.0158**	*0.0241±0.0114*	**0.0643±0.0135**
UDI	*-0.0158±0.0062*	-	-	*-0.0049±0.0025*	-
Region: Calanda deer in winter	**-0.3866±0.1090**	**6.3768±1.3087**	*-0.4954±0.2118*	**-0.6179±0.1718**	**-1.1242±0.2154**
Region: Prättigau deer in summer	*1.6656±0.7654*	**19.4311±3.5602**	**-2.4205±0.6313**	**-1.3351±0.4829**	**-2.8720±0.5871**
Region: Prättigau deer in winter	*0.6319±0.3201*	**9.2997±1.9071**	**-1.1346±0.3305**	**-0.7586±0.2568**	**-1.6247±0.3144**
Year: during wolf establishment (2013)	0.1422±0.0951	-	0.1025±0.0535	0.0408±0.0434	-
Year: after wolf establishment (2015-2017)	**0.1887±0.0579**	-	*0.0761±0.0350*	**0.0712±0.0230**	-
pH	-	**4.6548±1.2074**	**-0.6624±0.1925**	**-0.5457±0.1555**	**-0.9093±0.1987**
Adjusted R-squared	0.0833	0.2316	0.1811	0.0564	0.0911
Degree of freedom	8/343	5/388	8/348	8/385	5/390

Table 1: Linear regression coefficients (± standard error) for tree regeneration density of saplings between 10 cm and 130 cm separately for the most frequent tree species. The tree density was square root transformed (except for *Fagus* where a natural logarithm transformation was carried out). The reference for ‘Region’ is ‘Calanda deer in summer’ and for ‘Year’ it is ‘before wolf establishment (1996 – 2008)’. The results were considered as significant below a p-value of 0.01 (in bold) and as a tendency between 0.01-0.05 (in italics).

The browsing intensity decreased for maple and spruce saplings with increasing sapling density. UDI had a combined effect with region as the UDI decreased in the core zone of wolf in the Calanda, remained more or less stable in the region of Calanda with deer in winter and increased in region Prättigau (cf. Tab. 3). The results were therefore almost not interpretable and a subset analysis for each region was therefore performed.

With the exception of beech, for all tree species the browsing intensity decreased in Felsberg in the wolf core zone over time (Tab. 2 and Fig. 1). In contrast, the browsing intensity increased over time for all species in Untervaz (only significant for *Fagus*, tendency for *Picea*, Tab. 2 but see Fig. 1). In the region Prättigau, the UDI values increased over time but only the browsing intensity of *Acer* significantly increased over time in Seewis. Note however, that there were only a limited amount of sampling plots with tree regeneration (between 29 and 102 depending on the tree species) and the result would clearly gain accuracy with more sites and plots within sites.

	Region	Calanda				Prättigau			
	Hunting area	Felsberg		Untervaz		Seewis		Vorderprättigau	
Tree	Wolf establishment	Wolf summer core zone		Wolves in winter		Infrequent wolf presence			
Acer	during	-	-	0.0472	±0.1033	-	-	-	-
	after	**-0.3306**	**±0.0816**	0.1470	±0.1075	**0.2613**	**±0.0829**	0.0777	±0.1203
Fagus	during	*0.3793*	*±0.1628*	0.0879	±0.0531	-	-	-	-
	after	0.1862	±0.1484	**0.1667**	**±0.0526**	-0.0545	±0.0642	0.0427	±0.1461
Sorbus	during	**-0.4115**	**±0.1299**	0.1147	±0.1951				
	after	**-0.5795**	**±0.1756**	0.1414	±0.1947	0.0627	±0.1252	-0.0328	±0.1152
Abies	during	**-0.4004**	**±0.1357**	-0.2645	±0.1965	-	-	-	-
	after	**-0.3971**	**±0.1413**	0.1592	±0.2034	-0.1673	±0.0888	0.0942	±0.0866
Picea	during	-0.0632	±0.0324	0.0023	±0.1057	-	-	-	-
	after	*-0.0752*	*±0.0339*	*0.2487*	*±0.1089*	0.0101	±0.0587	-0.0155	±0.0207

Table 2: Linear regression coefficients (± standard error) for the subset analysis of browsing intensity before, during or after wolf settlement for the most frequent tree species in each region. The reference for 'wolf establishment' is before. The results were considered as significant below a p-value of 0.01 (in bold) and as a tendency between 0.01-0.05 (in italics).

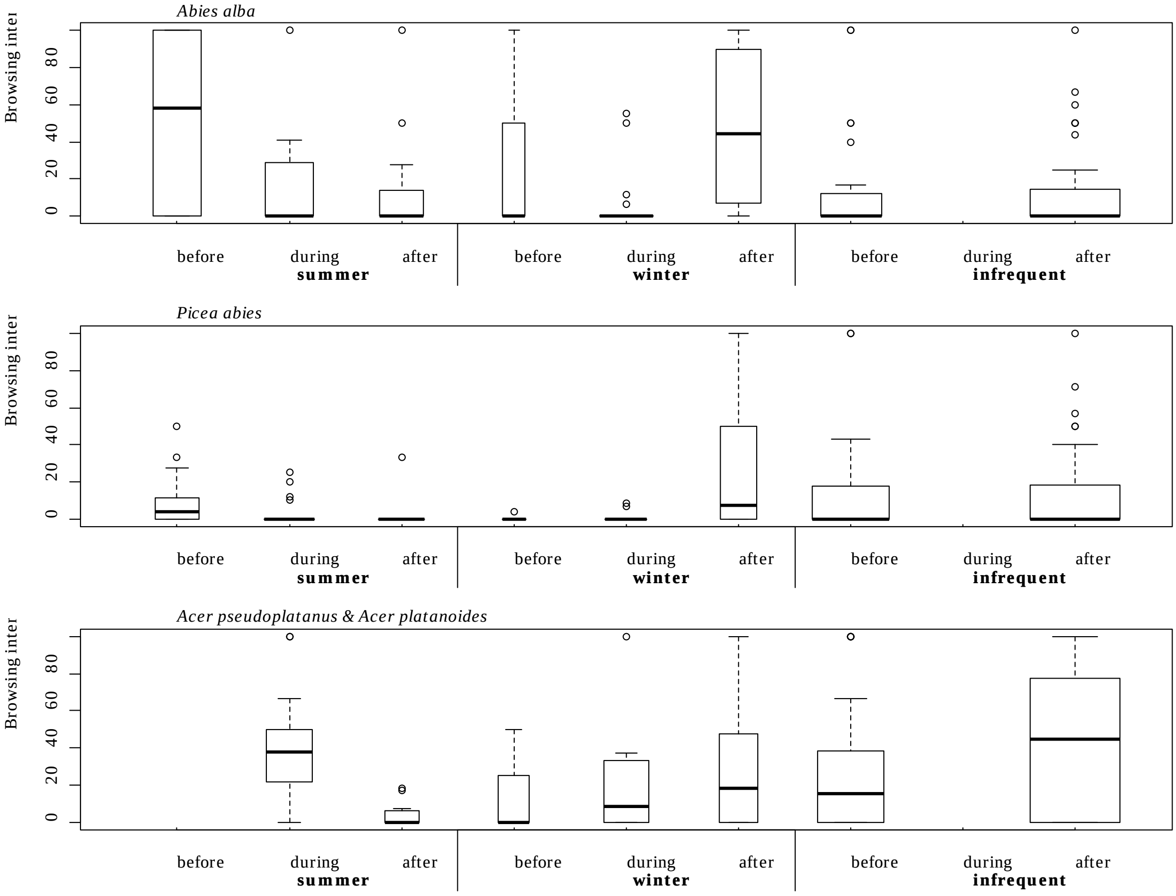

Figure 1: Browsing intensity for fir, spruce and maple before, during and after wolf settlement in the region Calanda with wolfs in summer or winter and in the Region Prättigau with infrequent wolf occurrence.

	Calanda		Prättigau	
	Wolf summer core zone	Wolves in winter	Infrequent wolf presence	
Region	Felsberg	Untervaz	Seewis	Vorderprättigau
Ungulate density Index	↘	→	↗	↗
Browsing intensity	↘	↗	→	→
Sapling density	↗	↗	↗	↗

Table 3: Summary of the main factors in the two regions and their effect over time.

Conclusion

The direct effect of wolves on the population size of wild ungulates naturally depends on the preferred prey species. In the core wolf area of Felsberg in the region of Calanda, the UDI decreased dramatically in 2013 and thus probably also the browsing intensity which probably lead to more tree regeneration (Tab. 3). In Untervaz with frequent wolves in winter, the browsing intensity rather increased over time. Both sites in the hunting district Untervaz are core winter habitats for roe and red deer and are situated within a winter wildlife protection area. There might have been shifts in the spatio-temporal use, in the group size and/or in the food selection of the wild ungulates due to the stress induced by the wolves. However, the effect of wolves may simply be overruled by other factors, such as decreased hunting. Hence, our study demonstrates that the equation 'wolf = less ungulates = fewer browsing' is not a general rule, in particular because of the small – scaled landscape of Switzerland that is strongly influenced by forestry, hunting and wildlife protection areas.

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Index to evaluate the vulnerability to climate change of Mayfly, Stonefly and Caddisfly species in alpine springs

Daniel Küry, Verena Lubini, Pascal Stucki

Abstract

In 2014 and 2015 the macrozoobenthos and the water temperature of 61 alpine springs of the Central Swiss Alps between 1720 and 2515 m a.s.l. were investigated and gave evidence of 99 EPT species (Ephemeroptera, Plecoptera, Trichoptera). A CCA showed, that 27 Plecoptera and Trichoptera species were associated with springs of high altitudes and especially cold water. Preference of high elevation, headwaters and spring habitats, endemism and short emergence period were the ecological traits used to develop a value indicating the vulnerability for each species. A new climate change vulnerability index (CCVI) revealed 53 of the 61 investigated spring habitats as being vulnerable to climate change.

Keywords

Ephemeroptera, Plecoptera, Trichoptera, global warming, sensibility

Introduction

Even though most spring habitats can show considerable annual and diel variations, the water temperature of alpine spring is rather stable and depends primarily on elevation, exposure and permafrost location in the catchment area (Küry et al. 2017). Temperature in springs shows a decrease with increasing elevation (Cantonati et al. 2006; Küry et al. 2017; Martin et al. 2015; Wigger et al. 2015). It is one of the key factors determining the species richness (von Fumetti & Blattner 2017; Wigger et al. 2015) and can have a higher impact on the composition of faunal communities than habitat structure (Smith et al., 2003).

In high altitude springs of the Central Swiss Alps a high proportion of the fauna of EPT (Ephemeroptera, Plecoptera and Trichoptera) is considered as endemic and is therefore endangered in Switzerland (Küry 2015; Lubini et al. 2012). Like all other habitats, springs will be exposed to climate change during the next decades. Scenarios for Switzerland predict that air temperatures will increase and precipitation will decrease in summer (CH2014-Impacts, 2014). The water will be warmer mainly in springs, where water is moving fast through wide subterranean flow paths (Küry et al. 2017). In high altitude springs the consequence will be a loss of suitable habitats for cold adapted species. While at lower altitudes crenobiont animals can climb to higher elevations to find suitable cold habitats, the macrozoobenthos of high alpine springs is expected to be unable to do so, because of a lack of suitable habitats. In previous studies, EPT species were predicted vulnerable to climate change by the following ecological traits: cold stenothermic adaptation, high elevation distribution, occurrence in springs or headwaters, endemism and short emergence period (Conti et al. 2014; Hershkovitz et al. 2015). The aim of this investigation was:

1. to verify the results of these trait studies,
2. to identify the vulnerable crenobiont and crenophil species by a field study and
3. to develop an index to evaluate spring communities and habitats endangered by climate change.

Methods

A total of 61 rheocrenes situated in the Swiss Central Alps (Gonseth et al. 2001) were investigated. Their elevation was between 1720 and 2515 m a.s.l. (median: 2027 m a.s.l.) and the catchments were dominated by alpine vegetation types. To investigate the temperature, HOBO loggers (Water Temp Pro v2, by onset®) were placed as close as possible to the water outlet to record temperature every 10 minutes for approximately twelve months (Küry et al. 2017).

All spring habitats were visited at least two times to investigate the macrozoobenthos. The sampling was performed using a standard protocol for spring habitats in Switzerland and included also a catch of adult EPT specimens (Lubini et al. 2014). Data analyses was performed using the software StatPlusPro:Mac by AnalystSoft Inc. © (linear regressions), multivariate statistics was performed with R (R Development Core Team 2015).

Results

The sampling of the macrozoobenthos resulted in 99 species: 11 Ephemeroptera, 40 Plecoptera and 48 Trichoptera. Crenobiont species had a proportion of 0%, 21% and 35% in Ephemeroptera, Plecoptera and Trichoptera respectively.

The number of all EPT species and Trichoptera species significantly decreased with declining mean annual temperature and decreasing distance to potential permafrost (Tab. 1). On the contrary, the correlation between the temperature or distance to potential permafrost and the number of Plecoptera and Ephemeroptera taxa was not significant.

	Number of species		Regression analysis (p-values)		
	all	crenobionts	Altitude	Average annual temperature	Distance Permafrost
EPT	99	24	0.00919**	0.00121**	0.00673**
Ephemeroptera	11	0	0,74173	0,50357	0,4963
Plecoptera	40	7	0,09077	0,37787	0,22167
Trichoptera	48	17	0.01263*	0.0003**	0.00758**

Table 1: Total number of taxa, number of crenobiont taxa and P-values of regression analysis of altitude, average temperatures, distance to permafrost and number of EPT taxa. Level of significance: **: p<0.01, *: p<0.05

Plecoptera	**Trichoptera**
Dictyogenus fontium **	*Acrophylax zerberus*
Isoperla lugens **	*Allogamus mendax/uncatus*
Leuctra ameliae **	*Apatania fimbriata* **
Leuctra dolasilla	*Consorophylax consors* **
Leuctra ravizzai	*Cryptothrix nebulicola* *
Leuctra rosinae	*Drusus alpinus* **
Leuctra rauscheri *	*Drusus melanchaetes* **
Leuctra schmidi	*Drusus monticola* *
Leuctra teriolensis	*Drusus muelleri* **
Nemoura undulata	*Drusus nigrescens* **
Nemoura sinuata **	*Ernodes vicinus* **
Protonemura brevistyla	*Rhyacophila bonaparti* **
Protonemura nimborella	*Rhyacophila glareosa*
	Rhyacophila intermedia

Table 2: Plecoptera and Trichoptera species associated with low temperatures according to the canonical correspondence analysis (CCA). *: crenophil species, **: crenobiont species. Gray letters: species occurring in < 3 springs.

In the canonical correspondence analysis (CCA) 27 species, 13 Plecoptera and 14 Trichoptera (Tab. 2), turned out to be associated with low temperatures and high altitudes. A weighted climate change vulnerability value (CCVV) for all EPT species (Tab. 3) was formulated by using their individual ecological traits. The highest weight of 4 was given to the trait cold stenothermic, while the altitude was weighted by a factor of 3. Both endemism and preference for spring habitats were weighted by a factor 2, and the life cycle trait had no extra weight.

A climate change vulnerability index (CCVI) was created to assess a possible impact of climate change on the spring habitats and their communities distinguishing five categories of different vulnerability. The CCVI takes into account the CCVV of all occurring species and their abundance (Fischer 1996; Lubini et al. 2014). By applying to the 61 springs investigated in the Swiss Central Alps 48 spring habitats (79%) proved to be moderately to highly vulnerable to climate change (Tab. 4).

	Score	Weight
T thermic factor (www.freshwaterecology.info)		
Cold stenotherm (<10°C)	1	4
Warm stenotherm / eurytherm	0	
A altitude factor (www.freshwaterecology.info)		
Median altitudinal distribution > 1500 m (sal/alp)	2	
Median altitudinal distribution 800 – < 1500 m (mon)	1	3
Median altitudinal distribution < 800 m (col)	0	
E endemism (www.freshwaterecology.info)		
Endemic Alps / Jura	1	2
Non endemic	0	
S preference springs (adapted for Switzerland)		
Crenobiont ÖWZ 16	2	
Crenophil ÖWZ 8	1	2
Rhithro- / potamphil ÖWZ ≤4	0	
Em emergence period (www.freshwaterecology.info)		
Short emergence period	1	1
Long emergence period	0	

Calculation of the specific CCV value (CCVV):

$$[(4 \cdot T) + (3 \cdot A) + (2 \cdot E) + (2 \cdot S) + (1 \cdot Em)] / 5$$

Table 3: Scores and weight of the factors for the calculation of the specific climate change vulnerability value (CCVV). The factors are determined according to the traits in freshwaterecology.info except the preference for springs, where the traits were adapted according to the own experience.

Category CCV index	CCV index	Description	Number of springs
CCVI-5	> 2.70	Highly vulnerable	5
CCVI-4	2.11–2.70	Vulnerable	20
CCVI-3	1.51–2.10	Moderately vulnerable	23
CCVI-2	1.00–1.50	Slightly vulnerable	13
CCVI-1	< 1.00	Not vulnerable	0

Table 4 : Categories of CCV index (CCSI-5 to CCSI-1) in 61 springs habitats of the Swiss Central Alps.

Discussion and Conclusions

The 27 Plecoptera and Trichoptera species associated with the coldest springs in this field study highly correspond to the species vulnerable to climate change as proposed by Conti et al. (2014) and Hershkovitz et al. (2015). This allowed to develop a weighted vulnerability value for EPT species. Giving an individual weight to each trait permits to differentiate the traits by their importance. This is the prerequisite to calculate a gradual vulnerability for both single species and whole spring communities. In consequence, the CCVI will provide an additional approach for conservation purposes to evaluate the impact of disturbances by human activities and will therefore complete indices assessing «crenophily» (Fischer 1996; Lubini et al. 2014) or the threat of species (red list categories). This new index shows that there is a new impairment even for habitats presumed as pristine like alpine springs. It is an additional tool applicable to spring habitats to indicate climate change sensibility of biocenosis in streams and rivers (e.g. Halle et al. 2016).

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Biodiversity and Landscapes: Where is the missing link?

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Keywords

Ecology; Nature Conservation; Landscape Metrics; Ecosystem Services; Ecological Modelling; Mapping

Summary

Around 15 years ago, the term ´Anthropocene´ was popularized by Nobel Prize-winning meteorologist Paul J. Crutzen, who described a new era of human induced global environmental change that put an end to the Holocene epoch with beginning of the industrial revolution in the late 18th century. Hence, the adverse consequences of this development regarding global biodiversity pools are manifold either being caused by direct actions such as urbanization, land transformation and associated land use change among others or insidiously affecting our biosphere by ever-increasing CO2 emissions. Accordingly, my dissertation (KUTTNER 2015) conflates a series of scientific articles that are dealing with various human-induced impacts that affect both ecosystem functioning and biodiversity patterns on different spatial scales. At this, I refer to the ´Pattern and Process paradigm´ which basically states that landscape structure is always reflecting its underlying processes. As the inherent geometrical attributes of basic spatial units that constitute a landscape, i.e. landscape elements can be quantified by certain indices, they may in turn being used as a toolset to assess certain ecological key functions a landscape is able to provide for local biodiversity as well as human society.

There is a broad consensus that habitat loss and landscape fragmentation are critically contributing to local extinctions, as habitat loss reduces the carrying capacity and associated fragmentation additionally aggravates dispersal and gene flow within landscapes of interest. Additionally, underlying feedback mechanisms that have been triggered by human induced global change processes which in turn affect biodiversity along with ecosystem service provision, are thus indirectly falling back to society as well (CHAPIN et al. 2000). Although ecosystem services are usually emphasizing on human well-being, they may also act as indirect measure of biodiversity as CARDINALE et al. (2012) revealed a strong interconnectedness between the magnitude of 'provision' and 'regulation' services and biodiversity. In this concern, landscape connectivity appears to be a key point interlinking these aspects, as for many ecosystem services the degree of connectivity across the landscape of interest is directly or at least indirectly affecting the magnitude of service provision, e.g. the effectiveness of pollination and pest regulation as well as water regulation and the flow of nutrients amongst others (MITCHELL et al. 2013).

In this context, various case studies have been conducted in the Neusiedler See – Seewinkel region and adjacent Hungarian areas. In particular, they are addressing the development of a rule set to quantify ecological key functions based on landscape structural parameters (KUTTNER et al. 2013); a new and fine-scaled assessment on major ecosystem services landscapes are able to provide for human well-being (HERMANN et al. 2014); a comparison if landscape structure is able to recapitulate ecosystem service provision throughout protected and unprotected areas (KUTTNER et al., 2014) and a spatially explicit assessment to estimate ecosystem service potential among the region (HAINZ-RENETZEDER et al. 2015).

In the scientific fields of landscape ecology and nature conservation, one major restraining factor that limits spatially explicit research assessments on broader scales is the availability of comprehensive and recent base datasets. Although advances in remote sensing, data processing and storage capacities have facilitated the emergence of new environmental raw data, the issues of data validation and subsequent post-processing still remain. As part of my dissertation I present the results of a combined approach including spatial data aggregation and harmonization from various sources complemented by additional modelling steps to establish a new habitat distribution map which covers the eastern alps and adjacent regions (KUTTNER et al. 2015). This spatially and thematically fine scaled map facilitates application within a broad range of research fields such as ecological modelling or network planning and allows, for example, comparative analysis on composition and configuration of certain key land cover classes among different conservation areas or between areas inside and outside of nature reserves. The map may also be used in various planning and feasibility studies to e.g. optimize trans-regional conservation measures such as ecological corridor planning between major protected areas.

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Unique and highly threatened - endemic plants at the cold edge of southern Europe

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Abstract

The Spanish Sierra Nevada National Park hosts an extraordinarily rich flora of endemic plant species – many being restricted to high elevations above 2800m. Given their limited distribution area and adaptation to low-temperature conditions, these species are at extremely high risk of losing their habitat through amplifying climate change. We show recent changes in endemic species occurrences and abundances in GLORIA permanent monitoring plots and discuss the risk of biodiversity losses through climate change and land use impacts.

Keywords

alpine vegetation, climate change, endemic flora, long-term monitoring, land use

Introduction

The Mediterranean Basin is Europe's only and one of 35 global biodiversity hot spots, which comprise the Planet's biologically richest and most endangered terrestrial ecoregions (MYERS et al. 2000). Sierra Nevada is Europe's highest Mediterranean mountain range, extending from the thermo-Mediterranean belt at sea level to the cryoromediterranean belt with alpine climate. Sierra Nevada's outstanding richness of endemic plants has long been recognised (e.g. QUÉZEL 1953, RIVAS GODAY & MAYOR LÓPEZ 1966). Most of its endemic species occur at high elevations (MOLERO MESA et al. 1996) and many are restricted to the uppermost zone, covering only ca. 40 km² (FERNÁNDEZ CALZADO 2007); these cryophilic species could be considered among the continent's most vulnerable due to the rapidly progressing climate change. Given this critical situation, the Spanish Sierra Nevada was one of the first GLORIA sites established, aiming at assessing magnitude and velocity of biodiversity losses through long-term monitoring. On the background of the unique situation of Sierra Nevada, this presentation focuses on three objectives:

1. GLORIA data series recorded during the period 2001 to 2015, specifically on the proportions of endemic species along the elevation gradient and their change in abundance and species numbers during the observation period;
2. the potential risk of habitat loss for endemic species through changing thermal and precipitation regimes;
3. the main land use practices causing pressure on mountain endemics.

Methods

Sierra Nevada is a small Mediterranean mountain range near the Andalucian coast in southern Spain, stretching over 90 km (and ca. 40 km of its part with alpine climate) in E-W direction. Due to its high elevations, with 3479 m a.s.l. Mulhacen is the highest point on the Iberian Peninsula, it represents an isolated 'island' of cold climate, ca. 700 km away from similar environments in the Atlas range and the Pyrenees. Climate is typically Mediterranean with winter rain/snow fall and arid summers, and bedrock of the high parts is siliceous (MOLERO MESA 1998). The eight GLORIA summit observatories (four in each study region ES-SNE and ES-SNN) are located between the upper oro-Mediterranean and the cryoro-Mediterranean zone, i.e. between 2600 and 3300m.

Sampling design and vegetation sampling followed the international standard GLORIA protocol (PAULI et al. 2015). On each summit biodiversity observatory, four 1-m² permanent plots in each cardinal direction and the entire summit area down to the 10-m isoline, divided into eight sections, constitute a monitoring site. All vascular plants and their abundances were recorded in each plot and summit area section.

For anthropogenic land use influences, a reconnaissance was conducted throughout the alpine life zone of Sierra Nevada by using standardised field sheets. In addition, qualitative semi-structured, guideline-aided interviews on land-use history and development plans were carried out with key-informants to assess types of anthropogenic activities as well as spatial and temporal dimension of land-use and anthropogenic influences at the target sites.

Results

The fraction of endemic species of the entire summit flora was 23% on the lowest and increased linearily to over 90 % on the highest summit. During the past 14 years, the proportion of endemic species decreased from 2001 through 2008 to 2015. High-elevation vegetation experienced thermophilisation, i.e. an increase in more warm-demanding species from lower-elevations and/or decline of high-elevation species. The following land use activities in high elevations of Sierra Nevada were identified, ranked by the estimated magnitude of impact on endemic vegetation:

1. skiing with artificial snowmaking infrastructure,
2. livestock pasturing (cattle, sheep),
3. tourist horse riding,
4. hiking along high-elevation summit trails,
5. growth of ibex (Capra pyrenaica) populations.

Discussion

The observed thermophilisation in the high-elevation vegetation of Sierra Nevada is a Europe-wide trend (GOTTFRIED et al. 2012), but Mediterranean mountains differ from central to northern European mountains by the stagnation or even decrease in species numbers. Endemic species in Sierra Nevada are also affected by such climate-driven decreases and are the most vulnerable due to upward shifting vegetation, because they already sit at the spatially very limited cold edge (FERNÁNDEZ CALZADO 2007, PAULI et al. 2011). Projected warming and less spring and summer precipitation (NOGUES BRAVO et al. 2008, PÉREZ-LUQUE et al. 2016) are expected to lead to widespread habitat losses and extinction processes of endemic plant species in the Sierra Nevada (FERNÁNDEZ CALZADO 2007, PAULI et al. 2011). Given that the vegetation is mainly built by endemics (MOLERO MESA et al. 1996), high-elevation ecosystems are at high risk to be completely transformed. Intensive land use practices also contribute to the decline of habitats for endemics.

Through its outstanding low-temperature environment, surrounded by Mediterranean summer-hot land and urban areas, Sierra Nevada is much demanded by different user groups. The most detrimental is a giant skiing resort. Second, livestock grazing still extends into high-elevation areas, despite the protection status of a national park and UNESCO biodiversity reserve. Touristic horse riding and increasing hiking impacts ('Camino Integral de los Tresmiles') reach virtually all summits over 3000 m. Finally, the population size of the Iberian endemic *Capra pyrenaica* has reached over 30000 individuals.

Conclusions

- Sierra Nevada's high elevation vegetation is mostly built of endemic plant species whose numbers are declining.
- If climate-warming projections hold true, most if not all habitats of alpine endemic plants will become unsuitable within this century. The predicted decrease of precipitation and land use pressures will amplify the effects of warming.
- Monitoring activities and associated early-warning indicators of biodiversity losses need to be supported and intensified at the most vulnerable endemic species and communities.
- An extension of conservation strategies and strengthening of measures leading to targeted guidance of tourism and the creation of strictly protected cores zones is required.
- Measures that support the continued existence of Sierra Nevada's unique flora must be a priority concerns on the regional, national and international levels.

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Education of environmental consciousness as an educational goal of the partnership between national park and new secondary school. Results of a qualitative evaluation study

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Abstract

The subject matter of the research is a project conducted by the national park ‘Nationalpark Hohe Tauern’ and the Neue Mittelschule (new secondary school) Matrei in Osttirol which is the national park’s partner school. In 2005 both the principal of the Neue Mittelschule (new secondary school) Matrei in Osttirol and the director of the national park agreed to establish a main emphasis on the national park as part of the curriculum of the Neue Mittelschule (new secondary school) Matrei in Osttirol. Together with the director of the national park ‘Nationalpark Hohe Tauern’ and the principal of the partner school the author agreed to investigate the benefits of the national park’s programme for the students in a research project. The children are supposed to become ambassadors of the national park and in addition there need to be re-examinations whether or not the educational objective can be reached through the programme. The results of this project can be used for purposes of empowerment evaluation as an input for further development of the concept.

Keywords

national park, new secondary school, empowerment evaluation, method triangulation, participant observation, interviews, group discussions, vignettes, environmental consciousness, education, nature, identification

Methods

The research work is ethnographic and is structured multi methodically. The participant observation covers a part of the methods and gives information about the habitat of the students, the national park rangers, the teachers and parents. The researcher accompanied the third year classes with their park activities for one school year. As the Grounded Theory is speaking of a circular process, another survey took place one year after the specific elicitation of data in the field which was meant for taking a closer look once again and for watching a schools class whilst performing an activity one more time. Additionally to the participant observation the point of view of all the actors, in this case the students of the third grade has been gathered through group discussions. The empiric foundations are formed by a method triangulation where additional data has been collected by conducting expert interviews with national park rangers, teachers and one representative of the PTO. The data has been assessed through content analysis (cf. Mayring, 2015). The conversations have taken place after the first field period. Selected vignettes and extracts of an observatory protocol have been the results of the participant observation in the field.

The analytical framework is formed by approaches to environmentally awareness theories, if the following is about environmental awareness the author refers to the tradition of the multi-component model, which has been established by Maloney & Ward (1973). ‘They have tried to capture environmental consciousness on a scale that consists of four subscales (a scale of knowledge, a scale of affect and one scale each for the recording of verbal and actual readiness to act).’ (Homburg & Matthies 1998, p. 50, author's translation).

There is agreement that environmental consciousness is a multidimensional construct, which is integrated in contextual conditions and substantially consists of the components environmental knowledge, the environmental experience and involvement or perception of environment, value orientations, behavioural intensions as well as the environmental act (cf. Spada 1996; Bolscho & Seybold 1996; de Haan & Kuckartz 1996 cited in: Hauenschild 2002, p. 86). As environmental consciousness depicts an abstract construct the author tries an approach through the terms environmental sensitivity and mindfulness with nature.

Education is to be understood as the personality development and development of individuality according to Wilhelm von Humboldt.

‘*The Humdboldtsche idea of education is firstly not about the accumulation of empiric (fact based) knowledge, but rather again about the development and perfection of the personality and the obtainment of individuality. The so called ‘Sich-Bilden’ is not conducted to reach a material goal but rather for oneself, it is an end in itself and serves in the end none other than the incarnation of the human being*’ (Lederer 2014, p. 52f., author's translation).

The author follows the explanations of GERNOT BÖHME (2002) when using the term nature. Nature in that comprehension is inner as well as external nature that surrounds us. Therefore on the one hand nature is being associated with landscape, meaning with something that occurs outside, however nature also includes people at the same time.

Results

After a clarification of the most important theoretical terms, the author begins the empirical part with the data acquisition in the research field.The results of the study can be distinguished into three categories. During the first step the question has been settled what the main natural concepts are that have been passed on through the educational programme. It has been determined that the natural concepts primarily include 'hands-on training on the scene' followed by the 'approach to learn', 'nature as an experience', the 'use of natural resources' and 'conservation about nature'.

There have been empirical analysis in a second discussion whether or not the students have been influenced in relation to their ecological consciousness. The deductive application of categories by Mayring (cf. MAYRING 2015, p. 97ff.) has been brought in to answer this research assignment. Altogether the group 'Mauerläufer' and the group 'Wintergoldhähnchen' have given 23 statements that indicate high environmental consciousness, 17 statements evoked an average environmental consciousness and no statements that have shown a weak environmental consciousness. Whether the overall positive result has been evoked through the educational programme or whether other undetermined factors are decisively responsible for the students of the Neue Mittelschule (new secondary school) Matrei in Osttirol showing average or high environmental consciousness, thus effects and process related changes have to be clarified in the following work.

The researcher has tried to answer the question whether the students identify themselves with the national park during the third step. After all the main emphasis of the educational programme is for the students to become ambassadors of the national park. Identification in terms of a psychological comprehension is described as a process that includes imitation and emulation of a person to whom there is a strong emotional bond (cf. SCHAUB & ZENKE 2000). In the available case the relationship to a person is being expanded to the bond to an institution. Surveys in the field as well as conversations indicate in many ways that the students show a strong reference to their living space which leads further to the conclusion that a high identification with the national park is given.

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Springs in the Bavarian National Parks as indicators for climate change

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Abstract

Springs are unique habitats colonized by particular, sensitive organismic communities. In protected areas, they remain mostly unaffected by disturbing factors other than the potential impact due to global warming. Based on long-term knowledge of spring recording and observation in Bavaria, in particular in the lime stone dominated Berchtesgaden National Park, we are developing a monitoring guideline for detecting the impact of a changing climate on springs. In order to check efficiency and applicability of the elaborated tools, the method is transferred to the Bavarian Forest National Park, where springs emerge from crystalline bedrock.

Keywords

spring, monitoring, climate change, National Park, Germany, Bavaria

Introduction

A spring is a characteristic element of the water balance and also a unique habitat for specialized biota. The emerging ground water is influenced by many factors: important are mineral composition, geologic stratification, altitude, storage conditions in the bedrock, the amount and distribution of precipitation in the catchment (Fig. 1). Of course, slope, substrata and flora in the immediate surroundings also impact the unique biotopes. All these factors form habitat conditions for particularly adapted species, often with restricted distribution areas. Particularly represented taxonomic groups are Acari, Mollusca, Microcrustaceans, or the Insect orders Trichoptera, Diptera, and Coleoptera (GERECKE & FRANZ, 2006; GERECKE et al., 2012).

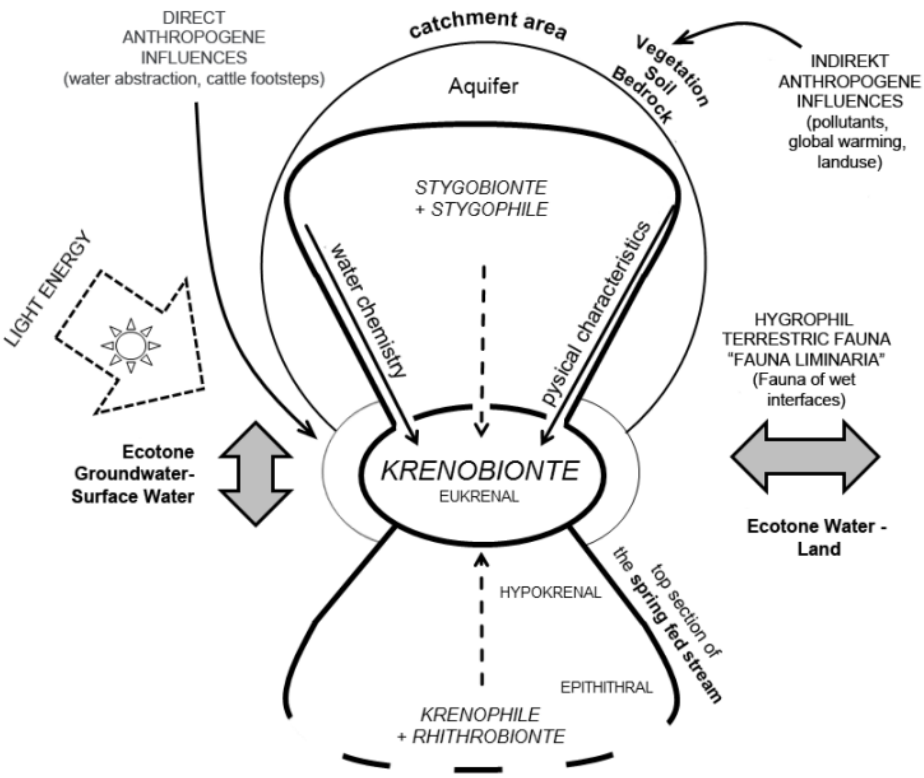

Figure 1: Factors influencing a spring habitat. The spring as an ecotone between groundwater and stream (after MARTIN et al, 2015)

Due to melting of permafrost, fluctuation of precipitation patterns, temperature shift and similar alterations potentially caused by changing climate (BAYERISCHES STAATSMINISTERIUM FÜR UMWELT UND VERBRAUCHERSCHUTZ, 2015, JYVÄSJÄRVI et al., 2015), spring waters and related invertebrate communities may also be affected in the future.
To detect changes in springs due to a possible climate change, a standardized monitoring method is required. Until now, no systematical methodology for documentation and long-term monitoring has been proposed for these unique habitats (CANTONATI et al, 2006). In order to fill this gap in our knowledge, we propose a set of tools to use the sensitivity of springs for indicating changes in climate. Such studies are best conducted in protected areas, where these habitats remain mostly unaffected by disturbing factors other than the potential impact due to global warming. The aim is to synthesize the previous knowledge and to develop a monitoring guideline.

In the Berchtesgaden National Park (BNP), hydrologists and biologists examined spring locations all over the area in the course of numerous research projects over a long time (GERECKE & FRANZ, 2006 and unpublished data) In the Bavarian Forest National Park (BFNP) locations of springs are known, but they were investigated under ecological aspects. Our methodology is developed mainly on the base of data available from a wide variety of springs at all elevations in BNP. In parallel, for verifying applicability and the potential for comparison of geologically differing areas our tools are applied in springs in all catchments of the BFNP. The process is accompanied by the Landesbund für Vogelschutz in Bayern e.V. (LBV), experienced over more than 20 years in spring monitoring and project leader of 'Aktionsprogramm Quellen', resulting in the development of a method to describe the structure of spring (BAYERISCHES LANDESAMT FÜR UMWELT, 2008a, 2008b)(Fig. 2).

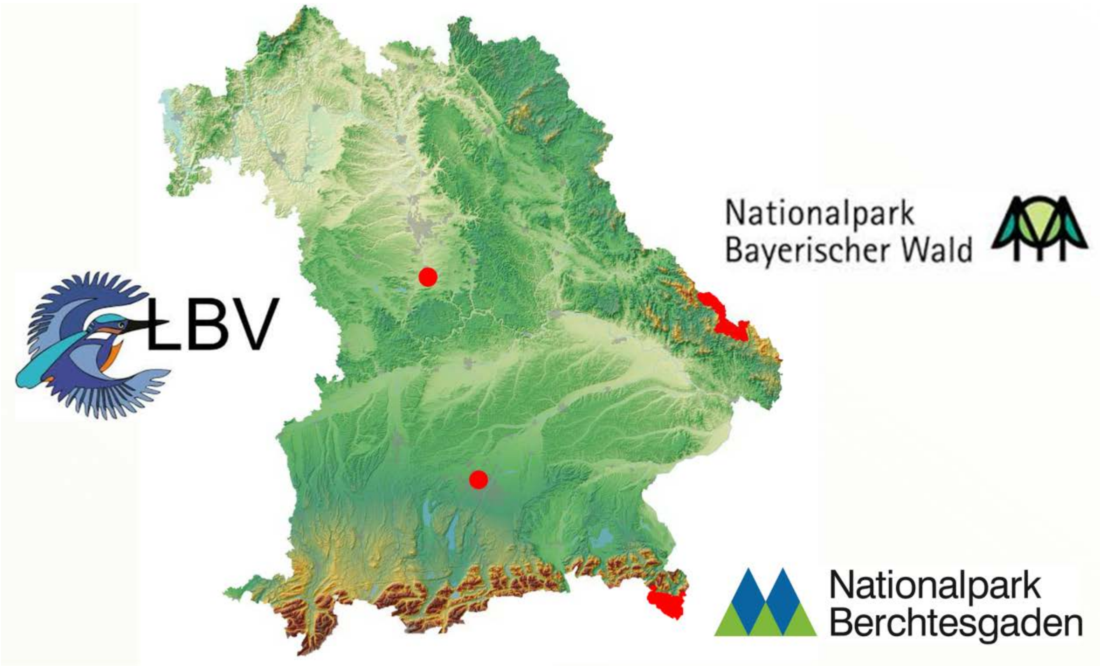

Figure 2: Project partners: Landesbund für Vogelschutz in Bayern e.V. (LBV), Berchtesgaden National Park (BNP) and Bavarian Forest National Park (BFNP). Data Source: FIN VIEW. Bayerisches Landesamt für Umwelt, www.lfu.bayern.de, Geobasisdaten @ Bayerische Vermessungsverwaltung, www.geodaten-bayern.de.

Methods

In BNP over 300 springs are recorded, for more than 100 locations information on structure, water quality and organismic communities is available. A synthesis of results from numerous research projects and time series of physicochemical data helps to develop a list of criteria for choosing the locations which are most significant for the life conditions in the area. Principal criteria are water quality parameters, structure and geographical altitude, discharge characteristics, but also accessibility. In a second step, information on genetic diversity of invertebrate communities which reflects all these parameters will be decisive for selecting a subset of the habitats most suitable for monitoring.

In BFNP, based on the existing knowledge of the river network, a set of 30 springs was selected for documentation. For each habitat, physical parameters, structural shape and fauna are examined. In a second step, based on the criteria elaborated in BNP, a subset of springs will be chosen.

Besides the morphological and molecular work of taxonomists to provide updated lists of the species occurring in the studied habitats, also metabarcoding techniques are used to describe the genetic diversity in both National Parks. From several taxonomic groups, species will be identified as indicator species on which future biogeographic work should concentrate. In this regard, particular ecological relations to spring habitats and specific distribution patterns are the principal criteria.

Our study will result in a general monitoring guideline for springs. The recommendations will encompass a list of criteria for choosing best suitable sites and their related indicator species, and proposals for setting up the monitoring in both National Parks. Furthermore a database model will be prepared to ensure sustainable future data management. After adaptations concerning the sets of indicator species, the guideline will be applicable also in other parts of Central Europe, and with regard to its principal elements also in all other parts of the continent.

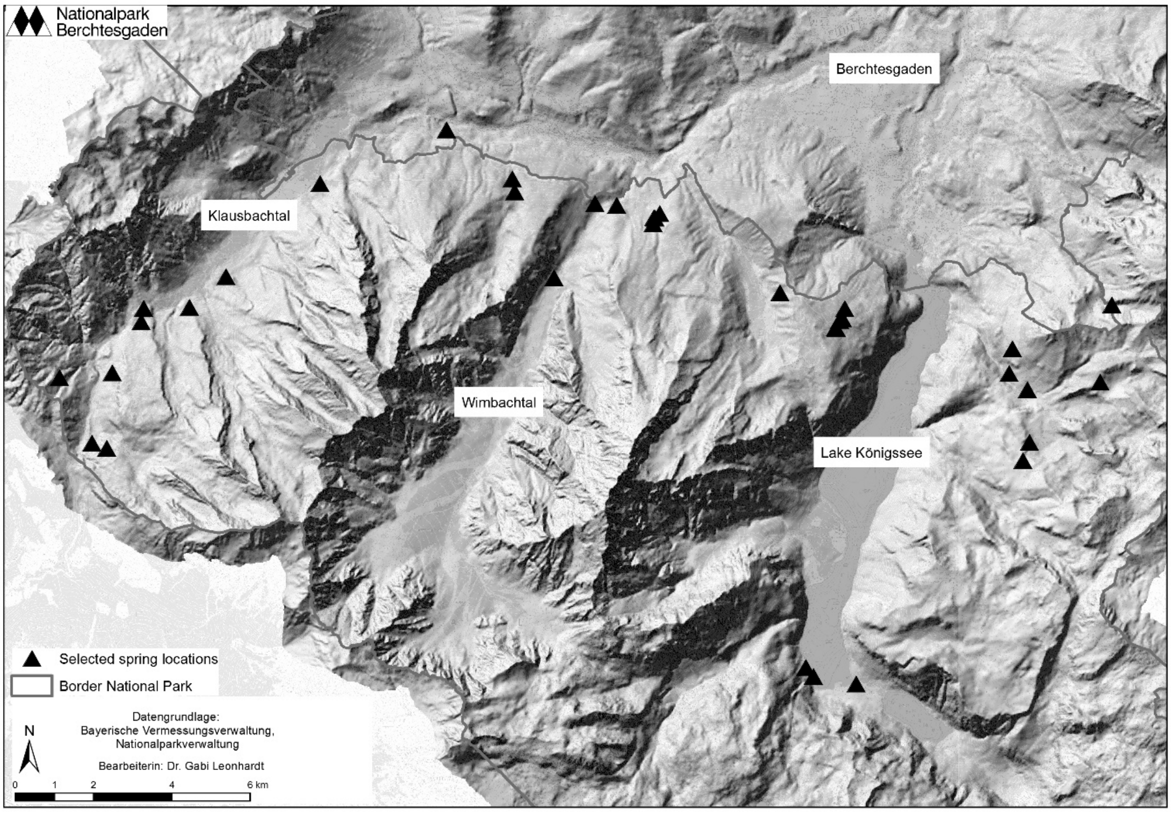

Figure 3: Selected springs in the Berchtesgaden National Park (Leonhardt).

Preliminary Results

For the field work in 2017, a set of 30 springs has been selected in the BNP and in BFNP. Fig. 2 shows the distribution of the springs chosen in the BNP. Principal factors for the selection were the availability of data from previous research projects and the extension of ongoing time series of data, respectively, but also structure, discharge, accessibility. The spring locations cover the three main valleys Klausbachtal, Wimbachtal and Königsseetal and are located at elevations from 600 to 1560 m asl. They are very heterogeneous regarding discharge stability of flow, structure and surrounding land use. As the next following step, based on the results of the taxonomic work including metabarcoding, a subset of 15 springs will be chosen for long term monitoring, and the database model will be set up. Based on the same abiotic and biological data, a subset of 15 springs will be identified in the BFNP as well.

Conclusion and Outlook

Springs are not only important elements in water balance, but also unique habitats inhabited by specialized biota. Possible climate change may cause an alteration of the habitat in the future, with potential effects on distribution patterns of many species. The aim of this project is to define standardized methods for selecting and observing springs in a given area suitable for a monitoring of these effects. The application of this monitoring guideline will produce a time series of selected parameters which later allow a statement about alterations and their possible connection to climate change. The method is developed in the Berchtesgaden and Bavarian Forest National Parks, but it is shaped in a manner that will allow its application also in all other areas of the Alps and Prealps.

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Water balance modeling and climate impact research in the Berchtesgaden National Park

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Keywords

Berchtesgaden National Park, water balance modeling, snow modeling, karst, changing climate, RCM

Summary

Hydrologic processes are underlying specific spatial conditions in high alpine regions. The altitudinal gradient, a complex geologic composition and the alpine climate affect surface runoff, subsurface storage and runoff, snow cover dynamics and discharge routing to the outlet. Within the watershed of the river Berchtesgadener Ache, which comprises the area of Berchtesgaden National Park, the physically based, distributed hydrological model WaSiM is established since 2009 to understand the water balance within the region. The model is set up with a spatial resolution of 50 m and a temporal resolution of 1h. The main focus initially was to examine the influence of alpine karst on the water balance and to improve the modeling of lateral snow transport. Previous tracer experiments and literature about the complex hydrogeological composition, subsurface pathways, spring locations, indicated that groundwater is redistributed within the high alpine valleys in the watershed. Modeling results showed, that the water balance in high alpine subbasins is not closed due to such heterogeneous subsurface storage and transport conditions. For the snow modeling, the reproduction of snow deposition and ablation processes was enhanced using an energy balance algorithm and by accounting for lateral snow redistribution. Based on this work, the focus is now lying on snow processes in forest environments and on climate impact scenario calculations. The model is forced with bias-corrected data from high-resolution regional climate simulations using the RCM WRF (5 km, based on MPI-ESM, IPCC-AR5 scenario RCP4.5) to assess potential impacts of a changing climate on the hydrology of the region. The reliability of the RCM simulations in the complex mountain environment of the catchment is validated by a reanalysis (ERA-INTERIM) driven model run and the dense meteorological station network operated in the National Park.

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Temporal and spatial variability of bedrock, debris and glaciers in the Austrian Alps since the Alpine Last Glacial Maximum and its relevance for ecological research

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Abstract

The distribution of bedrock and debris offers special habitats for animals and plants. A conceptual model explains the interaction of bedrock, debris and glaciers. We estimate the distribution of these areas at two different scales (Austrian Alps, Schober Mountains) focussing on their temporal variability since the Alpine Last Glacial Maximum. Based on these considerations the spatial extent of the surface types in the Schober Mountains is reconstructed for four stages since then.

Keywords

Bedrock, debris, glaciers, Last Glacial Maximum, spatial and temporal variability

Introduction

Areas with rocks and debris offer habitats for animals and plants which are adapted to bare surfaces, shady spaces between boulders and rock clefts. The characteristics of these environments stay relatively constant even if the macroclimatic conditions change, i.e. it does not matter much if the climate becomes slightly warmer or colder. Thus some species of rocky and bouldery environments have survived the coldest periods of the Pleistocene and are also able to find refugial habitats in a warming climate as long as bedrock and debris are available to a sufficient extent.

The spatial distribution of bedrock, debris and glaciers in the Alps depends on different factors such as climate (change), elevation, topography, lithology, tectonical setting and vegetation. The term 'debris' includes different types of loose material: autochthonous debris originates from weathering processes, allochthonous debris includes scree (transported by gravity), gravel (transported by water) and morainic sediments or till (transported by glaciers). In this study we attempt to quantitatively estimate the extent of the three surface types bedrock, debris and glaciers at two spatial scales: (i) entire Austrian Alps and (ii) a selected mountain group with sufficient available information. The glaciation of the Alpine Last Glacial Maximum (AlpLGM), approx. 25,000-20,000 years BP, is taken as a starting point.

Status of research

Entire Austrian Alps*:* VAN HUSEN'S map (1987) of the AlpLGM glaciation is an excellent basis although it does not provide bedrock and debris information. Despite a good knowledge of the glacial history (e.g. IVY-OCHS et al. 2009) no macro-scale reconstructions of glaciers during the Lateglacial have been published. During the Holocene the extent of glaciers frequently alternated between maxima similar to the one around 1850 ('Little Ice Age Maximum', LIAM) and minima smaller than today's glaciers. To estimate the range of Holocene glacier fluctuations information on both LIAM and current glacier extents (FISCHER et al. 2015) is available.

Schober Mountains (Central Alps, Hohe Tauern Range, Fig.2): Results of investigating the history of glacial and periglacial processes have been provided e.g. by LIEB 1988, BUCHENAUER 1990, KELLERER-PIRKLBAUER 2008 and REITNER et al. 2016. This allows us a first attempt to reconstruct four stages of glaciation as well as areas of bedrock and debris with a GIS-based approach.

Conceptual model of the interactions between bedrock, debris and glaciers

In order to describe the interactions between bedrock, debris and glaciers a deductive model of the processes involved has been developed. It shows in keywords how each surface type influences the two other ones resulting in six interaction processes depicted in Fig. 1.

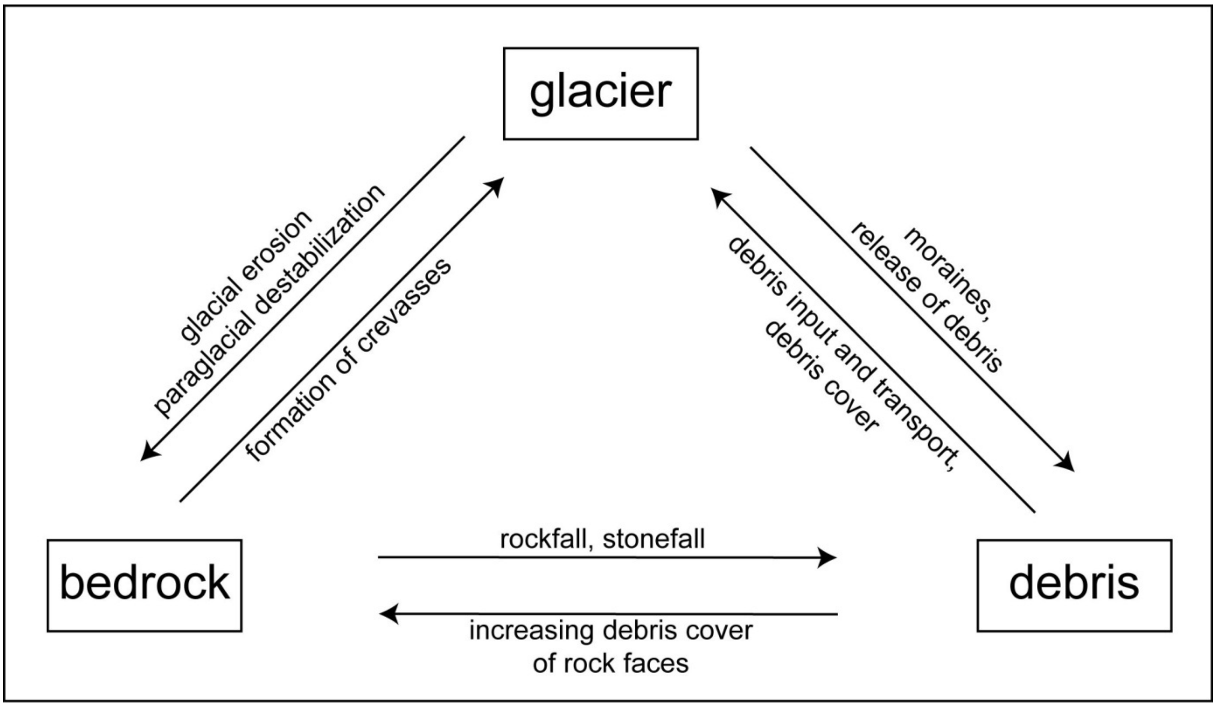

Figure 1: Processes connected to the interactions of bedrock, debris and glaciers in high mountain environments

Spatial variability of bedrock, debris and glaciers at two spatial scales

The Austrian Alps

In Austria the Alps cover ca. 55,000 km² (65 % of the entire territory, BORSDORF 2005). According to VAN HUSEN (1987) the AlpLGM glaciation in Austria covered ca. 40,000 km² leaving ca. 15,000 km² (27 % of the Austrian Alps) ice-free. It is assumed that these ice-free areas were nearly entirely bedrock and debris because vegetation during the AlpLGM was very sparse even in the lowlands. However, near the highest summits in the centre of the interconnected valley-glacier system small areas at crests and summits, wind-exposed plateaus or slopes and nunataks remained ice-free offering limited space for animal and plant life.

The Holocene maxima, which were similar to the LIAM, produced glaciations which amounted to ca. 940 km² (FISCHER et al. 2015), i.e. 1.8 % of the Austrian Alps. No reliable data for bedrock and debris is available. According to the most recent glacier inventory of the Austrian Alps (FISCHER et al. 2015) the glaciers in 2012 covered 415 km² (0.8 % of the Austrian Alps). The reduction of the glaciated area since the LIAM predominantly revealed bedrock and debris areas obviously more rapidly than the vegetation cover increased.

The Schober Mountains

The Schober Mountains cover ca. 390 km², in the following text the percentage of the glaciated area is given. Fig. 2 depicts one example of the four reconstructed stages.

- AlpLGM: To reconstruct the glaciation VAN HUSEN'S map (1987) was improved by a detailed analysis of crests and debris slopes using a DEM. The investigated area was covered by ice (Alpine valley glacier system, hanging glaciers on crests) to 94.6 %.
- Younger Dryas maximum (according to REITNER et al. 2016): To reconstruct this Lateglacial stage the monographs mentioned in the status of research-section were used. Uncertainties arise from the lack of evidence in some cirques which were reconstructed in analogy to neighbouring ones. Glaciers covered 20.6 % of the entire area exceeded by bedrock (21.2 %), the released debris (18.1 %) was widely moved by creeping permafrost. Lacking better data we used the 2000 m contour line as upper limit of vegetation cover (Fig. 2).
- Holocene maxima: The extent of glaciers (2.8 %) can be reconstructed exactly because of the existence of pronounced LIAM moraines. The extent of debris and bedrock was estimated using among others the digital version of the geological map 1:50.000 (LINNER et al. 2013).
- Current glaciation: It is restricted (0.3 %) to small areas beneath the highest peaks. The recent reduction of the glacier areas has primarily created further debris areas.

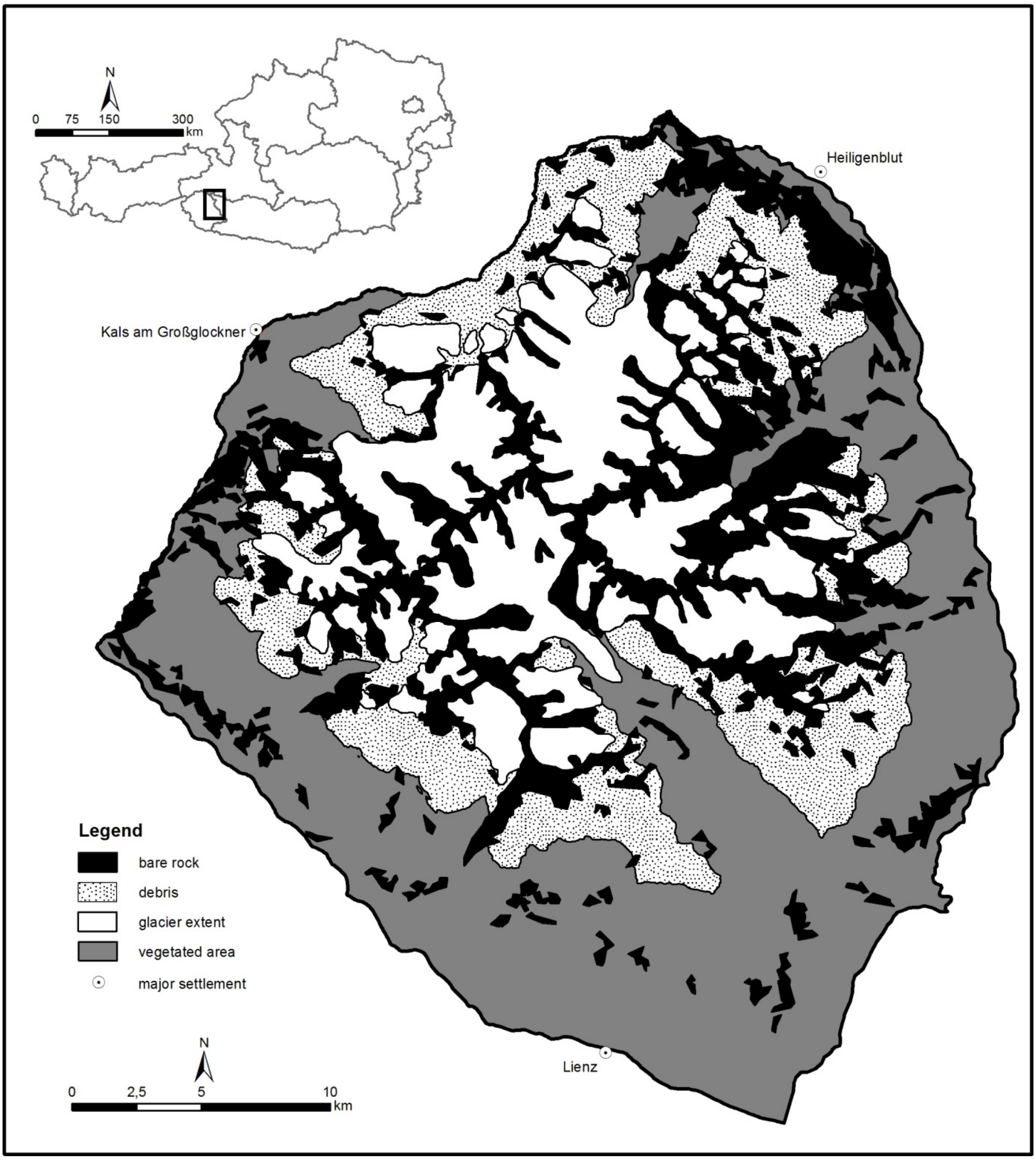

Figure 2: Distribution of bedrock, debris and glaciers in the Schober mountains during the Younger Dryas cooling event (Egesen stadial) around 12.000 years ago

Discussion

The processes which lead to the temporal and spatial variability of the distribution of bedrock, debris and glaciers were identified. However, there are uncertainties in quantifying the extent of these surface types. The best estimation at both spatial scales can be made for the glaciations which are reconstructed using geomorphological evidence. The extent of glaciers appears as the main factor of the distribution of the other two surfaces types.

The retreat of glaciation releases high quantities of debris which under periglacial conditions spread over large areas (transport of allochthonous debris by creeping permafrost) during the Lateglacial and Holocene period. However, the estimation of debris areas is quite uncertain because e.g. it is not clear how to deal with debris which is (slowly) covered by vegetation. In the Holocene the debris extent outside the glacier forefields was assumed to be constant. This follows the considerations that (i) Lateglacial debris areas (especially Egesen sediments are dominated by coarse boulders) were occupied by vegetation only to a limited extent until today and (ii) periglacial processes producing debris lasted over the entire Holocene resulting e.g. in the formation of rock glaciers.

Conclusion

Although a lot of questions regarding spatial extents of bedrock, debris and glaciers remain open – more on the Austrian Alps' scale – a first estimation could be given by our approach. The results show that there is an inverse relation of glaciers on the one and bedrock and debris on the other hand. The extent of debris increases with deglaciation. Plants and animals adapted to rock and debris environments thus found habitats during the entire investigated time period. Future research will have to focus on a more accurate delimitation of the distribution of autochthonous and allochthonuous debris.

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Monitoring of abiotic natural processes in the Hohe Tauern National Park, Austria: A long-term approach

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Abstract

In connection with a long-term ecological monitoring in the Hohe Tauern National Park a set of abiotic processes will be monitored. This paper presents these processes (weather, hydrology, glaciers, permafrost, morphodynamics), discusses the question of scale and gives information on the available data. Special emphasis is given to the variations of glaciers and permafrost.

Keywords

Long-term monitoring, weather, hydrology, glaciers, permafrost, morphodynamics

Introduction

In 2017 an interdisciplinary long-term ecological monitoring program in the Hohe Tauern National Park has been started (KÖRNER 2017). The focus of it is to monitor 'life at the limit under climate change'. Because environmental conditions largely depend on abiotic processes the decision was made to monitor those, too. The aim is to provide an annual report to stakeholders on the variations of abiotic processes.

A challenge in this context is the spatial scale. The ecological monitoring itself is carried out at 3 different scales:
1. catchment of rivers covering areas of some tens of km^2 (Fig. 1);
2. micro-catchments; and
3. permanent plots with only a few meters in diameter.

In contrast, the abiotic monitoring considers the scales of catchments and the entire national park. Therefore the problem arises how to transfer the data from point measurements to the catchment and the national park scale. The focus is to investigate the usability of already existing monitoring activities and to avoid new installations for financial and environmental protection reasons.

Overview of relevant abiotic processes

The most important abiotic processes influencing environmental conditions in high mountains ecosystem are (APCC 2014):
- Weather and climate: interannual (including extreme events) and long-term variations (climate change) are of interest.
- Hydrology: Critical for water supply depending on precipitation, evapotranspiration and runoff.
- Glaciers play a crucial role in high mountain environments, e.g. glacier retreat reveals new unstable ground.
- Permafrost widely exists at above 2500 m in the Hohe Tauern Range. It influences ecosystems indirectly, e.g. by creeping rock-ice-mixtures (rock glaciers).
- Morphodynamics: broad term comprising many processes which determine ecosystems. The most frequent ones are rock falls, debris flows, avalanches and erosion.

Monitoring activities on abiotic processes in the Hohe Tauern National Park

This chapter gives an overview of current monitoring activities on the processes listed in the overwiew chapter. Special emphasis is given to data availability and to glaciers and permafrost.

<u>Weather and climate</u>

As in almost all countries, monitoring of meteorological elements is carried out by a national institution. In Austria the Central Office of Meteorology and Geodynamics (ZAMG) operates a dense network of automatic weather stations. However, most of them are situated outside high mountain areas. In the Hohe Tauern National Park the Sonnblick Observatory (Fig. 1) located at a summit (3105 m) has to be mentioned because of its long data series (since 1886) and the representativeness for the nival belt of the Hohe Tauern Range. Other institutions run further weather stations.

Hydrology

In high mountains the only hydrological parameter which can be measured accurately is the river discharge. In Austria the Hydrological Services are responsible for a dense network of gauging stations and also run meteorological stations (temperature, precipitation). Some gauging stations are situated within the national park.

Glaciers

In contrast to weather and hydrology, monitoring of glacier and permafrost variations is not carried out by state institutions. Instead the Austrian Alpine Association (ÖAV) took over this task as early as 1891 establishing annual measurements of length variations of glaciers. The data are compiled to a report which is published in the ÖAV journal 'Bergauf' and in the internet. In the Hohe Tauern Range 36 glaciers were monitored in 2015 (Fig. 1). On a limited number of glaciers not only length but also surface elevation and flow velocity changes are measured.

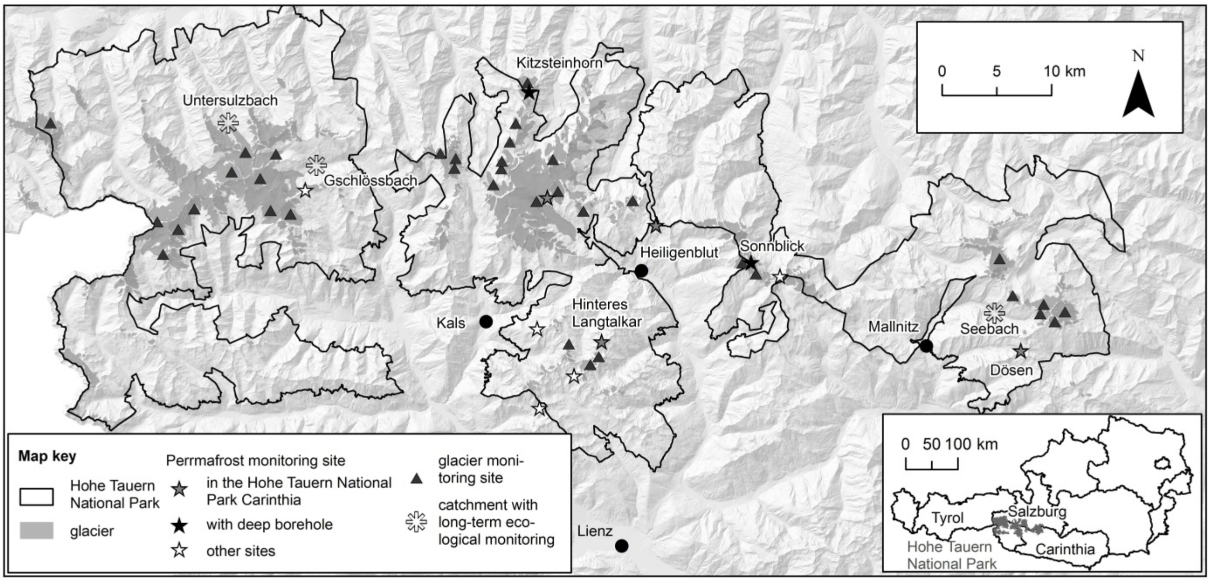

Figure 1: Overview of the Hohe Tauern National Park with locations of monitored glaciers and permafrost sites. The three catchments of the long-term ecological monitoring are indicated, inset map and major settlements for orientation. Glaciers based on FISCHER et al. (2015).

Unfortunately, mass balance measurements are not part of the ÖAV activities though are carried out at some glaciers by other institutions (WGMS 2017). However, there is sufficient information available to understand the annual glacier variations and their consequences – also with regard to the different meteorological and glaciological conditions which may occur at both sides of the Hohe Tauern central crest. This crest has a major effect on the transport of air masses as a crucial obstacle.

Permafrost

Compared to glaciers, the situation of monitoring is even worse because there is also no private organization like the ÖAV. However, since the 1990s measurement devices suitable for long-term monitoring have been installed within permafrost research. Because monitoring is commonly not part of research funding the researchers only in a few cases succeeded in maintaining their networks (KELLERER-PIRKLBAUER et al. 2015). E.g., the monitoring sites of the 'Graz permafrost monitoring network' (LIEB et al. 2016) in the Carinthian part of the Hohe Tauern National Park are supported by the National Park authority (co-financed by the ÖAV) since 2015.

Further permafrost monitoring is carried out at Sonnblick by the ZAMG (chapter weather and climate) and – slightly outside the national park – at Kitzsteinhorn (cooperation of institutions lead by AlpS, Innsbruck). The advantage of these two sites (Fig. 1) is the presence of boreholes which allow observing the long-term thermal behavior of permafrost better than surficial measurements do.

Considering the creep of permafrost, two rock glaciers in the Hohe Tauern National Park (Dösen, Hint. Langtalkar) are currently part of the Graz permafrost monitoring network (Fig. 1). Deformation rates of creeping permafrost indicate not only variations in air and ground temperature but also in seasonal snow cover.

Altogether the knowledge of permafrost variations cannot be considered sufficient until now because permafrost largely depends on substrates and topographies, the variety of which is not yet covered by the existing monitoring sites. This was an essential argument why a new monitoring site has been established in autumn 2017 in the western part of the National Park (Innerer Knorrkogel, Eastern Tyrol).

Geomorphodynamics

Until recently besides single studies morphodynamics only attracted attention when larger events caused damage. In such cases institutions like the Torrent and Avalanche Protection Service (WLV) document the events and investigate the reasons, but monitoring is started at single locations only where traffic lines or settlements are endangered. There are only few attempts of monitoring morphodynamics beyond endangered infrastructure, one of them within the Graz permafrost monitoring network (creeping permafrost and rock face denudation). An already elaborated concept for the recording of events (Lieb et al. 2016) has not yet been implemented.

Discussion

Based on existing monitoring networks there is sufficient information on the annual variations of weather, water runoff and glacier length changes available at a catchment and the entire National Park scale. Concerning permafrost, the recently established monitoring site will help to fill existing information gaps. For geomorphodynamics, however, only local scale information is available so far. Hence it is recommended to establish the already elaborated observation system soon.

In this paper only little emphasis has been given to methodological questions. This is due to the fact that the long-term monitoring discussed here had the focus on using synergies of the already existing monitoring networks. Improving methodology is of course desirable and should be kept in mind.

Conclusions and Outlook

No comprehensive report on the results of monitoring of the abiotic processes discussed above has been written yet – the first one will be published in 2018. It will comprise statements on the national park and catchment scale for weather, runoff, glacier and permafrost variations and their interactions. Areal information on geomorphodynamics should be added in the future. Hopefully this report will help the persons working on ecological monitoring to better understand their observations.

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Dynamic Processes in Austrian Natural Forest Reserves

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Abstract

The Austrian Natural Forest Reserve Programme has been started 22 years ago. Today it consists of 195 reserves with a total area of 8400 ha, in which forest management is not allowed in order to ensure a natural forest development. For current issues concerning biodiversity the Programme provides important reference areas.

Furthermore, research findings related to dynamic processes (increment/mortality) can respond frequently asked questions, for example regarding dead wood accumulation over time. Those results are currently available for a choice of forest associations. The future aim is to get information about deadwood enrichment and stand development phase for all forest association groups of the Austrian Natural Forest Reserve Programme.

Keywords

Natural Forest Reserves, dynamic processes, deadwood, stand development

Introduction

The Ministerial Conference on the Protection of Forests in Europe (MCPFE) in 1993 and the Alpine Convention in 1995 serve as political bases for the Natural Forest Reserve Programme. According to MCPFE, the Ministers for Forest and Environment committed to develop a network of forest protection areas representing all forest types. Furthermore, the Mountain Forest Protocol of the Alpine Convention contains a legal obligation to set up Natural Forest Reserves. Thus, the Austrian Natural Forest Reserve Programme was started in 1995.

Areas of near-natural forest have been selected and the abandonment of forest management measures in these areas has been contractually secured in order to ensure a natural forest development. At present, there are 195 reserves on a total area of approximately 8400 hectares. Stand and vegetation surveys were implemented at the time of each reserve establishment, hence vegetation-ecological and yield-science information is available.

Research in the Natural Forest Reserve Programme is undertaken by the Department of Forest Growth and Silviculture of the Austrian Research Centre for Forests (BFW) and focuses since 2013 on biodiversity-relevant aspects such as the presence of deadwood. The projects 'Biodiversitätsmonitoring für Bildungsgrundlagen in Naturwaldreservaten' (2013-2015) and 'Biodiversitätsreferenzflächen Naturwaldreservate' (2015-2017) have been funded by the Rural Development Programme (LE) and thus field surveys regarding stand structure, natural regeneration including browsing evaluation, vegetation, stand stability and the amount of deadwood could be implemented in more than 30 reserves. With regard to climate change and carbon dioxide storage capacity, the collected data now also provide information on current stand development phases (decrease in stand volume, increase in stand volume, equilibrium).

In the course of current surveys, the amount of deadwood is quantified. However, there is a lack of information on accumulation rates, which are of high importance according to current demands for higher biodiversity in forests. Assuming that stand mortality corresponds to deadwood accumulation, it is possible to determine the mortality rate using the results of stand development. In this way, statements about the forest development phases are possible on forest association group level. Data collection in Natural Forest Reserves in general takes place at forest association level (plant sociological associations). For evaluation, forest associations are summarized in groups.

Methods

During the establishment as reserve, in most of them, a grid of angle counting sampling points was set up in order to determine the financial compensation for the reserve owners (Frank & Koch 1998). A comparison with currently collected data allows detailed information on dynamic processes in basal area, stand volume and number of stems. As part of the LE projects, the survey set was extended by additional modules such as fixed sample plot or deadwood survey (Frank et al. 2014).

300 m² fixed sample plot

With fixed sample plots it is possible to get details about number of stems, distribution of diameter at breast height (DBH) and tree species composition. Compared to angle count samplings, the precision in low diameter ranges is higher. The data is collected on a clearly defined area of 300 m² (r = 9.77 m horizontal). Thus, repeatability is ensured and further surveys concerning other issues are possible on the same sample plots. By the use of horizontal distance, data is compatible with the angle count sampling.

deadwood survey

Deadwood surveys allow findings about volume, dimension, degree of decomposition, species composition and cause of death. Furthermore, they serve as basis for the assessment of decomposition rates as well as the stand and deadwood dynamics. The method is based on that of the Swiss National Forest Inventory for standing and lying deadwood, starting from a diameter of 10 cm (ROTH et al. 2003). Standing elements are measured on a sample plot of 300 m²; lying deadwood by using a line intersection method, positioned in the main cardinal directions.

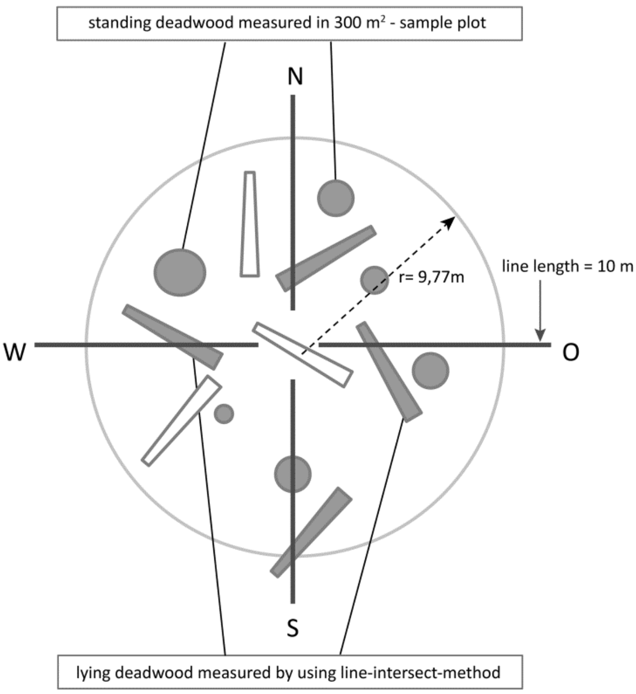

Figure 1: deadwood survey methodology in Natural Forest Reserves

Results

Deadwood volumes differ widely, not only within the forest association groups, but also with regard to the respective natural forest reserve. Individual extreme deviations of more than 200 m³ deadwood volume per hectare are either the result of a low number of samples or caused by calamities such as wind throw or bark beetle gradations.

As expected, the lowest average deadwood volume is calculated for larch and pine forests at 27.1 (±7.0) m^3ha^{-1}. In spruce forests the amount of deadwood is significantly higher with 69.1 (±17.9) m^3ha^{-1}. Regarding broadleaved dominated forests, there are minor differences between oak and hop beech forests with 77.7 (±15.2) m^3ha^{-1} and beech and lime forests with 85.5 (±12.1) m^3ha^{-1}. The highest average amount of deadwood is found in lowland forests and black alder-ash forests with 90.3 (±22.2) m^3ha^{-1}.

Conclusions on the stand dynamics of various forest associations are possible using the ratio of mortality to increment as index. A value greater than 1 means that mortality exceeds increment, the forest stand is in a phase of decreasing volume; a value less than 1 means a phase of increasing volume. An equilibrium is reached with an index value of 1.

Since mortality corresponds to deadwood accumulation, the ratio of increment and mortality can also be used to infer deadwood enrichment of a period. Thus, in addition to stand dynamics, the annual accumulation of deadwood can be estimated for different forest association groups in the reserves.

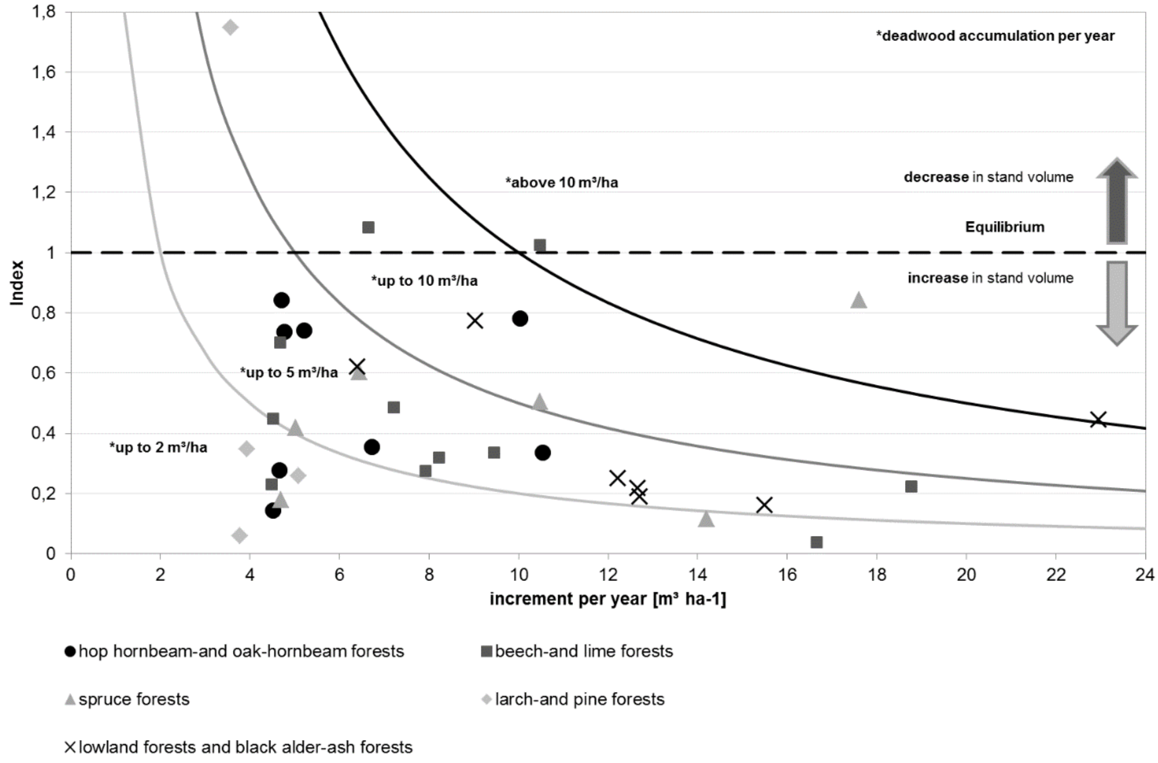

Figure 2: forest association groups in increasing/decreasing stand volume phase, respectively the annual deadwood accumulation

A large proportion of forest association groups investigated are in an increasing stand volume phase with an increment higher than mortality rate. High deadwood enrichment rates can be justified with disturbances, such as wind throw or bark beetle gradations.

Perspective

The aim is to carry out surveys continuously in further Natural Forest Reserves and thus generate a broader data basis. In future, information on the amount of deadwood should be available for all forest association groups in the reserves. A validation of the index with respect to deadwood accumulation is only possible by means of a prospective repetition of the deadwood survey. The generated data from the Natural Forest Reserve Programme can serve as guidance for close-to-nature forest management and as reference for ecological inventories.

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The sicilian system of Protected Areas Integrated planning and management policies for protected areas

Francesca Lotta & Filippo Schilleci

Abstract

Currently the Sicilian system of protected areas appears to be extremely advanced with its 12% of territory protected by regional regulations versus the nationwide average of 11%, but it is also the most contradictory one. Even today a large number of protected areas- also small ones - are subject to strong anthropogenic pressure, which favor fragmentation. In this paper we will analyze what kinds of anthropogenic pressure exist in Sicily and what could be a new perspective for protected areas

Keywords

protected areas, planning, metropolitan cities

Introduction

The last fifty years have seen scientific research in the field of city planning underline the importance of protected areas for the overall protection of the territory. More in detail, the importance of such environmental protection model has been confirmed within the planning process carried out at different territorial levels by governmental and non-governmental institutions and their national and international operational instruments. Sicily is particularly suitable for becoming a reflection field where the new perspectives on protected areas could be put into practice.

Discussion

Currently the Sicilian system of protected areas is made up of 1 recent national park (Pantelleria Island), 5 regional parks (*Etna, Madonie, Nebrodi, Fluviale dell'Alcantara* and *Monti Sicani*), 75 regional natural reserves, 6 protected marine areas and 2 other protected regional natural areas. An overall area of 310 hectares, more than 12% of the regional territory, making up a significant system in terms of number and size of protected areas with high environmental, social and economic value.

Moreover, in fulfilment of requirements of Birds Directive 79/409/EEC and Habitats Directive 92/43/EEC, there are 233 Sites of Community Importance and Special Areas of Conservation (15 SPAs, 14 SCIs/SPAs, and 204 SCIs). These areas make up 50% of parks and reserves and cover 12% of the regional territory thus making up about 24% of the territory of the whole Sicilian region. If considered from a nationwide point of view, the Sicilian system of protected areas appears to be extremely advanced with its 12% of territory protected by regional regulations versus the nationwide average of 11%, but it is also the most contradictory one (SCHILLECI 2008). It is a fact that even today a large number of protected areas are subject to strong anthropogenic pressure, which favor fragmentation.

If we consider the metropolitan city of *Palermo*, one of the areas most interested by fragmentation in past decades is the North-West area, between *Palermo* and *Cinisi* (GUECI & SCHILLECI 2006). By driving down the A29 highway from *Palermo* to the airport of *Punta Raisi*, one can realize how in this fragmented coast segment the fragmentation both in hilly and plain areas, generates an incessant loss of the last segments still preserving their natural features. The typical landscape of this Sicilian coastal area on the Thyrrenian Sea is characterized by outcrops of carbonate rocks surrounded by marine terraces eroding on the sea and by narrow coasts, often with irremediably degraded dune systems.

The process of fragmentation of the territory, and the changes in the landscape connected, starts with the building of major infrastructures with regional interest in the '60s, such as the *Palermo-Mazara del Vallo* highway, the SS113 and the railway, the airport of *Punta Raisi* and the selection of a large area destined to industrial agglomerations, which was then turned into shopping centers (GIAMPINO et al. 2015) that radically modified the relationship between sea and mountains of the territory. These transformations have generated increasingly rarefied forms which determine levels of complex fragmentation in comparison with both foothill agricultural surroundings and the natural system in which falls *Isola delle Femmine* natural reserves with the related protected marine areas of *Isola delle Femmine* and *Capo Gallo*; the SCIs *Raffo Rosso, Monte Cuccio e Vallone Sagana*, and the SPAs, partly coinciding with *Monte Pecoraro e Pizzo Cirina* SCIs *Monte Cane, Pizzo Selva a Mare, Monte Trigna*.

Today, 50% of the territory is covered in building, with a strong anthropogenic pressure on the same coast were the dune systems of *Isola delle Femmine* are threatened, and on special protection areas in the inland area. While many Italian regions are undergoing significant and interesting integration between environmental issues and territorial policies, Sicily is still lagging behind from both a cultural and regulatory point of view. Sicilian regional administrative authorities are still dealing with the theme of environmental planning within the framework of territorial interventions, and of the difficulty of the integration of environmental issues into ordinary territory planning instruments, especially as regards habitats and species protection.

Throughout the years, the need of an intermediate level to plan and manage the protected areas, derived from diffused reflections on the three different levels: regional, provincial and municipal level was recognized. If the existing regional level has a more general vision and should have coordination and orientation functions, as provided by law, the local level is limited to territories divided in administrative entities, but lacks a comprehensive vision of the territory, which is pivotal for an organized ecological approach (GUECI & TODARO 2008).

This need was met by the enactment of Rl 9/1986 that created an intermediate level of planning. This law created the so called regional provinces as intermediate level of territory planning. The rule envisaged that provinces had the obligation to develop a multi-annual *Piano di sviluppo economico sociale* aimed at planning, divided in plans and sector projects, and to expect a PTCP for the localization of works and infrastructures of extra-municipal interest, and the network of the main roads and railways. Once passed, this Plan should be managed and controlled by the provincial authorities and should be binding over the whole provincial territory

In this way, the province officially became the center for receiving different requests from the territory, not only being a link between regional and municipal planning, but also territorial and sector planning (SCHILLECI 2012). The Rl 9/1986, in conjunction with the creation of regional provinces, defined criteria to identify and define the agglomerations of several urban centers, defined as Metropolitan areas. The regulation then recognized three metropolitan areas as further intermediate level areas and defined their functions and objectives (art. 21). Actually the superposition of territorial authorities was solved with the perfect match of metropolitan cities to provinces. 15 years after the definition of the first Italian metropolitan areas, characterized by a significant number of provisions (MARTINOTTI 1998; SCHILLECI 2008; Mariano 2011; DE LUCA & MOCCIA 2015), new debates have spread about a possible reorganization of policies and integrated territorial planning, attempting to test agreements in territorial governance in a changing territory. The possibility to identify a new level of territorial management, indeed, could have obtained to the limits of provincial planning and claimed a central role in recognizing the new limits of environmental and ecological criteria, which are often strongly limited by administrative constraints

Conclusion

In Sicily, an autonomous region with a special statute, the discussion on different and multidisciplinary planning, that could develop better answers to environmental and urban problems, is confronted with the immediate political need to define administrative borders (LOTTA 2012). Instead of systemic interpretation of ecological and environmental elements aimed at recognizing the new post-urban models (MAGNAGHI 2010) and planning and manage it, it was preferred leaving the situation unchanged. Without debating on the missed occasion of identifying the territory according to heterogeneous and interscalar criteria, where morphological and typical features of environmental and residential systems cross (LOTTA et al. 2017) one should define the relevant contact points between territorial and environmental planning in the new administrative structure of the island, divided into three metropolitan cities and six Liberi Consorzi di Comuni.

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Landscape Monitoring in Berchtesgaden National Park – Comparative spatio-temporal Analysis of Land Cover Inventories

Annette Lotz & Andrej Oravec

Abstract

Berchtesgaden National Park uses aerial image interpretation to produce complete inventories of its land cover. The approach basically ensures data comparability between time slices and allows for change detection on different temporal and spatial scales. Experiences of HABITALP and cc HABITALP projects show increasing expectations of monitoring benefits in protected areas. For the first time since 1980 we analyze comparatively time slices of interpretation layers for the entire area. This leads to extended knowledge about landscape evolution and meets essential requirements of adaptive management.

Keywords

landscape, monitoring, change detection, time slices, aerial image interpretation, Berchtesgaden, National Park, HABITALP, cc HABITALP, ALPARC

Background and objectives

Founded in 1978 Berchtesgaden National Park (BNP) looks back on almost 40 years of protected area management. In contrast to the founding days current environmental data has to meet not only demands of topicality but also growing demands of comparability to the past decades.
Beside the concern for specific species, communities and habitats protected areas are responsible for mapping and monitoring their total landscape. Monitoring obligations require spatially explicit and fully covering information on the proportions and mosaicking of all land cover types. Suitable classifications and repeated inventories are needed to detect and monitor land cover changes on the desired spatial and temporal resolution. The analysis of these changes is essential to assess impacts of natural dynamics and management measures.
Collection intervals and availability of remote sensing data are accelerating. Image data allows for comprehensive and repeated assignment of visible landscape units including difficultly accessible areas. Manual and automatic delimitation methods equally require suitable means of standardization if applied in time series analysis.
In BNP the decision for comprehensive landscape monitoring by the manual interpretation of color infrared aerial images dates back to the 1980ies. The objective has always been to create a versatile layer of spatial information that is able to serve manifold aspects of research and management on different scales and that is at the same time suitable for reproducible inventories. Based on aerial image interpretation quite a number of mono-temporal applications have been developed in BNP (mainly ecological modelling and integration of terrestrial surveys) but the question of time series analysis has not yet been tackled systematically.

Methods

Starting with a first self-made interpretation key (list of land cover types that are detectable on aerial images) and its application to the 1980 flight campaign (MaB 1991) the method has continually evolved in BNP. It soon became obvious that the initial classification of land cover types was not differentiated enough and needed specific adaptations for the mosaic structure of natural habitats and alpine environmental dynamics.
Major steps of development were the introduction of the German national land cover classification and its revised issue (Bundesamt für Naturschutz 2002), the first common enhancement for alpine protected areas (1999-2001) by the Berchtesgaden, Hohe Tauern and Swiss National Parks (Kias et al. 2001) and the enlarging to an alpine scale (2002-2006) by 11 members of the Alpine Network of Protected Areas in the HABITALP project (Lotz 2006). As questions of change detection could not yet be answered satisfyingly the cc HABITALP project community (Swiss, Hohe Tauern, Gesäuse and Berchtesgaden National Parks) advanced the method from the mere status inventory to the cartography of changes by the comparison of two image generations (Haller et al. 2013, Hauenstein & Haller 2013).
Up to now four time slices of landscape inventories have been created in BNP for the years 1980, 1990, 1997 and 2003. The fifth time slice is presently under construction for 2015 including change cartography to 2003. Simultaneously BNP engages into the processing of datasets created in the past in order to exploit the potential of change analysis on a spatially comprising level.

Preliminary results

Even though comparability has always been of high concern in BNP, the topic has not yet received enough attention. First experiences show that quality-proven land cover inventories for each time slice as well as consistency-checked series of time slices are both indispensable pre-conditions for reliable long-term comparative analysis. The evolving interpretation method as well as the technical progress in image quality and spatial accuracy have a great impact on BNP data series and limit the possibilities of consistent spatio-temporal analysis.

Up to now data comparisons reveal the following natural processes as most relevant for BNP: forest successions, bark beetle infestations in various combinations with windthrows, avalanches (see example in Fig. 1 and Fig. 2) and mass movements (e.g. rock falls, landslides, fluvial activities). Concerning human influence certain management measures and infrastructural changes are of landscape relevance.

Figure 1: Aspect of avalanche zone (October 2015, downhill line of sight) shown in time series of Fig. 3 (Photo credit: Linda Camathias)

Figure 2: Aspect of avalanche zone (August 2016, uphill line of sight) shown in time series of Fig. 3 (Photo credit: Andrej Oravec)

For a selected area Fig. 3 shows land cover changes observed since 1980. Apparently no changes occurred from 1980 to 1990 as the same coding is applied (see code table in Fig. 3). In the period from 1990 to 1997 the hatched polygon in the center developed from a two-storeyed forest with rejuvenation (7021) into a coniferous mixed forest (7600). A smaller hatched area on the right margin developed from a windthrow (7700) into a forest with young tree growth (7011). Delimitations of all polygons remain unchanged although vegetation changes are clearly visible in the underlying CIR images. These changes are documented in the secondary levels of the hierarchical habitat code which are not displayed in the figure for practical reasons.
In 2003 the effects of an avalanche incident become visible. The hatched area described first was cut by the avalanche which resulted in the two areas coded as temporarily non-stocked (7710). The type of process observed as well as the degree of vegetation cover are both defined in the secondary coding levels. Differences in subordinate categories lead to adjacent polygons with identical main code.
The 2003 inventory not only shows natural changes but also the effects of the progressing interpretation method. The evolution of the habitat code from the coding of a mono-temporal status into a coding of changes between two inventories requires a more detailed differentiation of polygons (e.g. with regard to the degree of vegetation cover). Consequently the current image interpretation process applies coding of changes to 2015 and 2003 image generations. The outlines of the new polygons in 2003 loose comparability to the previous polygons in 1997 which were coded – due to the technical possibilities at that time – in much coarser spatial and attributional units. The polygons hatched in 2003 (in spite of being 'textually back-coded' to the 1997 syntax) thus also represent differentiations that are not due to real changes.
Looking at the hatched polygons 2015 we can see the changes observed in comparison to 2003. Within 12 years the avalanche areas (7710 in 2003) developed into forest types of different species composition (7311 and 7411 in 2015). Other 2015 polygons show progressing forest succession (7310 to 7311, 7311 to 7312, 7612 to 7613) or stages of natural disturbance and forest regeneration (7615 to 7710, 7614 to 7422).
Although covering only 0,09 km² out of a total of 210 km² this example gives an impressive insight into the history of changes occurring between habitat inventories on a time scale of several decades.

The challenge of time series analysis is now to gain optimal comparability and to benefit as far as possible from the information content of each land cover inventory. Therefore we presently focus on the standardization between time slices.
Due to the fact that the question comparability of has always been in mind since 1980 it is possible to compare pairs of interpretation layers (1980-1990, 1990-1997, 1997-2003, 2003-2015) without methodological restraints. However a consistent analysis thread covering the entire time series appears to be reasonable only for aggregated habitat groups or generalized layers of derived habitat information. Data processing is ongoing and further analysis is still to come until mid-2019.

Discussion and current conclusions

The present study is the first attempt of genuine multi-temporal analysis of BNP datasets with high spatial and attributional complexity. Unexpected efforts have to be invested into the upgrading of existing datasets and the consistency between time slices. However we consider these investments as crucial to achieve a genuine added value through comparative analysis.
Continued studies will aim at the development of adapted analysis methods to profit maximally of the existing information content in spite of the necessary aggregations and generalizations. Results should give hints to which degree the landscape inventories created in the past and at present are suitable for long-term comparative studies. Aspects of spatial scale and temporal interval have to be re-discussed in the light of time series analysis.

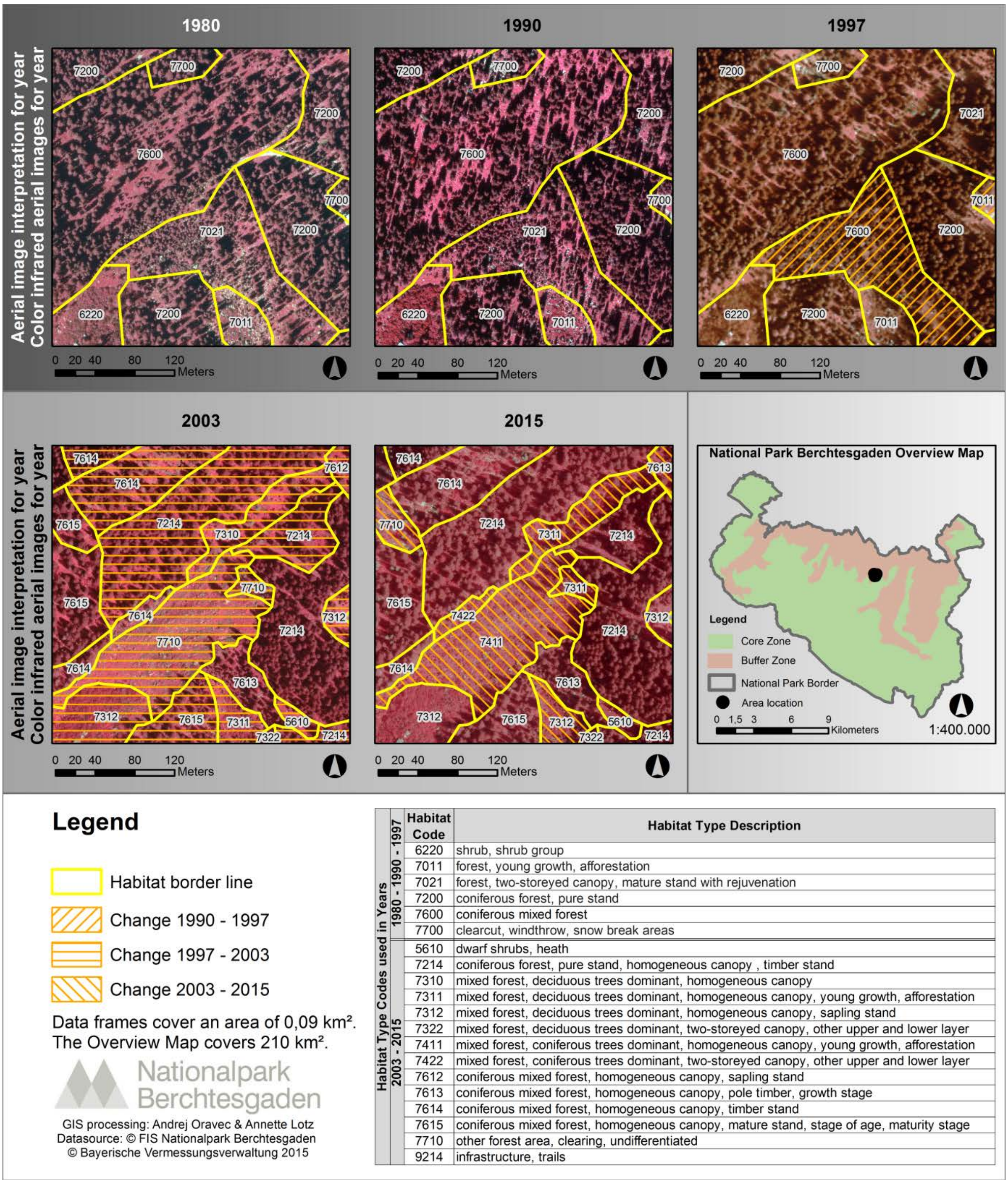

Figure 3: Exemplary time series of land cover changes in the period 1980-2015 in the Watzmann area (Berchtesgaden National Park). Partly simultaneous processes visible in the data frames are progressing forest succession, an avalanche incident, effects of other natural disturbances and forest regeneration stages.

Outlook and perspectives

In BNP the current method of aerial image interpretation is adapted to the documentation of thematic and geometric changes. Former landscape inventories require processing to achieve maximum comparability. Still prevailing consistency limitations suggest the potential alternative to apply the current method backwards to previous image generations. Future inventories are specifically designed for time series analysis. Nonetheless they should undergo plausibility checks for each time slice and repeated backward consistency-checks for the growing time series.

Experiences in Gesäuse National Park (Austria) show that the simultaneous consideration of three image generations helps to improve cartography of changes (oral communication Kreiner 2017). However the question of how to handle consistently more than three interpretations still has to be discussed. Furthermore future analysis workflows will have to foresee the updating of past landscape inventories.

With increasing time series the issue of adapted visualization becomes more urgent. This will be considered in the current project as time series visualization of progressing habitat mosaics can give insights into natural dynamics that might not have been obvious before.

Land cover inventories that can meet multi-temporal requirements need a time consuming process of creation if the current manual method is applied. The degree of differentiation results from a preceding inquiry of users (HALLER et al. 2013). On the other hand the facilitated availability of remote sensing data (e.g. two years repetition rate for federal Bavarian image flights) implies an enormous potential for complementary methods of automated evaluation. Nowadays image data is not the problem but affordable and standardized processes of evaluation that meet the actual demands of protected area management.
At the same time the expected benefit of monitoring in protected areas is a subject of rising importance. With the increasing protection duration demands of both topicality and comparability become more evident. In addition, natural dynamics create a complex mosaicking of habitats. This leads to the loss of former management dominated habitat boundaries (especially in forested areas) and increases the need for a spatial reference system that supports monitoring of land cover units all over the protected area and all over time.
Taking into account these conditions expectations of what land cover inventories and derivable spatio-temporal analysis actually should deliver have to be revised and defined into adapted demands of spatial and temporal scale as well as attributional content. In the frame of the present study BNP takes the chance to valorize previous efforts in the field of landscape monitoring dating back to 1980. The evidence that time series analysis can contribute to assess landscape evolution will influence future landscape monitoring in BNP.

As shown by the example of landscape monitoring BNP assumes its responsibility as long-term organization for archiving environmental data and for keeping it available for monitoring studies. These aspects have often been underestimated in previous database management. With respect to improving the data fundament for adaptive management decisions these aspects should be considered in administrative planning processes.

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Design, implementation and performance of an ecosystem monitoring program in Biosphere Reserves – the long-term observation of ecosystems in the Biosphere Reserves in the federal state Brandenburg (ÖUB)

Vera Luthardt, Robert Probst, Thomas Lüdicke

Abstract

Since 1999 a monitoring program (ÖUB) is performed within three Biosphere Reserves (BR) in Brandenburg, Germany. The design aims at the main ecosystems, and includes water, soil, flora and fauna. The value of this long term observation is demonstrated by example. The development of plant species richness in agricultural systems with different land-use practices in the BR Schorfheide-Chorin is shown. Furthermore, the documentation of changes in vegetation caused by elevation of groundwater tables in the BR Spreewald is presented.

Keywords

ecological assessment, long-term research, management support

Introduction

The MAB committee of UNESCO describes the implementation of ecological monitoring as one task of Biosphere Reserves (BR), adding to their protection and sustainable development functions. This monitoring is part of the integrated research and monitoring tasks of these protections areas (BfN 2008). The main aim of the ecological long-term observation is to record, trace and assess the ongoing development of typical ecosystems without direct human impact as well as ecosystems shaped by human land use in Biosphere Reserves (Luthardt 2010). In Germany the focus of monitoring activities at the Biosphere Reserves is set by the federal states in regard to their environmental and administrational framework.

At the late 1990s, the Brandenburg federal environmental agency installed a large all-embracing ecosystem monitoring program for its three Biosphere Reserves (Fig.1). It is focused on topical scale, as has been specified at the Sevilla-Strategy of UNESCO (1996). The program called ÖUB includes an observation of all ecosystem-compartments such as soil, water, vegetation and fauna (LUGV 2015). The main aims of the program are presented in Table 1. The monitoring is continuously executed since 1999 at the Biosphere Reserves Schorfheide-Chorin (BR SC) and Spreewald (BR SW). In the Biosphere Reserve Flusslandschaft Elbe (BR FE) it is conducted since 2003. The funding is carried out by the Brandenburg federal environmental agency. The leadership and administration are handled at the Eberswalde University for Sustainable Development (HNEE).

I	Documentation of the ecosystem development
II	Conclusions of the assessment of areas under the viewpoint of nature conservation
III	Basic knowledge for the control of the success of management measures
IV	Formulation of new strategies for the future use and management of ecosystems
V	Validation and Qualification of ecological Modelling
VI	Support for decision – making in nature conservation
VII	Public relations work about the development of ecosystems and representation of regional trends
VIII	Support for international duty to report within the framework of MAB-Network / continuous regional environmental reporting

Table 1: Main aims of the ecological long-term observation in the Biosphere Reserves in Brandenburg ÖUB (ÖUB 2017)

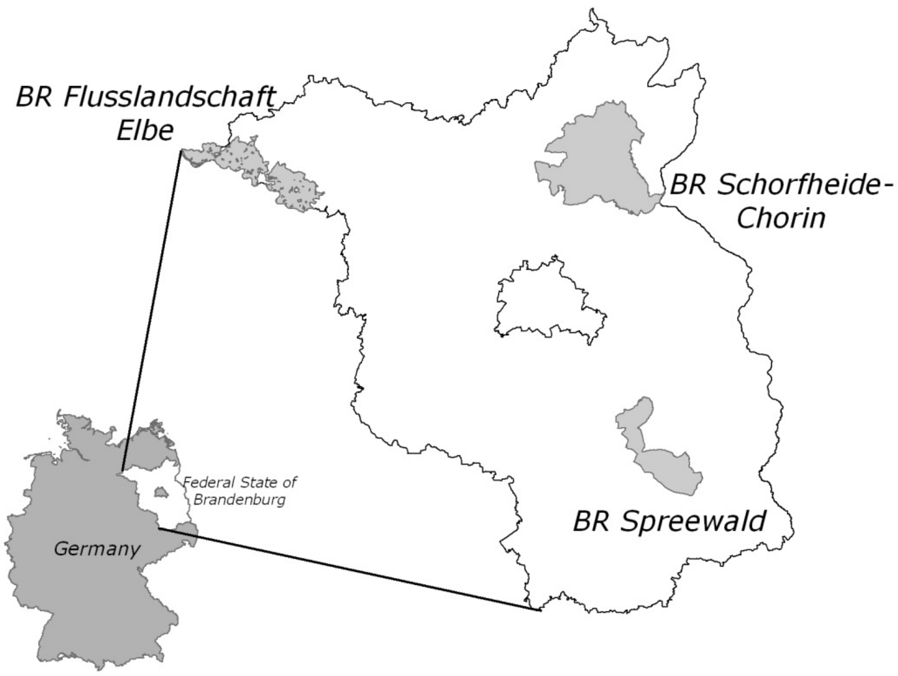

Figure 1: Localization of the three Biosphere Reserves in the land Brandenburg, Germany

Methods

The general steps to create a program for long-term observation are shown in Fig.2. At first the analysis of all different ecosystems (e.g. all types of forest ecosystems) in the BRs was conducted. These ecosystems were merged with existing types of land use (e.g. organic farming, conventional production) and in a work-sharing approach between all three BRs. Finally, 135 observation sites were chosen, each with specific combinations of ecosystem and land use (Tab.2). For further information see LUTHARDT et al. 2005 and VAHRSON et al. 2000.

Specific monitoring objectives were defined for each ecosystem category and standardized methods for handy measureable and interpretable parameters with high indicator levels were identified (LUTHARDT 2010; LUTHARDT et al. 2005). These methods and parameters are collected into a catalogue (LUTHARDT et al. 2006, ÖUB 2017). The measurements for the most parameters are repeated in a time interval of 3 years. A Microsoft Access-database was developed for archiving and data-mining.

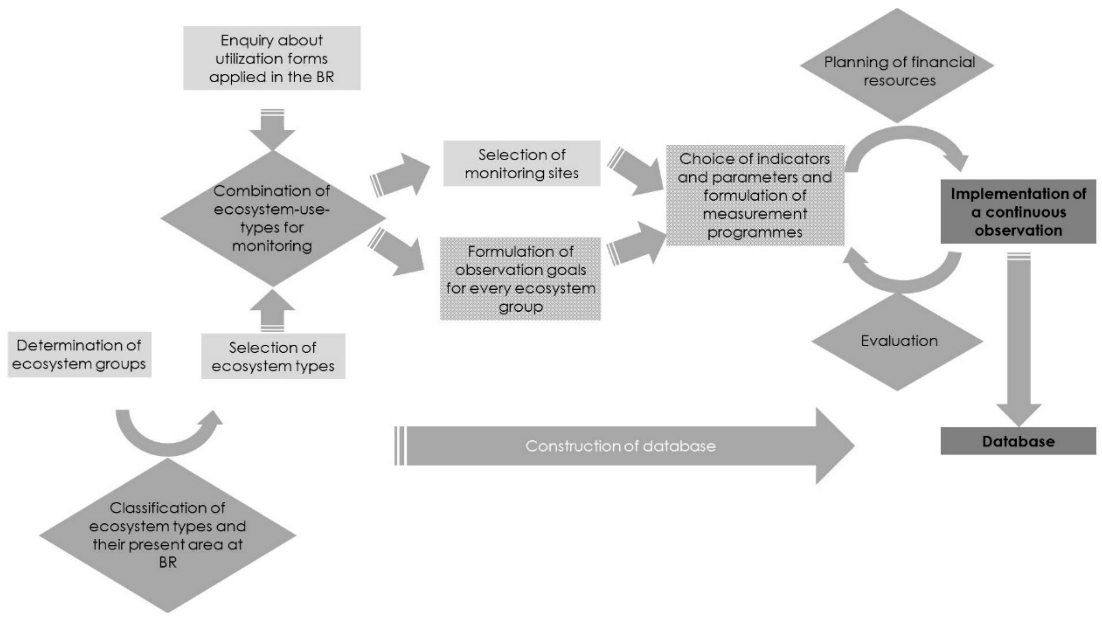

Figure 2: General steps to create the program for the long-term observation in the Biosphere Reserves of Brandenburg (LUTHARDT 2010)

Ecosystem Group	BR SC	BR SW	BR FE
Woodland / forest	22	8	8
Grassland on mineral soils	3	5	5
Grassland on peatlands	3	4	1
Arable land	5	2	-
Near-natural Fens	4	-	1
Lakes (* kettle holes,** back water)	30/4*	-	0/4**
Streams and ditches	-	13	13
Sum of observation sites	**71**	**32**	**32**

Table 2: Kind of ecosystem groups and number of monitoring areas of the ÖUB in the three biosphere reserves (BR) of Brandenburg – Schorfheide-Chorin (BR SC), Spreewald (BR SW), Flusslandschaft Elbe (BR FE)

Results

Up to 7 measurements are available per parameter collected with an interval of 3 years. Increasing knowledge of landscape development can be obtained with these datasets, according to land-use change as well as climate or water budget changes.

For example, different development between organic farmed and conventionally farmed land on areas with the same natural environment can be observed. With regard to their chemical soil properties no significant differences could be determined during the observation period. On the opposite, a significant difference in the population of arable wild species was documented. On organic farmed land a higher mean of plant species richness was determined compared to conventionally farmed land (Fig.3). Above all, arable wild species were more equally distributed on organic farmed land then on conventionally farmed land, where they are mainly on the edge of the site (BETHWELL et al. 2017). This is mostly referred to the application of herbicides. The documentation of rapid reclaim with species of sandy fallows and dry grassland on a sandy soil land during fallow is highlighted. Although, the permanent establishment of these plant communities depends on the further intensity of land use and abstinence of herbicides (BETHWELL et al. 2017).

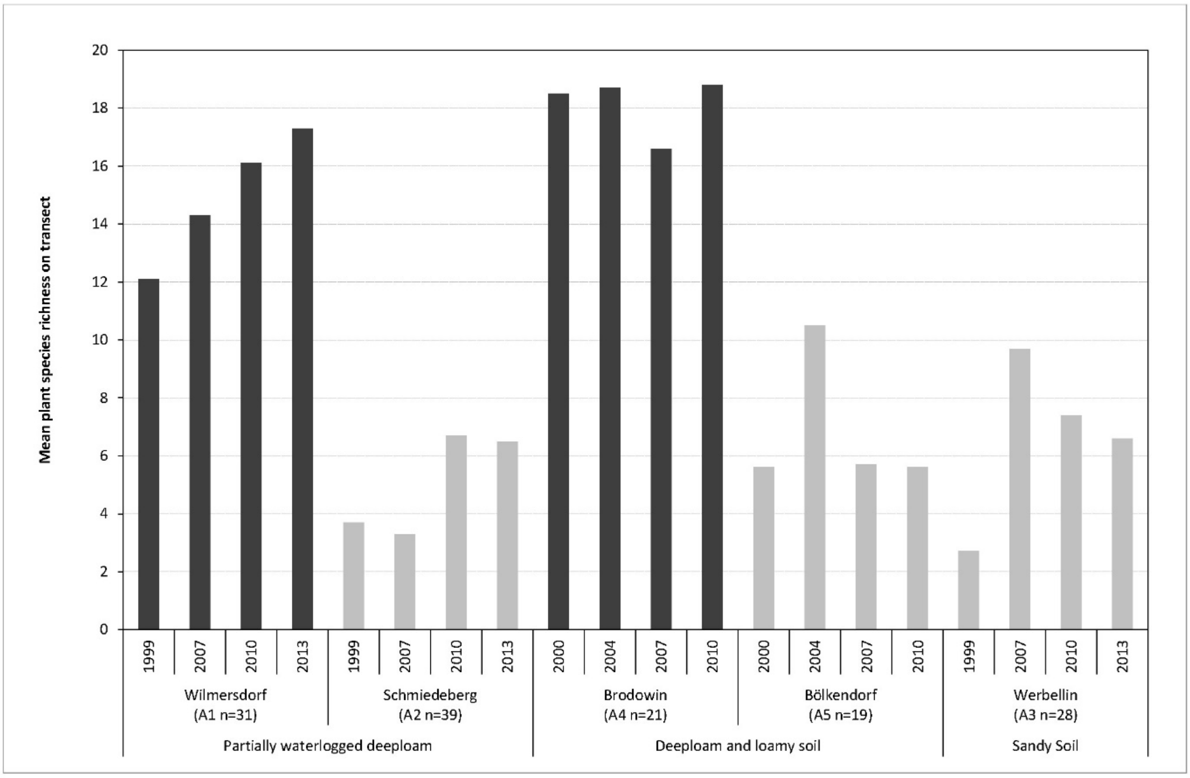

Figure 3: Wild plant species richness measured in a transect (average number of transect points with 6,3 m^2) of organic farmed land (black) in comparison with conventionally farmed land (grey) (BETHWELL et al. 2017)

Another example for the increasing knowledge about ecosystem development in the last nearly two decades, which is observed by long-term observation, is the concrete documented change of vegetation and plant associations of grassland ecosystems in the BR Spreewald. Due to open-cast mining in the 20th century around the Spreewald region the groundwater table decreased on a large scale. With the political transformation in the early 1990s and the changes in production of energy, open-cast mining was fast reduced and the old sites were flooded. Therefore the groundwater table is now increasing continuously (LUGV 2015). This development and the influence of wet and dry weather periods over some years led to a change in vegetation at central 'Upper Spreewald'(Fig.4). During the observation period, plant species that indicate wet conditions displaced species indicating moderate humidity. Not only the vegetation was documented but also the changes in ground beetle and grasshopper populations (BETHWELL et al. 2017). With ongoing increase of the groundwater table, the objectives of the BR and of land-use management have to be reconsidered now to take care for the future (BETHWELL et al. 2017). The long-term observation can support these decisions by documenting and displaying the development.

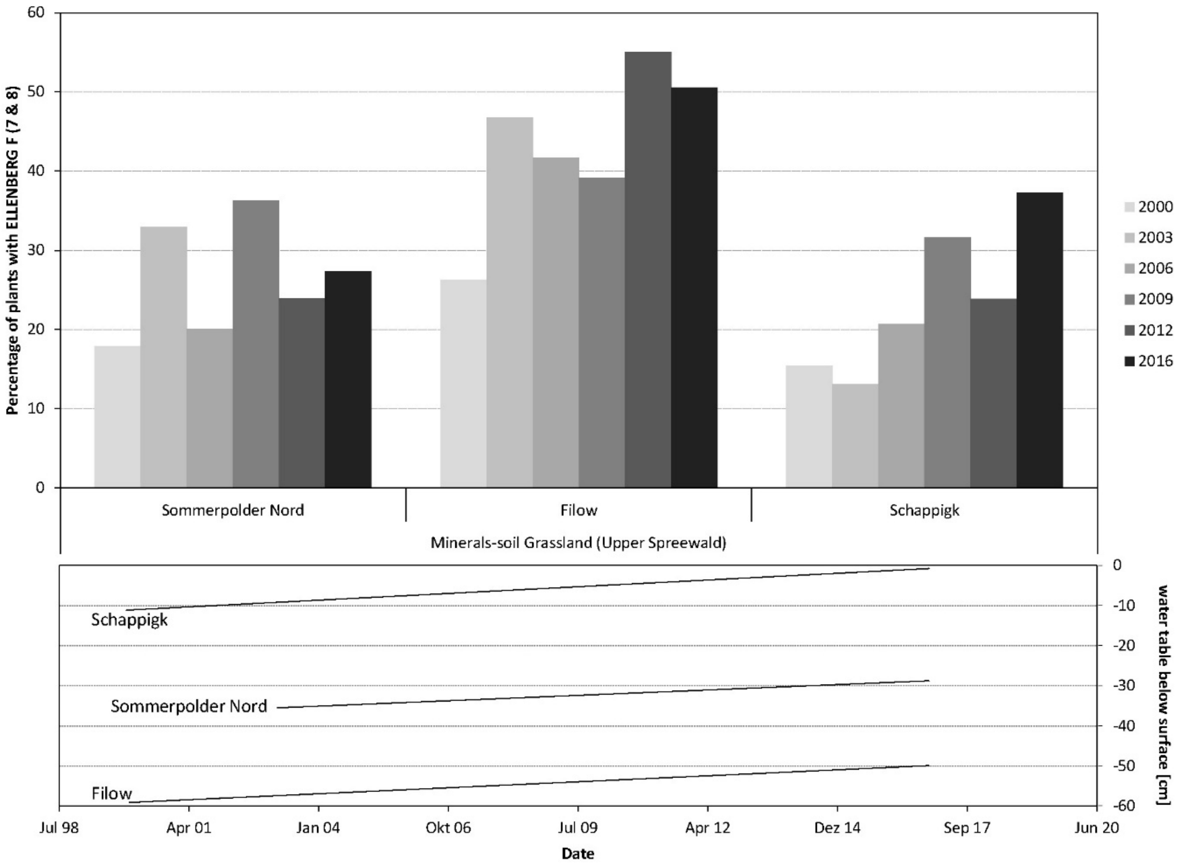

Figure 4: Percentage of plant species with an 'F-Zahl' according to ELLENBERG 7-8 (7 = wet, 8 = increasing wetness) and the course of the groundwater table in the last years at three observation sites of the ÖUB in the 'Upper Spreewald' in the BR Spreewald

Discussion

The monitoring program of the ÖUB was evaluated in 2015. All measurements were systematically analyzed and their value reviewed. Nearly all parameters were assessed as good in value as well as in measurement interval. The gaps pointed out should be closed in the close future. Priorities in monitoring objectives were switched for some ecosystem categories. The increasing value with duration was pointed out for the monitoring program ÖUB. The 135 observation sites are able to reveal a very satisfying impression of ongoing landscape developments, even though generalisations should be avaoided.

Conclusions

The ecological long-term observation of ecosystems in the Biosphere Reserves of Brandenburg provides information for the above shown main aims (Tab.1). The knowledge gained from this is very useful to support future management decisions to maintain and advance biodiversity in Biosphere Reserves. To achieve the optimal benefit, observations on topical scale have to be complemented with analyses on chorical scale to get a more accurate view on the complex landscape development. Similar to that, higher monitoring scales than the 'integrated monitoring' introduced by GEHRLEIN et al. (2014) are able to deal better with the complex requirements of decisions making in sustainable land-use. Observations on topical scale can support these monitoring approaches.

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Interspecific relationships within Romania's protected areas. Case study: the cohabitation Homo sapiens sapiens - Ursus arctos arctos, in Harghita Mountains

Gabriela Manea, Adrian Tişcovschi, Iuliana Vijulie, Elena Matei, Roxana Cuculici, Mihaela Preda, Octavian Cocoş

Abstract

The official assessments of the European Commission tell that Carpathian brown bear is a vulnerable species. The man-bear relationship must take into account three aspects of the bears' behavior: feeding, protection and aggressiveness. The aim of the study is to analyze the typology of the relation between *Ursus arctos arctos and Homo sapiens sapiens* within the protected areas in the Harghita County (the Eastern Carpathians). The research methodology was the following: surveying the literature dealing with brown bear's ecology and ethology; undertaking field research; running questionnaires; monitoring the online environment. The results show that the shrinkage of the brown bear's habitat is directly proportional with forest shrinkage. The typology of the man-bear relationships includes **commensalism, food competition and individual intolerance**.

Keywords

Homo sapiens sapiens, *Ursus arctos arctos*, Carpahian brown bear, relationships

Introduction

Unlike the wild species, which compete for food and habitat under the influence of natural laws, which in their turn regulate the inputs and outputs of the ecosystems, the contemporary man may be considered today the most numerous mammal species on Earth, having the largest biogeographical area. Practically, *Homo sapiens sapiens* is the only species of the animal kingdom capable of surviving and perpetuating, through cultural adjustments, in various environments (RICHERSON et al. 1996). Maker of artefacts and having consumerist behavior, man succeeded to unbalance the food chain by hindering particular species (like the brown bear) in finding the necessary food exclusively on the territory of their natural habitat. The direct effect of this dysfunctionality lies in the conflict situations arising more and more often between the two species, namely *Homo sapiens sapiens* and *Ursus arctos arctos*. The amplitude of these conflicts is directly proportional with the extension of the human habitat to the detriment of the one belonging to the bear. The dense human settlements may jeopardize the wild fauna, not necessarily directly, but through the human pressure exerted in different forms on the habitats, leading to topographic, hydrological and soil artificialization (http://marinebio.org/oceans/conservation/moyle/ch1 /).

This attitude might have its origin in the *Homo sapiens sapiens*, 'armed' with a number of artificial means by which he fights against his competitors, produces his subsistence means by extracting the natural resources from the environment. This represents an insurmountable ecological barrier for the large mammals, which try to regain their lost habitat. In the mountain habitats of Romania, one of the biggest losers of this conflict is the Carpathian brown bear (*Ursus arctos arctos*). The species *Ursus arctos arctos L.* has become, over the last decade, a real country brand, confirmed, among others, by the numerous (eco)touristic promotion sites in Romania. According to the official assessments of the European Commission, the Carpathian brown bear is a vulnerable species, because of the continuous degradation of its habitat following the socio-economic development of Romania (LINNELL et al., 2008). The studies on the ecology, ethology and conflict situations between men and bears have drawn the attention of domestic and foreign researchers, especially because the brown bear (*Ursus arctos arctos* – the Eurasian species) has been included on the Red List of IUCN as a species threatened with extinction (http://www.iucnredlist.org/details/41688/0). At present, the European biogeographical area of the species is very fragmented, and the most numerous specimens (according to the Red List of IUCN, 2016) are spread on the Romania's territory, specifically in the Carpathians, where the number of brown bears is estimated at about 6,000 (of the approximately 8,100 encountered in Europe). The encouraging factors for this specie, are the extension (for how long?!) of forested areas (SALVATORI et al. 2002; ROZYLOWICZ et al. 2011), some of them having a high degree of naturalness. According to the official data, in selected counties (e.g. Vrancea and Harghita), where the number of hunted bears is very high, the population increase (on paper) has been in some cases even 50%, i.e. four times higher than elsewhere in Europe or North America (http://www.ccmesi.ro/?page_id=1643).

In the man-bear relationship, one has to take into account the three sides of the bear's behavior: feeding, defense and aggressiveness. **The study area** is centered on the alignment of community interest defined by Nature 2000, for the Harghita Mountains (the Central Division of the Eastern Carpathians), namely Piatra Șoimilor (natural reserve on the administrative territory of Băile Tuşnad, covered by mixed forest vegetation broadleaf and coniferous trees, as well as grasslands with high floristic biodiversity; Lacul Sf. Ana (geological, flora and fauna reserve lying in the Ciomatu massif, Harghita County) and Tinovul [peat-bog] Mohoş (or the Mossy Lake), which is a flora and fauna reserve, situated in the Cozmeni commune, Harghita County (Fig. 1). According to the statistical data, provided by Environmental Protection Agency (APM) Harghita, the county's forests shelter between 900 and 1000 bears.

The aim of the study is to answer the following research question:
What are the types of relationships between *Ursus arctos arctos* and *Homo sapiens sapiens* in the protected areas found in Harghita County?

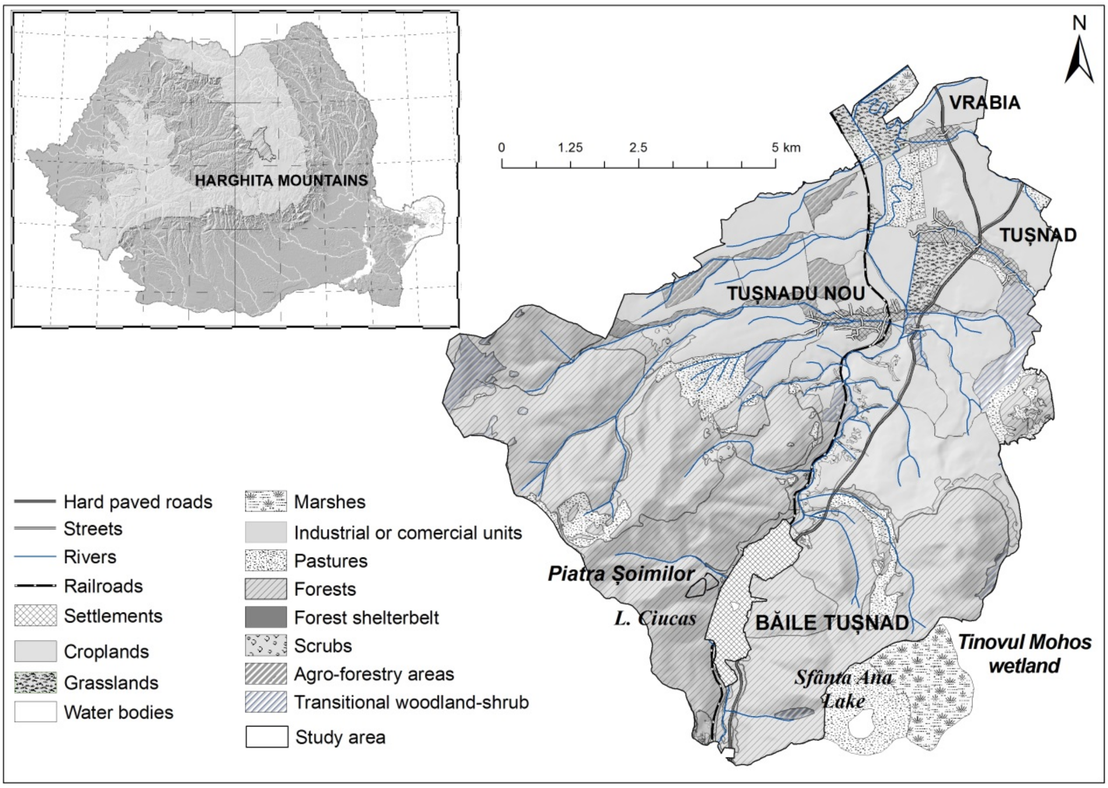

Figure 1: The study area

Research methodology

The research methodology was based on the following: reviewing the previous studies concerning the ecological and ethological features of the Carpathian brown bear; direct observations in the field, made by the authors in July 2016, in the natural reserves Piatra Șoimilor, Lacul Sfânta Ana and Tinovul Mohoş; indirect observations, made with cameras, which caught the presence of the bears in the built-up area of Băile Tuşnad spa resort (lying next to the Piatra Șoimilor reserve); the survey method, specifically the semi-structured interview, applied in the Băile Tuşnad spa resort; monitoring the online environment, by searching the keywords 'bears, 'bear', 'Romanian bears', and *Ursus arctos*, in order to highlight the level of interest on this subject; defining the man-bear interspecific relationships and gathering testimonials about man-bear conflict situations, occurring in the investigated territory.

Results and discussion

The shrinkage of the brown bear's habitat is directly proportional to the reduction of forest areas and the extension of human habitat. This environmental transformation has produced a paradigm change concerning the man-bear relationships, which has inevitably led to a conflict situation with negative effects for both species.

Under the circumstances, the relationships are the following:

1. **Competition for food and habitat.** This type of competition is harsher in the buffer area between the artificialized habitat of the human communities and the natural habitat of the brown bear, given that the first one is on the increase. The competition for food and habitat puts pressure on both species, as man competes for wild berries and shows individual intolerance, while bears are predators and come for food in the people's households.
2. **Commensalism**. The diminishing of the habitat's resources corroborated with the foul smell exhaled by the food scraps produced by human communities have turned the brown bear into a commensal, which at the same time can be an unannounced enemy. For the people in the area, this embarrassing and stressful situation is a good reason for securing the urban and rural habitats at all costs (Fig. 2). The feeding behavior is accompanied by exploratory habits, consisting in analyzing all the information that might lead to food sources.
3. **Individual intolerance relationships**. The bears spotted in the people's households can be aggressed or even killed by the property owners. Man-bear conflicts cannot be attributed to particular people or particular bears. PÂRÂU , 2006, has identified six professional categories that are prone to have problems with the bears. These are the following: animal breeders (39.8%), people living in the rural environment, having no permanent occupation (14.9%), forestry specialists (13.4%), hunters (7.3%), and beaters (6.7%), as well as fruit, mushroom and wood gatherers (6.1%). In theory, the main method for mitigating the interspecific conflict situations is the preventive management, because reactive management is less efficient. At present, in Romania the pyramid is reversed, as reactive management is still the main action tool (Pop, 2011). The previously mentioned relationships, which have developed on such a long time, may lead to behavioral changes both in man and bears. Thus, after repeated contacts with man and after enough positive experiences, the bear may learn to accept human presence (Fig. 3). Under the circumstances, the bear gradually becomes accustomed to human presence, being able to anticipate people's reactions (DOLSON, 2010).

2.1.commensalism 2.2. predation 2.3. Passive defense of human being

Figure 2: Interspecific relationships (Băile Tuşnad)
Source: Adrian Tişcovschi, 2016

Figure 3: Unusual encounter in the Lacul Sfânta Ana natural reserve
Source: http://www.ziuanews.ro/stiri/ursii-de-la-lacul-sf-nta-ana-turistii-se-pun-n-pericol-de-moarte-471838. Accessed 17.03.2017

<u>The level of interest of the local communities on this topic; testimonials about man-bear conflicts, in the study area.</u>

The discussions that we had with the representatives of the local community in Băile Tuşnad in the summer of 2016 led to the following conclusions regarding the man-bear cohabitation: in the warm season, especially during the night, the bears 'storm' the garbage sites in the spa resort in search for supplementary food, which gradually changes their feeding behavior, turning them into 'scavenger bears'; the bears also appear frequently in the perimeter of the mineral springs (Sfânta Ana Alley), which represent tourist attractions ; over the past 8-10 years, people have also noticed (usually in summer, at dusk) mother bears with cubs, behaving aggressively towards people.

The wandering bears create panic among the local population, compelling the people to stay indoors after dark. Every year, the residents blame the bears for the damage they have caused to their households and for the animal loss; for this reason, the Town Hall of the Băile Tuşnad spa resort decided to replace the classical garbage containers, made of plastic, with secure ones, inaccessible for the animals (Fig. 2, right side). Searching the online environment by using keywords like 'bears', 'bear', 'Romanian bears' and *Ursus arctos* allowed us to have access to an impressive number of sites, which proves that the level of interest of the human communities for the 'bear' phenomenon is high, although the points of view are different. The above-mentioned keywords returned the following results: 'bears' – 101,000 links, 'bear'- 1,630,000 links; 'Romanian bear' – 13,200,000 links.

Conclusion

The interspecific man-bear relationships are still in the attention of the Romanian researchers, because of the tensions that seem to persist in the study area and generally, in similar mountain territories. Even though frustrating for the time being for both species, the man-bear cohabitation within the study area will certainly continue for a long time. Therefore, by a wise management of conflict situations, it is possible that on a medium and long term *Homo sapiens sapiens* and *Ursus arctos arctos* will be able to build a relationship based on tolerance.

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Promoting terrestrial habitat- and species-diversity as consequence of river rewildering (middle Isar, Natura 2000-area)

Christine Margraf

Abstract

It is shown, that river restoration in Middle Isar between Freising and Moosburg resulted in for alpine-rivers typical morphological processes, even furcation. Vegetation and birds have become more diverse than in not restored stretches, and typical und very diverse species of wild bees/ wasps, carabids, spiders and birds benefit from the restoration. Essential factors for success are described.

Keywords

terrestrial biodiversity, alpine river-restoration, middle Isar

Introduction

Rivers and their floodplains are a hotspot of biodiversity in middle Europe. The special value of alpine rivers is the permanent changing spacial and temporal mosaic of different pioneer- und sucession-stages of very diverse habitats. They have become rare in regulated rivers, many of their typical species are threatened. By restoring rivers it is expected that these stages and their species are promoted.

The Middle Isar between Munich and Landshut (Upper Bavaria) with the broad floodplains is one of the most important area for coherent floodplain-forests, of national importance and part of the central line of habitat connection 'Isar'. It is protected as Natura 2000-area (FFH) 'Floodplain of Isar from Unterföhring to Landshut'. Additionally downstream Freising the area is protected as nature reserve 'Floodplain of Isar between Hangenham and Moosburg'.

Because of riverregulation, dike-construction, impoundment in the upper river, water outflow and therefore bedload-deficit and river-deepening the typical diversity of structures, habitats and species for an alpine river decreased. The area studied is a residual-water stretch with reduced hydrological and morphological dynamic.

Between Freising and Moosburg the authority for water resources Munich renaturated between 2002 and 2008 three sections (river-km 107,7 – 106,8 / 102 – 99 / 98,2 – 96,5): bank reinforcement was removed and in one section a river-neer dike was relocated to the edge of the floodplain (http://www.wwa-m.bayern.de/fluesse_seen/massnahmen/gek_mittlere_isar/index.htm).

The survey of flora and fauna in these sections was carried out by BUND Naturschutz in Bayern e.V. (environmental NGO), to explore the expected positive impact to terrestrial biodiversity and to the aims of the protected areas. The study was financially supported by the Bavarian fund for nature protection of the environmental ministry (85% of the costs).

Methods

In the three restroration-sections 2015 took place the mapping of flora/ vegetation (Margraf, Steidl), carabids / spiders (Willner), wildbees / wasps (Mandery), birds (Magerl), reptiles and amphibians (Drobny). Additional traps (yellow bowl, Barber pitfall trap and Malaise traps) were used. So the most essential groups of species in alpine rivers were mapped. The survey concentrated on the area with impact of the restoration measures (gravel banks and riverbanks).
Unfortunately no 'zero-mapping' before the restoration happened. However it is possible to correlate the mapped species with the restoration: through comparison with different data from earlier mappings, through long-term knowledge of the area of nearly all persons of the mapping-team and through comparison with non-restored sections.

Results

Since 2002 annual floods (HQ1 = 210 m^3/s) and four high floods caused dynamic processes. Essential for the effectiveness of the restoration were especially the HQ80 in 2005 and HQ20 in 2013. The following for an alpine river typical structures increased: bank erosion, development of new and re-arrangement of existing gravel banks, deposition of gravel in different altitudes partially overlaying existent vegetation (even very high, new development of dry grassland), deposition of dead-wood and drifted parts of trees, smale-scale alternating diversity of soil-substrats, building new channels and waterbodies of very diverse character, widening of the until now 60 m narrowed river up to more than double width (bevor regulation the Isar was a 200-500 m broad and often moving river), shortening meander-radius. In one section even a diversification of the riverbed in three river branches took place (furcation, figure 1).

During mapping there was a flood in May 2015. The species-range is therefore and because of the limited time of only one year surely not complete. Nevertheless there are notable results for the gravel banks and riverbanks (‘RL’ = Red List Bavaria):

– 310 species of **vascular plants**, 75 species of which were not noticed in the mapping of the nature reserve in 1997.
– Diversification of the typical pioneer- und ruderal **vegetation**, a more small-scale spacial mosaic of different succession stages than bevor / outside the restoration-area.
– New development of typical shrubs of alpine rivers with eleagnos willow (*Salix eleagnos)* together with daphne willow (*Salix daphnoides)* (**FFH-habitat 3240**, figure 2. Before restoration only single plants). High regeneration of till now old-grown softwood-forests (*Salix alba*, Salicetum albae – **FFH-habitat 91E0***), scattered forests with grey alder (*Alnus incana*, Alnetum incanae). New development of a dry nutrient-poor ruderal grassland on high gravel depositions in the floodplain.
– Of the 33 found species of **carabids** 10 are typical and 9 characteristical for gravelly or sandy gravel banks resp. 1 species for sandy riverbanks. Among these are species from all zones of the gravel banks (from waternear wash margin to the floodplain-forests), from all soil-substrates (gravel, sand, clay) and species which require complex habitats. For example: *Elaphrus aureus (*RL 2, especially in the range of bank erosion, steep bank in complex with (older) willow-shrubs and -forests) , *Bembidion testaceum* (RL V, gravel banks without vegetation), *Carabus ullrichii* (RL V, gravel banks with vegetation). 1984 not in the area found and therefore now new species are the three for alpine rivers typical carabid-species *Nebria picicormis* (RL V), *Carabus granulatus* and *Asaphidion austriacum*.High number of species of **wild bees and wasps:** 231 species from 10 families (119 of 506 species in Bavaria), among them 25 dangered und 8 highly dangered species. A lot of species are typical or of high quality, for example psammophilic species, oligolektic species specialised on willows (e.g. sand wasp ***Andrena nycthemera***, RL 2, especially in floodplains), typical for floodplain-areas (e.g. digger wasp ***Crossocerus walkeri*** (RL 2, nest in rotten standing deadwood near waters) or alpine species (e.g. apex-furrowed bee ***Lasioglossum bavaricum*,** RL D, in Germany only in the alps, nests in a little bit hardened limestone gravel). In conclusion species with very different demands concerning their habitats. They reflect the increased morphological structures und the more diverse vegetation. Highest species-numbers occurred in this section, where river-restoration *and* dike-relocation took place.
– New occurence of two for alpine rivers typical species of **spiders**, which 1984 along the Isar only were found in the Upper Isar: *Pardosa wagleri* (RL 3, especially in the area of open and regularly moved gravel with open-grained gap-system) and *Arctosa maculata* (RL 2, in cavities between gravels on gravel-banks, often close to drifted deadwood in their shadows)
– Concerning the **birds** it can be emphasised for example the successful reproduction of little ringed plover (*Charadrius dubius*) in the Isar after many decades without successful breeding, the increased number of breeding pairs of kingfisher (*Alcedo atthis*) or the general increased number of species in the restoration sections.The **amphibians** used 7 of 9 new developed water bodies very quick for spawning (*Bufo bufo*, *Rana temporaria* and species of the *Rana ridibunda/ esculenta*-group), although the waters have been regularely flooded and most have connection to the river. Despite existence of fish, *Rana ridibunda/ esculenta* reproduced successfully.
– For **Reptiles** like *Lacerta agilis* and *Natrix natrix* increased suitable habitats in quantity and quality (especially deadwoods for hiding, thermoregulation and protection during floods).

Discussion

As a guiding principle serve the structures and species of an intact alpine braided river with gravel-floodplains, summer-floods and not to steep declivity.

Essential and typical morphological structures and soils of an alpine river developed, leading to an increased variety of habitats and species (chapter 3). For some characteristic species and plant communities the new occurrence or benefits from the restoration can be proofed, for many this can be assumed. The three restoration-sections have different importance for different species-groups. For example is the middle section with its large gravel banks with great rearrangements during floods of high importance for spiders and carabids, whereas the other two sections with their broad ecological gradients and diverse vegetation, especially willow-shrubs and forests, are of special importance for wild-bees and wasps.

Nevertheless (still?) some expected typical species are missing, e.g. German Tamarisk (*Myricaria germanica*) or some carabid-species. It is possible, that time since 2002 was to short or that the distance to the next existant population is to far. Other deficits are the very limited effects in the floodplain (effects till now especially in the river and river-banks), not sufficient morphological dynamic in the area of the dike-relocation or increasing uncontrolled recreational use of the gravel banks.

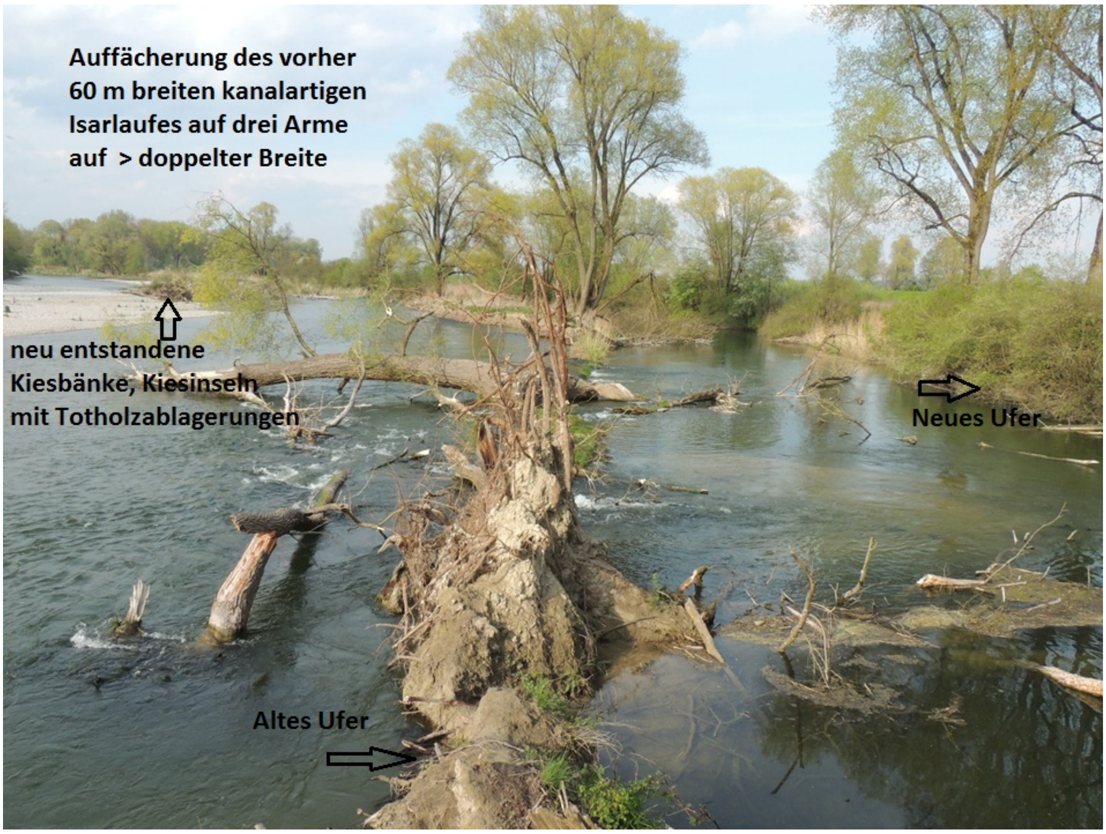

Figure 1

Figure 2

Conclusion

The studied restoration-sections of the Middle Isar have become more in line with the guiding principles concerning morphological structures, species-composition and -diversity. The development corresponds to the aims of the nature reserve and the Natura-2000-area. The development is continuing, long-time studies are necessary.

Essential factors for the positive results are: additional and small-scale diversity of wet and dry habitats and soils, occurrence of high floods, new broad ecological gradients from river to floodplain and therefore more complex habitats, considerably increased dead-wood and drifted organic material, existance and new generation of broad development areas (to allow unregulated dynamics), widespread measures and combination of measures in sections with different characteristics. Especially the big (and often long stable) depositions of whole trees with their roots in the river and on the gravel-banks have central role for occurrence of morphodynamic and building of islands, for sediment-diversity, for occurrence of diverse waterbodies, as hiding-places, shady and wet places (e.g. in hot summers) and for transport of animals and seeds (to repopulate restoration sections). Still existant deficits can be reduced by additional measures, some of them are proposed in the study.

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Biodiversity assessment in the Gesäuse National Park

Alexander Maringer

Abstract

We assessed the biodiversity database of the Gesäuse National Park and have now evidence of 7,216 taxa present in the last two decades. So far for Austria the first record of at least 114 new species was taken, 7 completely new species discovered and 75 endemic species detected.

Keywords

biodiversity, national park, Gesäuse, database

Introduction

The Gesäuse National Park, Austria's youngest national park, was established in 2002. The protected area covers 113 km² and is characterized by its main habitats of rock, alpine meadows, forests and waters. High relief intensity shapes the scenery reaching from 490 m (river Enns at Hieflau) up to an altitude of 2,369 m (Hochtor). The rugged peaks are made of Dachstein limestone and Ramsau dolomite. The comparatively fast weathering of the dolomite rocks creates extensive debris flows and the steep slopes cause a high rate of dynamic natural processes such as avalanches and landslides (MARINGER & KREINER 2016). Situated on the edge of the Alpine glacial shield during the last ice age, the Gesäuse region has retained a particularly high number of 143 endemic species (RABITSCH & ESSL 2009).

Identification and monitoring of species and species richness is a key issue to the national park's management. It is a vital necessity when it comes to implementation of strategies, policies and actions. After 15 years of comprehensive research efforts we established an architecture to efficiently analyse and utilize the data gained so far.

Methods

By summer 2017 approximately 200,000 records were stored in a Microsoft SQL database and maintained by the BioOffice 2.0.8 frontend (Biogis Consulting 2004). We assume that 80 % of the research results are included up to now, representing 270 research reports, monitoring results (KREINER & MARINGER 2017) and casual observations.
In order to illustrate biodiversity at this point in time, we chose the cutoff date to be 31.12.1989. Within the national park´s area of 113 km² we analysed 148,427 records. By definition, we counted taxonomically valid species as well as all taxa (such as species, subspecies, varieties, hybrids) as entered in the database. To the best of our knowledge, synonyms were excluded following the Pan-European Species Directories Infrastructure (PESI 2017) and expert assessments.

Results

Tab. 1 depicts 7,216 taxa present in the Gesäuse national park at the very moment and at least recorded once since the beginning of 1990. The numbers of the main taxa reasonably match the main findings of research (Spermatophyta & Pteridophyta: GREIMLER (1997), ZIMMERMANN & KREINER (2017), KERSCHBAUMSTEINER et al. (2012); Bryophyta: SUANJAK (2012); Lichens: WILFLING (2012); Fungi: POCK (2012); Mammalia: MARINGER 2012, PYSARCZUK (2009); Aves: MARINGER et al. 2017; Pisces: GUMPINGER (2017); Amphibia & Reptilia: MARINGER & REMSCHAK (2017); Insecta: FRIEß (2012), HABELER (in prep.), HOLZINGER (2012), ZECHNER (2012); Arachnida: KOMPOSCH (2012); Gastropoda: ARIANTA I-V WORKSHOPS (unpub. data), VOLKMER & KOMPOSCH (2015). Accepting various taxonomic disputes, we count 6,520 species in the Gesäuse national park so far. This represents the most recent state of knowledge and is not an estimation of overall biodiversity. For hard facts concerning specific taxonomic groups the citation given should be reviewed and referenced.

Some of these species were newly discovered such as *Leuctra astridae* GRAF 2005, *Leptosciarella gretae* HELLER 2012, *Camptochaeta austriaca* HELLER 2012, *Bradysia kirstenae* HELLER 2012, *B. fontinalis* HELLER 2012, *Hemerodromia strobli* WAGNER & GERECKE 2008, *Halacarellus fontinalis* BARTSCH & GERECKE 2011. For Austria the first record of at least 114 new species was taken in the Gesäuse region KREINER & MARINGER (2012).

In this period we verified the presence of 24 endemic plants and 51 endemic animals. This list is incomplete due to new findings by KOMPOSCH et al. (2015, in prep.) during their work on Coleoptera (Curculionidae, Chrysomelidae, Staphylinidae), Diplura, Arachnida (Palpigradi, Pseudoskorpiones), which started in 2015 and is not finished yet.

Taxonomic Group	Taxa	Species*
Plantae	1.223	1.015
Bryophyta	329	281
Lichen	519	477
Fungi	637	617
Mammalia	65	48
Aves	122	121
Pisces	15	14
Crustacea	64	60
Amphibia & Reptilia	13	13
Arachnida	456	364
Gastropoda	115	76
Lepidoptera	1.234	1.234
Hemiptera	458	436
Coleoptera	684	646
Diptera	730	632
Hymenoptera	271	246
Orthoptera	33	30
Trichoptera	85	72
Ephemeroptera	18	11
Plecoptera	65	57
Odonata	17	17
Various Taxa	63	53
	7.216	6.520

Table 1: Biological diversity found in the Gesäuse National Park (1990-2017). Area assessed: 113 km². *) see text for definition.

Discussion

Choosing a cutoff date led to a loss of 15,974 older records (10.8 %). Nevertheless, this fits into the park´s history when the first research studies were commissioned in the early 1990ies during the foundation phase.
Some of the data may be biased either because of misidentification of taxa by the responsible scientists, due to taxonomic unsteadiness and changes, or to deficiencies during data handling. However, this is the first attempt to merge almost all of the records that have ever been entered into the BioOffice 2.0.8 database for the Gesäuse national park.

Monitoring focuses on indicator species from the orders of Orchidacea, Hemiptera, Orthoptera, Arachnida and Aves as well as on species of the European Union's habitat directive and birds directive (Council Directives 92/43/EEC and 2009/147/EC). Thus, sufficient data for these taxa is available. So far unknown numbers of species are red listed for Austria or the federal province of Styria. This issue can be addressed by implementing digital lists of endangered species.

We are working on data refinement as well as on the integration of incoming and old data sources. A project realised by Nationalparks Austria members is currently dedicated to making Austria´s national parks´ biodiversity data available online. The results can potentially be matched with GBIF (Global Biodiversity Information Facility) databases or other projects. A first insight into the taxa presented here is given in GERECKE et al. (2012) and KREINER & MARINGER (2012). Peer reviewed papers and research reports commissioned by the Gesäuse national park can be found on www.parc.at or www.nationalpark.co.at/forschung.

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Assessment of forest wilderness in the Kalkalpen National Park

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Keywords

Forest wilderness, protected area, national park, Austria

Introduction

Europe has lost most of its untouched wilderness areas. Protected areas according to IUCN categories I and II can significantly help to preserve the last remnants of natural ecosystems or to enable a succession from managed to unmanaged nature. But is this task done effectively?

After 20 years of research and without silvicultural management in the Kalkalpen National Park the authors try the attempt of an assessment of the state of wilderness. As some research results are not available as quantitative data, a descriptive approach to the assessment of forest wilderness was chosen.

Evaluating the effectiveness of protected areas for the conservation and development of wilderness requires assessing the four qualities of wilderness: a) naturalness, b) undisturbedness, c) undevelopedness, and d) scale (EU Commission 2013).

Methods

The quality naturalness includes naturalness of vegetation, of the occurring species and of the natural processes (EU Commission 2013).

First one is described by forest hemeroby (methodology Grabherr et al. 1998), an inverse value. The ecosystem monitoring inventory data (300 x 300 metre grid, 1.900 recorded and 400 re-recorded plots) therefore was used. As zoological data are not considered in forest hemeroby, an analysis of the occurrence of indicator species for primeval forest ecosystems completes the picture of naturalness in the Kalkalpen National Park. The volume of dead wood and its developement are used to make dynamic processes, that cause a high diversity of forest structure, visible.

The degree of undisturbedness – the freedom from natural control or manipulation – can be measured e.g. by administrative, statutory or legislative agreements and stand age, that has a higher explanatory power than the protection time (20 years) and therefore indicates a degree of undisturbedness from a historical point of view. The development of forest hemeroby reflects an actual change of naturalness since the establishment of the national park. 383 re-recorded plots of the ecosystem monitoring were used to show this development.

Undevelopedness is described by length and density of roads. All fragmenting elements are recorded and categorised in road type and use, allowing detailed analysis.

Appropriate scale is an inevitable issue that arises within protected areas and is given by an effective functioning of natural processes (Dudley 2008). Aerial photo analysis seems most appropriate for the evaluation of the size of forest ecosystems.

Results

Naturalness

The analysis of the ecosystem monitoring data shows that more than ¾ of the sites are ranked as semi-natural or natural. While in Austria in general only 3 % of the forest areas show no visible human impact (ahemerob or natural), this class makes up for more than 25 % in the national park (Grabherr et al. 1998).

110 to 130 breeding pairs of the white-backed woodpecker live in the Kalkalpen National Park (Weißmair 2011). 21 of 115 relic beetle species of primeval forests (Müller et al. 2005) were recorded (Eckelt & Kahlen 2012, Eckelt 2014). Comparing dead wood volumes of the first and second data collection indicates an increase of dead wood by 60 % (Eckmüllner 2013).

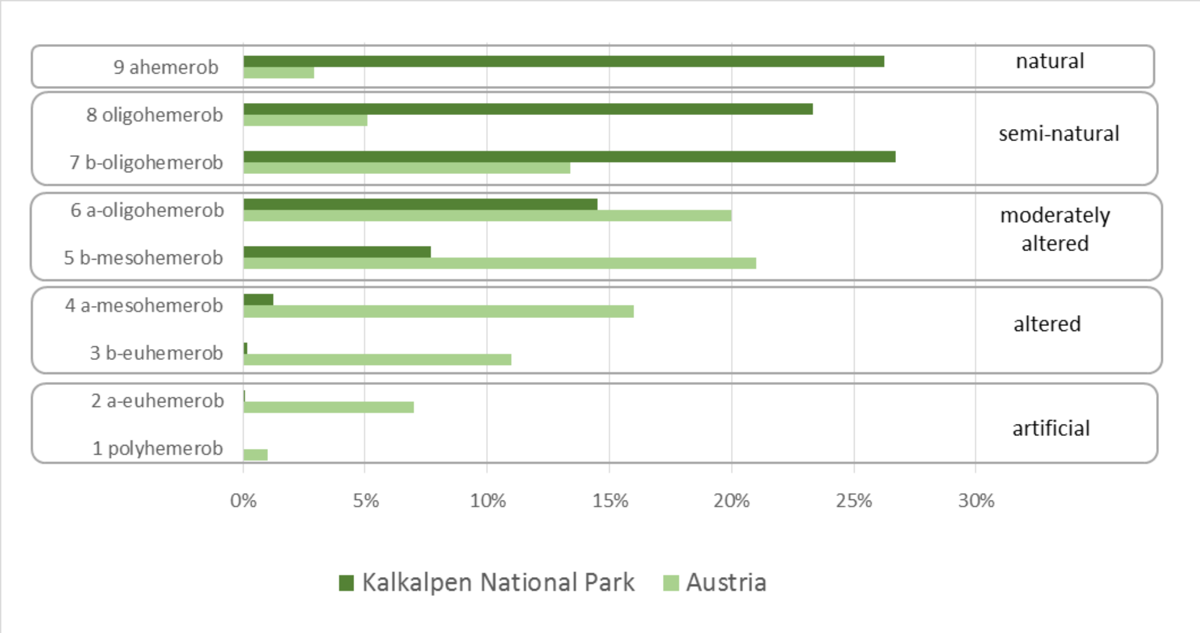

Figure 1: Comparison of forest hemeroby values in Austria (n=4892) (Grabherr et al. 1998) and Kalkalpen National Park (n=1595)

Undisturbedness

The national park consists of a 'core zone' (89 %) and a 'buffer zone' (11 %). The core zone only allows actions for implementing the management plan and for ensuring human security. The buffer zone also allows near-natural mountain pasture, sustainable forestry and maintenance of buildings and forest roads. Bark beetle management has to be done only in 25 % of the NP area due to an exception of the forest law.

Due to a high stock of game and its effects on forest regeneration, game stock regulation is mandatory, but only conducted in a designated area. 54 % of the national park area is currently called 'game-reserve-zone' without any game management.

An analysis of hemeroby development over the last 3 to 17 years (with a 10.8 years average time gap between the assessment of the first and second data collection) shows that naturalness is increasing within the national park (Tab. 1) and can therefore be interpreted as evidence for the absence of any actions disturbing the forest ecosystem – at least in forest wilderness zone.

Zone	First assessment	Second assessment	Development
Management zone (n=74)	6,45	6,50	0,05
Forest wilderness area (n=309)	7,19	7,43	0,23
National park total (n=383)	7,04	7,23	0,19

Table 1: Average hemeroby value of samples of the first and second assessment in the different management zones of the Kalkalpen National Park. 1= artificial – 9 = natural

51 % of the forests are older than 160 years. 16 % are between 121 and 160 years old; the remaining stands are between 81 and 120 years (12 %) and between 20 and 80 years (21 %) old. Forest age in combination with information about forest history shows the existence of forests that were used only once.

Undevelopedness

For assessing the developedness, all maintained public and forest roads in the national park and its surrounding have been taken into account. The average Euclidian distance of a site within the national park to the closest forest road is 598 m (Austrian average 55,6 m (ÖWI, results 1992-1996). About 22 % of the area is more than 1.000 m away from a road. As the use of roads is extremely restricted, impacts of fragmentation and disturbance stemming from forests roads are low.

Scale

Remote sensing data shows 81 % of forest coverage. Deciduous tree coverage makes up 41 % (about 8.500 ha) of the area and mainly consists of beech trees. In the face of the intensive silvicultural management, the proportion of spruce-dominated areas seems too high at 32 % and consists of primary and secondary spruce forests (about 6.600 ha). Larch (*L. deciduous*), pine (*P. sylvestris*) and fir (*A. alba*) trees (in this order) cover the remaining 1.700 ha of forest area. (PRÜLLER 2009). The forested areas are connected and are not separated by zones of high human interference such as farmland or settlements. This adds up to approximately 17.000 ha of forest ecosystems forming a mosaic of different development stages caused by age-driven tree deaths as well as by natural hazards.

Conclusion

When adding all the results of these different viewpoints of naturalness, undisturbedness, undevelopedness and scale, a picture of the high state of wilderness and its development can be drawn.

The method for assessing wilderness shows strengths and weaknesses. The assessment of the naturalness of dynamic processes in forest ecosystems requires a wider approach such as the checking of the coexistence of all natural forest development phases. The same applies to the assessing of scale. Diverse quality of data (quantitative, qualitative, age of data) deserves mentioning, too. The method's greatest strength is definitely the availability of quantitative data of the ecosystem monitoring as a basis for the hemeroby analysis which implicates the greatest significance in this article for assessing forest wilderness.

The methodological approach gives an assessment of the wilderness in a given protected area. By applying this to other areas, a benchmark system might be developed which helps to compare different results and to establish break values for various indicators.

Even though this benchmark data is not available yet, the results emphasise that the Kalkalpen National Park is an example of national parks (according to IUCN Category II) being eligible for conserving forest wilderness.

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Community livelihoods versus biodiversity conservation. Constraints to sustainability of the Santchou forest reserve in the Western highland region of Cameroon.

Protected areas' landscapes as resources for human health and wellbeing

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Abstract

Not only has the overall demand of land for agricultural production, urban expansion and other activities increased but also has the community need or demand for land for conservation as revealed by government policies. Certain predictions (McDonald & Boucher, 2011) foresee that global protected land might increase more in the next 20 years than they have in the last. These needs have as objective the conservation of biodiversity but to the local population, these areas have been their home for many generations on which they have based their livelihoods, culture and identity. It is thus not very surprising to note that biodiversity continues to decline (Aili et al, 2016) and reduces in the long run the capacity of these protected areas to maintain their roles and human wellbeing.

The intimate relationships that exist between the local population and protected areas have been explored as farmers and forest dwellers are the users of protected areas as well as lands connecting them. What has not been extensively addressed are other options to equitable reconcile sustainable livelihoods within and around protected areas. In protected area categories where agricultural activities are undertaken whether allowed by the law or not, there is need to consider productive activities which provide livelihoods in an equitable and environmentally friendly way. This is because the local population always tend to encroach on the resources of these areas taking into consideration the fact that resources around are scarce and the population tend to view protection areas as a way of depriving them of their land especially if participatory methods are not effective or were not put in place during the creation of these areas.

The objectives of our study are to analyze the forms of indigenous exploitations, the current mode of community management and its effects on biodiversity conservation. In addition to this, the contributions of exploitation of this protected area to community livelihoods will be discussed coupled with propositions on a sustainable model for its management.

Our research questions focused on the effects of an agro-industrial exploitation of protected areas by the local communities on biodiversity conservation on one hand and on the other, its influence on community livelihoods with the Santchou reserve as case study. Has this protected area achieved its conservation objectives and how has community participation or its absence contributed to the attainment of the objectives? Are the current conservation models sustainable or what are the flaws to sustainable conservation? We are thus advocating the proposal that though much effort has been invested in terms of conservation, there is little tangible evidence to support achievement of these projects.

Qualitative variables are mostly used for the research, obtained from simple observations through field exploration, photographs, an extensive literature review and finally through semi-structured interviews with the divisional officer, the park manager and guards and with some farmers. The interviews were transcribed verbatim and recurrent themes where identified. Our principal results are obtained from these themes using the thematic analysis approach.

Principal findings include widespread conflicts between the administration in general and the indigenous population or local communities. These tensions further undermine a sustainable exploitation leading to a rapid loss of biodiversity as poaching persist as a means of survival, reduce income sources for the community and insufficient respect of human rights in the protected area. Customary land rights are not overly respected and the bulk of the negative consequences are endured by the indigenous population.

Keywords

Livelihoods, Biodiversity conservation, Protected areas, Constraints, Community exploitation, Santchou, Cameroon.

Introduction

While awareness on the importance of biodiversity conservation and protection coupled with the negative effects of its destruction increases, socio-economic constraints are causing non-sustainable exploitation of such resources by indigenous communities. Reserves are vital tools for biodiversity conservation and management especially in areas threatened with extinction of species though their creation has done little to reduce the ever-increasing tide of degradation, which constitutes an eminent threat in the maintenance of global climatic equilibrium. Without an appropriate implication of these communities through participative management approaches, these protected areas are fast losing their ecological and cultural value with important externalities on livelihoods. Geographically, the Santchou Reserve is situated between latitude 5°10' and 5°15' North, longitude 9° 5' and 10° East and locally within 03 administrative regions of Cameroon i.e. the Western region with a very high population density, the Southwest and Littoral regions with low densities and made up of 09 indigenous villages. At the same time, a tropical montane savanna occupies the northern part of the reserve while the dense tropical rainforest occupies the southern part thus the reserve occupies 02 ecological zones. Geographically, this area is found in the Western highland region but owes its ethnic and cultural identity to the Mbo of the Sawa tribes. This reserve has successively been administered by the Ministry of agriculture, the General Delegation of tourism and today by the Ministry of environment, forest and wildlife protection. A diagnosis of the reserve presents symptoms of an acute advanced and multiform degradation where vast areas have been replaced with human settlements and an industrial type of agriculture and the once rich animal species inexistent or facing extinction. It becomes an imperative to preserve this unique forest through sustainable management approaches that integrates the needs of the indigenous population with the current conservation methods.

Brief history and delimitation of the Santchou reserve

It is by decree No 262 of 29 July 1947 during the French colonial rule that the Santchou reserve is created to favor natural reforestation, execute reforestation and protection works. It was originally a forest reserve and the decree of 29 September 1986 transformed it to an animal reserve due to the important variety and density of animal species especially the dwarf elephant. It covers an administrative surface area of 7000ha according to the Ministry of Forestry and Wildlife though about half is under human occupation. The main purpose of creating this reserve in 1947 was to protect/conserve the dwarf elephant and dwarf buffalo species which are now almost extinct because of human pressure and interferences, a variety of over 161 endemic bird species which are currently present in the Reserve and have suffered less threats from human presence. The Reserve is also home to a variety of monkeys and fauna amongst which are Gabon viper, python, wild boar, porcupines, and monitor lizards all currently under threat. The Santchou Reserve is said to be one amongst the two important bird and biodiversity reserves in Cameroon where the Guinea-Congo forests biome species *Phyllanthus Attripennis* prevails.

Results and discussion

The Santchou reserve today borders on abandonment and on the verge of a complete extinction of its prime biodiversity. Unless concerted conservation actions are undertaken to reduce this trend, future generations will only live a history of its former biodiversity glory due to infringement and exploitation by the population. The Reserve's manager and Divisional officer confirms an intimate relation between the population and the reserve as the formers essential livelihood is based on the exploitation of resources from the latter. While the fight for its conservation or sustainable exploitation is just and will be advantageous to the population in the short, and long-term, it will be a difficult task to accomplish because the idea of a Reserve is lost to the population. An interaction and a few interviews with the indigenous population clearly brings to light the fact the basic notions of the understanding of what the Reserve should be is lost to the people.

Degradation of the Santchou reserve: a diversified milieu with diversified causes and activities

Ignorance, insufficient knowledge and misinformation champion the cause for the rapid degradation of this natural reserve. The population mistook the creation of the Santchou Reserve and the conservation efforts of public authorities as a means to estrange them from their land, principal anchor of their livelihoods and cultural identity. In the local context, they imagined largescale evacuations or living in a fenced-in and enclosed space with wild animals thus exploitation of the reserve became a defensive action against such prospects. From the experience of the current Divisional officer who has tried to enforce conservation efforts, the hostility of the population could only be compared to the intense love they have for their ancestral land. The people's reaction could only be interpreted that neither did they have enough information on the importance and necessity nor had they been sensitized on the significance of the disappearance of the Reserve on the local and international scale. It is regrettable today that the vast variety and exquisite fauna especially the dwarf elephant that made up the pride of the population can no more be seen during important traditional feasts and might never be sighted again simply because they have migrated out of the area.

Large food and cash crop plantations now occupy vast portions of the Reserve and according to the population, their existence have accelerated this last decade due to the sedentarisation of strangers from the Western, North and South West Regions. These lands where sold by the indigenous population to these strangers according to certain sources. With the aid of bush fires especially in the montane savanna area, large areas have also been cleared for the establishment of plantations.

During the creation of this Reserve, several villages were already inside the delimited zone but they have increased in size due to demographic explosion and installation of migrants from neighboring zones especially the Western region where there is high pressure on land. Demand for firewood and other wood products from local craftsmen/artisans and for construction have accelerated destruction of the forest cover. In the words of certain individuals, chainsaws can be heard sawing away almost daily for timber exploitation and expansion of existing plantations.

Exploitation of medicinal plants and poaching has equally contributed to degradation of the reserve from increased demand from neighboring villages and towns. Increasing demand is also attributed to the galloping demography, accused on the introduction of polygamy by foreigners. Many wives equals many children and as a direct consequence many mouths to feed and the main community granary being the forest, there is bound to be an accelerated exploitation. The disappearance of elephants in the Reserve is also attributed to the embrace of the Western culture by the youths, they have refused to be initiated into the tradition of their ancestors i.e. the keeping of 'totems'. Wild animals regularly invade and lay waste to large plantations thus their extermination to preserve farmers crops. Since most plantations are owned by foreigners, they are accused of killing these animals to preserve their farms while the allogenes accuse the natives of using their totems to destroy their crops.

Generalized poverty and the presence of many jobless youths could explain the reasons for the activities responsible for the rapid degradation of the Reserve. While agriculture is gradually intensifying especially for the production of cocoa, coffee and oil palms, market outlets are still insufficient to assure sustainable livelihoods. The absence of agricultural processing industries also limit potential sources of income thus the economy is based on primary activities and the Reserve constitute the major resource base. It is thus evident that the population has to be sensitized on the importance of conservation or an eventual sustainable exploitation strategy. The development of other profitable activities might curb the high degradation rates of the park while the technical capacity of current management institutions have be reinforced to be able to efficiently manage the Santchou Reserve.

Conclusively, fight against the current degradation and an eventual restauration of the reserve will principally include the following actions: promote a sensitization of the local population on the value and potential of the reserve. Reduce poverty and the precarious livelihoods of the people in the area, promote participative management and forest regeneration. The development of alternative activities i.e. non-agricultural, promote sustainable agricultural practices and reinforce the capacity of institutions managing the reserve.

Concessions and willingness of the population towards a positive change

The negative effects of the degradation of the Santchou animal reserve are evident and immediate action required an effective mitigation to be achieved. From the administrative agents, it is understood that the population live in abject poverty with insufficient access to health services, malnutrition, limited cultivable space and low incomes. While they are willing to change because they are becoming aware of the inconveniences of degradation, other profitable activities have to be developed for the population to exploit. Many elites have mobilized and have sensitized the population against the sale of land to foreigners especially the indigenes of Balé. This group of settlers are accused of the rapid degradation especially the killing of animals to safeguard their plantations, they are also accused to be responsible for the high demographic growth rates which have further increased demand and consequently degradation of Reserve land. Limiting the settlement of foreigners might also reduce the popularization of the Western culture which has reduced the population of youths to be introduced to the tradition of totems. The practice of sustainable agricultural practices would be welcome as it requires less space and profitable but producers have to be taught on the practice of these production techniques. The youths are also eager to participate in the traditional activities of their ancestors and be able to see the famous animals they have heard so many stories about but their economic situation obliges them to exploit the vast resources of the forest for their survival. Most importantly, the population is willing to participate with the current administrative agents managing the forest for an effective conservation. Their proposed actions include the reforestation of certain portions of the forest and the liberation of certain migratory corridors of settlements to permit animal species to return to their natural habitat. While certain areas have been colonized without hopes of recovery, certain traditional rulers and the youths have proposed a redefinition of the Reserves' cartography.

Before these concessions, any action to reconcile the present gaps should integrate certain principal objectives by identifying signs and manifestations of biodiversity degradation with its corresponding causes. It should also determine the immediate, mid and long-term consequences of the reduction in fauna and floristic species on the communities while identifying insufficiencies in the current conservation system and management of the reserve. Identify the opinion, preoccupation and complaints of the population as regards the reserve and identify the natural and cultural potentials of the reserve with a view to a sustainable and profitable exploitation. Sensitize public authorities, national and international stakeholders about the advanced state of affairs. Lastly, propose best adaptation strategies to better the conservation conditions while considering the needs of the indigenes and their living conditions.

Conclusion

Protected Areas in Cameroon are suffering from a continuous invasion by the local population. While the conservation of biodiversity becomes a preoccupying issue as demands increases, a consideration still needs to be done at the level of integrating the indigenes. The delimitation of protected areas in Cameroon as a whole and Santchou in particular has deprived the local population of their resources and if the indigenous people are denied their basic livelihoods through administrative creations that hinder them from depending on their natural resources, there is an unsolved problem which only gets bigger as the years go by". Solving such a problem is making sustainable exploitation and development the lamp light of protected areas. While future prospects visualize the removal of the population that has settled along certain migratory corridors of the reserve, it will be difficult to displace indigenes because they occupied the area even before the creation of the Reserve. This study therefore recommends a proper Wildlife and Protected area law enforcement and monitoring, concerted actions in protection and conservation (integrating the local population) to avert forest cover loss and also the reintroduction of the extinct pioneer wildlife species such as the dwarf elephants and dwarf buffaloes to their natural habitat for future generations.

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Study on the introgression of hybrid poplar genes in the gene pool of black poplar in the Danube National Park

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Abstract

The black poplar (*Populus nigra*) is one of the characteristic species of the riparian forests. Plantation of hybrid poplars associated with the risk of hybrid poplar gene introgression into the gene pool of black poplar and the loss of habitat endanger the distribution of the black poplar.

The aim of this study is to analyze the genetic composition of the black poplar population located in the Danube National Park and to determine if hybrid poplar gene introgression in the black poplar gene pool takes place. The findings of this study are the basis for *in-situ* and *ex-situ* conservation of black poplars. In the course of this study, the genetic material of 317 offspring, 104 adult black poplars and 4 reference samples are investigated, paternity analysis is made and distribution-tendencies are illustrated.

The results show that introgression takes place and about 5-10 % of the offspring contain hybrid poplar genes.

Keywords

Black Poplar, Introgression, Danube National Park

Introduction

In 1998 / 1999, 1.532 sampling points were established throughout the area of the Danube National Park (Raster 400 m x 100 m). An angle count sampling accomplished in the Danube National Park during the winter months 2008 / 2009 determined 548 adult black poplars on 171 sampling points (ÖBF 2009; ECKMÜLLNER et al. 2008). On 24 of these 171 sampling points with black poplars, 101 hybrid poplars occurred (ÖBF 2009).

The research questions of this study are:

1. How many populations of black poplar can be determined in the Danube National Park?
2. Does introgression take place and if so, to what extent?
3. Is it possible to detect adult hybrid poplars as parents (parenthood analysis)?
4. Are there any distribution patterns?
5. What is the effect of a combination of different analysis methods with regard to the results?

Methods

Leaves of 105 adult poplars (dbh > 10 cm) and 318 offspring (dbh < 10 cm) were collected on 8 sample sites (Fig. 1) throughout the area of the Danube National Park. The adult poplars were located within a radius of about 100 m to the respective offspring. Adult hybrid poplars which could act as parent were also collected within this radius.

All individuals were marked and tagged with GPS. The DNA was extracted from the leaves with the Invisorb®Spin Plant Mini Kit.

439 samples (including reference samples) were analyzed by microsatellite markers to determine, if there is any influence of hybrid poplar genes.

Thus, 16 gene loci were examined: WIN3, wpms14, wpms17, wpms20, wpms09, wpms15, PMGC14, ORNL214, wpms16, PTR8, ORPM344, GCPM1894, ORPM29, ASP112322, GCPM1719 and PTR4.

The WIN3 analysis was done by agarose gel electrophoresis. For all further analysis methods, the fragment length of each gene loci was detected with the CEQ™ 8000 Genetic Analysis System (© Beckman Coulter).

All detected fragment lengths (exclusive the WIN3 gene locus) were noted in Excel. The values were compared to a reference list of fragment lengths provided by the Austrian Research Centre for Forests and compared to the fragment lengths of the reference samples. An individual was – mathematically – influenced by hybrid poplar genes when the occurred fragment lengths of one locus differed in both alleles (if existing) and one rare value occurred or when the fragment lengths of two gene loci were completely different from the reference list / reference samples.

The program R 3.3.2 (© The R Foundation) / RStudio 1.0.44 (© 2016 RStudio) Package PoppR 2.3.0 was used to put the individuals in various groups if more than 6 different fragment lengths on the analyzed gene loci / alleles between the compared individuals occurred. Individuals with 6 or less different fragment lengths were put together in one group.

Parenthood analysis was made with Cervus 3.0.7 (© Tristan Marshall 1998 – 2014 Field Genetic Ltd).

GenAlEx 6.502 – Genetic Analysis in Excel (Peakall & Smouse 2006, 2012) was used to calculate the genetic distance of the samples, conduct a principal coordinate analysis and analyze the molecular variance within and between individuals.

The calculation of the possible amount of origin populations was effectuated by Structure 2.3.4. (PRITCHARD et al. 2000; FALUSH et al. 2003, 2007; HUBISZ et al. 2009). The data provided by Structure 2.3.4 were analyzed with Structure Harvester (DENT & VONHOLDT 2012) and Clumpak (KOPELMAN et al. 2015).

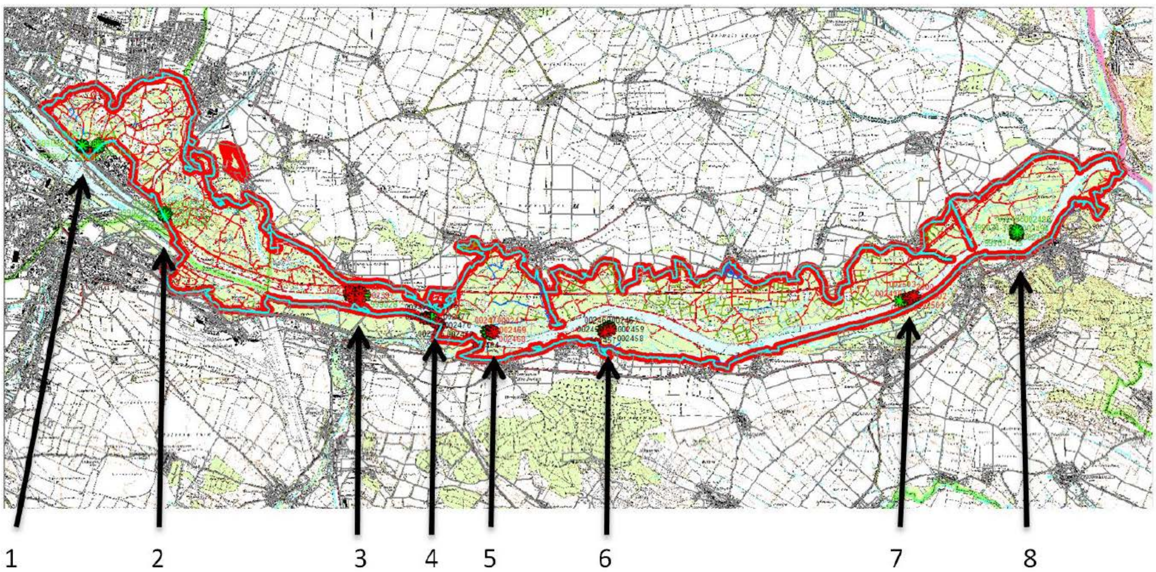

Figure 1: Location of the sampling sites. Red line = Border of the Danube National Park.

Results

1. Nowadays there is one single population of black poplar located in the Danube National Park. Gene flow takes place between the individuals throughout the whole area of the Danube National Park. Analysis show that this – nowadays single – population is composed of three origin populations.
2. 51 of the analyzed Individuals are influenced by hybrid poplar genes. From these 51 Individuals, 31 juveniles show an interference of hybrid poplar genes. Introgression takes place and about 9.8 % of the offspring is influenced by hybrid poplar genes.
3. 15 out of 22 sampled adult hybrid poplars were defined as parent-tree. 6.3 % of offspring could be assigned to a specific adult hybrid poplar.
4. 27.9 % of the offspring are located at the same sampling point as the designated parent-tree. 58.2 % of the investigated individuals show a difference of two sampling points between offspring / parent-tree.
5. Different methods of analysis showed a variable amount of individuals which were influenced by hybrid poplar genes. 29 of the individuals were found to be influenced in more than one analysis. 21 individuals were found to be influenced only by a single analysis method, independent of the method. Every analysis method shows - in some cases - different individuals which were determined as influenced by hybrid poplar genes.

Discussion

An allocation of one sample to a determined cluster in R does not mean that this sample is influenced by hybrid poplar genes. If samples are put in the same cluster it can be concluded that there is some kind of (family) relationship between the samples.

The combination of the WIN3 analysis and the allocation to a cluster in R give first clues if samples are influenced by hybrid poplar genes and if there is some kind of (family) relationship between these samples.

The results of the PCoA showed some kind of allocation of the samples in 3 different clusters with transition areas. It was not possible to detect a specific pattern within these clusters. It was not possible to find any correlation between age group and allocation to one cluster either. The molecular variance of 2 % between the sampling sites confirmed the suggestion that there is just one single population of black poplar which stands in genetic exchange throughout the whole area of the Danube National Park.

A mixture of genes between black and hybrid poplar across many generations could be excluded because of the analysis in Structure. The majority of analysed black poplar samples is not influenced by hybrid poplar genes.

Conclusion

The ascertained introgression accords to the results / presumptions of further studies (cf. HEINZE 2008). BENETKA et al. 1999 identified an introgression of about 9 % by spontaneous pollination in open nature.

It seems that the rate of introgression stabilizes by an amount from 7 – 10 %. To preserve the existing population of black poplar in the Danube National Park, it is necessary to renaturate the riparian forests and protect existing habitats. Specific removal of hybrid poplars is not necessary.

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‘What is a national park for?’ – Principles of worth in a Swiss national park project

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Abstract

This contribution analyses an environmental dispute and its underlying moral issues in a direct-democratic and bottom-up setting to understand principles of worth in national park negotiations. I follow the question ‘what is a national park for?’ and point to the complex nature of conservation negotiations. I argue that loosely defined ideas of park rationales and therefore different ideas of the common good can lead to additional difficulties for a bottom-up project.

Keywords

National parks; Principles of worth; Negotiations; Switzerland

Introduction

This contribution explores the moral issues underlying the negotiation and establishment of protected areas and follows the guiding question ‘what is a national park for?’. In order to answer this question, I analyse justification regimes people resort to in situations of conflict. The empirical case study I focus on involves the planned establishment of a national park in Switzerland, Parc Adula, which was based on a direct-democratic process and was abandoned after the negative outcome of a decisive popular vote in late 2016. The national park project was one of the first in accord with the Swiss federal ordinance on parks of national importance (ParkO), which came into effect in 2007 and defines the establishment of a national park as a bottom-up process. Parc Adula was intended to become a national park of this ‘new generation’. The term ‘new generation’ already suggests that there are or have been different understandings and definitions of national parks. For instance, the main ideas fostering the establishment of the Swiss National Park in 1914 were pure conservation and scientific research. In contrast, the concept of the new generation of parks aims for sustainable development in its economic, social, and ecological senses (KUPPER 2016; PICHLER-KOBAN & JUNGMEIER 2015). I therefore analyse how people affected by the Parc Adula case justified their opinions in order to understand perceived objectives of a national park and underlying principles of worth, which are guiding such ideas.

Case Study and Methods

Parc Adula, a national park candidate in Switzerland, was planned to be established between 2001 and 2016. The proposed park covered 1230 km2 spanning the border between the cantons of Grisons and Ticino, in the Alpine area of south-eastern Switzerland. Approximately 14,000 people live in the 17 municipalities in the park area. On 27 November 2016, a slight majority of the eligible voters living in the area voted ‘no’ on the park’s establishment in a referendum on municipality level.

Data was collected during several field visits to the Parc Adula region in summer 2015 and in summer and autumn 2016, before the popular vote. Seventeen semi-structured interviews and eleven unstructured interviews were conducted. In addition, open conversations and extensive participatory observation were used to gain further understanding of ongoing debates in these valleys. All data was analysed using MAYRING’S (2007) qualitative content analysis.

What is a national park for?

According to the IUCN, national parks are ‘large natural or near natural areas set aside to protect large-scale ecological processes, along with the complement of species and ecosystems characteristic of the area, which also provide a foundation for environmentally and culturally compatible spiritual, scientific, educational, recreational and visitor opportunities’ (IUCN 2017). This definition comprises different goals of protected areas, not only focusing on ecology, but also on social aspects. In the Parc Adula case, many different park rationales were negotiated. Some of these are elaborated in this section.

...for regional development?

Protected areas in the Alpine regions of central Europe are often regarded as opportunities for regional development. Topics such as the possible positive influence of eco-tourism or labels on the economic development of rural areas form the main body of current central European literature on protected areas (see MAYER et al. 2010; SIEGRIST & STREMLOW 2009; WEBER 2013). Economic surplus and regional development are also the main forces driving the politics of Swiss parks (BAFU 2010). In the Parc Adula case, the park proponents relied strongly on economic arguments about regional development, relating to recent discourses addressing economic hardship in alpine valleys (see MÜLLER-JENTSCH 2017). However, economic arguments were also used by opponents, who were afraid that the park could hinder business opportunities.

...for nature conservation?

Nature conservation was regarded as a positive side effect of a national park used chiefly as a regional development tool, but justifications based on environmental ideas were never presented on their own, as can be seen in the following quote from an interview:

'*Often, the argumentation is 'you have to protect now in order to conserve the environment'...when you say that, no one wants to cooperate. But, if we say, we make a park, with which you can earn money, then the park and the money we earn will help to establish the protection*'.

To some extent, this was used as a strategy by proponents to address more salient challenges in the valleys than protecting nature and thus to reach a wider audience. Indeed, THÉVENOT et al. (2000: 242) argue that the emphasis on economics is a keen strategic move to 'appeal to the sensitivity of politicians to economic arguments'.

...for conservation of cultural heritage?

The park project esteemed the preservation of local traditions and heritage and placed these at heart of Parc Adula's aims. For example, the project co-funded various restoration projects, such as the renovation and repair of dry walls on Alpine pastures. Many local residents stressed the importance of heritage and traditions in every-day life. Some respondents saw the park as an opportunity to maintain alpine culture and simultaneously spark new ideas. Others feared the park as something that could freeze the status quo and turn the villages into a museum-like setting.

...for solidarity or renown?

Some interviewees considered the park project as a great opportunity for regional development in other valleys in the region that struggle more that one's own. Furthermore, they described the park as an interesting opportunity to cooperate with other villages.

Considering the political process, the non-establishment of the park was very disappointing for policy makers, since it would have been the first national park in accord with the ParkO:

'*...it would be a failure when...10 years after the establishment of the law we won't be anywhere. Different political circles would ask, well, why don't we achieve this in Switzerland*'.

Conclusion

Rationales of national parks are very diverse and complex. Parc Adula's promoters relied on promises of neoliberal conservation as a way to sustain rural communities by ensuring additional income opportunities and long-term economic security (see IGOE & BROCKINGTON 2007). But, many other rationales of protected areas were also discussed within the negotiations, leading to multi-layered discourses surrounding Parc Adula. This 'discursive blur' (see BÜSCHER & DRESSLER 2007) seemed hard to translate into reality for many local residents and formed a very challenging basis for voters' decision-making. Diverse pro-park arguments rather resulted in an obstructive setting for the establishment of Parc Adula. The questions arise whether a national park brings together too many principles of worth, and thus whether nature conservation measures and regional development should be approached separately and by their respective principles to avoid the plethora of values that leads to a discursive blur and an ambiguous answer to the question 'what is a national park for?'.

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Zoning in spatial planning for protected areas and tourism destinations in mountain regions - case of the Kopaonik National Park in Serbia

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Abstract

All mountain tourism destinations (MTD) in Serbia are located with at least one of their part in the protected natural heritage areas (MTD-PA). The trend in the world and in European countries is an integrated natural heritage protection zoning and land-use zoning for the protected areas (PA) and their surroundings. The integrated MTD-PA zoning in Serbia is achieved through the spatial planning process – the spatial plans for special purpose areas (SPSPA). The innovations for improving the role of zoning in spatial planning are analysed at the example of the SPSPA for the Kopaonik National Park (SPSPA Kopoaonik). The innovative methodological approach is based on the combined use of integrated and collaborative approaches in the process of developing the SPSPA Kopaonik. The main task was to harmonize the conflicting sectoral decisions on nature protection zoning for the protected area and land-use zoning for tourism development. The compromise solution was selected, which enabled an adequate natural heritage protection and sustainable use of limited resources for the development of all-year-round tourism, as well as the sustainable development of local communities in immediate and wider surroundings of MTD-PA.

Keywords

Protected area, tourism destination, mountain region, nature protection zoning, land-use zoning, spatial planning

Introduction

The mountain regions of Serbia cover about 34% of its territory. By their specific potentials for the mountain tourism development, the high-mountain regions (above 1500 m a.s.l., covering an area of 5,389 km^2) with their immediate hilly-mountainous surroundings (1000-1500 m a.s.l.) covere the total area of 9,680km^2 of the state territory (Milijić et al. 2013). All high-mountain regions and a part of their immediate hilly-mountainous surroundings are located in the protected areas.

Staring from results of the previous research projects published in the Institute of Architecture and Urban & Spatial Planning of Serbia, this paper identifies the key problems in realizing the role of nature protection zoning in spatial planning and the coordinating role of spatial planning in the strategic planning and management of sustainable development of MTD-PAs in Serbia. Starting from the key problems, the possible answers are offered at the example of spatial planning for the Kopaonik National Park, which is the key tourism area in the Kopaonik MTD, where the innovations in the spatial planning for the MTD-PAs in Serbia are implemented relative to the previous practice.

Zoning in spatial and strategic planning of protected areas and tourism destinations in Serbian mountain regions

The nature protection zoning is used for the parts of the MTD in the PA in accordance with the legal bases, declaration of protected areas and management plans for the PAs. The three-stage protection regime established in Serbia by the Law on Nature Protection (2009) and the Regulation on the Protection Regimes (2012) can be compared with the IUCN categorization:

- level I protection regime (strict protection) corresponds to category Ia;
- level II protection regime (active protection) corresponds to category Ib;
- level III protection regime (proactive protection) corresponds to categories V and VI (Ristić 2016).

The trend in the world and European countries is an integrated nature protection zoning and land-use zoning for PAs and their surroundings (Naughton-Treves et al. 2005). The integrated zoning facilitates the meeting of often conflicting demands for strengthening the protection of natural heritage, cultural heritage and natural resources, on the one hand, and for developing the tourism and other activities and improving the quality of life of local residents, on the other hand (Ibid.; Maksin et al., 2014). In Serbia, the integrated zoning is made through the process of spatial planning, namely through the spatial plans for special purpose areas (SPSPA) which are elaborated for PAs and MTD-PAs.

Methodological innovations for zoning in spatial planning of protected areas and tourism destinations in Serbian mountain regions - case of Kopaonik National Park

The innovations for nature protection zoning and land-use zoning in spatial planning are analysed at the example of the Spatial Plan for Special Purpose Area for the Kopaonik National Park, adopted at the end of 2016 (SPSPA Kopaonik 2016).

The innovative methodological approach is based on the combined use of integrated and collaborative approaches in the process of developing the SPSPA Kopaonik 2016.

The problems in the previous environmental and natural heritage and natural resources protection, as well as in the achieved development of tourism, other economic activities and infrastructure systems and in the quality of life of local residents, were identified in the first step in the process of developing the SPSPA for MTD-PA.

In the next methodological step, and based on the analysed problems, it was possible to identify the key conflicts in the protection and in sustainable development of MTD-PA and its local and regional surroundings. Several conflicts were identified, out of which the key ones included the conflicts between the tourism and the natural heritage protection. Further mountain tourism development within the National Park depends to a great extent on the overcoming of current conflicts regarding the protection of nature and natural heritage in the most suitable terrains for Alpine skiing under the level II protection regime and within the tourism complexes/resorts under the level III protection regime with intense and unplanned construction.

A set of thematic maps with all spatially identified mismatches in relation to the planning solutions from the previous SPSPA Kopaonik (2009) and in relation to the approximately determined new boundaries of the National Park and zones under the three-level protection regime from the new Law on National Parks (2015), were produced using the GIS tools (Fig. 1a).

Based on the identified conflicts, the principles and strategic commitments for their relativization were established. They served in the next methodological step for checking the sustainability and harmonizing the conflicting sectoral decisions on nature protection zoning (from the Law on National Parks and the Decree on the Protection Regimes) and on land-use zoning for tourism development (from the Master Plan for the Kopaonik tourism destination and from the urban plans for the tourist sub-resorts in the National Park and tourism settlements located at its boundaries).

Starting form good practices of European countries, particularly good practices of the MTD-PA in the Alpine countries, several scenarios for the differentiation between the nature protection zones and the land-use zones with terrains suitable for Alpine skiing and for tourist resort development were offered– with a radical shift away from the previous practice in zoning for the PAs in Serbia (dividing the area of the National Park into several most valuable entities with the three-level protection regimes and separating the land-use zones for the development of tourism centres and ski resorts outside its coverage) and with more or less compromise options for the protection and sustainable development of MTD-PA.

For achieving the coordination and relativization of conflicts, it was necessary to use the collaborative approach in a way to also include, besides the protected area managers, the key stakeholders in the environmental and natural heritage protection, tourism and spatial planning at national and at local levels of management into the process of considering the offered scenarios and decision making on the selection of the most suitable scenario. This enabled to negotiate with stakeholders on certain solutions, until the final solution was agreed and selected.

A compromise solution was selected for harmonizing the land-use zones of tourism and recreational infrastructure with stricter regimes for the nature protection (I and II level protection regimes) (Fig. 1b). Based on this solution, minor corrections of the coverage of the zones with level I protection regime and with level II of the protection regime were made, the number of ski runs was reduced and the capacity of ski runs was increased, the position of ski infrastructure was corrected, as well as connecting the parts of the ski resorts into a single entity was enabled. The sustainable spatial development of tourism was supported by several options (concerning the accommodation and other contents) for redirecting the focus of tourism offer development from the tourism resorts in the National Park to the tourism settlements in its immediate surroundings.

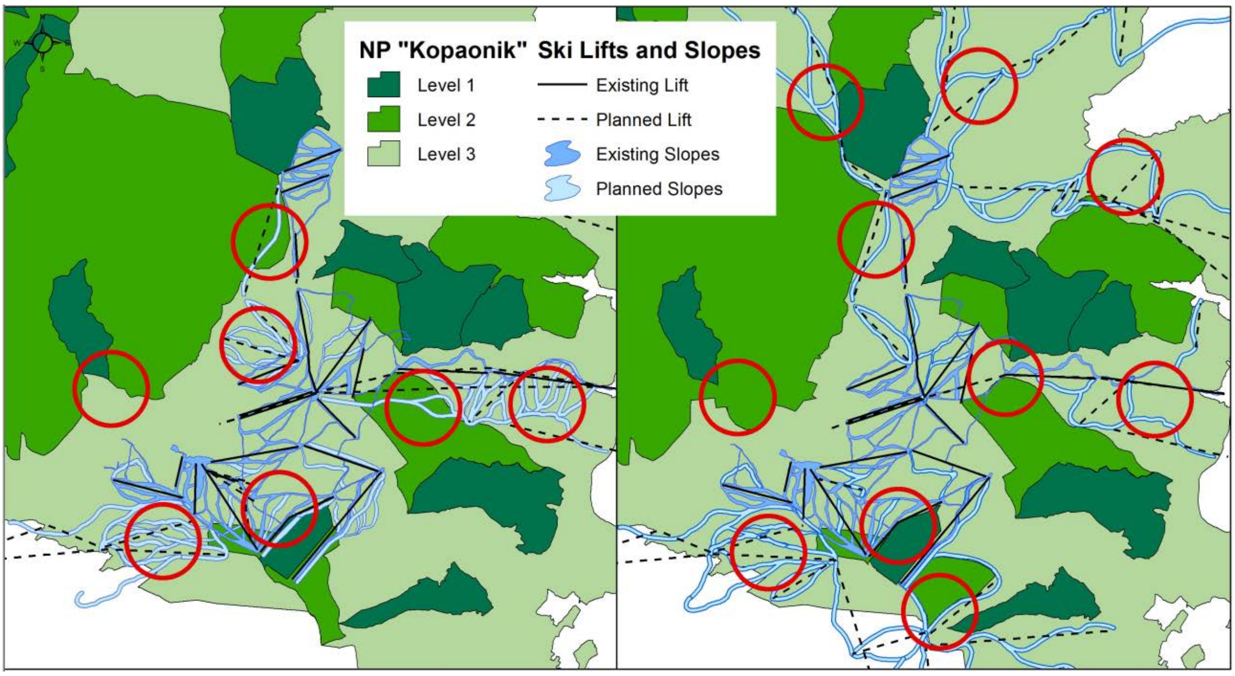

Figure 1a & 1b: Identified mismatches between nature protection zoning and ski infrastructure (1a, left picture) and agreed compromise solution (1b, right picture)

Concluding Remarks

The effects of the innovated methodological approach are that the changes enabled an integrated planning and management of the protection and sustainable spatial development of MTD-PA through:

- the coordination and integration of nature protection zoning and land-use zoning ;
- the collaboration of key stakeholders and participation of local residents and entrepreneurs in selecting planning options, and decision making.

Assessing the effectiveness of integrated zoning (nature protection zoning and land-use zoning) in protection and sustainable development of the MTD-PA should be based on the monitoring the implementation of the spatial planning instruments for MTD-PA.

It is necessary to achieve the coordination among different sectoral plans and programs through the spatial planning process, primarily the coordination among the nature protection and tourism development sectors; multisectoral coordination and collaboration among all competent development entities in the public and private sectors; participation of local residents and entrepreneurs in the planning process; as well as to establish partnerships among the key stakeholders in the decision making and implementation of the adopted decisions.

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Potential for applying Intergenerational Practice to involve underrepresented age groups in protected area management

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Abstract

Many protected areas´ management objectives, in addition to conservation, include preserving cultural practices, education and supporting socioeconomic development of surrounding communities. Stakeholder participation is highly important in this respect, but certain groups remain underrepresented, such as older and younger generations. The contribution presents barriers and motivations for participation among youth and elderly women in activities of Lungau & Nockberge Biosphere Reserve in Austria. The authors suggest Intergenerational Practice as a potential solution for involving these underrepresented groups - an important aspect of reconciling protected area management with local sustainable development.

Keywords

intergenerational practice, participation, biosphere reserve, youth, elderly women

Introduction

Protected areas (PAs), in addition to preserving biological diversity, can play an important role in sustainable development on the local and regional level (CBD 2008). In order to implement this role, many PAs´ management objectives, in addition to conservation, include preserving cultural practices, education and supporting socioeconomic development of the surrounding communities (GETZNER et al. 2010). Participation of the local residents in PA activities is considered important for successful management (eg. BERKES 2009), and constitutes a key aspect of sustainable development, equity and justice (ZELDIN et al. 2005; BUFFEL et al. 2014). However, some population groups remain underrepresented, such as older and the younger people (BUFFEL et al. 2014).

MITROFANENKO et al. (2015) proposed that involvement of these groups in PA management could be supported via Intergenerational Practice (IP) - an approach which facilitates cooperation among people of different generations via purposeful, mutually beneficial activities, which can also result in wider benefits for participants' communities (BUFFEL et al 2014). Potentials for using IP are further explored in this contribution using the case of Salzburger Lungau & Kärntner Nockberge Biosphere Reserve (Lungau & Nockberge). Youth and elderly women were least represented during the participatory process leading to the reserve's designation (KÖSTL & JUNGMEIER 2012; HUBER et al. 2013). The following research questions are addressed:

– What are the barriers and motivations among the youth and elderly women for taking part in biosphere reserve activities and in intergenerational activities?
– How could IP help overcome barriers to the participation of these groups?

Methods

Mixed methods were used to collect data, including: literature analysis, semi-structured interviews, focus groups, and World Café. Purposive sampling and key-informant interviews were used to receive background information and references to interviewees. In total 25 elderly women (60+) and 40 youth (20 and younger) have been interviewed. In addition, 2 reserve managers, 2 process facilitators and 5 middle-aged women (40-50) were asked about their perception of the age groups in question. All accounts were recorded and transcribed. The data was analyzed via qualitative content analysis.

Results

The results, presented in tables below, reveal barriers and motivations to participation of youth and elderly women in the activities related to the Lungau & Nockberge (Tab. 1), and to their participation in intergenerational learning activities (Tab. 2).

Table 1. Barriers and motivations to participation in the Lungau & Nockberge Biosphere Reserve - related activities by the local youth and elderly women	
Barriers	**Motivations:**
• *For the elderly women:* o Lack of economic benefits and frustration o Old age, lack of self confidence and reservation o Traditional behavior patterns and gender roles	• *For the elderly women:* o Interest in the theme of an event o Receiving a personal invitation
• *For youth:* o Missing respect for the youth and insufficient addressing of youth	• *For youth:* o Possibility of receiving food or monetary compensation for involvement o Spending time in a convenient and relaxed atmosphere
• *For both groups:* o Lack of information and awareness, unappealing information materials o Perceived power inequalities, lack of agreement and trust o Disinterest o Lack of time o Logistical Inconvenience	• *For both groups:* o Equity in participation, providing a contribution o Learning and education o Benefits for community: Potential for economic benefits and promotion of local products o Health o Social aspects and entertainment

Table 1: Barriers and motivations to participation in the Lungau & Nockberge Biosphere Reserve - related activities by the local youth and elderly women

Table 2. Barriers and motivations to participation in intergenerational activities by youth and elderly women living in the Lungau & Nockberge Biosphere Reserve region	
Barriers:	**Motivations:**
• For the elderly women: o Differences in interests and worldviews o Criticism of the youth' way of life and strong dependence on technology o Reservation and shyness o Lack of access to the young generation, including lack of meeting places	• For the elderly women: o Maintaining contact with the youth, appreciation of their worldview o Receiving help and also providing help if needed o Reducing isolation
• For youth: o Perceived lack of appreciation for knowledge and skills of the youth o Lack of communication by the elderly o Lack of interest among some youth	• For youth: o Trust and appreciation towards the elderly o Learning about the local cultural and natural heritage o Changing the attitude of the elderly towards the youth and mutual respect
• For both groups: o Perceived lack of interest and understanding from the other group o Perceived prejudice and generation gap	• For both groups: o Spending time together and learning from each other

Table 2: Barriers and motivations to participation in intergenerational activities by youth and elderly women living in the Lungau & Nockberge Biosphere Reserve region

Most of the identified barriers to participation in biosphere reserve activities could be addressed via intergenerational practice – related examples from IP literature are presented in Tab 3.

Table 3. Proposed solutions from IP literature to identified barriers to participation of youth and elderly women in biosphere reserve-related activities	
Barriers	**Examples from IP literature**
Perceived lack of benefits	• IP could support processes leading to local economic development – such as sustainable tourism development based on the traditional knowledge (of the elderly generations) and networking and technical skills (which could be provided by the youth) (Mitrofanenko et al 2015). • IP has been used to help stakeholder groups to set priorities, take reflective actions, and evaluate their efforts – useful in sustainable development process (EAGLE 2008).
Power hierarchy and conflicts, missing respect	• IP can enhance participation and communication among stakeholders, as well as support community cohesion, trust, cooperation and mutual respect among age groups in the community (Zeldin et al. 2005; Vegeris and Campbell-Barr 2007; Newman and Hatton-Yeo 2008; Springate et al. 2008; Mitrofanenko et al. 2015). • Successful IP activities should be planned well and participants selected carefully (Zeldin et al. 2005; Cohen-Mansfield and Jensen 2015); during the activities open discussion and expression of opinions should be encouraged (Springate et al. 2008).
Disinterest	• IP can lead to enhanced rates of volunteering and active citizenship in community development (Vegeris and Campbell-Barr 2007; Newman and Hatton-Yeo 2008). • IP can facilitate pro-social life values (EAGLE 2008, Buffel et al. 2014), and has been used to increase interest and engagement in conservation and biodiversity protection Mitrofanenko et al. 2015).
Lack of time	• IP could be integrated into school activities (to address the lack of time among the youth), which could render academic, social, and emotional benefits to both youth and elderly (Cohen-Mansfield and Jensen 2015).
Old age, lack of self-confidence	• IP can increase self-esteem and self-confidence for both elderly and youth (Vegeris and Campbell-Barr 2007; EAGLE 2008; Newman and Hatton-Yeo 2008; Buffel et al. 2014). • IP can facilitate increasing individual capacity and energy, improved health and well being extended social networks and inclusion for the elderly (Vegeris and Campbell-Barr 2007, Reisig and Fees 2006).

Table 3: Proposed solutions from IP literature to identified barriers to participation of youth and elderly women in biosphere reserve-related activities

Discussion

The revealed barriers in participation of the underrepresented groups in Lungau & Nockberge activities are consistent with previous studies conducted in the reserve (KÖSTL & JUNGMEIER 2012, HUBER & ARNBERGER 2015) as well as other studies addressing participation in PA management elsewhere (RAVINDRA 2004; REED 2008; HUBER 2011). The identified barriers and motivations for participation in intergenerational activities are also consistent with literature (eg. ZELDIN et al. 2005; SPRINGATE et al. 2008, REISIG & FIES 2007; BUFFETL et al. 2014).
Mutual interest and motivations to engage in IP expressed by both elderly and young interviewees imply that IP activities organized by the biosphere reserve could facilitate participation of these groups in the reserve management. Since motivations and barriers are consistent with other studies, IP could be also suitable for involving these underrepresented groups in other PAs.

Conclusion

The findings suggest that IP could facilitate participation of underrepresented age groups in PA management, which will contribute to reconciling PAs with local sustainable development. IP organized by the management could provide suitable occasions for increasing awareness about the biosphere reserve, facilitate development initiatives and constitute an added value of the reserve for the region.

Based on the study results, general recommendations have been elaborated for biosphere reserve managers, which might also be applicable to other PAs:

- Managers should facilitate IP activities in cooperation with schools and other local associations. These activities can inform the youth and elderly about the PA. However, most of all they can help to mobilise hitherto untapped opportunities (e.g., synergies between traditional knowledge/skills, creativity and digital skills of the youth) for sustainable PA development .
- Specific needs and interests of the youth and elderly should be considered in designing PA communication strategies. Local youth and elderly could be involved in preparing PA-related information, as well as in co-organizing PA participatory activities
- Barriers for participation of the underrepresented groups should be considered when organizing PA activities and events

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Aspects of carrying capacities and recreation management: The case of Triglav National Park, Slovenia

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Abstract

Overall, protected areas, and predominantly national parks, are facing increasing visitation. The national parks are recognized as 'brands' for an authentic nature experience and also as 'playgrounds' for numerous recreational activities. In recent years the development of recreational activities has been rapid and accelerated by the tourism, marketing and equipment industries. Management institutions in protected areas need to survey the activities that are practiced within their respective boundaries as well as understand the potential impacts. Future protected area management needs to be in accordance with nature protection goals. The paper presents various aspects of carrying capacities in the Triglav National Park (TNP), Slovenia that are related to visitation and recreational activities.

Key words

recreation, carrying capacities, protected areas, Triglav National Park, Slovenia.

Introduction

Visitation within protected areas in Slovenia has been continuously increasing, and visitors are also practicing diverse recreational activities depending on the natural conditions of the areas. Increased visitation and changing demands of visitors represent specific challenges to management institutions which aim to conserve the natural and cultural heritage and also enable good experiences for park visitors. From a management perspective systematic visitation monitoring is important in order to recognize the so called 'hot spots' as well as emerging and potential future management conflicts in these protected spaces. Surveying the status and changes in the natural environment in relation to visitation helps to identify informed and practical measures in visitation management (i.e. with information infrastructure). One of the most demanding tasks of protected areas management institutions is the estimation of various carrying capacities based on data (i.e. visitation surveys, biodiversity monitoring) and expert assessments (MRAK 2014). Triglav National Park (TNP) is the only national park (IUCN categories II and V) in Slovenia, located in the predominantly mountainous northwest part of the country (Fig. 1). TNP is 83 982 ha and includes 33 permanent settlements with 2420 inhabitants (MANAGEMENT PLAN. 2016). Visitation of the park has never been systematically surveyed and only estimations of visitor numbers were made within partial studies (i.e., ŠOLAR 2009, CIGALE et al. 2010). Due to observed and documented visitation pressures, in 2016 the TNP management in collaboration with its own expert team and external experts launched a study focused on park visitation .The main research goals were to establish a systematic survey of park visitors to be used as a basis for visitor management and for TNP infrastructure planning; to identify and define measures for nature conservation and the protection of cultural heritage; and to begin a process of monitoring various aspects of carrying capacities (environmental, social, economic and physical).

Methodology

The first research phase consisted of identifying all of the official sources of data related to park visitation that are available. The focus was to prepare a baseline dataset that will be used to guide systematic visitation monitoring in the future. The data from previous partial studies were considered in this first phase as well.

The data on visitation were gathered using survey questionnaires that addressed visitors' motives, planned activities, length of stay, frequently visited areas, and so forth. The aim was to get information on why people come to the park, what they do there, where they go and for how long. Part of the survey focused on sustainable mobility in the park and the last set of questions was related to visitor concerns regarding current and future environmental changes. All together 1718 questionnaires were filled either in the park area or over the survey webpage. The majority of respondents were visitors (86 %) followed by park inhabitants (11 %) and second home owners (3 %). In the first phase descriptive statistics were used to identify the basic trends. We calculated frequencies and descriptive statistics as measures of centrality and dispersion. In the second phase some advanced statistical methods were applied. A clustering method was used to divide respondents into groups (i.e., clusters) based on their characteristics.

Results and discussion

TNP and its vicinity (the Man and Biosphere Reserve of the Julian Alps) had 30 474 beds in 2014 (24, 7 % of the total number of beds in Slovenia). In the same area in 2014 there were 1 880 047 overnight stays (19,6 % of all the 2014 overnight stays in Slovenia). The data show how significant the wider area of TNP is within the tourism sector of the entire country. The analysis of survey data shows that the prevailing recreational activities, and therefore motives, to visit the park are as follows: mountaineering; experiencing natural and cultural heritage sites; swimming; and biking. Ascent of Mount Triglav (2864 m), the highest peak of Slovenia and national and cultural symbol is also among the top six reasons for visits within the park. Ascents are most frequent in the summer months. Significantly, the seasonal pressures increase the hazardousness of mountaineering routes and diminish the general experience of the mountain summit. The data from the Mountain Rescue Service of Slovenia show the highest numbers of accidents in the area of Triglav. One of the possible interventions in the future could be daily mountaineering quotas and the establishment of a reservation system for the ascents. The most visited areas in the park (Fig. 2) are facing severe pressures from visits and intense motorized traffic predominantly in summer months. The majority of visitors reported that they stay in the park one day and the most important value of the park is its nature and the opportunity to enjoy in peace and silence. The most visited areas are related to high motorized traffic density which represents environmental hazard (e.g. air pollution). Traffic pressures are also disturbing local inhabitants, especially in the area of Bohinj Lake. The survey showed that visitors are willing to use sustainable mobility options (i.e. walking, biking, and public transportation), although i.e. Soča Valley and Vršič pass remain perceived as the areas most efficiently visited by car. Identifying measures to solve the traffic situation in the park during summer months is one of the biggest challenges for park management. Any efforts in this area need to be defined in cooperation with local communities; in addition pressures to access TNP from other areas in Slovenia will have to be solved with support at the national level. Future visitation management will need to be well considered in terms of existing infrastructure carrying capacities (i.e. parking lots, number of beds, etc.) and an effective information system will enable oversight of the park visitation.

Figure 1: Location of Triglav National Park

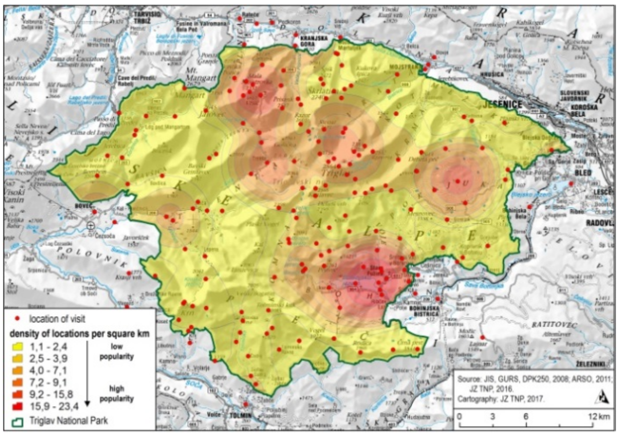

Figure 2: Most visited areas in Triglav National Park

Environmental carrying capacity is not yet defined, although the most valuable areas within the park are known. The park management goal is to keep certain areas as 'peace zones' where visitation is not encouraged. However, environmental quality should be monitored in relation to visitation throughout the park. Where degradation by visitor pressure is observed, measures will need to be taken such limiting the number of visitors or banning access to certain areas in conjunction with educational and informational activities (i.e. guided tours, events for various target groups, etc.) in order to raise awareness about the importance of conservation. Social carrying capacity related to recreation in the park will need further investigation in the future. Yet, some indications can be reached through an in-depth analysis of the survey results in the next phase and considered in park measures related to visitation. Nevertheless, the quality of life of the local population should not be threatened by the rising numbers of visitors and the diversity of outdoor recreational activities. On the other hand, tourism and recreation in the park represent an important economic opportunity also for the park inhabitants.

Conclusions and future challenges

The main TNP management challenges are to assure positive park experiences for local inhabitants and visitors and to achieve conservation goals. Within the research on visitation in the TNP that was started in 2016, the initial data that are crucial for the preparation of the visitation monitoring action plan were gathered and analyzed. In the next steps the research is and will be focused on visitation-related environmental, social and economic impacts. One of the important missing data is the total annual number of visitors which shall be gained through setting up a network of counters. Special attention shall be given to the most visited areas in order to follow a sustainable tourism development path. Finally, the research and management challenges underscore the environmental changes underway and their impact on visitation and recreational activities.

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Population density and habitat preferences in a Tawny Owl *Strix aluco* population in floodplain forests in Eastern Austria

Christina Nagl & Christian H. Schulze

Abstract

Owls are among the most secretive birds on Earth. Hence, few data about these species are available, especially from the highly dynamic and often inaccessible floodplain forest ecosystems. In this study we assessed population density and habitat preferences of Tawny Owls *Strix aluco* in lowland floodplain forests along Danube and Morava River in Eastern Austria. Owls were surveyed using playbacks. To avoid double counting we recorded their calls, which allow individual recognition of the majority of birds. Following 50 river kilometres and covering an area of more than 10,600 ha altogether, we recorded and identified 60 individual male Tawny Owls. The high territory densities (5.0–7.8 territories/10 km^2) indicate a high habitat quality of floodplain forests for this species. While our habitat models showed no significant difference of the occurrence probability of Tawny Owls between hardwood and softwood floodplain forests and no avoidance of Eagle Owl *Bubo bubo* territories, old trees (>80 years), a certain amount of openland and high amounts of standing deadwood did positively affect its occurrence. Our study provides evidence that the floodplain ecosystems with patches of old forest stands characterized by a high density of dead trees represent high quality habitats for Tawny Owls.

Keywords

Vocal individuality, Donau-Auen National Park, WWF-Nature Reserve Marchauen, standing deadwood, age of forest stands, Eagle Owl *Bubo bubo*

Introduction

Due to their nocturnal activity and secretive lifestyle, many owl species are difficult to monitor (Terry et al. 2005). For some species, such as the Tawny Owl, their vocalizations turned out to be an effective and high-valued investigation-tool, as structural features of their calls can be used to identify individual birds (Appleby & Redpath 1997a, Galeotti 1998). Hence, in this study vocal individuality of Tawny Owls was used as tool to assess its population density in the Danube-Morava-floodplain forests in Eastern Austria, which represent one of the last remaining large floodplain forest ecosystems in Central Europe. For this unique ecosystem conservation measures are essential. Changes in the hydrologic balance, intense forest management measures, forest damage, immigration of neophytes and excessive game stocks threaten the balance and existence of floodplain ecosystems and its species richness (Lazowski 1999). Additionally, their protection is an important step to maintain near-natural forests and their associated high biodiversity.

Despite its low ecological specialization, the Tawny Owl is a good indicator for habitat quality (Hirons 1985) and classified as flagship species for hardwood floodplain forests (Flade 1994). Beside assessing the species' population densities in large floodplain forests along Danube and Morava River, this study aimed to evaluate the importance of landscape and forest structure on the species' habitat use. As deadwood volume and the presence of ancient trees simultaneously increase the availability of prey and breeding sites for owls (Scherzinger 1996), we expect that forest age and the amount of standing deadwood both are positively related to the occurrence of Tawny Owl. Furthermore, habitat choice and population densities of Tawny Owls may be negatively affected by the Eurasian Eagle Owl *Bubo bubo*, which is recorded frequently as predator (Sergio et al. 2007).

Methods

Study site

Tawny Owls were surveyed in 10,602 ha lowland floodplain forest along the Danube and Morava River in northeastern Austria. The main part belongs to the Donau-Auen National Park (DANP, 9,338 ha). Most of the remaining area (1,129 ha) is located in the WWF-Nature Reserve March-Auen (Fig. 1). The study area ranges from Vienna to the Slovakian border, following approximately 36 river kilometres along Danube River and 14 km along Morava River.

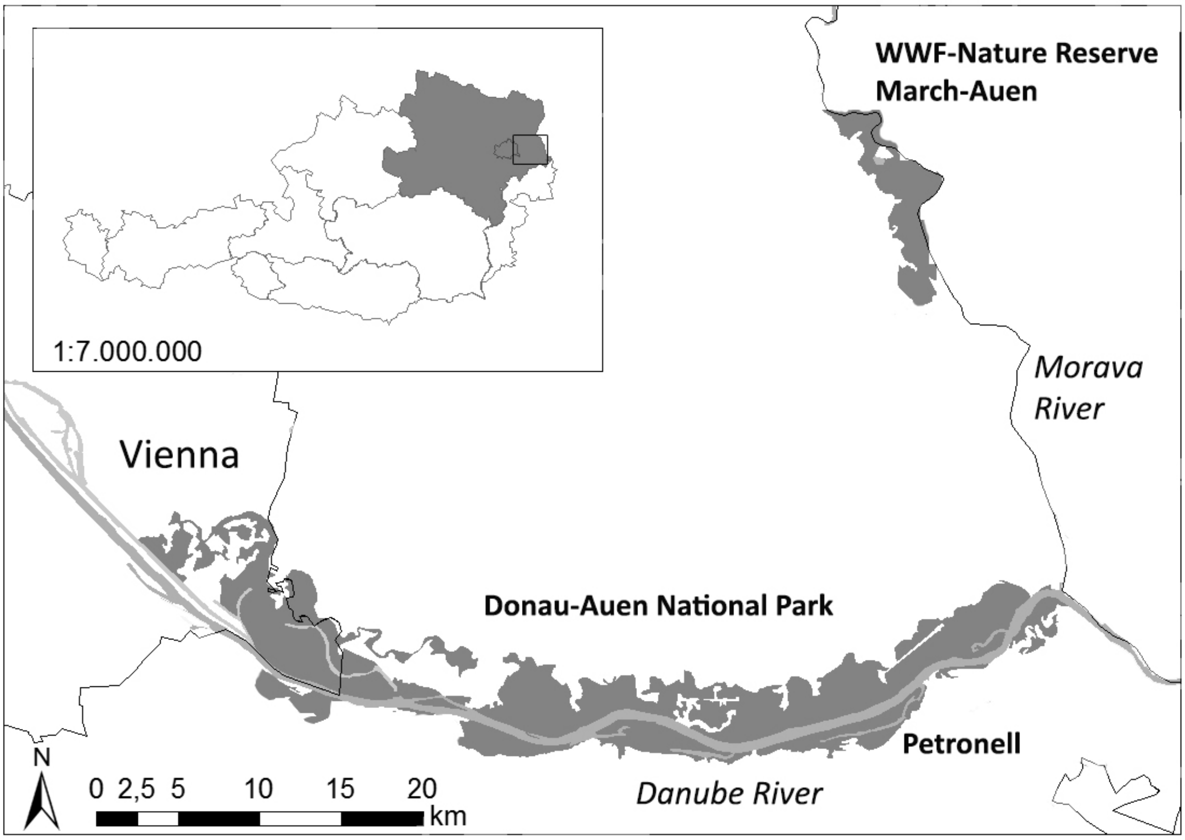

Figure 1: Study areas along Danube and Morava River marked in dark grey. Source: Esri.

Tawny Owl survey

Surveys were conducted during spring mating season between 1 March and 18 June 2012. Owl territories were located using a playback method (ZUBEROGOITIA & CAMPOS 1998) combined with a point-count methodology (JEDICKE 2009). In total 203 census points (with a minimum distance of 0.5 km between each other) were distributed over the study area and were visited once (census time: 30 min, REDPATH 1994). Hootings of territorial individuals were stimulated by using a playback of an unfamiliar male bird. Calls of males were recorded in good weather conditions with a Fostex Field Memory Recorder connected to a Telinga Pro 7 parabolic microphone.

Bioacoustical analysis

Sonograms of owls' hoot calls were plotted to take eight temporal and three frequency measures, which were subsequently used to identify individual owls.

Habitat variables and statistical analyses

To identify parameters affecting the Tawny Owl's territory choice, habitat type (openland, softwood and hardwood floodplain forest cover within 200 m radius), forest age, standing and lying deadwood classes and the occurrence of Eagle Owls were considered. A model selection approach (e.g. BURNHAM & ANDERSON 2002) was used to evaluate the importance of individual variables on the occurrence of Tawny Owls.

Results

Population density

Based on the sonagram analyses (Fig. 2), a total of 60 Tawny Owl territories were estimated for the entire study area, corresponding to a territory density of 0.57 territories/100 ha. Highest territory densities were found in the WWF Reserve Marchauen (0.78 territories/100 ha) and at Petronell (0.70 territories/100 ha). A slightly lower density of 0.50 territories/100 ha was recorded for the Lobau (western part of DANP).

Habitat choice

Our model selection approach indicated particularly strong effects of forest age and the amount of standing deadwood on the occurrence of Tawny Owls. The variables Eagle Owl territories, percentage hardwood forest and lying deadwood did not occur as explanatory variables in the group of best models, indicating that they had only a minor or no effect on the probability of Tawny Owl occurrence. The probability of Tawny Owl occurrence increased with forest stand age (> 80 years) (Fig. 3A), and increasing amount of standing deadwood (Fig. 3B).

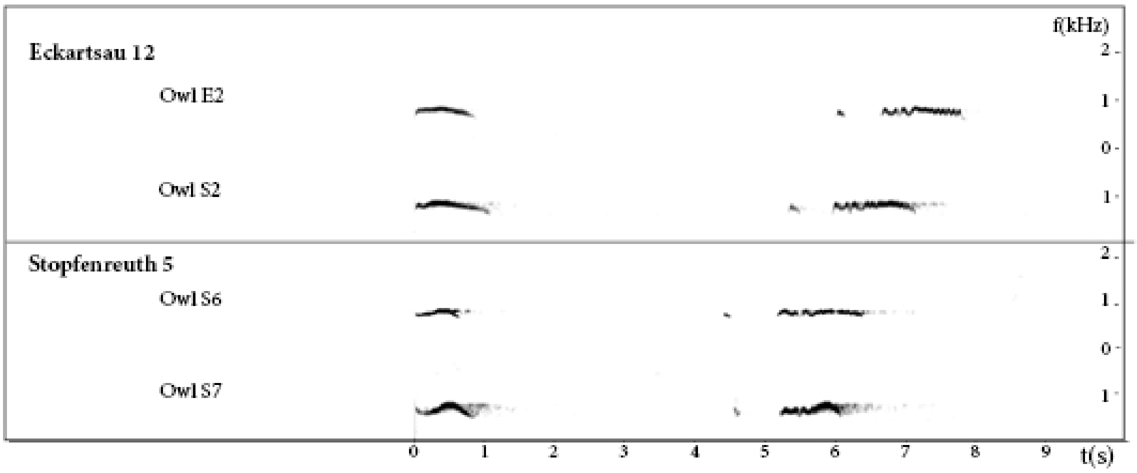

Figure 2: Sonagrams visualizing the calls of different Tawny Owl individuals on the same census points.

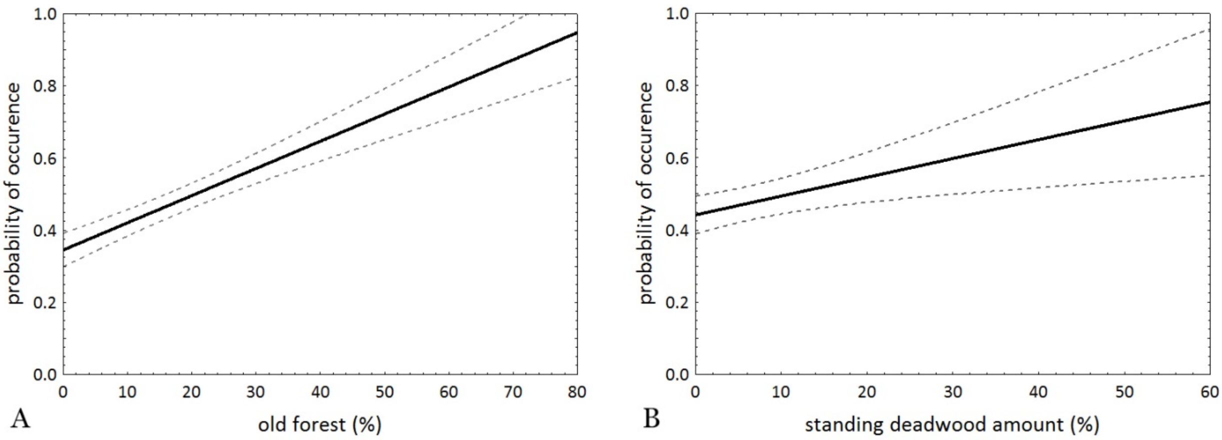

Figure 3: Relationships between predicted Tawny Owl occurrence and **(A)** old forest stand (>80 years) and **(B)** standing deadwood. Probabilities of occurrence were calculated for the best model. Dashed lines represent 95 % confidence intervals.

Discussion

Population density

The high population densities reported by this study indicate that floodplain forests along Danube and Morava River in Eastern Austria appear to be of great importance as breeding and hunting habitats for Tawny Owls. To assess the population density, vocal individuality proved to be a reliable tool (this study, APPLEBY & REDPATH 1997a, GALEOTTI 1998).

Habitat choice

Although Tawny Owl territories appeared to be more or less evenly distributed across our study areas, the presence of forest stands older than 80 years and a high deadwood amount increased the likelihood of territory occurrence. Forests of the Donau-Auen National Park are mainly between 20 and 60 years old (>74 %), only about 14 % of the trees are older than 80 years (POSCH et al. 1999). Mature oaks, for example, are twofold beneficial: they are cavernous (CARLSON et al. 1998) and during mast crop years they support prey productivity (JĘDRZEJEWSKI et al. 1994). Furthermore, old trees as well as standing deadwood represent valuable nesting sites for secondary cavity nesters (HAGAN & GROVE 1999), such as Tawny Owls.

Conclusion

Riparian lowland forests represent a unique ecosystem. The high population densities of Tawny Owls recorded in this study suggest, that the floodplain forests along Danube and Morava River represent high quality habitats for this owl species due to valuable amounts of old trees and a high standing deadwood volume. This generalist owl species shows preferences for near-natural forests, interspersed with patches of openland. The implemented reduction of forest management measures in DANP and the WWF-Nature Reserve Marchauen will have long-term effects on cavity richness, deadwood amount, tree age and prey availability. Hence, these conservation aims most likely will further optimize Tawny Owl habitats.

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Honest thanks go to the team of the Donau-Auen National Park GmbH for providing invaluable support. For providing detailed forest data of the DANP, we are grateful to the team of the Vienna Municipal Department 49 'Forestry Office and Urban Agriculture' and the Austrian Federal Forests ÖBf AG. Many thanks for the support to the team of the WWF-Nature Reserve Marchauen and C. Abensperg-Traun for granting permission to survey owls in Petronell-Carnuntum.

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Impact of inundation regime and meadow management on wild bee communities and bee-flower networks in the Donau-Auen National Park

Ulrich Neumüller, Bärbel Pachinger, Konrad Fiedler

Abstract

Wild bee communities on flood-prone meadows were compared with those on rarely inundated sites in the National Park Donau-Auen. Flower-visiting bees were sampled on 32 meadows between April and August 2016. Counter to expectation, flooding regime had no significant impact on observed individual numbers. Rather, bee species richness was higher on regularly flooded meadows. As a potential driver of this pattern, an increased beta diversity among annually flooded meadows was identified. Additionally, three network metrics derived from a bipartite plant-bee interaction matrix were analyzed. None of the network indices was affected by flooding regime. We conclude that extreme floods may have a devastating effect on wild bee populations, but communities quickly recover. This resilience surely depends on recolonization from the surrounding landscape. Hence it is important to consider biodiversity on a landscape scale beyond the limits of the nature reserve.

Keywords

Wild bees, community recovery, species richness, floodplain, bipartite networks

Introduction

Intensity of meadow management is well known to alter species composition and structure of grassland vegetation and its inhabiting fauna (STEFFAN-DEWENTER & LESCHKE 2003). Close to running waters severe pulse disturbance can also be caused by flooding episodes (GERISCH et al. 2012). Population declines caused by floods have been described for wild bees (FELLENDORF et al. 2004) and other insect groups (GERISCH et al. 2012). Nevertheless, strong resilience to flooding was reported for ground beetles by GERISCH et al. (2012), and TRUXA AND FIEDLER (2012) even found a richer moth fauna in annually inundated floodplain forests than in neighboring non-flooded forest habitats.

While responses of bee assemblages to environmental gradients have been documented in some cases (FELLENDORF et al. 2004), less is known about the biotic networks and associated dependencies that result from interactions between flowers and bees.

The aim of this study was to analyze how flooding and mowing regime shape local bee communities and bee-flower networks on meadows interspersed in floodplain forest.

Methods

Thirty-two meadows were sampled four times each, between April and August 2016. Sixteen of the meadows were situated on the flood-prone and another 16 on the flood-protected side of a levee which stretches through the reserve. Sampling units lasted 30 minutes on 30 x 60 m plots in a central position on the meadow. Plant species on which bees had been collected were recorded and assigned to their observed flower visitors.
Interaction webs of individual meadows were characterized by three network metrics using the package “bipartite” (DORMANN et al. 2016), viz.:

1. H2′: A network-level measure of specialization (DORMANN et al. 2009);
2. Vulnerability: Weighted mean number of bee visitor taxa per plant species (TIEDEKEN et al. 2015); and
3. Niche overlap: Mean similarity in interaction pattern between bee species (DORMANN et al. 2009).

To quantify bee species richness, randomized species accumulation curves were calculated for samples aggregated within either flooding regime using the package ‘iNEXT’ (CHAO & HSIEH 2016). To test for relationships between site descriptors and response variables (bee activity density, bee species richness, network metrics), Generalized Linear Mixed Models were calculated using the package ‘lme4’ (BATES et al. 2016).
To determine if the position of meadows relative to the dam affected wild bee differentiation diversity, a permutation-based multivariate analogue of Levene’s test for homogeneity of variances was performed (OKSANEN et al. 2017).

Results

In total, 92 wild bee species interacting with flowers of 62 plant species were recorded. A significantly higher activity density ($z=-8.901$, $p<0.001$; $mR^2=0.563$; $cR^2=0.563$) and species richness ($z=-6.575$, $p<0.001$; $mR^2=0.501$; $cR^2=0.519$) was found on meadows which had not been mown since the preceding survey (Fig. 1). Flood regime had no significant impact on species numbers or activity density per site and survey (Fig. 1). Species accumulation curves indicate an even higher species richness aggregated over all meadows south of the dam (Fig. 2). Additionally, bee differentiation diversity was significantly higher on regularly flooded meadows ($F_{1;30}=7.556$, $p=0.011$). None of the tested network metrics was significantly affected by flood or mowing regime.

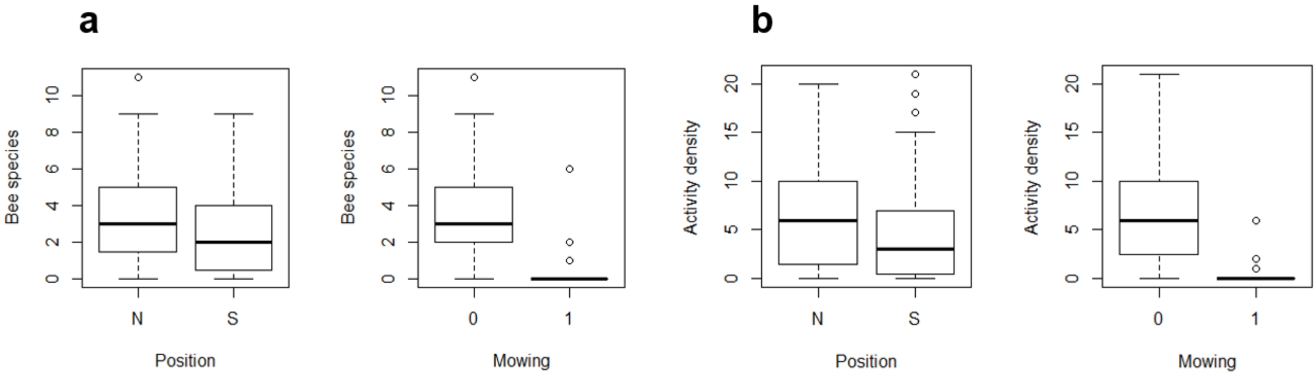

Figure 1: Number of observed bee species (a) and activity density (b) relative to the position of the levee and mowing status. Box-and-whisker-plot, range = 1.5 * IQR. N = North of the dam, S = South of the dam, 0 = not mown since last survey, 1 = mown since last survey.

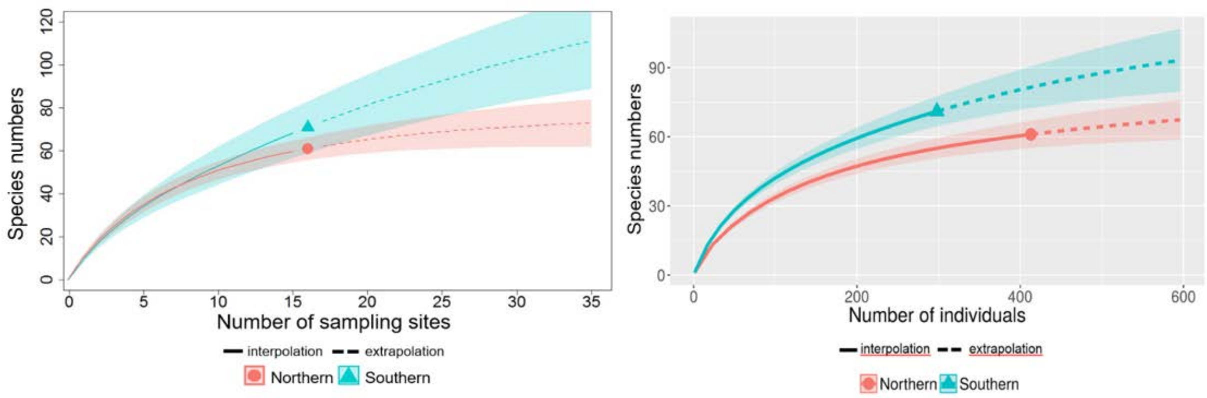

Figure 2: Sample site based (left) and individual based (right) randomized species accumulation curves of wild bee species numbers north and south of the levee. The shaded areas represent 95% confidence intervals.

Discussion

TRUXA AND FIEDLER (2012) investigated forest moth communities in relation to flood regime in eastern Austria. They also found a slightly richer moth fauna in flooded forest stretches of the National Park Donau-Auen. Similarly, bee species richness was higher in the flood-prone part of the national park if aggregated across sites. Increased species turnover that we observed between meadows south of the levee represents a likely explanation for this pattern, as turnover between local patches is closely linked to species richness on a wider scale (WHITTAKER 1972).

GERISCH et al. (2012) found that species richness and abundance of ground beetles decreased strongly after a flood but pre-flood values were restored only two years later. Diversity patterns of wild bees relative to the levee suggest that these insects are likewise quite resilient and communities were able to recover since the last extreme flood event that had hit our study sites in 2013, just three years earlier. Also the lack of differences in the network metrics related to the flood regime indicate that local bee communities in the National Park Donau-Auen are well able to cope with regular inundation events.

As expected, mowing had a disastrous effect in the short run. However, the characteristic meadow vegetation and its associated insect communities of semi-natural grassland habitats on the long run depend on continuation of extensive mowing or grazing (STEFFAN-DEWENTER & LESCHKE 2003).

Conclusion

The meadows in the near annually flooded part of the national park house unexpectedly species-rich and resilient bee communities. These would vanish from the reserve if meadow management were totally abandoned. The non-flooded parts of the reserve likely act as an important source for recolonization processes after extreme floods that largely wipe out bee populations on a local scale. Hence, it is extraordinarily important for this conservation area to consider biodiversity not only locally, but on a wider landscape scale. Since mowing almost completely eliminates food sources of bees at a short term, it is advisable to maintain the custom of unsynchronized mowing of the meadows as conservation management practice.

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Climatological reference data of a newly established long-term monitoring program in the central Alps

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Keywords

alpine climatology, snow cover duration, microclimate, soil temperature, topography

Summary

Above the alpine treeline, life conditions are controlled by topography and type of plant cover (CERNUSCA 1976, TAPPEINER & CERNUSCA 1996, KÖRNER 2003). Weather stations are thus, unable to capture the actual life conditions of plants, animals and microbes in high elevation, treeless terrain. The seasonal mean temperature in alpine surface soils (where most alpine plants have their shoot meristems and where both animal and microbe activity is highest) has been shown to vary across short horizontal geographical distances by more than air temperature does across 2000 m of altitude (SCHERRER & KÖRNER 2009). The topography driven mosaic of habitat temperatures offers alpine organisms short distance habitat alternatives in times of rapid climatic change. This is why alpine regions have always been organismic refugia during periods of climate change. Such short distance contrasts in life conditions also provide opportunities to study the biological effect of steep thermal gradients (and their co-variables such as snow depth and snow duration as well as soil moisture and evaporative forcing). A long-term monitoring program has been launched in the central Alps that capitalizes on such 'experiments by nature' across sharp snow melt gradients (see contribution by KÖRNER, this volume).

Here we present the first climatological data for this large-scale, comparative undertaking. These basic data permit comparing sites and positions within sites, and they allow positioning the test areas in a wider European context (KÖRNER et al. 2003). Single channel, automatic temperature loggers have been deployed across four different test regions (three in the Hohe Tauern National Park in Kärnten, Tirol and Salzburg, one region in the Swiss central Alps). Installed 3-4 cm below soil surface in typical alpine vegetation, ca. 200-300 m above the natural climatic treeline, the data collected by these devices currently cover 12 month (August 2016 - August 2017), and permit characterizing the test sites. At each site, transects (3-6 per site) had been established on the flanks of so-called snow-beds that cover both the most least favourable ('pessimal') as well as the most favourable ('optimal') locations over distances of less than 10 m.

The data for 20 transects now permit a ranking of all transects with respect to snow duration, winter and summer extremes, season length and seasonal temperature regimes. For sites that had no climate station at close distance, we also measured air temperature at 1.8 m height as a reference and as a means to link our observations to the weather service network. These data also permit to quantify the contrast between atmospheric conditions and the actual thermal life conditions along our transects.

We show that soil temperatures in winter differ greatly across otherwise similar ecological settings, with some sites experiencing soil frost down to -15°C, while others experience a constant 0°C situation under a thick, insulating snow cover. The date of snow-melt at the 'pessimal' edge of our transects is, on average, 5 to 30 days later than at the optimal edge, with the growing season defined by a weekly mean temperature of 5°C, varying in length from 86 to 143 days across the 20 transects, if we assemble the records for 2016 and 2017 into one 12 month series (Fig. 1).
After snow melt the soil temperatures are very similar at all points of the transects (Fig. 2). We arrive at a seasonal mean temperature for the lower and upper end of our transects between 8.9°C and 12.3°C (Tab. 1).

Overall these data illustrate the thermal matrix into which this long term monitoring program is embedded. Given the regional differences among the transects temperature conditions, we can rank the transects by certain temperature criteria, which offers an additional dimension for testing hypothesis and explaining biodiversity and ecosystem processes in a climate change context. The coming years will add a year to year time component to these data.

	Untersulzbach	Innergschlöss	Seebachtal	Furka
yearly mean air temp. [°C]	1.4°C	1.6°C		
season mean soil temp 'optimal' [°C]	11.8°C (138)	11.7°C (123)	10.5°C (143)	12.3°C (135)
season mean soil temp 'pessimal' [°C]	11.5°C (127)	8.9°C (86)	9.6°C (111)	11.7°C (88)

Table 1: Yearly air temperature and season mean soil temperature on the "optimal" and the "pessimal" point of the transects and number of days (xx) where the weekly mean of the soil temperatures was above 5°C.

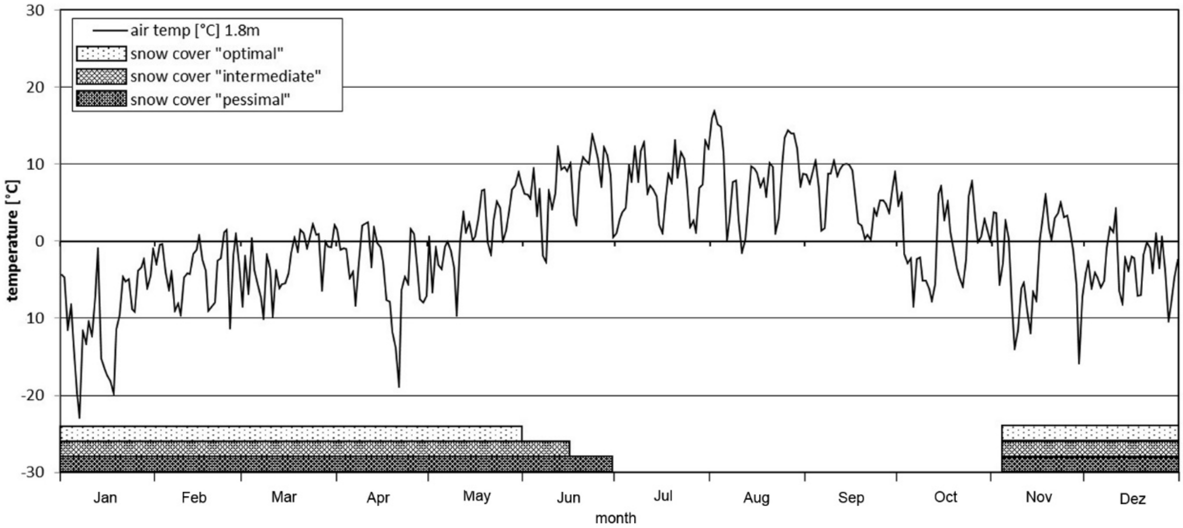

Figure. 1: Daily mean air temperature at a transect in Innergschlöss for the period August 2016 to August 2017 and the duration of the snow cover (strips) at the 'optimal', 'intermediate' and 'pessimal' point of the transect. A time lag of one month in snow cover duration at the beginning of the vegetation period can be seen between the 'optimal' and 'pessimal' point of the transect.

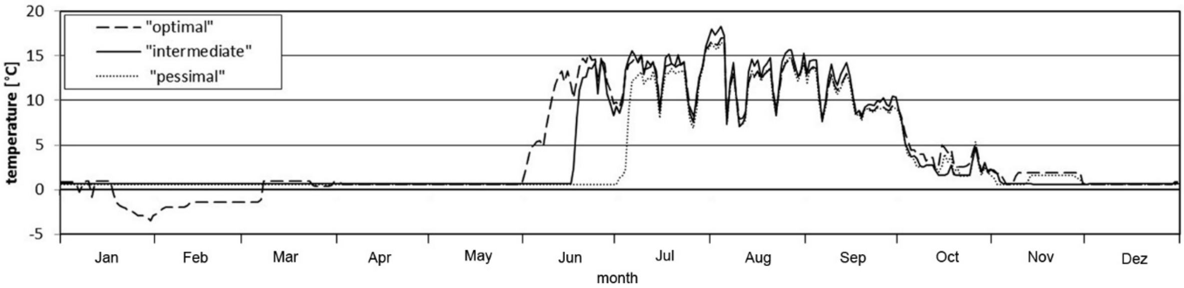

Figure. 2: Daily mean soil temperature at a transect in Innergschlöss for the period August 2016 to August 2017. The soil temperatures were recorded at 3-4 cm depth and show values from the 'optimal', 'intermediate' and 'pessimal' point of the transect. Soil temperatures well below 0°C indicate snow-free periods during winter and at snow melt, they increase rapidly above the freezing level. After snow melting no significant different can be seen.

Acknowledgements

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LE 14-20 Entwicklung für den Ländlichen Raum

Europäischer Landwirtschaftsfonds für die Entwicklung des ländlichen Raums: Hier investiert Europa in die ländlichen Gebiete

Winners and losers of climate change in the Central Alps

Lena Nicklas, Martin Mallaun, Brigitta Erschbamer

Keywords

Alpine, GLORIA, vegetation resurvey, increasing species, decreasing species, functional traits, nival, treeline ecotone.

Summary

Climate warming is one of the essential drivers for the ongoing changes in high altitudes. The consequences are a matter of debate: alpine diversity is expected to decrease, species going extinct by the end of the 21st century, while other studies suggest a time lag of extinction or highlight escape opportunities for high altitude species, stressing the possibility of horizontal niches.

To gain empirical results, long term monitoring studies are necessary. One of the unique monitoring programmes worldwide is the project GLORIA (Global Observation Research Initiative in Alpine Environment, www.gloria.ac.at) dealing with the quantification of diversity changes in high altitudes. At target regions, four summits from the treeline ecotone to the nival zone, are monitored every 5-10 years in order to detect diversity changes and to highlight potential risks. In the Central Alps, the GLORIA site IT_TEX (Nature Park Texelgruppe, Ötztal Alps) was established in 2003; in 2011 the first resurvey was performed. Now, after 14 years, a resurvey was made to analyse and evaluate the following hypothesis: Responses of plant species to climate change (increase, decrease, no difference) depend on elevation, compass direction, community structure, species pool, environmental site factors at the summit and on functional traits of the species.

With this project, it will be possible to develop a clear indication of the consequences of climate warming in the Central Alps by outlining the direction of changes, the migration potential of the species, and the traits of winners, losers and ubiquitous species. Species pool data will be of particularly high value for modelling approaches, targeting at the identification of species being under threat of extinction vs. migrating species from lower altitudes.

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Spatial and temporal variation of chironomid assemblages in high altitude streams of the Hohe Tauern Nationalpark: environmental niche differentiation

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Keywords

alpine glacier-fed streams, glacier retreat, indicator, autecology, invertebrates, sub-alpine.

Summary

Macroinvertebrates are widely used as indicators to detect and assess anthropogenic impacts on freshwater ecosystems. However, despite being considered useful in indicating effects of environmental change in alpine catchments, little is known about species preferences for local conditions in such environments.

In exploring the occurrence of 59 taxa within the dipteran family Chironomidae in relation to key-environmental variables in alpine and sub-alpine streams of the Hohe Tauern Nationalpark, we showed that sediment load, water temperature, periphyton density, and fine particulate organic matter mostly explain assemblage structures. Two-way-cluster analyses identified stream-type specific assemblages, indicator value analysis defined indicator species for glacial and non-glacial streams, and weighted averaging regression models confined preferences for local environmental conditions by summing their optima and tolerance widths regarding environmental key-factors (NIEDRIST & FÜREDER 2016).

The definition of habitat requirements identified stenoecious taxa with preferences for high and low values of respective variables thus identified most suitable indicators for future studies. This master thesis revealed manifold preferences within the dominant benthic invertebrate family, underlined their enormous potential for monitoring purposes, and is a step forward in better understanding ecosystem properties and biodiversity (NIEDRIST 2014). Fundamental requirements for these kinds of indicative traits, essential to understand cause-effect relationships in environmental change issues, are a robust taxonomy and a comprehensive set of physical and chemical data.

Acknowledgements

The research was carried out within the project 'Monitoring Alpine Rivers' (FÜREDER & SCHÖNER 2013; FÜREDER et al. 2017), funded by the Nationalparkrat Hohe Tauern, the 'Austrian Federal Ministry of Agriculture and Forestry, Environment and Water Management', the federal states Salzburg, Carinthia, Tyrol and the European Union (European Agricultural Fund for Rural Development). We are very grateful to Stefanie Aumayr, Alexandra Mätzler, Nikolaus Medgyesy, Sabrina Schönenberger and Ursula Windner for their help during the fieldwork and thanks to Josef Franzoi, Gry Larsen and Salvador Morales-Gomez for the chemical analyses.

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Feeding plasticity of alpine stream chironomids: evidence from river monitoring in the Hohe Tauern NP

Georg H. Niedrist & Leopold Füreder

Abstract

Glacier retreat provides striking evidence of environmental change in alpine streams. Overall effects on the invertebrate community structure are largely understood, but potential alterations in functional strategies are not. Here we show how the flexibility in feeding and food exploitation might explain the dominance of larvae within the chironomid genus *Diamesa* in glacial headwaters. Our results indicate that glacier retreat not only affects macroinvertebrate community structure but also favors species that are able to be flexible in terms of functional traits for living in harshest environmental conditions.

Keywords

Trophic ecology, glacial streams, Bayesian Mixing Modelling, stable isotopes, omnivory, trophic niche, niche breadth.

Introduction

Glaciers, the most significant water source for streams in the Alps, retreat because of human-induced warming (IPCC 2014). Consequently, the physical living conditions for stream biota in glacier-fed streams are changing (MILNER et al. 2009). The relationship of different environmental conditions and the structure and composition of benthic communities is largely understood (e.g., LENCIONI & ROSSARO 2005, ROTT et al. 2006, UEHLINGER et al. 2010, NIEDRIST & FÜREDER 2016) and even used to indicate environmental change (FÜREDER & SCHÖNER 2013, SCHÜTZ & FÜREDER 2013). Although changes of community structures can be expected under the progression of climate change and glacier retreat (ZEMP et al. 2009), the functional consequences for stream ecosystems are difficult to predict due to the inadequate understanding of the functions and services of stream biota (NIEDRIST & FÜREDER 2017). The main function of alpine stream invertebrates, their trophic performance, remained poorly studied for long time (but see ZAH et al. 2001, FÜREDER et al. 2003). Recent studies, however, aimed to improve the general understanding of different aspects of invertebrates' trophic ecology (CLITHEROW et al. 2013, MÄTZLER & FÜREDER 2013, ROBINSON et al. 2015, KHAMIS et al. 2015, NIEDRIST & FÜREDER 2017).

This presentation presents the effects of in-stream habitat conditions on the feeding plasticity of dominant invertebrate taxa across a sequence of streams with differing glacial influence. In particular, we try to understand whether invertebrates' feeding performance in terms of their trophic niche extension and their trophic height is different in glacier-fed streams with divergent living conditions in the Hohe Tauern National Park. Usually, chironomid taxa (Diptera: Chironomidae) dominate glacial headwater streams (FÜREDER 1999, FÜREDER et al. 2001, LODS-CROZET et al. 2001, NIEDRIST & FÜREDER 2013, 2016) and are often the first connection between producers and consumers in these remote systems (NIEDRIST & FÜREDER 2017). We hypothesized that flexibility in feeding behavior ensures the survival and successful reproduction of chironomid populations in harsh glacier-fed streams, where food availability is usually low (UEHLINGER et al. 2010).

Methods

Samples were collected in six glacial streams in the Hohe Tauern National Park in 2014. All streams are continuously monitored in the long-term project 'monitoring alpine rivers' (Füreder & Schöner 2013), where data on water temperature, discharge, and sediment concentration were used for data analyses herein. We combined these environmental factors by performing a PCA and extracting the scores of component 1, which was defined as multifactorial environmental gradient, called 'environmental harshness', and ranging from 'benign' to 'harsh'. We analyzed stable isotope signatures of carbon and nitrogen in chironomid individuals belonging to a) *Diamesa steinboecki* and b) *D. latitarsis*-group. Bayesian Standard Ellipses and SIBER (Jackson et al. 2011) was used to quantify and compare their isotopic niche area (‰^{2}) and their variability among glacial streams along the gradient of environmental harshness.

Results & discussion

We found that both chironomid taxa (*D. steinboecki* and *D. latitarsis*-group.) were the dominant invertebrates in all surveyed glacial streams and had similar patterns in their isotopic niche areas. The individual areas (standard ellipse area) of each population increased with increasing harshness of the in-stream environmental conditions (Fig. 1).

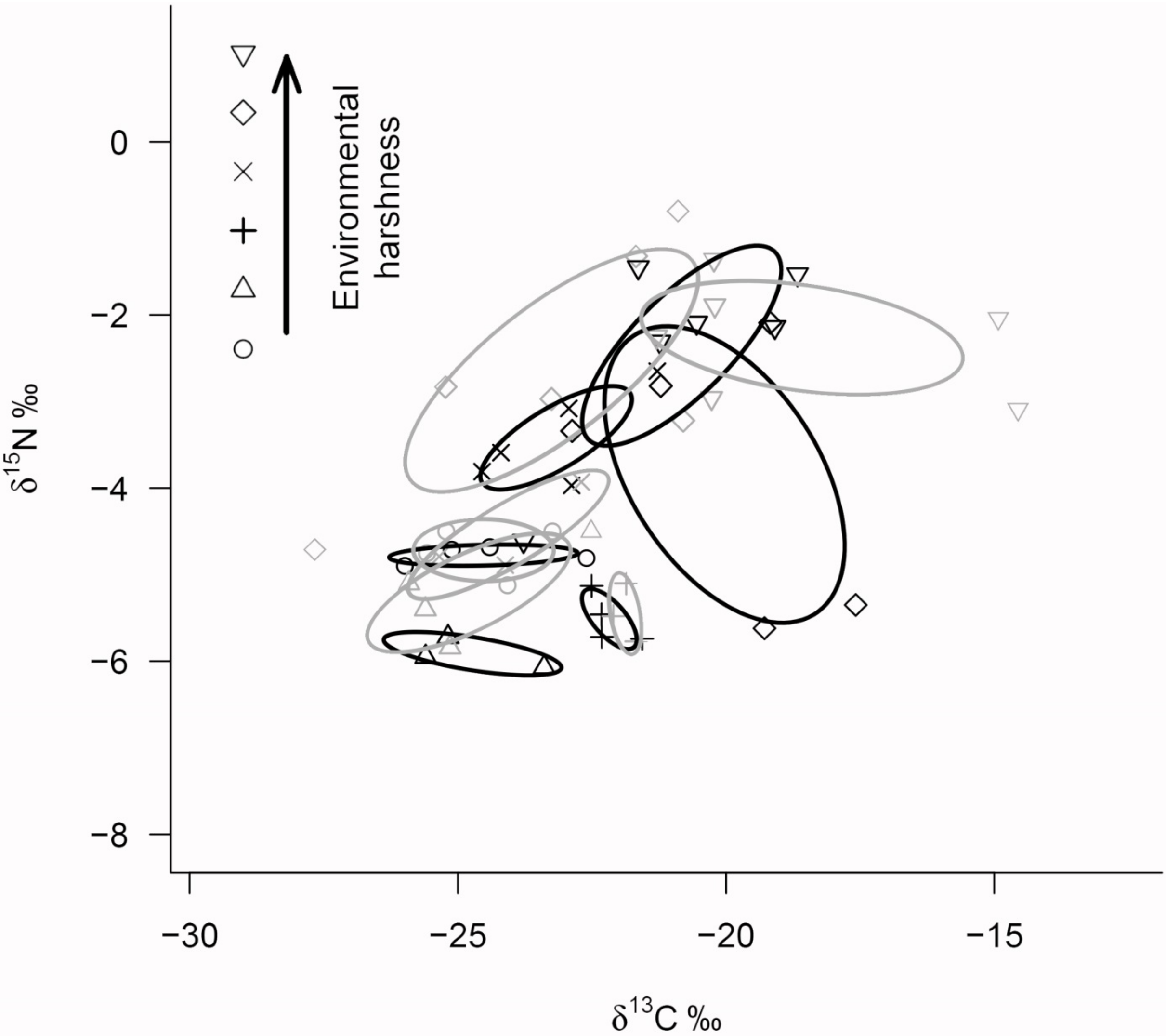

Figure 1: Standardized Ellipse Areas of individual A) *Diamesa steinboecki* (in black) and B) *D. latitarsis*-gr. (in grey) stable isotope data in glacier-fed streams with differing environmental harshness, which is related to glacial influence. Standard Ellipse Areas quantify the isotopic niche area of all site-specific populations, and allow conclusions about their feeding variability (the larger the niche, the higher the feeding flexibility).

Differences in the isotopic niche area can point to differences in the trophic breadth or trophic niche area of analyzed taxa (JACKSON et al. 2011). Hence, our results show that both chironomid taxa (*D. steinboecki* and *D. latitarsis*-group) enlarge their trophic niche area when conditions get harsh, meaning that each individual needs to feed on what it finds, which was already assumed by FÜREDER et al. (2003). In other words, invertebrates living in harsh glacier-fed streams seem to feed more variable on the available food sources. In contrary, individuals living in streams fed by smaller glaciers feed most likely on the same food sources.

Conclusion

We conclude that variable and opportunistic feeding behavior is an adaptation of organisms living in harsh ecosystems, such as streams fed by large glaciers. The detected ability of chironomid taxa to enlarge their food spectra and feeding flexibility might be a decisive mechanism aiding to survive in harsh ecosystems, where food availability is usually low and living conditions are tough. Additionally, such opportunistic feeding strategy of chironomid populations in glacial headwaters could explain their dominance in these systems.

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The expansion of the Kalkalpen National Park from the perspective of political ecology

Philip Nigl

Keywords

political ecology, National Park Kalkalpen

Summary

The Kalkalpen National Park was founded in the year 1997. Its statutes declare that the national park area should grow continually. The reasons why this has not happened to the necessary extent until today are complex. On one hand the economic crisis and its aftermath led to a discontinuation in negotiations between representatives from the federal state Upper Austria and landowners in the year 2009. On the other hand some stakeholders are acting vehemently against the expansion of the national park. The investigated areas for an expansion include the nature reserves Haller Mauern, Bosruck and Warscheneck. In this scenario, the national park would grow from the current 208.5 km^2 to a total area of 267.86 km^2.

The empirical research method chosen in my master-thesis is the qualitative problem-centered interview. This method was used to summarize the opinions about the conflict potential from different perspectives. Afterwards, the findings were interpreted in the context of political ecology.

The results of the research show that the national park expansion has a high conflict potential, although the areas of the expansion scenario have already been designated as conservation areas. In case of dedication as a core zone of the national park, the protection measures in the investigation area would become stricter. Especially huntsmen would be affected because conventional hunting would no longer be possible. Another conflict potential results from the fact that the nature reserve Warscheneck has always been a very interesting development area for the tourism industry. There are plans to connect the ski resort Hinterstoder-Höss with the ski area Wurzeralm and for that purpose parts of the protected landscape would have to be utilized. Advocates of this project emphasize the importance for the regional economy and the creation and preservation of jobs. Opponents rate the project as an economic and ecological disaster.

Such conflicts over environmental resources can trigger a decision-making process in which politicians and local residents decide if they want or do not want to develop their region complying with the national park concept.

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Small ruminants in a sustainable socio-ecological metabolism: A case study from Samothraki, Greece.

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Keywords

Sustainable agriculture; social metabolism; social ecology; social learning; decision support app; sustainability transition; small ruminants; citizen science

Summary

I am presenting a socio-ecological case study about a small Greek island that aims at pursuing scientific and practical goals. The conceptual framework of social metabolism (FISCHER-KOWALSKI et al. 1997) serves as the scientific basis to answering key questions regarding more sustainable farming practices and how they can be integrated into farming communities, within protected areas on islands. The outlined transdisciplinary approach involves the application of a decision support app for small ruminant farmers (HAPPY GOATS APP 2016) in order to support social learning opportunities among these farmers. It also enables public involvement into the research process (citizen science).

The north Aegean island of Samothraki represents a unique site of archaic wilderness, rarely found among the Greek archipelago. Because of the island's outstanding ecological values, the largest part of its terrestrial area and 50km^2 of the adjoining marine area, were included in the Natura 2000 network. The ongoing efforts of the scientific and local community to include the island into the worldwide network of Biosphere Reserves resulted in a successful submission of an application to UNESCO in 2013. Despite increasing efforts in environmental protection activities, the development process of recent decades has generated a wide variety of environmental and social problems the island community is currently facing. One of the major threats is the sharp increase in free roaming sheep and goats since the 1960s, which has led to overgrazing, forest reduction and soil erosion (BIEL & TAN 2014). As studies from other Greek islands and mainland regions reveal, the agricultural and respectively, the small ruminant sector, is transforming throughout the country at unprecedented rates for several decades now (e.g., HADJIGEORGIOU 2011; KIZOS et al. 2013). Throughout the Mediterranean, livestock has begun to lose its many essential functions which had been fulfilled with traditional systems. Those systems were built mostly on circular nutrient and resource flows with little or no external inputs, where animals were mainly fed on biomass not suitable for human consumption and manure was used as fertilizer for crop production (DUMONT et al. 2013). Land use and marketing practices have gradually been adapted according to these changes. The former, mainly circular, local economies are now being increasingly replaced by import oriented economies, making it more difficult for farmers to sell their products at local markets. It is therefore of great importance to understand how current development pathways affect small ruminant farming on islands and to identify feasible strategies for a sustainable future of the sector on Samothraki.

Our findings indicate that since the 1980s grazing resources were not sufficient to keep the growing number of animals adequately fed and farmers had to supply more imported animal feed (FETZEL et al. In submission). Data from local fodder importers show that, despite increasing animal numbers in the 1990s, imports of supplementary feed did not initially increase, resulting in growing grazing pressure on the islands ecosystems. After local feeding resources became less productive and numbers of animals suffering from malnutrition increased, farmers were forced to supply more feed which then only exacerbated their difficult economic situation. Since 2001 the sector is declining, with the reduction of the number of animals to those levels experienced in the early 1990s and a 50% reduction of the population economically active in the primary sector.

A planned survey with several dozen local sheep and goat farmers will be conducted by using citizen science methods and the Happy Goats App. The survey will not only yield high quality bottom-up data which will be used for outlining scenarios that aim for a sustainable development of the sector in three dimensions, i.e. socially, economically and environmentally. It also serves as an opportunity to introduce the Happy Goats App to farmers and foster social learning opportunities which might open new and promising perspectives for local small ruminant farmers. In my contribution, I will give background information on the ongoing research process on the island of Samothraki, present latest findings about the small ruminant sector of the island and report from the survey with local small ruminant farmers.

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Water availability as a key factor of forest dynamics in protected areas – long-term perspectives inferred from tree rings

Walter Oberhuber

Keywords

dendroclimatology, dry inner Alpine valley, riparian forest, Scots pine, tree mortality, water table

Summary

Drought is known to have a large influence on forest health and to be one of the most important factors triggering both temporary declines and the mortality of susceptible species in temperate forests (e.g. ALLEN et al. 2010; ANDEREGG et al. 2015). Tree mortality and forest die-off events are expected to increase as a result of further global warming and increasing drought stress (ALLEN et al. 2015). Tree ring analysis gives a long-term perspective of tree growth and stand dynamics, and allows determination of environmental stresses (e.g. SCHWEINGRUBER 1996). The focus of this study was to evaluate the impact of drought stress on long-term growth trend and stability of two contrasting forests located within protected areas in the inner Alpine dry valley of the Inn River (Tyrol, Austria): a xeric Scots pine forest (Tschirgant-Bergsturz) and a grey alder dominated riparian forest (Mieminger and Rietzer Innauen). Selected stands are within c. 15 km in linear distance. The study area has a relatively continental climate with mean annual precipitation and temperature of 716 mm and 7.3 °C (long-term mean during 1911-2013). To accomplish our goals dendroclimatological techniques were applied (e.g. HUGHES et al. 2011).

On a postglacial rock-slide area (Tschirgant-Bergsturz) situated in the montane belt (c. 750 m asl; cf. PRAGER et al. 2008) we found that radial growth of Scots pine (*Pinus sylvestris* L.) growing on shallow, stony soils responds extremely sensitive to water availability during spring (April to May) and wood formation already peaks in May prior to occurrence of more favorable environmental conditions, i.e. increase in precipitation in summer (GRUBER et al. 2010, SWIDRAK et al. 2013, OBERHUBER et al. 2014). Evaluation of long tree ring series (>150 yr) revealed a stepwise growth decline of trees predisposed to die, which indicates that the effects of drought stress accumulated slowly until tree death occurred (OBERHUBER 2001). The long-term nature of the individual mortality process illustrates that *P. sylvestris* can sustain growth at very low rates for decades and emphasizes the role of accumulated stress or slow-acting processes (e.g. competition) in tree mortality (SCHUSTER & OBERHUBER 2013, CAILLERET et al. 2017). Accordingly, moderate growth reduction and only sporadically found tree death of *P. sylvestris* in response to the extraordinary 2003 heat-wave can be related to (i) spring precipitation as the primary growth limiting climate variable, (ii) biological preconditioning in previous years and (iii) substantial lag effects associated with drought impacts (PICHLER & OBERHUBER 2007). Although results of this study provide evidence that drought-prone forest ecosystems dominated by *P. sylvestris* show a high resilience against short-term climatic stresses, xeric sites within dry inner Alpine valleys might gradually become treeless or be replaced by more drought tolerant tree species like *Quercus* spp. as a result of climate change (cf. RIGLING et al. 2013).

P. sylvestris also dominates along riversides on free-draining gravel beds, which are only occasionally subject to flooding. The dominance of *P. sylvestris* at these sites is thought to be caused by high tolerance of water table fluctuations alternating with soil drought during the growing period (POLACEK et al. 2006). For this reason *P. sylvestris* is able to invade the riparian forest of the special nature protection area Mieminger and Rietzer Innauen (c. 635 m asl). Stands, currently dominated by grey alder (*Alnus incana* Moench.) grow on rarely flooded alluvial terraces (flooding occurs about once every 10 years; cf. GATTERMAYR & STECK 2006), and are exposed to extreme seasonal fluctuations of the water table (>2 m). We evaluated the impact of fluctuations of the water table and of climate factors (precipitation, temperature) on year-to-year variability of tree growth and long-term basal area increment of dominant tree species (ASTER 2015, DEMAR 2015, RASS 2017). Statistically significant correlations between water availability and annual increments of grey alder indicated that tree growth is severely constrained by water supply in spring and summer leading to reduced stand height, lower basal area increment, pronounced top-killing and crown-thinning at some sites. Results also revealed that drought stress during the growing season caused only temporary growth reductions and no distinct decrease in long-term trend of basal area increment was detected. However, owing to mean tree age >50 yr of some stands, tree mortality (most likely drought triggered) will increase in the future. Whether *P. sylvestris* can subsequently spread in developing gaps of the riparian forest will depend on the duration and frequency of extreme weather events, i.e. drought, heat-waves and flooding.

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Dianthus plumarius subsp. blandus – Monitoring under extreme conditions

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Abstract

Dianthus plumarius subsp. *blandus* is a narrow endemic with 10 populations in the National Park Gesäuse. Using eight permanently marked rectangular plots, the number and growth stage of clusters of this plant was mapped in 2015. This census has been repeated in 2017. The changes in size, number of shoots and location within the monitoring plots will allow conclusions regarding recruitment and mortality. These investigations will provide insight in the population dynamics and if necessary help to decide on the appropriate management measures to preserve this beautiful species.

Keywords

Gesäuse, narrow endemic, pink carnation, monitoring, population dynamics, habitat instability

Introduction

After extensive search for unknown populations and investigation of the extent of already known populations of *Dianthus plumarius* subsp. *blandus* (in short: *Dianthus blandus*) in the National Park Gesäuse in 2015, it was decided to establish monitoring areas to gain insight into *Dianthus blandus*' population dynamics (Köppl & Oberklammer 2015). How endangered is *Dianthus blandus*, mainly settling in instable and often steep gravel slopes alongside ephemeral creeks and streams?

Due to enhanced precipitation and snow melting strong sediment movement occurs regularly ('wild water, steep rock' is not without cause the Gesäuse's slogan) and makes the habitat changes of *Dianthus blandus* unpredictable.

Thus, it was decided to set up monitoring areas at various locations with different likelihoods of being vanished, buried under gravel or staying stable. The monitoring is focused on providing information on rejuvenation trends, recruitment and mortality of Dianthus blandus in the National Park Gesäuse.

Methods

In summer 2015 eight rectangles were chosen due to criteria such as sufficient presence of *Dianthus blandus*, ageing structure and diversity in stability. 8 plots were finally set up in 7 different populations, using four steel bars for marking the corners of each plot. Each corner's distance to at least two distinct landmarks (trees, heavy rocks) was measured and documented. All plots have a width of 2 meters and a length ranging from 4 to 20 meters.

Within each plot all individuals of *Dianthus blandus* were mapped using a simple coordinate system, including information such as diameter, number of shoots (for small individuals), number of blossoms and other interesting observations (signs of browsing, infested buds, etc.).

All data were transferred to Excel tables and used to create plots showing the distribution and size of individuals within each monitoring area as an easy-to-read graphic. Furthermore, the obtained data was used to calculate ageing structure and blossoming rate according to growth stage of each monitoring plot. To simplify repeating the census sketches highlighting all necessary information on the surroundings were drawn and a detailed 'how-to' guide was created. The further responsibility for the execution of the monitoring was not settled at the time of the first report in autumn 2015.

In summer 2017, it was independently decided by the authors to repeat the census out of sheer interest in the development of *Dianthus blandus* and changes within the monitoring areas. All plots were visited and the census repeated, facing the first difficulties, such as loss of markings and parts of monitoring areas. The monitoring activities were executed regardless of shifting of corners. It was decided that most likely the monitored area itself will also have moved with the steel bars, if a rectangle remains visible and measurable.

Results

Plot stability

As briefly described, first difficulties occurred after two years, such as:

- Ground break-off
- Moved sediment
- Vanished corner markings

The lower populated half of one monitoring area (Langgries, situated directly at a steep break-off) had vanished, leaving 20 small individuals of *Dianthus blandus* in the upper section instead of 55 in 2015.

One other, seemingly stable monitoring plot (Höll) on a creek shoulder already stabilized by *Salix eleagnos* was totally buried in gravel, only leaving one individual above ground, where 86 individuals had been recorded 2015. Furthermore, one corner steel bar was lying upstream, one was gone altogether, while the other two had remained in the ground but had moved downstream. The original position of the plot could be reconstructed from photos and measurements and the remaining individual of *Dianthus blandus* was mapped accordingly.

Other monitoring plots have shown signs of immigration due to ground slipping (Gseng Alte Straße), but proven to be semi-stable to stable so far.

Census repeatment and subjectivity

Dianthus blandus grows according to its habitat either in a circular, pillowy form or grassy, using offshoots. (Fig. 1, Fig. 2) Thus, it is difficult to distinguish an amount of single, small individuals from mere offshoots. While in the first census it was tried to distinguish every possible individual in the grassy vegetation form, it was decided to combine probable offshoots to one bigger individual. This showed to have minimal influence on the graphic representation regarding total inhabited area but higher influence on the ageing structure as several small individuals from 2015 are now represented as one in a higher growth stage.

Still, this approach will be followed from now on because it does not change the inhabited area per plot, is easier to carry out and seedlings can easily be distinguished anyway.

Figure 1: Pillowy habit of *Dianthus blandus* – easy distinction of individuals

Figure 2: Grassy habit of Dianthus blandus – difficult distinction of individuals

Ageing structure

The main target of the monitoring is to find out if *Dianthus blandus* is endangered. Observing how individuals are developing over the years will allow to calculate extinction and growth stage transition probabilities. Results of 2017 show mainly a decrease of seedlings and small plants up to 1cm in diameter, with a loss ranging from 100% to 52% in 6 plots and an increase in two plots (200% and 16%).

Discussion

Time

The main obstacle in drawing conclusions regarding the development of *Dianthus blandus* is the short time the project has been in process. In 2015 the method was created and has since been slightly modified. Only the generation development along a timeline of several years will allow conclusions regarding transition probabilities between growth stages, providing insight into possible extinction probabilities at certain growth stages. Regression incidents may also be of interest.

Plot instability

There are different options on how it should be dealt with moved or 'vanished' plots. We decided to keep track of the moved sediment in order to keep monitoring the same individuals of *Dianthus blandus* over the years. This will also lead to width and length instability but we plan to reset the corner markings according to the already known plants. In the case of Höll, where the marked corner steel bars have (been) moved down- and upstream we will rethink the marking altogether. For 2017 a tree that has been part of the plot in 2015 was used to temporarily measure the position of the last present individual of *Dianthus blandus*. It will be decided 2018 if more stable means of marking the corners in this specific area should be used.

Another issue that might occur could be the total vanishing of *Dianthus blandus* in one plot, as it almost happened in Höll. It was decided to keep on monitoring because there could be a re-establishment form below ground or immigration - which would be interesting to watch.

Conclusion

The first repeat of the monitoring in 2017 has proven the instability of *Dianthus plumarius* subsp. *blandus*' favourite habitats and enabled further improvement of methods. It is necessary to pursue the annual monitoring activity to gain more information to be able to predict *Dianthus blandus*' development in the National Park Gesäuse. How to deal with the difficulty of monitoring individuals over the years in such instable terrain is another question to be solved (again) within the next census repeat.
The authors are very much looking forward to revisit all monitoring areas each year to 'keep in touch' with the ongoing changes in habitat structure and population development. As a cautious hint, we assume that the transition probabilities of seedlings and small plants to major growth stages are relatively small due to the outcome of this years' monitoring.

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Conflict Management – Case studies from the Austrian Natural Forest Reserve Programme

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Abstract

The Austrian Natural Forest Reserve Programme consists of 195 Reserves, mainly represented by small scale areas of 5 to 20 ha in size. This large number of individual areas requires a lot of monitoring und maintenance activity. Furthermore, various conflict events occur. Conflicts can generally be distinguished between legal issues, such as contract violation or traffic safety measures, nature conservation demands including browsing by game or neophytes and public interests contrary to the protection aims of the programme. Though legal standards and regulations exist, case studies make clear that each situation needs to be evaluated separately in order to find a compromise between all stakeholders.

Keywords

Natural Forest Reserves, conflict, legal issues, nature conservation, public interest, bark beetle infestation, species protection

Introduction

Natural Forest Reserves (NWR) are areas of nature conservation by contract which ensure a natural development of ecosystem without any forest management activity. The areas represent the potential natural forest communities (PNWG) as best as possible. Currently, there are 195 NWR with a total area of 8400 ha in the Austrian Natural Forest Reserve Programme, started by the federal government in 1995.

For each NWR a contract between the forest owner and the Republic of Austria, represented by the Federal Ministry for Agriculture, Forestry, Environment and Water Management (BMLFUW) is concluded. This agreement defines the rights and obligations for both contracting parties. The forest owner commits to refrain from all forestry uses and receives an annual compensation in exchange therefore. Exceptions are hunting, legally required measures and interventions necessary in order to prevent liability claims.

A regular support of the contract areas is necessary, including monitoring and maintenance measures. The workload is correspondingly high because of predominantly small areas of 5 to 20 hectares in size. Additionally, once per year forest owners report about occurring events in the NWR, such as wind throws, bark beetle infestations or browsing by game. However, such natural events are not the only arising problems, which need to be discussed and solved. Conflicts emerge when different interests or demands meet, such as existing treaties and laws, but also social claims or contradictions.

According to the contract (‘Agreement on the NWR [...]’) forest owners have to inform the contract partner, respectively the supporting body (Federal Research Centre of Forests - BFW), in case of an event, whether this concerns requests or legally required measures. For each case or event a technical evaluation in cooperation with BFW and if necessary the Forestry authority is essential.

Conflicts

In 22 years, a large number of requests and problems arise. Although the list is incomplete it allows a general overview. Commonly occurring cases include browsing by game, forest pest infestation, forest pasture and requests for hunting infrastructure, a trail construction or protection facilities (rockfall protection).

The large number of reported cases can be distinguished into three categories. **Legal conflicts** emerge when the protection objective or measures are contrary to applicable laws. On the one hand there is contract violation per se, on the other hand are cases like a mass reproduction of forest pests or required traffic safety measures. **Nature conservation problems** are neophytes occurring in the reserves or a vegetation development that differs from the favourable conservation status (Natura 2000). Often **public interests** such as recreation demands or property protection function of a forest are not in line with an undisturbed forest development.

Discussion of Case Studies

Forest Pest Infestation

According to the Austrian forestry law, forest owners have to observe and control their forest regarding a mass reproduction of forest pests and to report about a critical development to the responsible forest authority (§ 43 ForstG). Is a pest infestation increasing in a dangerous manner, the forest owner has to immediately act (§ 44 ForstG). The NWR contract contains the authorisation of 'legally compulsory interventions' as well. Given a large number of small NWR this is necessary since a potential endangerment of neighbouring stands frequently occurs.

Following the usual procedure, the forest owner must immediately report a detected pest infestation to the forest authority and the supporting body of the contract partner (BFW). During an on-site visit all stakeholders discuss and define necessary measures. The examples below outline different decision possibilities. In all cases a bark beetle infestation (*Ips typographus*) followed a wind throw event.

First reserve is about 10 ha in size and bordering two neighbours. Bark beetles (*Ips typographus*) attacked thrown and broken spruce trees after a storm event. In agreement with BFW, the infested trees were debarked. A possible expansion to other trees as well as to neighbouring stands was carefully observed and not detected. Another bark beetle attack a few years later was successfully combated as well by a fast reporting, assessing, deciding (in agreement with BFW and the forestry authority) and acting. The trees concerned were cut down and debarked, but left in the NWR.

The second area, about 100 ha in size, was affected by wind throw on an area of 7 ha located at the southern border of the reserve. The neighbouring stand is an object protecting forest, so it was very important to avoid a propagation of the bark beetle infestation. During an on-site visit, forest owners, forestry authority and BFW discussed the situation and possible solutions. Due to the high risk of propagation (southern slope, spruce dominated forest) the affected area was excluded from the NWR, in order to allow timber processing and an efficient bark beetle control. Subsequently, the contract agreement was adapted in size and payment.

In the third example a bark beetle infestation spread so quickly and severely after a wind throw, that the forestry authority had to order a clearance (§§ 44 and 45 ForstG). The impact of combating measures, infestation in the following years including the necessary control measures, and an expected propagation resulted in the termination of the NWR contract.

Species Protection

In a Natural Forest Reserve in Upper Austria, there was a request regarding the protection of *Asplenium adiantum-nigrum* (black spleenwort). The fern species is extremely rare and threatened by extinction in the province of Upper Austria. In detail, the question concerned the removal of competing vegetation, such as blackberry or ivy, as well as of foliage around some individual plants. During a local assessment of the situation it came out that the fern is not affected by competing vegetation (probably also not for the next 5 years) because it grows under a closed canopy alongside a path. A removal of leaf litter around individual plants by hands does not endanger the protection objective of the reserve as such and is allowed.

Public Interests

In a NWR in Carinthia, three rock climbing routes for private use were requested. The on-site visit of the forest owner, BFW and the 'applicant' resulted in a technical permission. The influence on the NWR was classified as marginal, because measures would concentrate on a very small area close to the NWR border (20 m), not expecting a major disturbance.

Another request regarding the construction of a trail for tourist use in a reserve of 10 ha in size, however, had to be rejected from a technical point of view. On the one hand the construction itself is not allowed; on the other hand would the effects of construction as well as of the subsequent traffic safety measures be significant.

The arguments for permitting the reconstruction of an existing historic trail after snow breakage and landslide in another NWR were based on the marginal influence of the reconstruction work on the total reserve area of 210 ha and the high importance (necessity) of the trail for hunting and research in a very steep terrain.

Conclusion

The case studies presented demonstrate the diversity of potential 'conflicts' or 'concerns' in NWR. Each of them requires an individual analysis and decision. Of course, valid legal norms and laws exist that have to be followed. Beyond that, it is about trying to find the best possible compromise to preserve the NWR, in order to allow a natural development process but also to meet different social demands.

Cooperation of forest owners, authorities and all stakeholders involved is necessary, not only for a sustainable conflict solution; it creates respect and understanding for the different opinions. Therefore it is a key element to ensure the success of the Natural Forest Reserve Programme.

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Seasonal snow cover evolution in the Nationalparks Austria since 1961

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Abstract

We analyse past snow cover changes and trends (seasonal mean snow depth SD, seasonal snow cover duration SCD) within the six Nationalparks Austria over the period 1961 to 2017 using a spatially distributed numerical snow model calibrated with homogenized long-term point measurements and satellite data and driven with newly available gridded meteorological data based on point observations. Results show a marked and significant SCD decrease (-5 to -7 days per decade) over the whole investigated period in all analyzed parks, whereas past SD changes are only significant negative in half of the parks. There is no strong elevation dependency of the calculated SCD trends although numbers start to become less negative above 1000 to 1500 m a.s.l. Negative SCD trends are even visible up to 2500 m a.s.l. For most of the shorter time (sub-) periods in the investigated period trends become non-significant as natural inter-annual to decadal variability of the snow cover dominates. Positive significant snow cover trends are not visible in any park within the investigated period.

Keywords

snow cover, cryosphere, snow depth, snow cover duration, warming climate, climate change

Introduction

Observed changes of the natural seasonal snow cover in Austria are characterized by high inter-annual to decadal and regional variability (NACHTNEBEL et al. 2014) which indicates a high sensitivity to atmospheric and climatic conditions and thus climate change. In Austria, temporal changes of the seasonal snow cover have widespread implications i.e. for society and economy (e.g. winter tourism), hydrology (temporal storage of water, evapotranspiration, soil moisture) and ecology (influence on the vegetation cycle and on plant species). For the six national parks in Austria ('Nationalparks Austria' (NPA)) these impacts are mainly restricted to hydrological and ecological impacts, although changes in the winter landscape may also have effects on park tourism and thus economy. Many studies about past snow cover variability and changes exist for Switzerland (e.g. BENISTON 1997; KLEIN 2016; LATERNSER & SCHNEEBELI 2003; MARTY 2008; MARTY et al. 2017) but less for Austria (e.g. HANTEL et al. 2000; SCHÖNER et al. 2009; MARKE et al. 2015). The most recent analysis of the snow cover evolution in Austria was conducted within the ACRP -funded project SNOWPAT (SCHÖNER et al. 2013; MARKE et al. 2015; 2016). A majority of these studies report a decrease of the snow depth since the mid-1980s for stations in lower elevations. MARTY et al. (2017) recently found a region independent reduction of snow water equivalent in the Swiss Alps driven by increasing temperatures and a coincident weak reduction of precipitation.
All of these studies make use of local station recordings and do not present an area-wide, spatiotemporal assessment of snow cover changes. Currently, MARKE et al. (in prep) and OLEFS et al. (in prep) are preparing first area-wide assessments of past snow cover changes in Austria using spatially distributed numerical snow models. In this study, we extract and analyze the results of the study of OLEFS et al. (in prep.) for the areas of the NPA.

Methods

A climate version of the operational SNOWGRID model (OLEFS et al. 2013) is used to derive daily grids of snow depth and snow water equivalent at a spatial resolution of 1x1 km for whole of Austria since the year 1961. This is done using recently created gridded datasets of air temperature, precipitation (HIEBL & FREI 2016; 2017) and snow sublimation (adapted from HASLINGER & BARTSCH 2016) at same temporal and spatial resolution that take into account the high variability of these variables in complex terrain. The model accounts for the shortwave radiation balance (PELLICCIOTTI et al. 2005) and uses a simple 2-layer scheme, considering settling, the heat and liquid water content of the snow cover and the energy added by rain as well as a simple scheme for lateral snow redistribution (FREY & HOLZMANN 2015). In a next step, so called snow indicators (e.g. snow cover duration, max. 72-H snow amounts) are derived that allow a climatic characterization of the snow cover to finally calculate area-wide changes and long-term trends. Calibration and validation of the model results are realized using homogenized long-term time-series of total snow depth and new snow amounts, recent operational snow depth measurements using laser sensors, winter glacier mass balance measurements, cumulative runoff data and satellite products (MODIS fractional snow cover). The selected snow indicators mean seasonal snow depth (SD) and snow cover duration (SCD) for the months November to April (NDJFMA) are extracted from the raster dataset for the NPA. SCD indicates the number of days with snow depth >= 1cm. The extraction is done using shapefiles of the national park borders (average of all pixels inside the respective park; Shapefiles are provided by the Umweltbundesamt GmbH - data.umweltbundesamt.at) and investigated with respect to past changes and trends (Mann-Kendall test (MANN 1945; KENDALL 1975)).

Results

The results of the model validation against point measurements (69 homogenized long-term point measurements: squared correlation coefficient of 0.69; Bias = 0.03 m) and satellite data (>600 scenes; skill score = 0.76) indicate a very good model performance over Austria.

During the climate normal period (1981-2010), SD and SCD in the analyzed NPA (see Fig. 1) are in the range of 1 to 128 cm and 33 to 174 days, respectively. As Tab.1 suggests, significant decreasing SCD trends (-5 to -7 days per decade) are calculated in all six parks for the period 1961-2017, for SD this is only found in the Salzburg part of the Hohe Tauern, the Kalkalpen park and very small (but significant) trends in the Donau-Auen park. Fig. 2 shows the average temporal evolution of SCD in all six parks for the period 1961 to 2017. Fig. 3 depicts the results of a running-trend analysis of SCD in all six parks based on the time-series shown in Fig. 2 (trends are not analyzed for periods < 20 years) and indicates that significant decreasing SCD trends over the last 50 to 55 years are found in all parks whereas they are only visible in the Gesäuse and Kalkalpen Park at shorter time-scales within the period 1961-2017. A marked SCD decrease since the year 2005 that is striking in Fig. 2 is still to recent in time to be analyzed in terms of possible trends (minimum 20 year window). Above around 1500 m a.s.l. negative SD and SCD trends over the whole period become gradually less negative with elevation in most of the relevant parks (Hohe Tauern, Kalkalpen), in Gesäuse park this already starts at 1000 m a.s.l.. Below these altitude limits there is practically no elevation dependency of the calculated trends. The Kalkalpen park is the only one with largest decreasing trends in mid elevations (1100 to 1500 m a.s.l.). Trends are still negative in 2500 m a.s.l. in the Hohe Tauern park. Above this altitude model uncertainty largely increases due to wind effects (lateral snow redistribution). In general, there are no positive significant snow cover trends in any park within the investigated period.

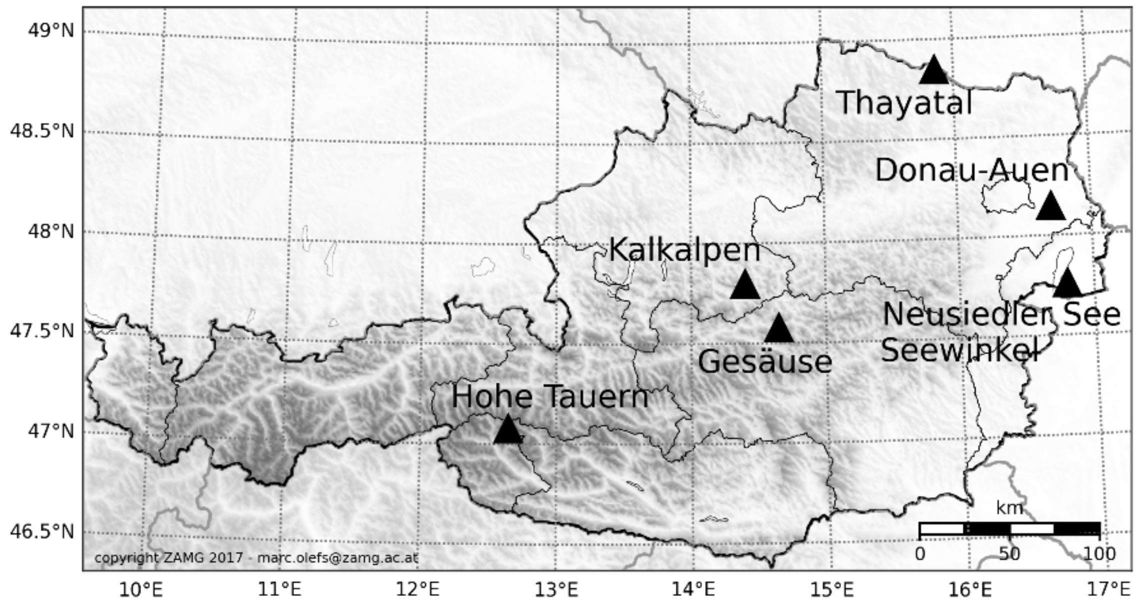

Figure 1: Topographic map with the six Nationalparks Austria (NPA) investigated in this study.

national park	SD cn [cm]	SCD cn [d]	SD Trend [cm/dec]	SCD Trend [d/dec]	MAE SD [cm]	MAE SCD [d]
Hohe Tauern KT/TI/SB	128	174	-4	-7**	8	19
Hohe Tauern KT	126	174	-3	-7**	8	19
Hohe Tauern TI	145	178	-3	-7*	8	19
Hohe Tauern SB	114	171	-5*	-7**	8	19
Gesäuse	52	145	-2	-6**	6	22
Kalkalpen	54	139	-4*	-7**	8	14
Thayatal	2	37	0.0	-5*	<1	7
Donau-Auen	2	37	-0.0*	-5*	1	7
Neusiedler See / Seewinkel	1	33	0.0	-5*	1	7

Table 1: Climatological snow cover characteristics and past changes calculated with the SNOWGRID-CL model for the Nationalparks Austria. SD = seasonal mean snow depth for the months November to April (NDJFMA) in cm, SCD = snow cover duration (NDJFMA) in days, Cn = climate normal period 1981-2010, Trends are given in units per decade (dec) for the period 1961 – 2017, significant trends are marked with one (95 % significance level) or two (99% significance level) asterisks, MAE = mean absolute error of the model compared to homogenized long-term measurement in the surroundings of the respective parks. For the Hohe Tauern park province specific analyses are performed (KT= Carinthia, SB = Salzburg, TI=Tirol).

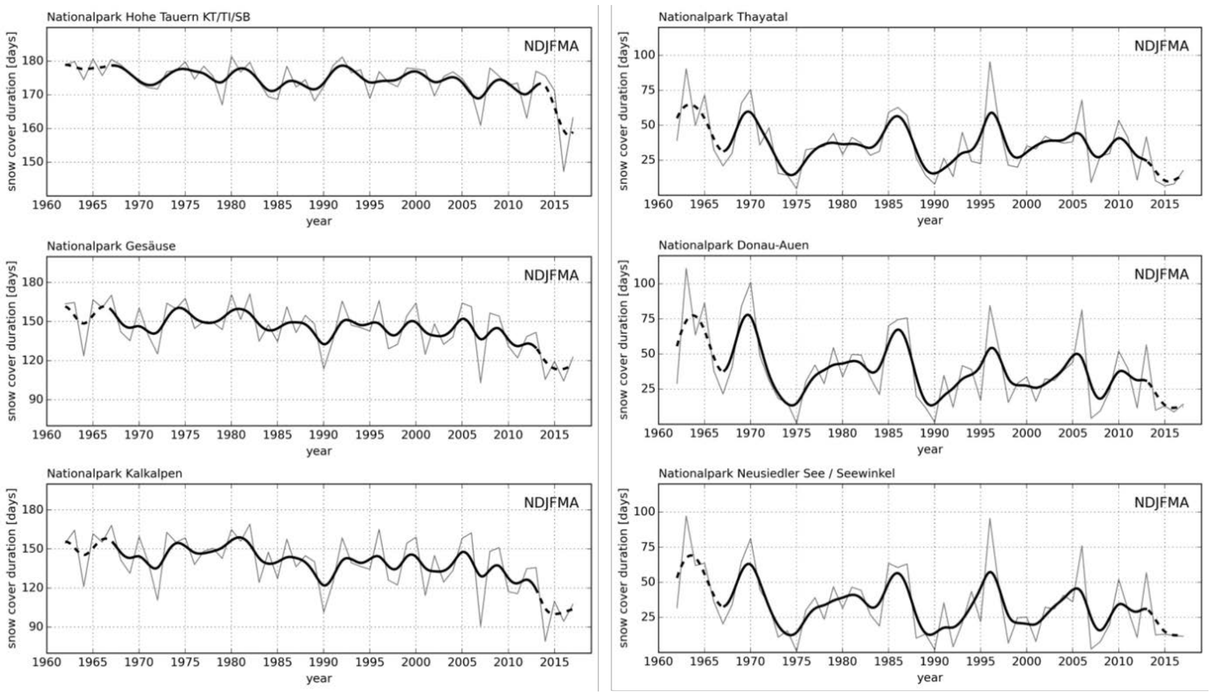

Figure 2: Calculated seasonal snow cover duration (NDJFMA) for the period 1961 – 2017 in the six Nationalparks Austria (annual values (thin line) and 11-year low-pass (gaussian) filtered values).

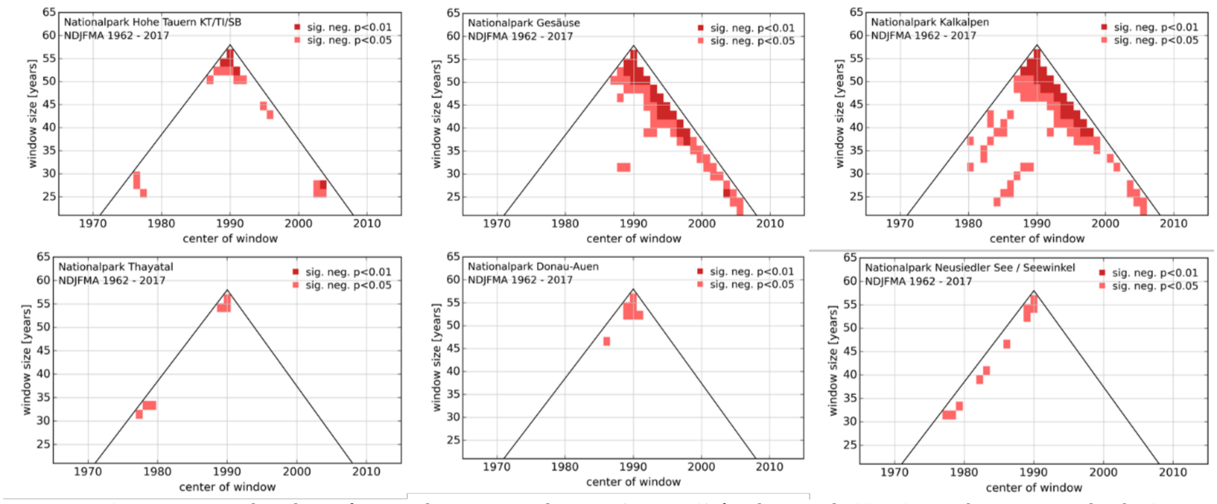

Figure 3: Running-trend analysis of seasonal snow cover duration (NDJFMA) for the period 1961-2017 in the six Nationalparks Austria. Blank areas in the triangles indicate no significant trends, light or dark red or grey (greyscale version) squares significant decreasing trends at the 95 or 99 % significance level, respectively.

Discussion

All results shown here are calculated using a spatially distributed numerical snow model driven with gridded meteorological data based on point observations. Both the numerical model and the gridded data introduce errors that propagate to the trend analyses. As mean absolute model errors for every park given in Tab.1 are all smaller than total SD and SCD changes over the entire period we have a very high confidence in the trend analysis results concerning the whole investigated period of 56 years. For shorter sub periods, we have high confidence in all results for periods > 30 years. For shorter sub periods, model errors often dominate and there is a large natural inter-annual to decadal variability of the snow cover.

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Habitat selection of alpine chamois under different climatic conditions in the Alpine and Carpathian mountain chains

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Abstract

In its native environment alpine chamois occupies habitats from montane to alpine altitudinal zones of the Alps. The introduction into the forested foothill and montane altitudinal zones of the Carpathians exposes the species to diverse weather and climate conditions. We discuss differences in habitat selection under boreal-alpine climate conditions and humid continental climate conditions based on long term monitoring data (Berchtesgaden National Park) and field studies (Great Fatra National Park).

Keywords

chamois, habitat selection, climate, weather, Alps, Carpathians, Berchtesgaden, Great Fatra, national park

Introduction

Weather and regional climate have been long recognized as the main factors influencing the biotic systems (FIRSINA & FIRSINA 2008). In the case of ungulates inhabiting a certain climatic region the influence of climatic conditions is one of the major limiting factors for the species distribution. In general alpine chamois is considered to occupie habitats from montane to alpine altitudinal zone of the Alps with seasonal changes in habitat selection, which are repeated periodical every winter and summer (KNAUS & SCHRÖDER 1975). The common pattern for the chamois population in the Alps is characterized by a seasonal vertical migration between the higher subalpine and alpine zones in summer and the lower montane forest zones in winter (ELSNER-SCHACK 1985). In 1955 a population of alpine chamois was introduced to the Carpathian National Park Great Fatra (SOKOL 1965). In the area neither a subalpine or an alpine zone exist. In this montane forested environment, vertical migration is virtually excluded and chamois population is exposed to other climatic conditions, as in the natural area of species distribution (ORAVEC 2010). We discuss the habitat selection of alpine chamois under different climatic conditions of the Alps and Carpathians based on long term monitoring data (Berchtesgaden National Park) and field studies (Great Fatra National Park).

Methods

The research area in the National Park Berchtesgaden, which represents the native environment of alpine chamois, is situated in south-east Germany (Bavaria) in the Northern Limestone Alps. The National Park is located in the climatic transition zone between temperate oceanic climate and cool continental climate (KONNERT 2004). The altitude difference of 2110 meters creates typical mountain local-climate that affects the variation of main meteorological factors (KRALLER 2008). That creates extremely diverse conditions with habitats range from hard oligo-mesotrophic waters with benthic vegetation of *Chara spp*. to permanent glaciers (LANG & WALENTOWSKI 2008). Large predators are not present and chamois hunting is only allowed in the buffer zone of the National Park. The Data were collected by observers in Jenner and Watzmann area since 1997 until the year 2012 (LOTZ 2000). Recorded was location, total count of individuals, sexual and age structure. The environmental variables where extracted with GIS. No further statistical analysis was undertaken and the data are not published yet.

The area of the field studies in the Carpathian Mountains is located in the middle Slovakia in the south-west part of the National Park Great Fatra. The introduced individuals are influenced with warm continental and temperate continental climate (VESTENICKÝ et al. 1986). The research area is a mountainside between foothill and montane altitudinal zone predominated by Medio-European limestone beech forests, secondary originated non forest areas and limestone rock habitat with Western Carpathian calcicolous *Pinus sylvestris* forests, with the highest elevation 1069 m a.s.l. All large predators are present in the area and chamois hunting is allowed. The data on the chamois population were recorded since 2008 until 2010 with continual focal animal sampling method (MARTIN & BATESON 2007). The total number of individuals, habitat unit and their activity was collected. The significance of differences in habitat selection was tested by a single-factor variance analysis ANOVA. Nonparametric Kruskal-Wallis single-factor analysis, its associated Kruskal-Wallis multiple comparison test and Tukey-Kramer multiple comparison test were used to test the differences. All tests were made at a significance level of 0.05.
The habitat types were very specifically structured for each project target in both areas (e. g. Rock edges, Bottom of cliffs). In order to match the habitat types, they were all grouped into three general categories: Forest area, Non forest area, Rock and scree area.

Time periods of the year are bimonthly grouped (e. g. January - February). In National Park Berchtesgaden the data has been collected yearly from May to October and the data from November to April are not available.

Results

Tab. 1 summarizes the preferred habitat selection of the chamois under different conditions of Alps and Carpathians. The important environmental variables for the species and both study areas are listed.

Prefered Environmental Variables	National Park Berchtesgaden	National Park Great Fatra
Avg. Altitude (Meters)	1697,5	887
Exposition	West	South
Avg. Slope (Degrees)	36,2	36,5
Habitat type	Rock and Scree	Forest area

Table 1: Preferred habitat selection of chamois in National Park Berchtesgaden and Great Fatra (own representation)

The average elevation selected by chamois in Berchtesgaden Alps is greater than the average selected elevation in Great Fatra Mountains. The chamois in both areas select slopes with equal inclination. The predominant exposition selected in National Park Berchtesgaden is west and south-west. In the Great Fatra National park individuals select mostly the south sides. Rock and scree habitats were selected by chamois in the alpine environment and forest areas (Medio-European limestone beech forests) dominated in the selection of the Carpathian chamois (HURTA 2009).

Fig. 1 shows the habitat selection of chamois in Berchtesgaden (B) and Great Fatra (GF) National Park. In bimonthly time periods of May – June (M - J), July – August (J - A) and September – October (S - O) the chamois in the Carpathians mainly selected the forest areas. The selection by the chamois in the Alps remained constant over this three bimonthly time periods. Statistical significant was the selection of the forest areas in the Carpathians by chamois in the time period May – June (Kruskal-Wallis nonparametric test, $H_{0.05,\,5,\,375} = 15.74$; p = 0.007642). The individuals selected the forest areas more often as in the rest of the year. The total number of individuals was also higher in this period of the year as in the winter periods ($\beta = 0.346$, Wald $\chi^2 = 11.46$, p= 0.0007) (ORAVEC 2010). The average selection of forested areas by chamois in Great Fatra is twice as much as the selection of forested areas in Berchtesgaden.

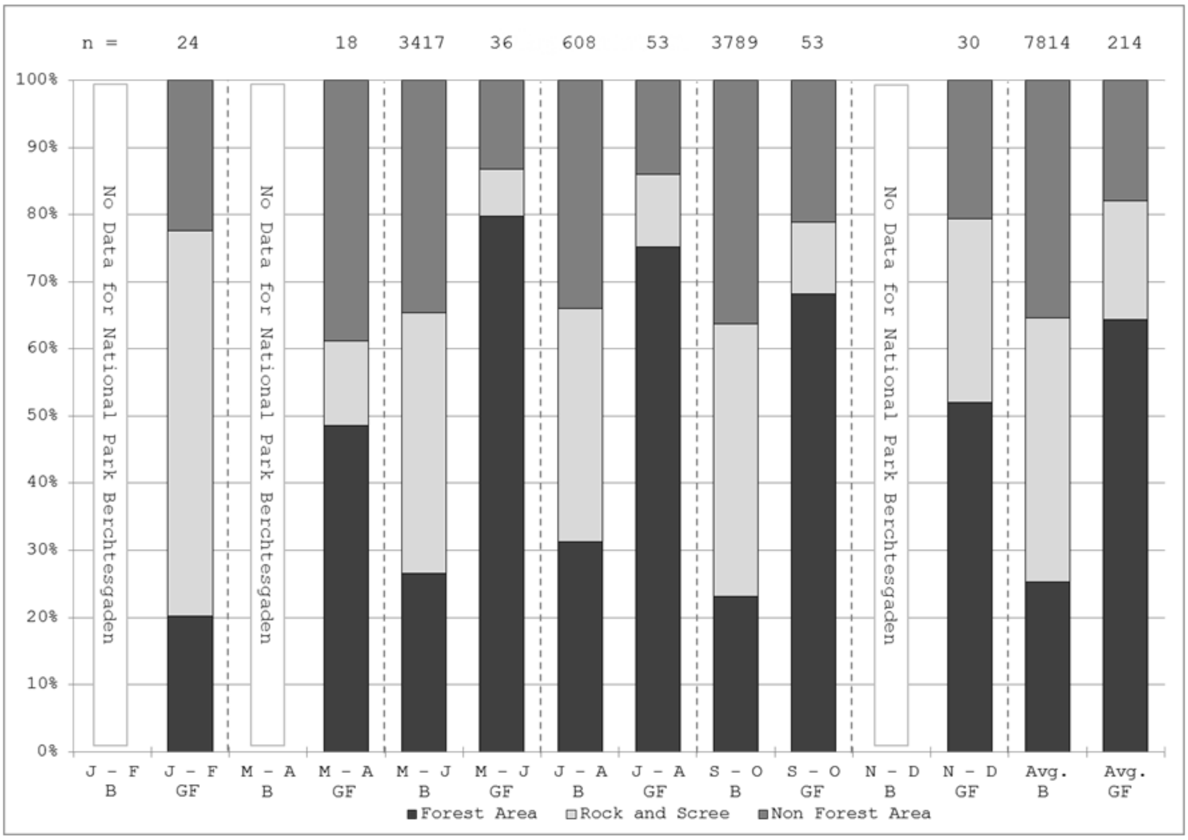

Figure 1: Habitat selection of chamois in National Park Berchtesgaden (B) and Great Fatra (GF) grouped by bimonthly periods (ovn representation)

Discussion

The chamois population in the Alps is characterized by a seasonal vertical migration (ELSNER-SCHACK 1985). In summer chamois selected higher altitudes. The reason is the availability of qualitative food supplies, lower ambient temperature and better visibility of the environment (JAMROZY et al. 2007). Chamois in Carpathians select in summer months predominantly the forest areas (ORAVEC 2010). Such similar patterns have been observed in the forest living populations in Switzerland (BAUMANN & STRUCH 2001), Czech Republic (JIRÁT 2000), Spain (GARCIA-GONZALEZ & CURTAS 1996) and New Zealand (YOCKNEY & HICKLING 2000). The migration in higher altitudes in summer like in the alpine native environment is not possible and the individuals are forced to adapt to the new conditions. The significantly higher selection of forested areas by the individuals in the bimonthly periods of May – June, July – August and September – October is probably caused by a behavioral thermoregulation. The animals select the coldest habitat and lower their activity level in the summer months. This is a strategy of the individuals to avoid the heat stress and to keep the energy expenditures for body cooling at its lowest. This strategy may be the clue to overcome the conditions in warm climatic regions where the possibility to vertically migrate in higher altitudes is not given. The strategy was observed in other ungulates such as *Alces alces* (LOWE et al. 2010), *Tragelaphus strepsiceros* (OVEN-SMITH 1998) and *Capra hircus* (SHI et al. 2006). The populations that live under these different conditions such as the population in Great Fatra or individuals in the Nature Park Upper Donautal show that the species has a broader ecological valance than has been claimed. The resulting factor of the chamois distribution in an area is not the altitude but the steepness of the terrain, which is the common factor for both areas in our comparison Table in the chapter Results. The adaptability and broad ecological optimum shows the introduction of chamois to the Mount Cook Mountains, New Zealand, in 1907 (YOCKEY & HICKLING 2000).With an absence of natural predators and hunting pressure individuals spread to lower steep forested areas near the sea level. In the Great Fatra, individuals of alpine chamois were introduced to foothill and montane zone in 1955. Their genetic information can be now found in the population of tatra chamois (*Rupicapra r. tatrica*) that inhabits the subalpine zone of the Low Tatra Mountains (ZEMANOVÁ et al. 2015). This is the present evidence that the species can occur also in low range mountains or even in steep lowland landscapes. The historical evidence shows that chamois not only occurred in the highest mountains. Fossil findings of chamois skeletons from caves and excavations all over Europe show that the glacial Pleistocene distribution of the species was much larger than today (JAMROZY et al. 2007). The Alps where covered with glaciers and the ice age chamois was forced to use steep slopes in the low altitude mountains. There are some similarities with the introduced population in the National Park Great Fatra, but not the warm climate. How affects warm climate the survival or reproduction rates, behavior and seasonal patterns of chamois in Great Fatra? Is the species adaptability and ecological optimum greater than we supposed? That could be new research questions for species that live in such different environmental conditions.

Conclusion

Chamois are considered to be an alpine species, which is contradictory to the occurrence of an introduced population in Great Fatra National Park.

Individuals in both areas select the common steepness of the slopes. Differences become apparent in habitat selection, where chamois in the Carpathians select more often forested areas as chamois in the Alps. The switch in Habitat selection towards the forested areas may due to warmer climatic conditions and impossibility of vertical migration. Research on chamois populations in predominantly forested environments can bring new insights into adaptability and ecology of this species.

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Predicting future glacial lakes in Austria – preliminary results

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Keywords

Glacial lakes, glacier change, climate change, modelling

Summary

Glacier retreat is one of the most apparent consequences of temperature rise in the 20th and 21st century in the European Alps. In Austria, more than 260 new lakes have formed in glacier forefields since the Little Ice Age (BUCKEL et al., submitted). A similar signal is reported from many mountain areas of the world (CARRIVICK & QUINCEY, 2014; GARDELLE et al., 2011; ZHANG et al., 2015). Glacial lakes can constitute an important environmental and socio-economic impact on high mountain systems including water resource management, sediment delivery, natural hazards, energy production and tourism. Their development significantly modifies the landscape configuration and visual appearance of high mountain areas. Some proglacial lakes have attracted public attention due to disastrous hazard events like outburst floods or increasing hazard potential and risk downstream (ICIMOD, 2011). Increasing public awareness of climate change and related hazards, as well as scientific interest from landscape evolution studies, has put glacial lakes in the spotlight of current high mountain research (CARRIVICK & TWEED, 2013; HAEBERLI et al., 2016). Knowledge on the location, number and extent of future lakes can be used to assess potential impacts on the high mountain geo-ecosystems and upland-lowland interactions. This information is significant to appraise threads and potentials provided by the new lakes for society.

The recent developments of regional ice thickness models (FARINOTTI et al., 2017) in combination with high resolution glacier surface data enables to produce models of the future ice free topography below current glaciers by subtracting modelled ice thickness from glacier surface. Analyzing these potential glacier bed surfaces reveals overdeepened bedrock depressions that represent potential locations for future lakes.

In order to predict the formation of glacial lakes within the ice covered terrain in the Austrian Alps we apply different ice thickness models using high resolution terrain data and available glacier outlines. The results are compared and validated with glacier thickness data from geophysical surveying. Additionally, we run the models on three different glacier extents provided by the Austrian Glacier Inventories from 1969, 1997 and 2006 (FISCHER et al., 2015). We present preliminary results of the first model runs here which are compared to existing glacial lakes and geophysical data on ice thickness. First results show a significant mismatch between the models and reality. The applicability of ice thickness models for the detection of future lakes therefore needs critical consideration.

Methods

We applied two different ice thickness models to Austrian glaciers at different extents. Initial ice thickness distribution was developed according to the ice thickness estimation method (ITEM) of HUSS & FARINOTTI (2012). This physically based method requires an estimate of the surface mass balance gradients to calculate ice volume flux along the glacier. Using an integrated form of the flow law for ice, glacier thickness is calculated including the spatial variability in the basal shear stress distribution with respect to valley shape and inclination of the glacier surface. The second model developed by FREY et al. (2014) is a modification of the GLABTOP approach first published by LINSBAUER et al. (2012). GLABTOP and GLABTOP2 use the shallow ice approximation method which derives ice thickness from the basal shear stress distribution underneath the glacier. The latter is derived using an empirical relation between shear stress and elevation range of the glacier proposed by HAEBERLI AND HÖLZLE (1995). The methods computes ice thickness from shear stress, glacier surface slope, gravitational acceleration and a shape factor. Ice gradient is the main control on ice thickness in this model. In GLABTOP2 ice thickness is quantified for random cells and subsequently extrapolated. The resulting model of ice thickness delivers the topography of bedrock underneath the glaciers that contain the targeted depressions likely forming new glacial lakes.

Both models use digital elevation data and glacier outlines. Glacier outlines were produced by LAMBRECHT & KUHN (2007) and FISCHER et al. (2015) documenting the shape and size of glaciers at 1969, 1998 and 2006 . Digital elevation models (DEM) of 10 m resolution exist for all glacier extents derived from aerial imagery from the corresponding years. Subglacial depressions have been generated by simple subtraction of ice thickness from the ice surface DEM.

Results

The models produce around 200 depressions underneath the existing glaciers in Austria. Both models produce depressions at similar locations (Fig. 1). Glabtop2 tends to produce larger objects and more depressions at similar locations in all three model runs. A total area of 8.7 and 12.2 km² of subglacial depressions is modelled by Huss&Farinotti and Glabtop2, respectively.

Evaluation of the ice thickness models is performed using field data on ice thickness delivered from ground penetration radar measurements. A first comparison reveals that both models overestimate the ice thickness thus producing lower bedrock surfaces potentially leading to more and deeper depressions.

Comparing modelled depressions using the 1969 glacier extent with existing lakes reveals a poor location match (< 25 %). GLABTOP2 and Huss and Farinotti produce significantly more depressions (96% and 43%, respectively) than existing lakes. However, around 90% of modelled depressions are located in flat terrain (< 5°) indicating possible locations of filled-up depressions within the glacier forefields.

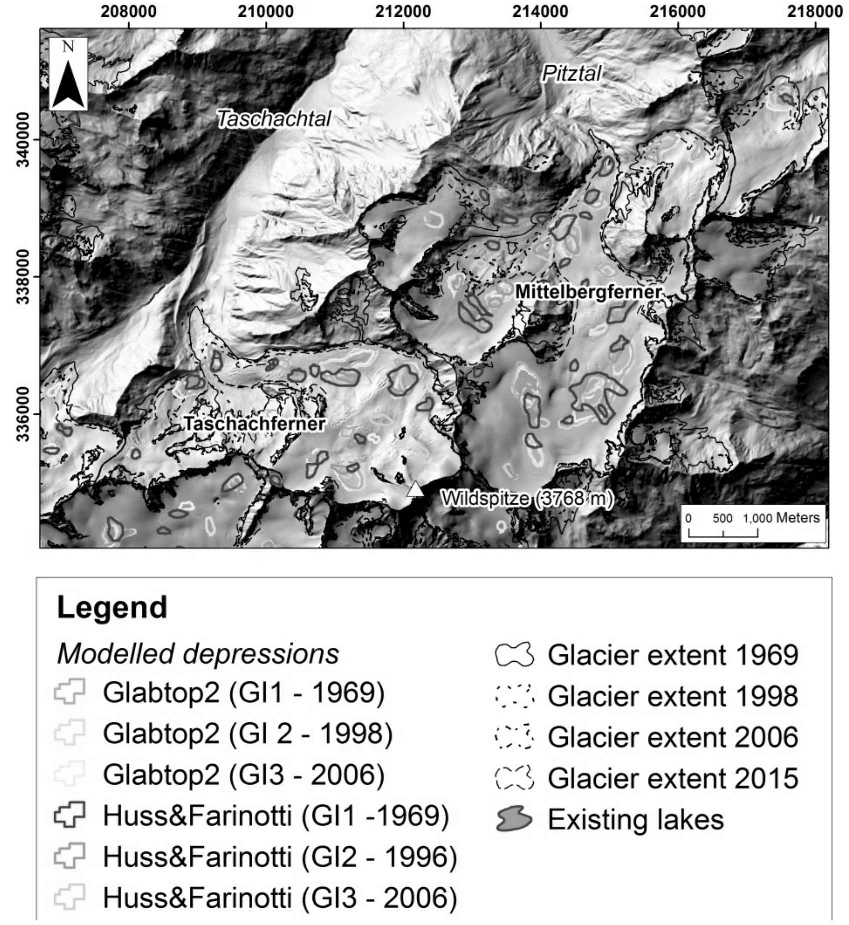

Figure 1: Locations of modelled depressions in the Taschachtal/Pitztal area (Tirol).

Conclusion

The models generated potential subglacial depressions in a similar pattern. First comparison however shows that the results need to be considered carefully and critically discussed. Various impacts on the modelling performances will be analyzed and discussed in a next step including geomorphologic controls for example due to glacial sediment deposition, glaciological controls and impacts due to model principles such as the application of a single shear stress value for an entire glacier.

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Stakeholders' opinions about the relevance of human activities in Natura 2000 sites: comparison among three European countries (Italy, Slovenia, Slovakia)

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Abstract

Natura 2000 network represents the cornerstone of European Union's nature conservation policy, aimed at ensuring the long-term protection of endangered species in their natural habitats in the territory of EU Member States. The EU based the implementation and management of the Natura 2000 network on the dynamic-innovation approach (integration approach), which combines human activities and nature conservation purposes in the sites or in close proximity to these. The success of the integration approach rests on the collaboration among different stakeholders. Collaboration is fundamental to facilitate the social acceptance of the potential restrictions to the economic activities and to reduce the conflicts due to the perceived unequal distribution of costs and benefits between social actors. The aim of the present study is to analyze the stakeholders' opinions about the relevance of human activities in the Natura 2000 sites in three EU members' countries (Italy, Slovenia and Slovakia). In order to achieve this aim three steps were followed in each country: stakeholder analysis; questionnaire survey; data processing and interpretation of results. Through the stakeholder analysis 96 stakeholders - 56 in Italy, 25 in Slovenia, 15 in Slovakia - were identified and further involved in the survey. The stakeholders' opinions were collected using a questionnaire administered by email. The results show that in all three countries the stakeholders consider nature conservation as the most important human activity in the Natura 2000 sites. In addition, the Slovenian stakeholders emphasized the relevance of forest activities, while the Italian stakeholders highlighted the importance of environmental education and the Slovakian stakeholders the relevance of agricultural activities.

Keywords

protected areas, nature conservation, integration approach, stakeholders' involvement, multi-stakeholders, survey.

Introduction

The Natura 2000 network - established by the Directive 92/43/EEC (or 'Habitats Directive') and Directive 79/409/EEC (or 'The Bird Directive') - was implemented and managed by the European Union (EU) according to the 'integration approach' (JONES et al. 2015). The integration approach is based on combining human activities - i.e. recreational activities, agricultural and forestry practices, environmental education, research activities - and nature conservation aims in the same area or at least in close proximity (STOLL-KLEEMANN 2001). This approach is considered the most suitable one for the management of protected areas in Europe because a large part of Natura 2000 sites are located in rural contexts where significant human activities have always existed and may even have contributed to the creation of certain habitats of conservation value. In these situations the protection of habitats and wildlife species including at the same time inhabitants' wellbeing and better quality of their lives is a priority of the integration approach (PIETRZYK-KASZYŃSKA et al. 2012). At local level the stakeholders' involvement is a key point in order to implement the integration approach, as recognized by the Declaration of EI Teide Declaration (2002): '*…the success of Natura 2000 will require the support of European citizens, especially of local people and landowners, and their participation in the decisions on the implementation of the conservation and management of the areas involved*". Individuals and organized groups (public institutions, private organizations, and associations) can be involved in the decision-making process at different levels namely information, consultation, collaboration and empowerment (BALEST et al. 2016, BRESCANCIN et al. 2017). Information is the level at which stakeholders are assisted in understanding decisions' alternatives through balanced and objective information. Consultation consists in identifying the variables considered relevant in the system to be managed with the purpose to obtain public feedback on analysis, alternatives and/or decisions. Collaboration is the level of participation in which the stakeholders are involved in each aspect of the decision including the development of alternatives and the identification of the preferred solution. Finally, empowerment is the level of participation which places the final decision making in the hands of the stakeholders (IAP2 2007).

Starting from these considerations, the main objective of this study is to analyze stakeholders' opinions about the importance of different human activities in Natura 2000 sites. Relevant stakeholders involved in the process of consultation during Natura 2000 network implementation have been surveyed through a questionnaire. The study was developed in three EU member countries - Italy, Slovenia and Slovakia - involved in the COST Action FP1207 'Orchestrating forest related policy analysis in Europe' (ORCHESTRA - https://sites.google.com/site/costactionfp1207/).

Materials and methods

The study was structured in three main steps:

1. stakeholder analysis;
2. questionnaire survey;
3. data processing and interpretation of results.

Stakeholder analysis

The stakeholder analysis encompasses a range of different methods and techniques used to analyze in systematic way stakeholders' roles, relationships, interests, and influence in the decision-making process (REED 2008). The objective of stakeholder analysis is to identify any individuals and groups who are affected by or can affect parts of the process, and to prioritize them in respect to their involvement in the decision-making process (REED et al. 2009, PALETTO et al. 2015).

In the present study, in order to identify and classify the stakeholders in the three EU member countries (Italy, Slovenia and Slovakia) was adopted the same stakeholder analysis approach. During the first step, a preliminary list of stakeholders was developed by a group of researchers involved in the COST Action 'ORCHESTRA' with the support of national experts. Relevant stakeholders in Natura 2000 network implementation were identified based on their influence and relevance in the ambit of the process of sites implementation. Then, previously unknown stakeholders were identified with a snowball sampling approach, in which first identified relevant actors provide additional stakeholders to the preliminary list (HARRISON & QURESHI 2000). At the end of this step, 56 stakeholders in Italy, 25 in Slovenia and 15 in Slovakia were identified and involved in the survey.

During the second step of stakeholder analysis, the stakeholders were classified in four groups based on their status and interests for Natura 2000 network (Tab. 1): public administrations, universities and research institutes, environmental NGOs, farmers and forest owners associations. The different and not always balanced distribution of stakeholders in the four groups is due to the political structure of the country (centralized system in Slovakia and Slovenia and federal system in Italy) and to the non-response rate.

Country	Groups of stakeholders	Number of stakeholders
Italy	Public administrations	29
	Universities and research institutes	7
	Environmental NGOs	8
	Farmers and forest owners associations	12
	Total	*56*
Slovenia	Public administrations	8
	Universities and research institutes	8
	Environmental NGOs	4
	Farmers and forest owners associations	5
	Total	*25*
Slovakia	Public administrations	7
	Universities and research institutes	6
	Environmental NGOs	1
	Farmers and forest owners associations	1
	Total	*15*

Table 1: List of stakeholders involved in the survey by country and group of stakeholders.

Questionnaire survey

A semi-structured questionnaire was used to collect data aimed to investigate stakeholders' opinions about the importance of human activities in Natura 2000 sites in the three EU member countries. The questionnaire is formed by 25 questions divided in three thematic sections ('Personal information', 'Natura 2000 network perceptions' and 'Public participation in the implementation of Natura 2000'). The present paper is focused only on the question 'Could you compare the importance given to nature conservation (biodiversity), agricultural activities, productive forest activities, recreational activities, environmental education and research activities in the Natura 2000 network?', belonging to the second thematic section. The list of human activities considered in the study was developed by researchers involved in the COST Action 'ORCHESTRA' and national experts (Tab. 2).

The semi-structured questionnaire was administered to previously identified stakeholders by email. After 15 days, a reminder email to all those who did not respond to the initial mailing was sent.

N°	Activity	Description
1	Nature conservation	Nature conservation activities are aimed at saving the structures that have evolved in the Natura 2000 sites over time. The nature conservations activity includes all those practices aimed to preserve and improve the natural environment.
2	Recreational activities	Natura 2000 sites are the backdrop for non-consumptive recreational activities such as hiking, bird watching, wildlife viewing and relaxing. Conversely, in Nature 2000 sites are excluded the following recreational activities: gaming, fishing, picking non-wood products.
3	Agricultural activities	Agricultural practices achievable in Natura 2000 sites in accordance with the restrictions established by current legislation. The main restrictions concern mowing in the meadows and pastures in the spring-summer time, number of cattle grazing, and tillage of the soil.
4	Forest activities	Silvicultural treatments aimed to improve the productive function (timber and bioenergy production) of forests in accordance with the restrictions contained in the current legislation.
5	Environmental education	Environmental education is a learning process that increases people's knowledge and awareness about the environment and associated challenges, develops the necessary skills and expertise to address the challenges, and fosters attitudes, motivations, and commitments to make informed decisions and take responsible action (UNESCO, Tbilisi Declaration, 1978).

Table 2: Description of human activities achievable in Natura 2000 sites. Source: DE MEO et al. (2016).

Data processing

Analytic Hierarchy Process (AHP) method was applied to analyze relevant stakeholders' opinions concerning the importance of human activities in the Natura 2000 sites. AHP is a method that uses pairwise comparisons of the alternatives for solving multi-criteria decision-making (MCDM) between a finite number of alternatives. This method was developed by SAATY (1987) in order to solve complex decision problems and make accurate decision and judgment for complex systems.

In this study, relevant stakeholders evaluated the importance of the five human activities reported in Tab. 2 comparing them in pairs:

Activity 1	5 Much more important	3 Somewhat more important	1 Equal importance	1/3 Somewhat more important	1/5 Much more important	Activity 2

A pairwise comparison for all five activities was applied, followed by the calculation of the priority value of each activity using the eigenvalue method. The eigenvalue method is based on a procedure of averaging the direct and indirect estimations of the comparisons. At the end of the procedure, the priority score of each activity was used as indicator of stakeholder's individual perception of activities' importance. In addition, we tested the consistency of the matrix using the following formulas:

$$CI = \frac{(\lambda_{\max} - n)}{(n-1)}$$

$$CR = \frac{CI}{RI}$$

Where: CI is consistency index, CR is the consistency ratio, RI is the expected consistency index obtained from random generated comparisons of the same order n. CR is used to measure how consistent the judgments have been relative to large samples of purely random judgments. The value of CR should be lower or equal to 0.1 (10%) in order to have consistency of the matrix.

Results

The results show that in the three EU member countries nature conservation is considered as the most important human activity in Natura 2000 sites in order to maintain a high level of habitat and species biodiversity. Nature conservation priority scores reported in Tab. 3 are similar for the three countries and respectively 0.3029 in Italy, 0.2849 in Slovenia, and 0.3212 in Slovakia. According to stakeholders opinions in Italy and Slovakia environmental education occupies the second position in importance (priorities scores respectively 0.21 and 0.20), while in Slovenia forest activities are ranked second in the rating. In all three EU member countries recreational activities are considered marginal in the Natura 2000 sites with a priority score of 0.1088 in Italy, 0.1192 in Slovenia, and 0.1503 in Slovakia.

Activity/Country	Italy (n=56)	Slovenia (n=25)	Slovakia (n=15)
Nature conservation	0.3029	0.2849	0.3212
Recreational activities	0.1088	0.1192	0.1503
Agricultural activities	0.1921	0.1957	0.1700
Forest activities	0.1880	0.2455	0.1611
Environmental education	0.2081	0.1548	0.1975
CI	*0.0107*	*0.0063*	*0.0027*
CR	*0.0072*	*0.0042*	*0.0018*

Table 3: Priorities scores for five human activities in Natura 2000 sites by country.

When observing the results by group of stakeholders interesting differences are highlighted in the three countries (Tab. 4). In Italy all groups of stakeholders consider nature conservation (priority score for public administrations 0.2695, environmental NGOs 0.3015, universities and research institutes 0.3577, farmers and forest owners 0.3509) the most important activity in Natura 2000 sites. Conversely, environmental education occupies the second place for two groups of stakeholders (public administrations and environmental NGOs with priority score respectively 0.2143 and 0.2782), while for the representatives of the other two groups (universities and research institutes and farmers and forest owners associations) agriculture represents the second activity with a priority score respectively 0.2233 and 0.1966.

In Slovenia nature conservation is the most important activity in Natura 2000 sites for three groups of stakeholders (public administrations, environmental NGOs, universities and research institutes), while for farmers and forest owners associations forest activities are considered the most important in Slovenian Natura 2000 sites with a priority score 0.2851.

In a similar way, in Slovakia nature conservation occupies the first place for three groups of stakeholders (public administrations, environmental NGOs, universities and research institutes) while for the farmers and forest owners associations the most important activities are forest activities (priority score 0.4147) followed by agricultural activities (priority score 0.3052).

These differences are due to several geographic, territorial and socio-economic variables such as main land uses in Natura 2000 sites or in close proximity, relative importance of human activities, and cultural background of stakeholders in each country. For example, Slovenia has a long forest management tradition and the wood products are important for the local economy as merged from results. Besides, in Slovakia many Natura 2000 sites are in rural area and therefore stakeholders underline the relevance of agricultural activities also in these protected sites. In Italy, in the last decades, the non-marketable ecosystem services are often considered more important than timber and bioenergy production; for this reason stakeholders point out the importance of nature conservation and environmental education rather than forest activities.
Finally, it is important to highlight that for all comparisons, the consistency ratio (CR) resulted less than 0.1.

Italy				
Activity/Group	Public administrations (*n*=29)	Environmental NGOs (*n*=8)	Academia and research institutes (*n*=7)	Farmers and forest owners associations (*n*=12)
Nature conservation	0.2695	0.3015	0.3577	0.3509
Recreational activities	0.1137	0.1019	0.0839	0.1134
Agricultural activities	0.1914	0.1595	0.2233	0.1966
Forest activities	0.2112	0.1589	0.1767	0.1611
Environmental education	0.2143	0.2782	0.1583	0.1781
CI	0.0153	0.0369	0.0106	0.0045
CR	0.0103	0.0248	0.0071	0.0030
Slovenia				
Activity/Group	Public administrations (*n*=8)	Environmental NGOs (*n*=4)	Academia and research institutes (*n*=8)	Farmers and forest owners associations (*n*=5)
Nature conservation	0.2889	0.3303	0.2904	0.2153
Recreational activities	0.1178	0.2091	0.0960	0.0982
Agricultural activities	0.1772	0.1181	0.2120	0.2712
Forest activities	0.2593	0.1387	0.2630	0.2851
Environmental education	0.1568	0.2038	0.1386	0.1301
CI	0.0366	0.0668	0.02111	0.0164
CR	0.0246	0.0449	0.01417	0.0110
Slovakia				
Activity/Group	Public administrations (*n*=7)	Environmental NGOs (*n*=1)	Academia and research institutes (*n*=6)	Farmers and forest owners associations (*n*=1)
Nature conservation	0.3698	0.2816	0.2994	0.1144
Recreational activities	0.1375	0.2260	0.1530	0.0918
Agricultural activities	0.1289	0.1169	0.2051	0.3052
Forest activities	0.1246	0.0939	0.1838	0.4147
Environmental education	0.2393	0.2816	0.1587	0.0737
CI	0.0203	0.0323	0.0245	0.0364
CR	0.0136	0.0217	0.0164	0.0244

Table 4: Priorities scores for five human activities in Natura 2000 sites by country and group of stakeholders.

Conclusion

The results of this kind of studies can be used as starting point for future researches aimed at investigating stakeholders' opinions and views relating to human activities and Natura 2000 sites implementation. This issue is relevant - as recognized by international literature - because the success of Natura 2000 is strictly dependent from the relationship between human activities and ecological conservation in the protected sites (BEUNEN & DE VRIES 2011, TSIAFOULI et al. 2013). Many European countries (FERRANTI et al. 2010, MILLIGAN et al. 2009) experienced conflicts and difficulties during the process of Natura 2000 network implementation and in some cases occurred that directly affected stakeholder have been in a suspicious attitude because they were not consulted (WURZEL 2008).

In this context, the valuation of stakeholders' opinions about the relevance of human activities in the Natura 2000 sites is an important aspect in order to ease the social acceptance of nature conservation policy. Furthermore stakeholders' involvement in the protected areas management is a key ingredient to reduce the potential conflicts between opposite interest parties and to increase the reciprocal trust. Finally, the consultation of stakeholders in the management of protected areas has the advantage to increase the positive partnerships between civil society and public authorities.

Providing an exhaustive knowledge base of the different stakeholders' point of views can support the improvement of policy strategies to reconcile nature conservation and human activities in Natura 2000 sites.
Being these kind of studies based on stakeholder analysis and questionnaire implementation, the methodology can be easily replicated in different contexts and similar studies can be easily be carried out in other European countries.

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Bioclimatic indices in the context of biodiversity, Karkonosze/Giant Mts., SW Poland

Piotr Pawliczek

Abstract

A number of bioclimatic indices were calculated for Szrenica in Karkonosze Mts. The analysis for the years 1961-2015 showed an temperature increase from 2.1 °C in 1961-70 to 3.4 °C in 2001-15. The other bioclimatic indexes values that were calculated did not show any significant changes throughout the analyzed period.

Keywords

Bioclimatic indices; Biodiversity; Climate change; Karkonosze Mts.; Sub-alpine zone

Introduction

The mountain area of the Karkonosze Mts. due to the relatively small transformations of land use by man, is a good place for credible climate research. Furthermore, a sensitive ecosystem with high biodiversity is very susceptible to any environmental change, including climate change. Progressive warming of the climate is also observed in the Karkonosze Mts. and cannot be carried out without changes in the environment.

Research area and methods

Szrenica (φN 50°44' and λE 15°44'; 1362 m a.s.l., meteorological station at 1335 m a.s.l.) is a peak in Western Karkonosze, situated within the dwarf pine belt. According to the classification by ELLENBERG (1978), Szrenica belongs to the sub-alpine climate zone. It's located in the Karkonosze National Park, which is also an area of Transboundary Biosphere Reserve Karkonosze (Poland-Czechia).

Based on thermal data from period 1961-2015 at Szrenica Mt., a number of bioclimatic indices were calculated: mean annual temperature, annual temperature range, Gorczinski Continentality Index (GORCZYŃSKI 1920), JOHANSSON-RINGLEB'S continentality index (1926, by OKOŁOWICZ 1969), De Martonne aridity index (DE MARTONNE 1925), Ellenberg's climate quotient (ELLENBERG 1988). Temperature and precipitations from period 1961-2000 were measured at station belonging to University of Wroclaw. Data's from 2001-15 are reconstructed on values from Labská Bouda which was founded in 1979 and is managed by Czech Hydrometeorological Institute (ČHMÚ). Both stations are close together (about 3 km), at near altitude (respectively 1335 and 1320 m a.s.l.). Temperature correlation between stations in period 1981-2000 (when both stations were in operation) is about 0.99. Precipitation correlation is weaker, probably in case of significant influence of wind, but still it is 0.84.

Results

Mean annual temperature in 1961-2015 was 2.6 °C. Since the late 1980's a noticeable increase in average annual temperature has been observed (Fig. 1.). Higher temperature is reflected in the extension of the growing season. Average growing season in the period 2001-15 lasted 162 days compared to 143 days in 1991-00, 141 days in 1961-70 and also in 1981-90 and 130 days in 1971-80.

Value of the Gorczinski index (K_G), based on annual temperature range, varies throughout the whole analyzed period between 25% and 55% (Fig. 2.) and average was 42% (where 100% means extremely continental climate in Verkhoyansk). This shows the lack of change between the continental and oceanic influences of air masses though the years. Similar conclusions can be drawn from Johansson-Ringleb's (K_{JR}) index values, which was also stable throughout the analyzed period. Unlike the K_G index, K_{JR} index takes into account the temperature difference between autumn and spring.

Ellenberg (EQ) and De Martonne(I_{dm}) indexes uses besides thermal values also annual precipitation value. EQ index (which include temperature of the warmest month in year) shown steady course over the years (Fig. 3.) with slight deviations due to the rising temperature of the warmest month of the year as well as the increase annual sum of precipitation. The resulting average value of 8.7 is typical for subalpine zone (EQ<10). I_{dm} index indicates a steady course since the mid 80's (Fig. 4.). Previous large fluctuations were due to greater annual variability of annual average temperature. The average value of 65 in analyzed period puts the subalpine zone in Karkonosze Mts. in extremely humid climate zone (I_{dm}>55).

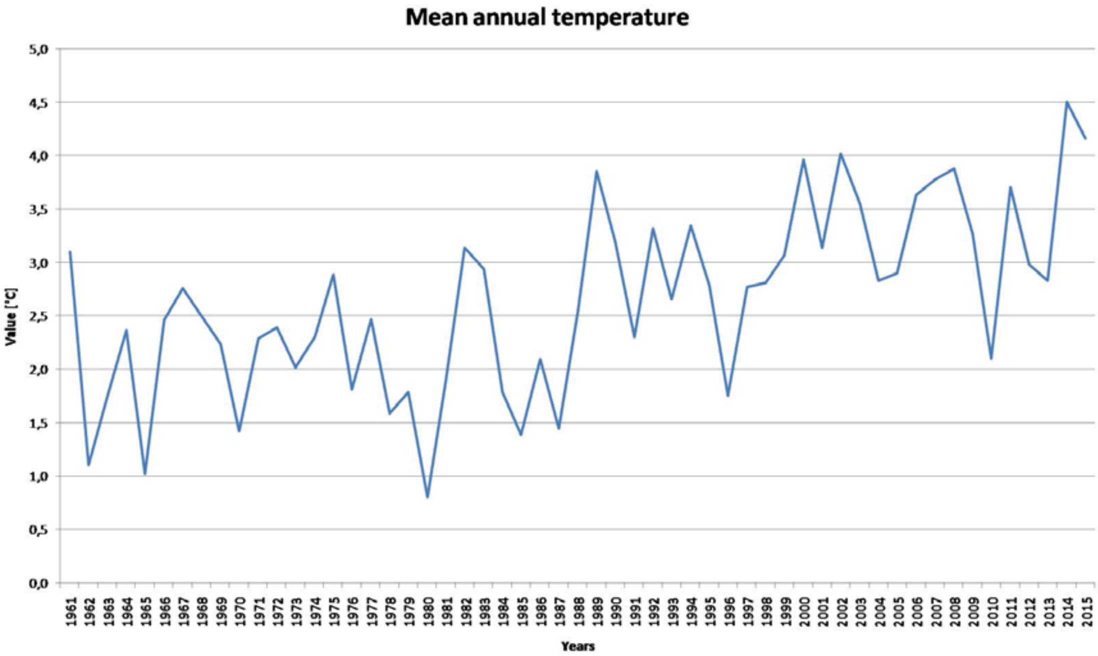

Figure 1: Mean annual air temperature at Szrenica, 1961-2015 period

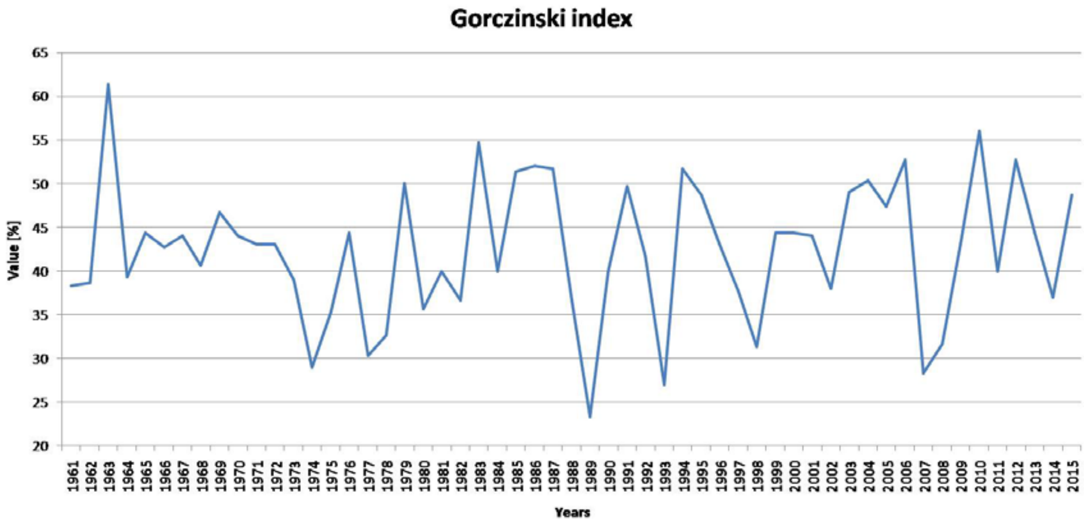

Figure 2: Gorczinski index value at Szrenica, 1961-2015 period

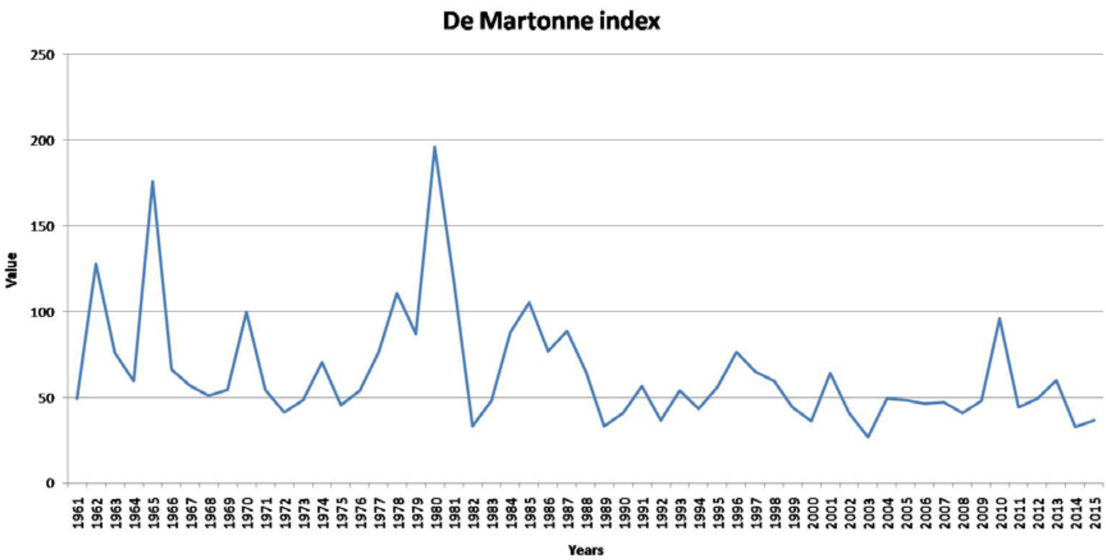

Figure 3: De Martonne index at Szrenica, 1961-2015 period

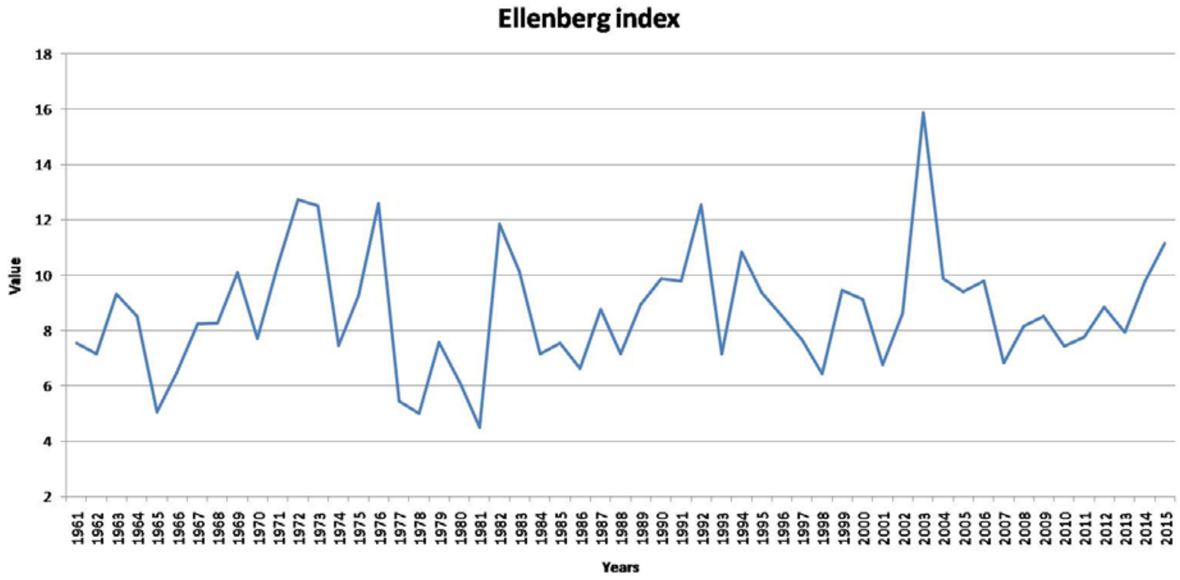

Figure 4: Ellenberg index at Szrenica, 1961-2015 period

Discussion and conclusion

The vast majority of bioclimatic indices show no significant change in values between 1961 and 2015. This proves the preserved balance between oceanic and continental air masses through the year. Also no important change in annual precipitation value was observed. The only major change is the increase in air temperature.
The steady rise in temperature, that has occurred over the last 30 years, undoubtedly leads to environmental changes affecting plant habitats. Research on the Czech side of the Karkonosze Mts. has shown the raising of the tree line (TREML 2004), but you cannot forget that climatic conditions are not the only factor influencing the location of the upper forest border. Higher temperature throughout the year, shorter snow cover and extension of the growing season by almost a month in the period 2001-15 compared to the period 1961-90 will be reflected in the environmental conditions.

The temperature increase of 2-2.5 °C degrees predicted by the end of this century (IPCC 2013) will result in the disappearance of up to 80% of the habitat area of 30-50% of subalpine plant species in different mountain ranges of Europe (ENGLER et al. 2011). The question is how much will this impact on biodiversity in the Karkonosze Mts.?

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The Alpine Health Region Salzburg - an evidence-based health tourism approach for the valorization of natural resources within and outside protected areas

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Abstract

Regarding the growing scientific evidence of nature's positive effects on human health and well-being, protected areas' landscapes build an excellent base for the development of evidence-based health tourism. The Federal State of Salzburg currently follows the approach of a government-driven health tourism development of location-bound natural healing resources. Within the Alpine Health Region Salzburg evidence-based health tourism products are developed and promoted. The strategy is characterized by a constant dialogue between the federal government, medical research and science, and the tourism industry.

Keywords

Health tourism, evidence-based medicine, regional development, protected areas, natural health resources

Introduction

Our modern urban societies increase the need for recreation and preference for nature. Outdoor recreation in natural environments is well on the way to becoming an important element of a healthy lining and a remedy against the deficiencies of an urban life separated from nature (BELL et al., 2007, HÖHNE, 2015, VAN DEN BERG et al., 2007). Therefore, health tourism built on natural resources is seen as a growth driver within the tourism industry and an increasing number of tourism destinations are positioning themselves as health regions in order to attract health-conscious customers (CHANG & BEISE-ZEE, 2013, PERIS-ORTIZ & GARCÍA, 2015, RULLE, 2008).

Medical evidence, i.e. the use of scientifically proven and effective resources and interventions, is an essential prerequisite for health tourism. Regarding the growing scientific evidence of nature's positive effects on human health and well-being, natural resources build an excellent base for the development of evidence-based health tourism (HARTL et al., 2016, STECKENBAUER et al., 2017).

Destinations with a rich heritage of location-bound natural health resources, such as Alpine regions and especially protected areas, dispose of excellent prerequisites for health tourism product development. However, to exploit the growth potential of sustainable nature-based health tourism, a systematic innovation process as well as a structured product and destination development approach is required.
The Alpine Health Region Salzburg

The Austrian Federal State of Salzburg is currently following this approach through a government-driven health tourism regional development initiative. In 2012, a project was launched to evaluate health tourism potentials of natural resources in Salzburg. Within this project, around 200 healing resources relevant to the development of health tourism were identified, located on a resource map and assessed by their tourism potential (STECKENBAUER, 2013, WINKLMAYR & HARTL, 2013).

This potential analysis built the base for the development of the 'Alpine Health Region Salzburg' (Alpine Gesundheitsregion SalzburgerLand). Within this strategy, the province positions itself as major health tourism destination in Europe. In cooperation with all relevant stakeholders evidence-based health tourism products are developed and promoted. A strong focus is on location-bound natural healing resources as basis for health tourism development and USP for specific destinations (SALZBURGER LAND TOURISMUS GMBH, 2016).

The strategy of the Alpine Health Region Salzburg is characterized by a constant dialogue between medical research and science, the tourism industry and regional development agencies. This high level of interdisciplinary interaction fosters quality, professionalism and specialization, and guarantees the development of tourism services based on scientific evidence at all stages of the process (STECKENBAUER et al., 2017). For this approach, the initiative won the Austrian national award 'Flagship Project for Innovative Tourism' in 2013 (BMWFW, 2013).

Future Perspectives

Regarding the further development of the Alpine Health Region Salzburg, great importance is attached to medical-scientific substantiation of identified healing resources and to qualification and knowledge-transfer initiatives in order to strengthen the innovation capacity and knowledge base in health tourism. Currently, the Alpine Health Region Salzburg is involved in two EU-Interreg projects with the target of developing sustainable health tourism products and service chains:

The project 'Trail for Health Nord' (Interreg V-A - Austria-Germany/Bavaria 2014-2020, AB40) focuses on the demographic change and its impact on health tourism. In a cross-border cooperation of research facilities, tourism destinations and transfer organizations, innovative concepts for health tourism are developed that focus on the growing market of senior citizens. A randomized controlled clinical trial, conducted by the Institute of Ecomedicine at the Paracelsus Medical University, builds the base for product development in three tourism regions (TRAIL FOR HEALTH NORD, 2016).

'WinHealth', the second EU-Interreg project, aims at the sustainable valorization of health tourism potentials in Alpine winter tourism (Interreg V-A - Italy-Austria 2014-2020, ITAT2015). The project addresses the urgent need of Alpine regions to develop innovative and environmentally responsible tourism concepts to respond to the already noticeable impacts of climate change and altering customer demands (PICHLER & HARTL, 2016).

The Alpine Health Region Salzburg has raised considerable awareness not only on regional and national, but also on EU-policy level. Within the EU-macroregional strategy EUSALP, health tourism is now seen as strategic sector to increase the economic potential of the Alpine region: Under the chairmanship of the Federal State of Salzburg, the subgroup 'health tourism' within the action group 2 of EUSALP was established (EUSALP, 2017). The interdisciplinary group works on the integration of health tourism as a core area for the establishment of new forms of sustainable Alpine tourism strategies. In this way, it also contributes to nature conservation, as economic benefits derived from nature-based health tourism can serve as incentives for natural resource conservation (SALLETMEIER et al., 2017).

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Vertigo Effect: Institutional dynamics in nature conservation

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Abstract

Red lists of endangered species are meaningful instruments to prioritise efforts in nature conservation in general and in the management of protected areas in particular. By example of Desmoulins's whorl snail (*Vertigo moulinsiana*) we investigate the complex societal and institutional processes that lead to the inclusion of the specimen into IUCN´s and other red lists. In a transdisciplinary research design, we integrate historic and contemporary materials. First results propose that red lists can be considered important societal norms rather than stringently scientific concepts. This would allow and call for new perspectives on nature conservation and protected areas as well.

Key words

Red Lists, protected area management, Desmoulin's whorl snail, transdisciplinary research

Introduction

The presented project is financed by the Jubilee fund of the Austrian National Bank. The object of research is the social and institutional processes that cause endangered animal and plant species to be placed on red lists. We study this using the example of Desmoulin's whorl snail (*Vertigo moulinsiana)* a tiny inhabitant of humid habitats distributed mostly in Europe. The species is on national and international red lists and protected by national legislation of various countries and under Annex II of the EU Habitats Directive.

The available literature shows that the classification of *V. moulinsiana* as a red list species is based on scientific arguments and arguments related to nature conservation biology. However, the initial hypothesis is that red lists are like standards and are derived from the need for standards in specific administrative and legal processes and in political decision-making processes. Unlike, for example, industrial standards, nature conservation decisions are made in an open yet not very explicit process with the participation of civil and scientific actors. Our aim is to investigate this using the instruments of institutional analysis and to answer the following research questions using the example of *V. moulinsiana*:

– What are the societal and institutional processes that lead to the high significance of a specific animal species?
– Which social and institutional processes are expressed in the assessment of a species as 'endangered' or 'protected'?
– What impact does nature conservation classification as 'endangered' or 'protected' have on subsequent social and institutional processes?
– What general conclusions can be drawn from the results for theory-based and practical nature conservation work at international, European, national and local level?

The research team has already dealt with motives and social concerns leading to conflicts in terms of nature conservation topics and especially in protected areas (PICHLER-KOBAN & JUNGMEIER 2015, 2017). The conflicts are often historically justified but also play a major role in the research project outlined here. They are therefore closely linked to the topic of the 'Parks and Management – Conservation Conflicts in Protected Areas' session.

Methods

The methodical approach comprises inquiries based on literature and documents, qualitative interviews and qualitative text analysis. The interdisciplinary project team represents a mix of natural sciences, social sciences, humanities, jurisprudence and economics. The transdisciplinary research design uses the interaction between science and societal reality as a knowledge path culminating in socially robust knowledge (GIBBONS et al. 1994; UKOWITZ 2012, 2014). Perspectives from various specialist fields relevant to the topic and perspectives of relevant public institutions are raised and discussed. The project outcomes are aimed essentially at two target groups: relevant social stakeholders (representatives from politics, public administration and various interest groups) and scientific communities.

Results

As regards *V. moulinsiana*, the process, as portrayed in Red Lists, emerged as follows. Researchers initially focused their attention on the animal. They were specialists with a passionate, albeit undirected devotion to the discovery and labelling of new species (Fig. 1). In 1849, Dupuy described the species. The oldest Austrian evidence dates back to Meynrad von Gallenstein in 1848 and the 'Moorwiesen südlich von Klagenfurt' (bog meadows south of Klagenfurt) (MILDNER 2000). In 1999, zoologist Paul Mildner searched for *V. moulinisana* in the Carinthian Wetlands and identified approximately 30 locations (MILDNER 2000). ELLMAUER (2005) cites 35 recent and one historical Carinthian location. Contrastingly, there have been isolated sightings in the Federal States of Burgenland, Lower Austria, the Tyrol and Vorarlberg with scattered sightings across the whole of Europe. One person made a valid comment on the distribution of Red List species, namely that sightings and dissemination correspond more so to the geographical location of the experts *per se* rather than to the dissemination of the species concerned.

Figure 1: The figure gives an impression of the size of our research object– here named as *Pupa moulinsiana,* one of various synonyms in use for the snail (Photo: Descouens 2013).

Red Lists constitute an attempt to assess the degree of vulnerability of the respective species. A brief review of the history of their emergence shows that the classification – which started out as the initiative of individual researchers – was highly subjective and depended on the experience and preferences of the respective expert. With the increasing importance attached to nature conservation at international level, a professionalization process started to emerge around the creation of Red Lists. The International Union for the Conservation of Nature (IUCN) established a Species Survival Commission (SSC) and set itself the task to develop worldwide standards for developing Red Lists and introduced these in 1994 as Red List Categories and Criteria. Red Lists are legally incorporated in international conventions, e.g. Convention on Biological Diversity, Bonn Convention. At the same time, other national and regional Red Lists continue to be strongly influenced by individual researchers. The Berne Convention was launched on the international stage in 1979. In Austria, the content essentially deals with the Bird Protection Directive and the Fauna Flora Habitat Directive. The provisions are stipulated in the nature conservation and hunting laws of the Federal States.

The afore-mentioned agreements and laws are reflected in numerous regulations which must be implemented within official nature conservation directives, e.g. the designation of Natura 2000 sites due to the presence of specific types of habitat or the presence of annex species. The associated constraints or restrictions and potential resulting conflicts are areas where the impact of Red Lists can be initially perceived for various interest and population groups.

Discussion/Conclusion

Our research to date suggests that the selection and classification of species as 'endangered' or 'protected' are partly due to chance and partly to subjective perception. Decisions made on this basis are all well and good. However, if there is no evidence to show how these decisions were reached, they will be deemed 'arbitrary' and vulnerable.

Application of the Red List option at several levels (international, national, regional) as well as the list of annex species at European level and the legally binding implementation in federal structures generate a complex institutional landscape and considerable density in terms of nature conservation. It is perceived by large parts of society as 'overbearing nature conservation'.

The considerable relevance of Red Lists in many areas of nature conservation shows how important it is to examine this tool. Even some participating stakeholders are unclear as to how Red Lists emerge, how they are applied and how much impact they ultimately have. Individuals interviewed at all levels (regional, national, international) welcome the scientific debate surrounding this topic.

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The recovery of ecologically and chemically impaired tributaries in the Podyí/Thayatal National Park

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Abstract

The Fugnitz and Kajabach brooks enter the Podyjí/Thayatal National Park loaded with impacts from upstream reaches. In the Fugnitz brook fine sediments and bacteria from manured fields are washed in during rainfall, leading to a deterioration of habitats for aquatic invertebrates.

In the Kajabach brook with its more densely forested catchment area pressures are caused by fish ponds that alter the substrate conditions and release littoral species into lotic habitats. However, within the National Park the chemical and ecological situation improves markedly in both watercourses.

Keywords

tributaries, land use, bacteria, benthic invertebrates, precipitation

Introduction

On the Austrian side of the Podyjí/Thayatal National Park two major tributaries flow into the River Thaya, the comparably large Fugnitz brook (with a catchment area of 138 km²) and the much smaller Kajabach brook (with a catchment area of only 20 km²). The aforementioned runs through intensively used farmland and lacks larger areas of woodland, whereas large fishponds alter the ecological system of the latter. Due to the massive fine sediment loads that enter the River Thaya via the Fugnitz brook and heavily affect the aquatic coenoses there, a preliminary study on the fluvial morphology of the river and its tributary was carried out (PÖPPL 2010), clearly identifying several hot spots for land erosion along the Fugnitz brook. In a further step, the present biological survey was conducted, dealing with the impact of the eroded material on water chemistry, microbiology, and benthic invertebrates, as well as on the ecological status according to the EU water framework directive.

Methods

A total of seven sites was surveyed. In the Fugnitz brook four impaired sites were located in the upper reaches outside the National Park, in intensively used farmlands, in the vicinity of erosion hot spots, large fish ponds or impoundments, respectively (Fugnitz 1 – Fugnitz 4), whereas one as unimpaired a reference site as possible was chosen within the borders of the National Park near the mouth (Fugnitz 5). In the Kajabach brook an impaired site outside the National Park (Kajabach 1) was situated directly below the outlet of a large fish pond, created by impounding the stream, and an unimpaired reference site (Kajabach 2) was studied within the National Park, right below the mouth of a major tributary. In each sampling site benthic invertebrates were collected according to the Multi Habitat Sampling method (MOOG 2004) during aestival low flow conditions. Water chemistry and microbiology was evaluated at three dates, (1) following constant low flow conditions in summer, (2) at the peak of a sudden thunderstorm-induced flood event, and (3) during a receding flood event caused by a continuous rainfall for several days in a row. Water samples were taken and analysed at the laboratory of the Institute for Water Analyses (IWA) of the Linz AG (Asten, Austria).

Results

Water chemistry. (1) During aestival low water conditions all nitrogen parameters (nitrate, nitrite and ammonium) showed a continuous increase along the Fugnitz brook from Fugnitz 1 to Fugnitz 4; in the reference site Fugnitz 5 within the protected area they dropped markedly, reaching concentrations even lower than near the source. The same pattern was found with electric conductivity and sulphate. (2) The thunderstorm-induced peak discharge led to a massive increase in filterable substances and in organic matter in all five sites in the Fugnitz brook. Electric conductivity decreased in the four sites outside the National Park, when it remained more or less unchanged in the reference site Fugnitz 5. Dissolved organic carbon increased in the four impaired sites but remained stable within the National Park. (3) After a long and continuous rainfall filterable substances decreased in all five sites, reaching concentrations lower than during low water conditions. The same is true for organic substances. While in the four impaired sites chloride, sulphate, calcium, magnesium, carbonates and electric conductivity increased by far when compared to the situation after the sudden thunderstorm, the opposite was true for the site in the National Park.

Microbiology

1. Even during low flow conditions germ numbers were high for natural watercourse standards in both brooks; in the Fugnitz brook coliform bacteria densities ranged from 110 to 470 germs per 100 ml, the lowest concentrations occurring within the National Park. This is also true for the Kajabach brook where 275 bacteria per 100 ml outside and 150 germs per 100 ml within the National Park were detected.
2. During the thunderstorm-induced flood germ contamination increased abruptly and massively in all sampling sites in the Fugnitz brook with coliform bacteria densities continuously rising along the continuum, starting at 101,000 germs per 100 ml in the site nearest to the source and reaching more than 201,000 germs per 100 ml right outside the National Park. Within the National Park, however, a marked reduction was detected, nevertheless still reaching concentrations of 74,000 coliform bacteria per 100 ml. In the Kajabach brook the thunderstorm-induced flood led to a slight decrease of coliform bacteria in the pond outlet outside the National Park, but at the same time to a massive increase within the National Park.
3. After the peak discharge caused by a continuous multi-day rainfall, in the Fugnitz brook coliform bacteria were found in much lower concentrations than during the thunderstorm peak, but with densities still reaching from 14,500 to 20,100 germs per 100 ml. In the Kajabach brook the pattern was the reverse compared to the thunderstorm-induced peak; while there was an excessive increase of germs in the pond outlet, germ concentrations were markedly reduced in the reference site within the National Park.

Benthic invertebrates

Marked differences were detected in terms of the numbers of specimens per m^2 in the Fugnitz brook; densities ranged from only 500 to 4,200 invertebrates per m^2 in the four impaired sites outside the National Park, whereas they reached more than 6,900 within its borders. Biodiversity in terms of species numbers was highest in the National Park where 68 species were detected, whereas only 36, 42, 46 and 53 species, respectively, were found in the disturbed sites outside the protected area. Large differences were found with regard to species group compositions. In the site next to the most evident erosion hot spot the largest numbers of pea mussels, oligochaete worms and water lice were detected, whereas in the National Park those groups were largely absent and at the same time amphipod crustaceans reached their largest densities; as did caddisfly and mayfly larvae. Saprobic indices were found to rise continuously along the watercourse from an organically unimpaired 1.55 in the site next to the source to 2.12 at the erosion hot spot (clearly exceeding the natural state and thereby indicating organic pollution) and even to 2.73 right outside the National Park. Within the National Park, however, the index dropped abruptly to 1.69, restoring an organically unimpaired status. As for functional feeding groups, the composition proved natural or near natural in the two sites nearest to the source, but deviated markedly from natural conditions downstream of the erosion hot spot; in the National Park, the composition was found to be restored to natural. In all four sites outside the nature reserve there is need for action when the ecological status according to the EU water framework directive is concerned, with benthic invertebrate communities indicating either a moderate or even a poor ecological status. Only in the National Park a good ecological status was proven.
In the Kajabach brook invertebrate densities were similarly high in both sites, but species numbers differed markedly; in the fish pond outlet there were only 39 species, the natural stretch in the National Park comprised 67 species. While pea mussels, oligochaete worms and water lice were numerous in the impaired site, they almost lacked in the natural site where, on the other hand, mayflies, stoneflies and caddisflies reached much higher numbers than in the impaired site. In the stretch outside the National Park the saprobic index was 2.33, thus indicating organic pollution, within the National Park it was 1.61 and therefore organically unpolluted. While there is need for action in the site outside the National Park with a poor ecological status, a good ecological status could be proven within the National Park.

Conclusion

In the Fugnitz brook germ contamination was high at all times and in all sites. During low flow conditions coliform bacteria were represented by E. coli exclusively, clearly indicating recent manure fertilization in the catchment area as these intestinal bacteria hardly reproduce outside their hosts. The development of nitrogen parameters along the watercourse shows a constant increase from the source to the borders of the National Park, resulting from the intensive land use; in the National Park natural decomposition and reduced further input due to the densely forested catchment lead to a considerable reduction of nutrients.

Need for action was proven in all four sites in the Fugnitz brook outside the National Park, for different reasons – but the excessive input of fine sediments and the resulting siltation effects proved to be most relevant. In the morphologically intact site Fugnitz 1 near the source these siltation effects turned out to be responsible for missing the aim of a good ecological status; taxa dependent on high structure quality like mayflies, stoneflies or caddisflies were outnumbered by ten by indifferent dipteran species. A similar situation was detected in the massively impaired stretch Fugnitz 3 next to an erosion hotspot, where fine sediments cover the whole riverbed and drive away species with high demands. In site Fugnitz 5 within the National Park a considerable improvement was detected – the natural woodlands in the catchment result in a good ecological status, a markedly improved saprobic index, the lowest amount of coliform bacteria, the lowest nutrient concentration, the lowest increase of germs in the course of precipitation, or the lowest input of nitrite and ammonium during short and heavy rainfalls.

In the Kajabach brook, the differences between the two surveyed sites results mostly from a chain of three large fish ponds on the brook, resulting both in atypically high water temperatures and in large numbers of species typical for standing waters that have been washed into lotic stretches, partly replacing the typical fauna. Additionally, discharge is very low in this brook, hence its inability to take away accumulated fine sediments.

When within the National Park a significant tributary adds to the discharge, ameliorates the temperature regime and helps rinsing the natural substrate from fines, the ecological status improves markedly and abruptly.

The study showed that both watercourses suffer from various impacts, most of all from the intensive land use or water use, respectively. In both cases adverse effects on water chemistry, microbiology and benthic invertebrates – and eventually on the ecological status – were proven. Heavy rainfall onto open surfaces in the catchment lead to a distinct deterioration that could be mitigated in the natural landscapes of the National Park. This leads to the conclusion that a sustainable enhancement of the watercourses is only possible with considerable measures in the catchment area, e.g. by creating natural alluvial forests along the brooks to keep the amount of eroded material low.

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Bacterial communities changes in cryoconite on an alpine glacier

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Abstract

Cryoconite holes are small pits present on the glacier surface containing a fine-grained sediment on the bottom. They are a biologically active and protected microhabitat in the glacial ecosystem. In this study it has been studied the temporal variation of bacterial communities in crioconite holes on the Forni Glacier (Stelvio National Park, Italian Alps). The results showed a temporal trend characterized by a predominant autotrophic Cyanobacteria population in the first part of the ablation season, followed by an increasing in abundance of heteroptrophic Sphingobacteriales populations. Also some hole feature explained a fraction of the variation of bacterial communities, but less than temporal variation.

Keywords

Cryoconite, Glaciers, Alps, Bacteria communities, Temporal variation

Introduction

Glaciers represent a real ecosystem, in fact, even if they are characterized by extreme conditions, they host viable miroorganisms (Boetius et al., 2015). Cryononite holes are peculiar structure of glaciers surface that host a metabolically active microbial community. They are the consequence of the deposition of a wind-born sediment (cryoconite) on the glacier surface composed by both abiotic and biotic matter. This sediment decreases the albedo effect melting the underlying ice and forming a small pit full of melting water with cryoconite on the bottom: the cryoconite hole (Wharton et al., 1985).

These structures have been found in different places like Arctic, Antarctic and also on temperate mountain glaciers (Cook et al., 2016; Edwards et al, 2013). Cryoconite holes are of big interest and different studies evidenced the influence of many environmental factors on their bacterial communities: sediment thickness (Telling et al., 2012), hole area (Cook et al., 2010) and hydrology (Edwards et al., 2011). Few studies instead investigated the temporal variation of bacterial communities, and they were conducted on Arctic glaciers (Stibal et al., 2015). At the best of our knowledge these studies have never been conducted on a temperate mountain glacier (Cook et al., 2016). In this study the aim was to investigate temporal variation of bacterial communities during the ablation season in relation with environmental conditions of cryoconite holes on Forni Glacier.

Methods

On Forni glacier (46°12'30'' N, 10°13'50'' E; Italian Alps, Fig.1) 20 samples of cryoconite were aseptically collected on July, August and September for a total of 60 samples. Oxygen concentration, pH and temperature were measured in each hole during the sampling with a portable oximeter/pH meter (HACH LANGE HQ40D, Loveland, CO), and maximum depth recorded by a ruler. The area was estimated using the picture of each hole with a reference ruler by an automatic method (Hodson et al., 2010). Organic matter content of cryoconite was measured with the loss-on-ignition method by heating the samples at 400°C overnight (ASTM, 2000). DNA extraction was performed using the FastDNA Spin for Soil Kit (MP Biomedicals, Solon, OH). DNA processing, PCR amplifications and Operational Taxonomic Unit (OUT) definitions were conducted according to Daghio et al. (2016). The number of OTUs obtained and selected to compare all the samples was considered an index of alpha diversity. Statistical analyses were performed with the LMERTEST, MASS, MICE, MULTCOMP, MULTTEST, PACKFOR and VEGAN packages in R 3.2.2 (R Core Team, 2013).

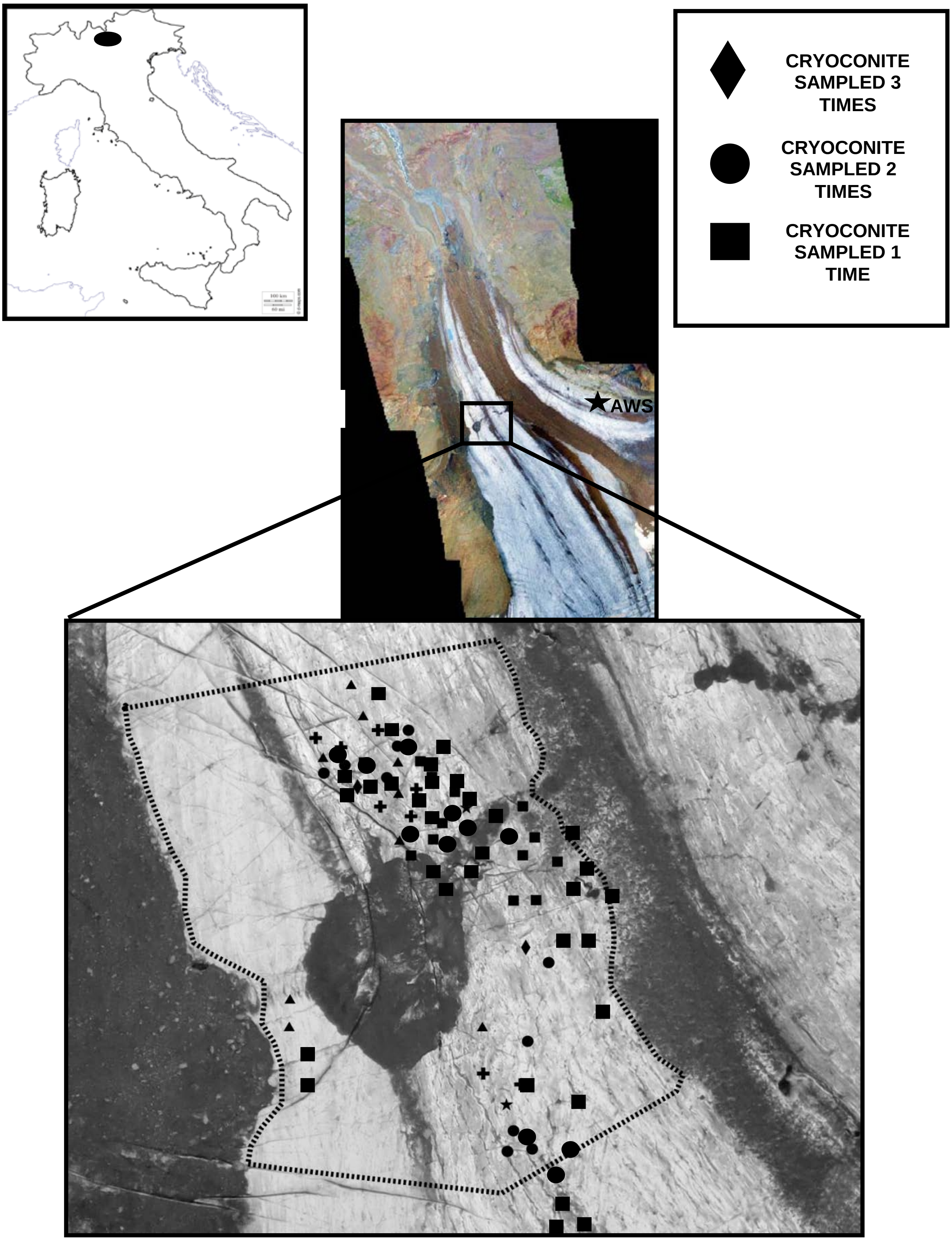

Figure 1: Forni Glacier

Results

60 samples have been collected, and 596 OTUs were registered. The most abundant orders found were Sphingobacteriales, Pseudomonadales, Rhodospirillales, Burkholderiales and Clostridiales, that together with Cyanobacteria and an unclassified order belonging to Actinobacteria represented more than the 80% of bacteria in cryoconite. Redundancy analysis (RDA) showed that the structure of the communities changed in relation with months (Pseudo-$F_{2,57}$=11.565, p=0.005 in all classes) and that such variation accounted for 26.4% of total variance in bacterial communities.

Bacterial communities also changed according to environmental conditions, hole depth and area, amount of organic matter in the cryoconite and oxygen concentration (Pseudo-$F_{2,57}$==3.431, p=0.001), which overall explained 14.2% of variance. Generalized linear mixed models and Post-hoc tests were performed and indicated that the abundance of Cyanobacteria and Clostridiales was higher in July than in August and September (Fig. 2). While the opposite was seen for Sphingobacteriales and Burkholderiales. Depth of cryoconite holes and oxygen concentration changed significantly between months ($F_{2,52} \geq 8.794$, $p_{FDR} \leq 0.002$).

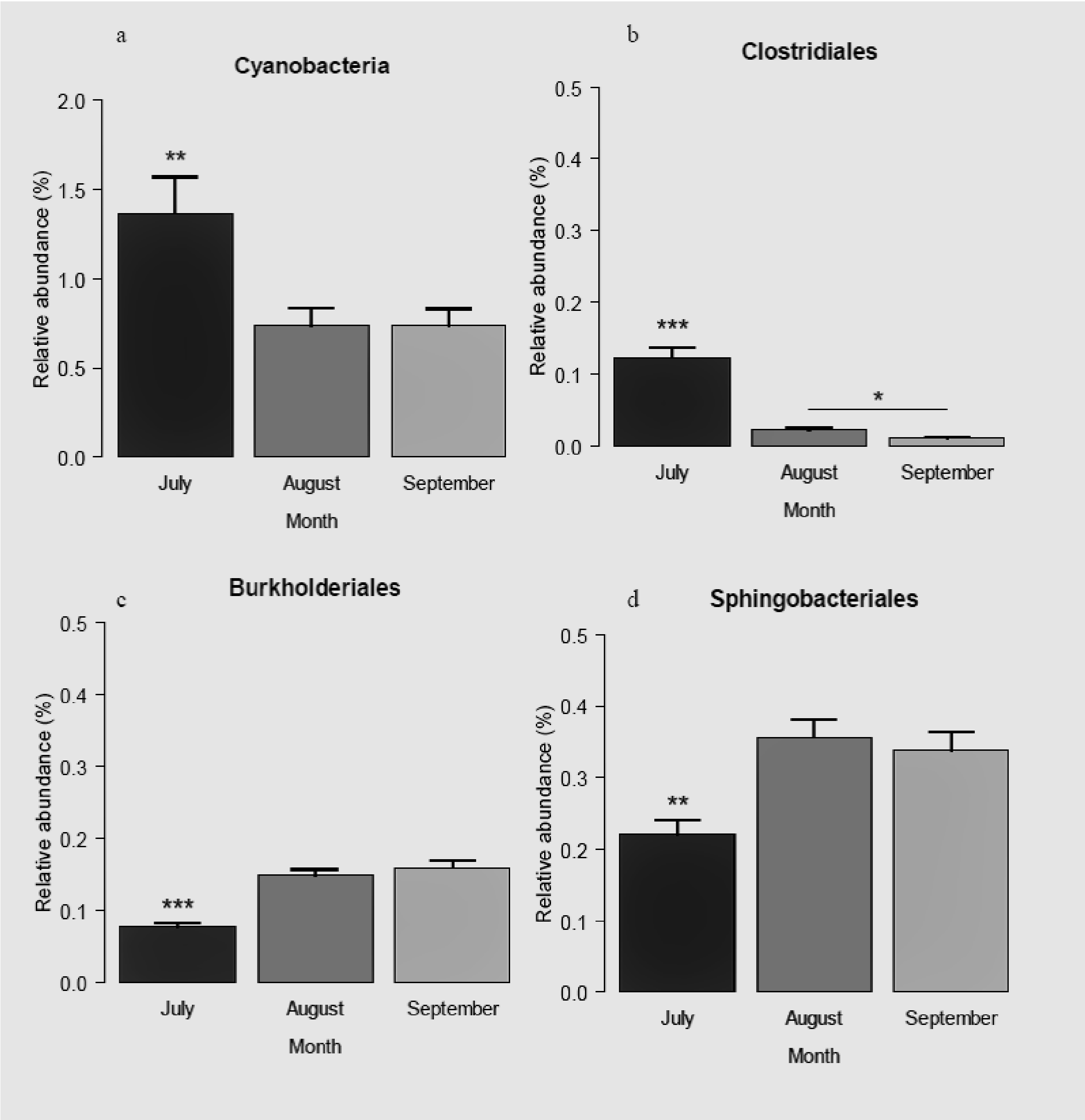

Figure 2: Relative abundance of Cyanobacteria, Clostridiales, Burkholderiales and Sphingobacteriales during the ablation season.

Discussion

Bacteria communities in cryoconite holes changed among months, in particular the relative abundance of photosynthetic bacteria decreased, while heterotrophic populations increased later in the ablation season. This trend is consistent with previous studies (SIGLER et al., 2002). Also the effect of environmental conditions changed the structure of bacterial communities, in particular hole depth and oxygen concentration which in turn changed along the melting season as already reported (GOKUL et al., 2016). Variation partitioning analyses, however, indicated that variation among months per se was the most relevant effect. Since cryoconite holes on Forni glacier seem ephemeral structures it's more probable that variations of bacterial communities are driven by temporal changes of ecological conditions rather than by an ecological succession within the holes.

Conclusion

This study showed that bacteria communities in cryoconite holes on Forni Glacier exhibit a temporal variation during the ablation season with an initial colonization of cryoconite by autotroph bacteria, followed by an heterotroph bacteria predominance. Temporal variation could act both directly on cryoconite communities and indirectly changing the hole features, but temporal variation seems to be more important than local environmental conditions in modifying bacterial communities. In this study other variables have been considered but didn't show any significant contribute (i. e. organic matter and hole area).

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The effects of mountain farming on biodiversity-monitoring and evaluation of vegetation changes on managed and abandoned mountain pastures in the Gesäuse National Park (Styria, Austria) in an eleven years timescale

Claudia Plank, Andreas Bohner, Thomas Wrbka

Abstract

Mountain pastures, a characteristic element of the Austrian cultural landscape, cover large parts in protected areas. In our study, we analysed the impact of management and abandonment of mountain pastures on phytodiversity in Gesaeuse National Park (Styria, Austria). Furthermore the effects of short-term shifts in management or climate change were investigated. Permanent plots were used to detect changes in plant species composition and plant species richness of managed and abandoned mountain pastures. Monitoring was realised in an eleven years timescale (2005-2016). A phytosociological characterization was performed. Additional analyses with indicator values were implemented. The relevance for nature protection was assessed with biodiversity indices (number of vascular plant species, Shannon diversity index and Evenness).

The plant species composition showed a few differences at each plot. No significant changes of phytodiversity have been observed during the monitoring period. Trends are visible. The highest phytodiversity was observed in plots of managed mountain pastures. Plant species richness and Shannon diversity index in plots of abandoned mountain pastures were significantly lower. In some abandoned mountain pastures heavy browsing by wild animals was observed. There, a high number of vascular plant species was found. No effects of climate change were observed. From nature conservation point of view, an extensive, site-adapted management should be continued in the Gesaeuse National Park.

Keywords

Nature conservation, mountain farming, preservation of cultural landscape, short-term monitoring, plant species composition, plant species richness, climate change

Introduction

Mountain pastures are a characteristic element of the Austrian cultural landscape. They often cover large parts in protected areas such as National Parks. Due to their diverse small-scale habitats with a locally adapted flora and fauna they are often hot spots for biodiversity. Niedrist et al. (2009) found that extensively managed mountain pastures belong to the species-richest ecosystems in Central Europe.

Since the beginning of World War II, many mountain pastures were abandoned due to intensification of grassland sites in the valley (Niedrist et al. 2009; Bätzing 2003; Egger & Aigner 1999). Also mountain pastures in protected areas were concerned by that progress, leading to changes in biodiversity.

Nowadays, as a consequence of climate change, it is assumed that mountain farming can regain its original importance. The grazing period is restricted by the length of the growing season which may extend due to increase in temperature. In the long run, the rise in temperature may also cause changes in the plant species composition, possibly leading to an increase of the forage yield of mountain pastures which may further result in a higher stocking rate (Bohner 2010).

In this study, permanent plots were used to detect changes in plant species composition and plant species richness of managed and abandoned mountain pastures at Gesaeuse National Park. In order to examine short-term shifts in management or climate change this study was conducted in 2016, after eleven years timeframe. Furthermore, the importance of sustainable mountain farming for phytodiversity was assessed. The following specific research questions were examined:

- Did the plant species composition and phytodiversity change within eleven years? If yes, which factors are responsible? Did the site-adapted management change or are influences of climate change visible?
- What is the impact of management and abandonment on phytodiversity (average number of plant species per plot, Shannon diversity index) of mountain pastures?

Study area

The study was conducted on six managed and abandoned mountain pastures in the Gesaeuse National Park in Austria (coordinates 47°35“, 14°38“), which is part of the LTSER platform Eisenwurzen (Long Term Socio-Ecological Research). Predominant rocks are northern limestone and dolomite rock. Characteristic soil types are calcareous brown loam and rendzina. The study region is influenced by a mild and damp central European/oceanic climate. The vegetation surveys were carried out between 1023 and 1691 meters a.s.l.. The grazing period lasts from June to September.

Methods

Altogether, 36 vegetation surveys on permanent plots were carried out to detect changes in plant species composition and plant species richness in an eleven years timescale. 36 additional vegetation surveys were realised. They were conducted between June and September 2016, according to Braun-Blanquet with a modified scale for species cover consisting of three subdivisions per Braun-Blanquet cover class. Only homogeneous vegetation plots were investigated. The size of each plot was 20 m². A cluster analysis, followed by non-metric multidimensional scaling and phytosociological characterisation of the vegetation surveys were performed. In addition, the Ellenberg indicator values were compared and analysed. ANOVA and GLM as well as post-hoc tests were used for tests of the statistical significance. The importance for nature protection was assessed through biodiversity indices (number of vascular plant species, Shannon diversity index and Evenness). Supposing that an extensive management of mountain pastures generates a higher phytodiversity than abandonment, categorical comparisons were implemented.

Results and Discussion

No significant changes of phytodiversity could be observed during the monitoring period. Small trends are visible. There were only slight changes in plant species composition and plant species richness during the eleven years timeframe. Also the Ellenberg indicator values did not change significantly. This is probably linked to the management. There were only minor changes in the number of grazing cattle, stocking rate and area of forage of the observed mountain pastures. We observed no effects of climate change, probably due to the short monitoring period.

In the present study, a positive effect of extensive grazing on phytodiversity was found. The vegetation plots of managed mountain pastures showed a significantly higher phytodiversity than the plots of abandoned mountain pastures (Fig. 1). The average number of vascular plant species was 54 in plots of managed pastures and 40 in plots of abandoned mountain pastures.

In Europe, a plant community is considered as species-rich if it comprises more than 50 different vascular plant species, mosses and lichens in an area of 100 m² (HOBOHM 2005). In accordance to NIEDRIST et al. (2009), MAAG et al. (2001) and TASSER et al. (2001), our study shows that the phytodiversity of extensively managed mountain pastures is remarkably high. Thus, mountain pastures can be very valuable for nature protection. The results are also in line with the Intermediate Disturbance Hypothesis (CONNELL 1978), claiming that a low intensity of disturbance, such as temporary grazing, leads to an increase of phytodiversity (BOHNER et al. 2009; NIEDRIST et al. 2009).

In some plots of the abandoned mountain pastures, heavy browsing by wild animals, especially chamois and red deer, was observed. Nevertheless, a high phytodiversity was found with an average number of vascular plant species of about 45 per 20 m². According to studies of TSCHÖPE et al. 2004, SCHÜTZ et al. 1998 and SCHREIBER & SCHIEFER 1985 wild animals can modify the process of ecological succession by delaying the secondary succession and maintaining species richness over several decades. In combination with natural disturbance processes such as windthrow, avalanches and debris flows it may be possible that wild animals create a similar level of biodiversity like it can be found in extensively managed mountain pastures. However, the spatial scale would be different as on the one hand there would be less phytodiversity on average area but on the other hand the number of species-rich disturbance patches could be more frequent. Further investigations on that topic might be interesting for protected areas like National Parks, as they have designated zones where natural processes occur without human disturbance.

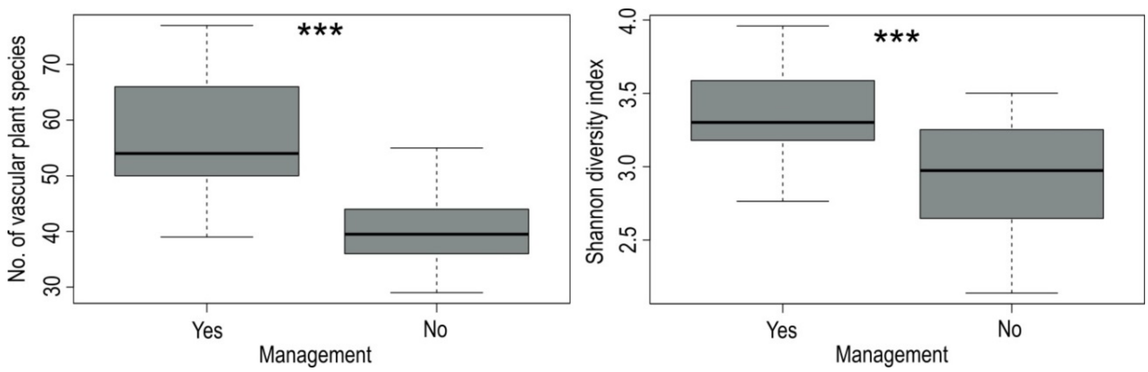

Figure 1: Phytodiversity of vegetation plots on observed managed and abandoned mountain pastures in the Gesaeuse National Park (n = 54, significance level after post-hoc test: p ≤ 0,001 = ***).

Conclusion

The results of this study demonstrate that sustainable agriculture in the form of extensive, site-adapted grazing of mountain pastures can contribute to species-rich mountainous ecosystems. However, it was also observed that wild animals can contribute to preserve a high phytodiversity, at least within an eleven years timescale. The analysis of vegetation changes provides a valuable data base for the development and implementation of further monitoring and management measures. Until now, no effects of climate change were observed.

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Are we willing and are we able to protect endemic species from becoming extinct?

Ute Pöllinger

Abstract

Legal protection for endemic species depends where they appear. In protected areas, it is simpler to argue for their preservation because the ecological balance is a target of these areas. Otherwise, you can discuss the protection of endemic species along an environmental assessment if needed. The last resort perhaps is a species conservation assessment. Other legal makeshifts do not help.

Keywords

legal protection, kinds of protected areas, ecological balance, species conservation assessment

As ombudsman for the environment my job is to forward the interests of nature and environment in administrative proceedings. In such proceedings, the interests of economy often collide with the interests of nature protection. Those discussions are difficult enough, if a project should take place in a protected area or if they endanger some nice animals or beautiful plants. The protection of endemic species is even much more difficult to argue because there is no specific legal protection for them.

In Styria the Koralpe is besides Gesäuse and Zirbitzkogel the most important hot spot for endemic species. This mountain ridge is situated between Pack and Soboth and it is the scene of many large-scale projects with huge drain of land resources (windfarms, pumped storage power plants, forest roads etc.). On the other hand, there are broad areas without protection status. The Koralpe hosts many local endemic species in the higher regions, which are extremely sensitive.

By my order, the first comprehensive representation of the zoological and botanical endemic species of this unique mountain massif was compiled in 2016 (ÖKOTEAM – KOMPOSCH et al. 2016). Therefore, now a scientific document is available which describes which endemic species do exist at the Koralpe and where. Now the question is what to do with this knowledge?

If we talk about a project which takes place in a protected area we have to ask for the purpose of the rule: the bylaw of 'Landschaftsschutzgebiet' normally does not say much about the purpose of the rule and is not very definite. Nevertheless, law points out to the fact, that for approvals, among the rest, you also have to take care for the balance of nature and its interactive system. This means, the correlation of biotic and abiotic environmental factors make sure that all indigenous species can exist and develop. It is sure that you can transfer this regulation to negative repercussions a project has for endemic species: if it endangers a certain population, the ecological balance may come out of order. Similar questions in small nature reserves have to be handled in the same way, because the law refers to the same basis, e.g. the conservation of ecological balance. Natura 2000 is a little bit different because here only FFH habitat types and species are relevant.

If a project does not take place in a protected area but an environmental assessment is necessary, endemic species are also an important part, because animals, plants and their habitats are protected resources in these administrative proceedings. Therefore, the knowledge about the existence of endemic species and the effects a project has on them, are an important question in the EA.

A project without EA and out of protected areas might be relevant for the protection of species. FFH directive says, that there are species, which are protected everywhere, not only in reserves. Styria has used the implementation of the FFH directive to protect 'all local species' in some orders or families. For example, all grand beetles larger than 20 mm are protected. For sure, this bylaw also is in force for endemic species. Therefore, the study mentioned above (ÖKOTEAM – KOMPOSCH et al 2016) is very important, because one can prove if a certain endemic species is endangered by a project. If that is the case, a special administrative proceeding is necessary, the species conservation assessment (SPA). However, we have a problem, when the project applier refuses to apply for approval because there is no possibility to force him. In this case, you can only report to the authority and they can give a fine or instruct him to re-establish the former state. This is very unsatisfactory, because damage is done and unique local endemic species may be extinguished forever.

Endemic species, which the bylaw about species conservation does not mention, have no specific protection. In such a case, legal remedies like the environmental liability law are not useful, too, because the annex does not list endemic species. Therefore, now we are at the border of juridical possibilities for the protection of endemic species: if you cannot argue with the bylaw concerning the protection of species at least, there is no protection at all. For sure, there are agreements of international law, which point out to the importance of biodiversity. Nevertheless, there are no binding rules to transfer those agreements into national law.

Endemic species, which you cannot incorporate in the protection rules explained above, are without protection. Therefore, I really think that we do not want to protect them, because it is complicated and might disturb "the economy" although they are a treasure and we are just beginning to lift it.

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The importance of heterogeneous shoreline habitats for ecosystem functions in large regulated rivers

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Keywords

Danube, shoreline habitats, organic carbon cycling, river restoration

Summary

River systems have long been viewed as drainage pipes simply transporting terrestrial matter to the oceans, but are actually active players in the global carbon cycle and a key ecosystem property. Large amounts of organic carbon and nutrients are not only stored in river sediments, but are also degraded, transformed and mineralized due to microbial activity in the water column and sediments (BATTIN 2009). Especially for regulated rivers and water ways with altered main channel habitats, riparian habitats and shoreline structures are considered to be bioactive zones, so called 'hot spots', for biological activities (e.g. HEIN et al. 2005).

In the last century the Danube, like most large rivers of highly urbanized and developed regions (see e.g. PETTS et al. 1989; DYNESIUS & NILSSON 1994; WARD 1998), has been morphologically modified to a large extent for flood protection, navigation and hydropower production. The Danube reach downstream of Vienna is one of the last remaining free flowing sections of the Upper Danube. It is surrounded by the largest still existing floodplain landscape in central Europe- a designated Natura 2000, Ramsar and Nationalpark area. While still exhibiting its high ecological value, this former highly dynamic river ecosystem was hydrologically decoupled to a large extent due to radical and far-reaching river engineering measures. Channelization and straightening of the fluvial corridor has increased the flow of surface water and minimized contact time and space between the active channel and it´s riparian subsystems as bioactive zones. Therefore, especially during mean and low water levels, instead of extended floodplains and heterogeneous river banks, artificial shoreline habitats, such as groyne fields or restored side arms, are the only remaining structures within the riverine landscape with a potential of performing some important functions in the carbon and nutrient cycle.

Ecologically orientated planning and management of biological active areas, thus require an understanding of the relationship between their structures and functions (VERHOEVEN et al. 2006). However, until recently the restoration focus was mainly on morphological structures rather than on processes and functions (FRIBERG et al. 2016). Therefore, in this study we investigated the carbon dynamics of different artificial and altered shoreline habitats assuming, that morphological structures and hydrological patterns frame sediment dynamics, which in turn control the carbon cycling in these habitats. We also expected that based on these environmental conditions some habitats will show an intense cycling and thus, could be identified as key habitats for carbon cycling in regulated rivers. Therefore, we compared six different shoreline habitats in March and April 2015 at water levels below riverine mean water level as to the turnover and degradation of organic matter in the water column and sediments (e.g. DOC concentration, benthic respiration, extracellular enzymatic activity). A groyne field, a secondary flow channel and a restored side arm, all relatively dynamic and well connected to the main channel during the period of this study, were sampled in the free flowing reach of the Danube. The other three habitats are artificial shoreline habitats within the impounded section of the Danube in Vienna, built as compensation measures in the course of the construction of the hydroelectric power plant Freudenau. One of these sites is only connected to the Danube via pipe culverts, one has several lateral connections upstream and downstream and the third one is a shallow habitat with a single downstream connection to the main channel (Fig. 1 showing 5 of 6 habitats).

Our results show that the less dynamic and more isolated shoreline habitats were the ones where more fine sediment accumulation occurred. The mean share of fine sediment to total sediment varied from 13 to 92%, and was of mostly mineral origin, with organic contents ranging from 0.6 to 5.4 %. The accumulation of fine sediment and organic content was highly correlated though.

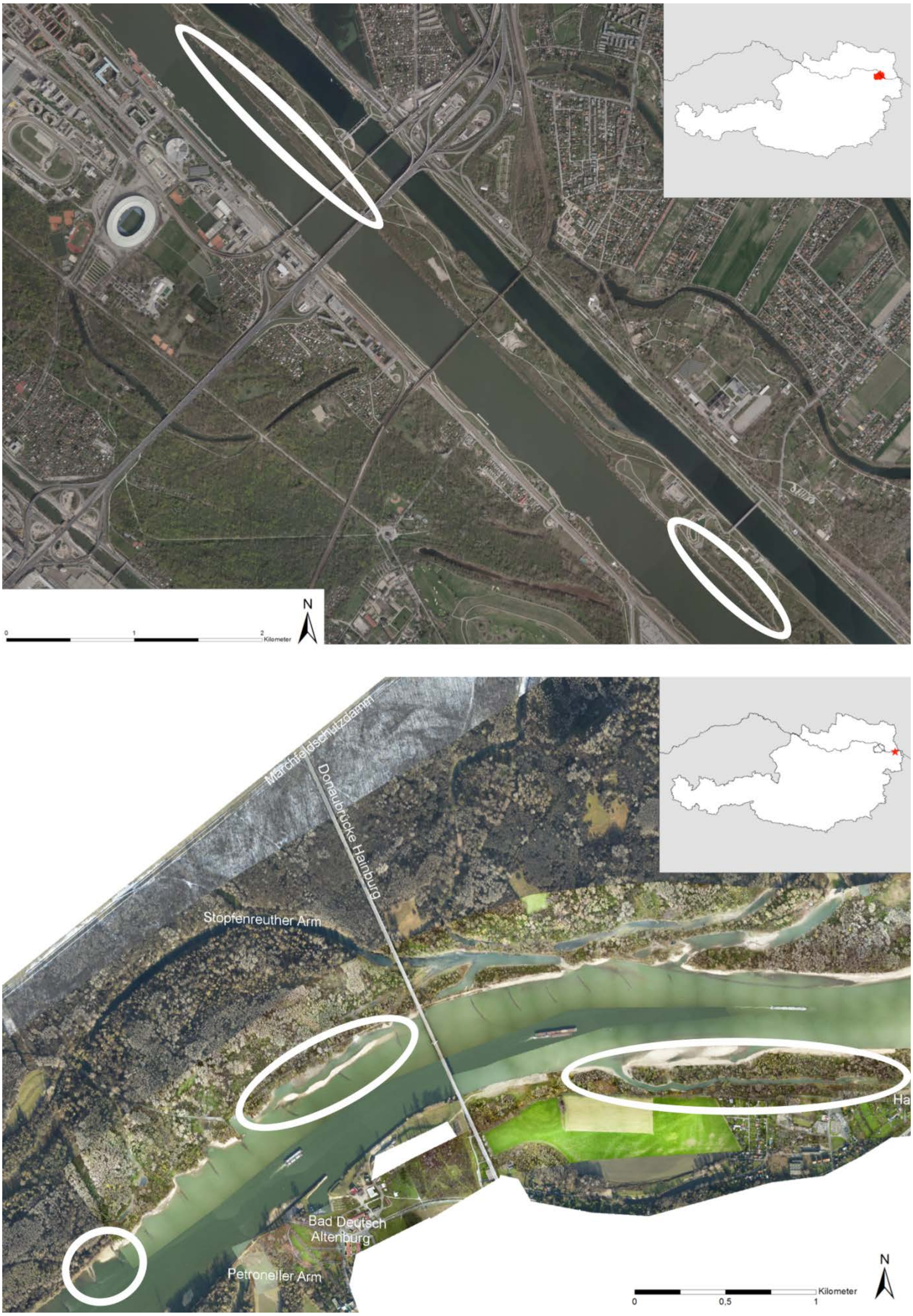

Figure 1: © ArcGIS (ESRI World Topo Map), via Donau

This has a massive influence on biological processes and the ecosystem functioning of these habitats, because sediment properties turned out to be the main factor influencing microbial activity and carbon turnover. Benthic respiration, extracellular enzymatic activity and the amount of DOC in the sediments for example increased significantly with the share of fine sediment. Similar respiration rates as to the ones from the isolated habitats were found in fine sediment dominated rivers like the Elbe River, while the values of the more dynamic habitats were comparable to gravel bed streams and rivers with high amounts of allochthonous organic material (FISCHER & WILCZEK 2006). If the overall river dynamics cannot be restored - as in impoundments - the character of shoreline habitats of gravel bed rivers may differ drastically from pristine conditions. However, these shallow and isolated habitats might be able to partly compensate for the lack of adjacent floodplains in terms of storage and turnover of organic carbon, at least on a small scale. The results for the dynamic habitats in the free flowing section on the other hand approach more riverine type conditions, with the secondary flow channel showing a significantly higher response in microbial activities in the sediments than the groyne field and the reconnected side arm.

In summary, different shoreline habitat types in large, regulated rivers- from shallow, isolated to dynamic and connected ones- offer a wide range of processes and functions regarding the carbon cycling. In highly transformed rivers with limited possibilities to achieve pristine conditions due to flood protection, navigation and hydropower production, these artificial shoreline habitats can contribute to an improved ecosystem functioning and ecosystem service provision.

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Ecosystem Services in NATURA 2000 areas of Crete: Information and communication campaign for the ecological, social and economic values of ecosystem services

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Abstract

This paper refers to the 'LIFE Natura2000 Value Crete project' (LIFE13 INF/GR/000188), an environmental awareness project that is being implemented under the framework of LIFE+ Information & Communication Programme 2013. The project aims to support the NATURA 2000 (N2K) sites in Crete and motivate lay public and stakeholders to seize the opportunities and address the challenges associated to the economics of ecosystems and biodiversity into the societal decision-making. To achieve this goal, a baseline survey was implemented so as to firstly assess the current level of knowledge, attitudes and practices of local stakeholders and targeted audiences. Results were used to develop a Communication Strategy addressed towards targeted audience consisting of representatives from the major sectors of the island's economy, namely farming, stockbreeding and tourism, as well as other key stakeholders. This study suggests that project's impacts on citizen's perception with regards to the benefits of the N2K Network should be monitored and evaluated not only once, but in several time intervals after the completion of the project, so as to gain representative feedback regarding the embracement of its messages by the citizens.

Keywords

Crete, Natura 2000 Network, ecosystem services, values of ecosystem services, stakeholders, communication strategy, economy, attitudes.

Introduction

Crete has 53 N2K sites and only one Management Body of a Protected Area (National Park of Samaria). N2K sites cover approximately 30% of the islands' surface (NYKTAS 2016; PROBONAS et al. 2015). Crete faces numerous environmental problems including stressed natural resources, desertification, deforestation, loss of biodiversity, and industrial-scale development of renewable energy sources (KOUTROULIS et al. 2010; SBOKOS 2017). The aforementioned issues are enhanced by inadequate law enforcement and lack or low level of implementation of the EU regulations and environmental policy (SBOKOS 2017). Regrettably, the majority of the local population in Crete is not adequately informed since many people still believe that residing in a N2K area excludes them from the development opportunities of the rest of the island. The LIFE Natura2000 Value Crete project (LIFE13 INF/GR/000188), an environmental awareness project under the LIFE+ Information & Communication Programme 2013, is connected to major sectors of the island's economy, namely farming, stockbreeding and tourism. Experience so far has proven that working with the local societies aiming to their consensus in species and habitats protection and applying concrete and localized management actions is more successful than trying to put into effect the national or European legislation in a broader sense (KETTUNEN et al. 2011). Therefore, the project aims to support the N2K Network in Crete and motivate locals and stakeholders in general to seize the opportunities and address the challenges identified by integrating the economics of ecosystems and biodiversity into the societal decision-making.

Methods

Crete is the biggest island in Greece and the second biggest in the Eastern Mediterranean. The population of the island is approximately 630,000, with a percentage of 7% living within the N2K Network (NYKTAS 2016). The Region of Crete participates in the Gross Domestic Product (GDP) of the country with a share of 5%, while it contributes 9.53% to the added value of the primary sector at national level (2012 data) (REGION OF CRETE 2015). The impressive 35.7% of the inhabitants of the N2K sites work in the Primary Sector, in contrast with only 10.8% inhabitants in the rest of Crete (NYKTAS 2016), clearly stating the importance especially of the Provisioning Services not only for the local economies of these areas, but also for the differentiation of the national GDP when considering the worldwide shift of economies towards tertiary sector, as a result of globalization and technological development. In line with the main objectives and the structure of the project (i.e. information on: ecological value of the SACs / SPAs, legal obligation for their conservation, perspectives for social and economic development), stakeholders were categorized as follows:

1. Inhabitants with property within the N2K sites;
2. Farmers practicing agricultural activities in semi-mountainous and mountainous areas;
3. Fishermen earning their living in marine SPAs;
4. Hunters who take action within SPAs; and
5. Professionals involved in the tourism sector.

The Communication Strategy was based on our findings from the literature review, the establishment of a clearing house mechanism (CHM) and a community awareness survey conducted in early stages of the current project (Fig. 1).

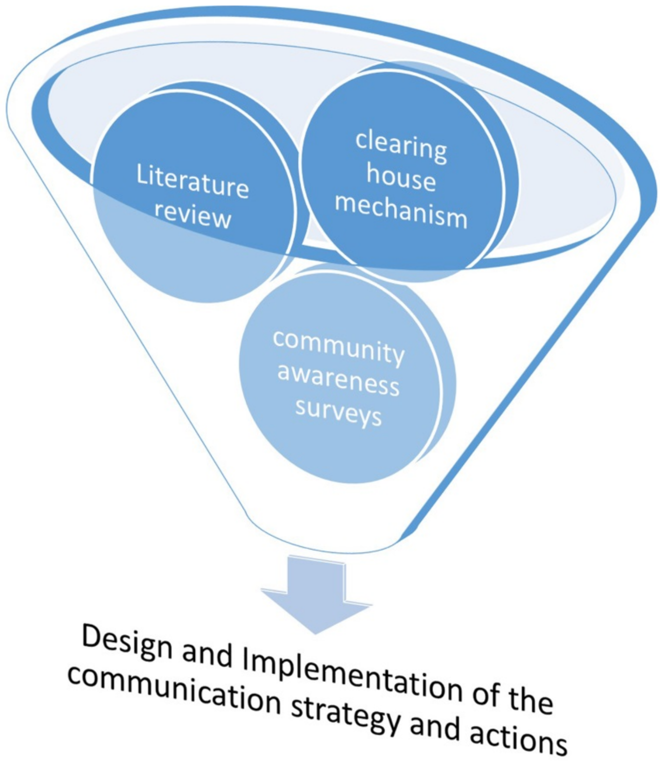

Figure 1: Preliminary actions that produced the Communication Strategy of the project.

<u>Literature review, establishment of a clearing house mechanism (CHM) and community awareness surveys</u>

Literature review for the establishment of a CHM and community awareness surveys have defined the framing of the communication campaign that followed. These preliminary actions were aimed to update our knowledge on the Greek legal framework and the current economic and social situation in the N2K sites of Crete, so as to establish a framework for linking ecology and economics in the N2K sites of Crete. The steps undertaken in the course of implementation of these actions involved:
1. review of the Greek legislation,
2. sorting data and information potentially useful for the assessment of ecosystem services, and
3. definition of a conceptual framework that links ecology with socio-economic factors.

Moreover, an integrated geographic database was established, focusing on relevant indicators based on existing socio-economic information. This database served the production of comparable data between the N2K sites and the rest of Crete. GIS was the platform that brought together the aforementioned information and became the core tool for the establishment of a CHM (NYKTAS 2016).

Since there were no official public surveys in Crete regarding the status of the current level of awareness of locals towards the N2K Network and the economics of ecosystems and biodiversity, a baseline survey was implemented (PROBONAS et al. 2015). The aim of this survey was to assess the current level of knowledge, attitudes and practices of the stakeholders and targeted audiences with respect to the project's objectives. The survey was conducted in the 24 Municipalities of Crete using random sampling and self-completion questionnaires. At the end, 3,587 questionnaires were collected and 3,570 were processed. Statistical analysis was conducted and the final results have contributed to the finalization of the Communication Strategy of the project.

Implementation of the Communication Strategy and public awareness actions

The implementation of the communication campaign has commenced in 2015 and is foreseen to be completed by 2018. Main project's actions are the development of printed material (information booklets, posters, banners, two special issues of 'Oionos' magazine, T-shirts, hats, stickers, calendars) and audiovisual environmental communication material (documentary, TV spots and Radio spots). The implementation of the awareness-raising campaign also involved several direct communication activities (26 workshops, 10 open events, participation in local festivals, a travelling photo exhibition), as well as the development of an Information Centre (NATURA Hall) at the Exhibition Premises of the Natural History Museum of Crete. The promotion of the key messages of the environmental communication campaign was also facilitated through an environmental education campaign addressed to pupils of all levels of education and through media (press conferences, advertising campaign and broadcast of the documentary).

Capacity building of professionals involved in tourism, journalists and media employees, as well as the students of the University of Crete and the Technical University of Crete is currently under completion through Training Seminars that provide participants with specific skills so as they are able to support the conservation objectives of the NATURA 2000 Network. The project's impacts will be monitored to gain representative feedback regarding the effect of the communication campaign and the embracement of its messages.

Results

Preliminary actions

Data and literature review indicates that recent developments have led rural sector to overexploit natural resources in an unsustainable way or to change land uses ending to the deprivation of wildlife habitat and degradation of the agricultural environment even in N2K sites (e.g. excessive and illegal logging for firewood, misuse of water supplies, transformation of olive groves to photovoltaic installations etc.).

Moreover, one of the most significant deductions of conservation work has been the ignorance of the majority of specialized scientists and civil servants on the utility and financial potential of the N2K Network. Existing information on the socio-economic significance of the N2K Network is mainly related to benefits arising from direct and indirect employment supported by the N2K sites, in particular through tourism and recreation.

The results from the community awareness survey show that 51.8% of the respondents believe that the N2K Network protects the natural environment and 44.3% believe it also benefits the regional economic growth. However, 60.6% of the respondents mentioned that infrastructures and/or investments have been limited in their area since its integration in the Natura 2000 Network. In addition, the majority of the respondents (83.7%) believe that ecotourism activities make great profit for those involved in them, whilst half of the professionals in the tourism sector who participated in the baseline survey mentioned that they do not intend to be professionally involved or are already involved in ecotourism or other forms of ecological tourism. Finally, mixed responses were received with regards to whether they are sufficiently informed regarding the N2K Network and its legislation, limitations, responsibilities and benefits (Fig. 2).

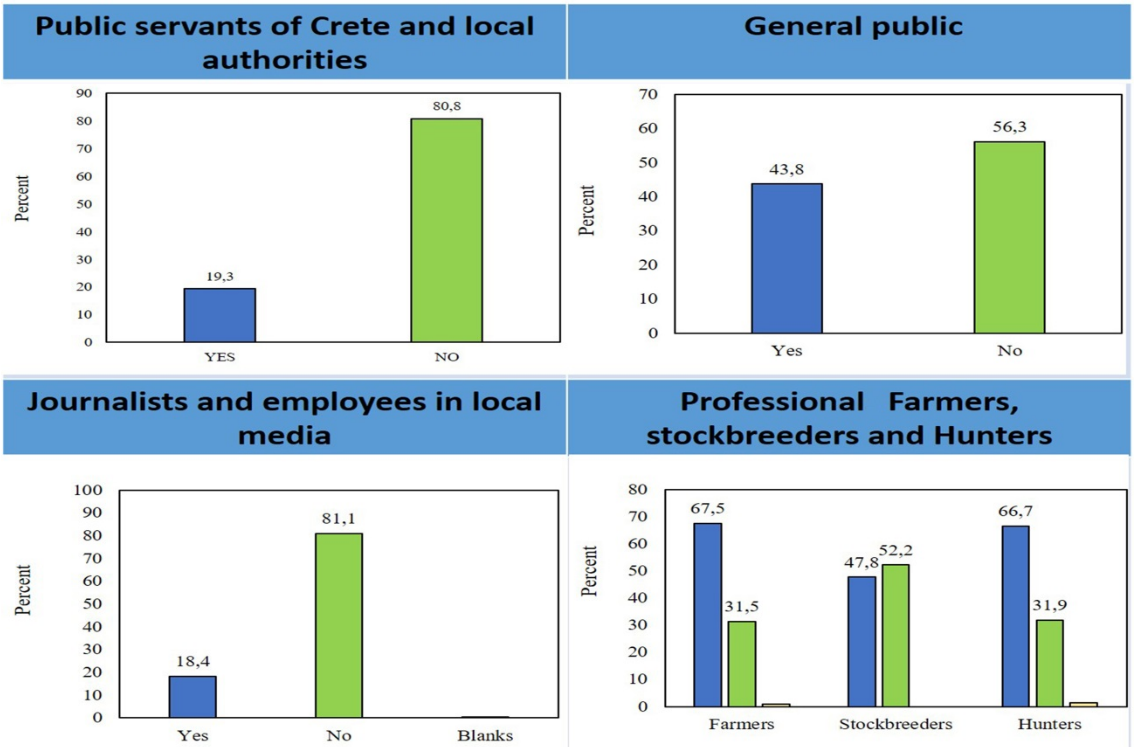

Figure 2: Responses to the question: *'Do you believe you are sufficiently informed about the NATURA 2000 Network in Crete (legislation, limitations, responsibilities, benefits)?'*

Communication campaign

Communication campaign was commenced in 2015. Up until today, all actions have been in full operation. Examples of the actions along with a brief description, aim and results are being displayed below (Tab. 1, Tab. 2).

Action	Number of events	Attendants
Workshops & Open events	18	446
Training Seminars	5	262
Participation in local festivals	12	6,700
Travelling photo exhibition	10	12,000
Information Centre	1 X 11 months	30,000
Total		**49,408**

Table 1: Selected actions of the communication campaign of the project, number of events and attendants.

Action	Brief description	Action in numbers
Documentary	Thematic documentary on the N2K Network is being broadcasting in local and national media.	30 minutes duration 1,000 DVD copies
Radio spots	Intend to inform the audience on the ecological, social and economic value of the rural, mountainous and coastal ecosystems of Crete.	3 Radio spots
TV spots	Each spot informs stakeholders and targeted audiences on the ecological, social and economic value of the rural, mountainous and coastal ecosystems of Crete.	3 TV spots
Calendar	They include information relevant to the benefits on everyday life from the N2K Network in Crete. Distributed to stakeholders and targeted audiences.	3,000 & 2,500 copies for 2016 and 2017, respectively
Booklets	They include information related to the ecological, social and economic value of the rural, mountainous and coastal ecosystem services. Booklets are being distributed to the lay public and stakeholders.	3 booklets (56 pages each) 50,000 copies in total
Posters	Each poster is dedicated to one of the following types of ecosystems: Rural, mountainous and coastal. Booklets are being distributed to the lay public and stakeholders.	3 types of posters 15,000 copies in total
Stickers, T-shirts & hats	Material produced in order to promote the project and its main messages and objectives. Distributed to stakeholders.	3,000 T-shirts 1,000 hats 1,000 stickers
Magazine special issues	Special edition dedicated to the LIFE Natura2000 Value Crete project. The magazine was distributed to subscribers, stakeholders, collaborators etc.	2,500 issues
Press articles	Published at local networks, released at least once a month and targeted in informing the public about the ecosystem services of the N2K Network in Crete.	>20 press articles already released
Environmental Education	Material addresses to primary and secondary school level and includes: Booklet, CD and teachers booklets with guidelines.	1,000 copies
Information banners	Topics covered: Ecosystem services definition, Natura 2000 Network, rural, coastal, mountainous ecosystems in Crete.	5 banners

Table 2: Other actions of the communication campaign of the project.

Discussion

Regarding the preliminary actions, it can be referred that respondents appear not to be sure whether the N2K sites are an obstacle or an opportunity in terms of economic regional growth. Although 44.3% believe that the N2K Networks' benefits the regional economic growth, still 60.6% of the respondents mentioned that infrastructures and/or investments have been limited in their area since its integration in the NATURA 2000 Network. Additionally, they appear to be unaware of the legislation and limitations of N2K Sites. Minor shifts from the initial design on our communication campaign have been implemented in certain actions (i.e. Workshops and Open events). Concerning the Workshops, project management team has decided to decrease the number of presentations and expand the discussion section. Having done so, participants have the chance to pose specific questions directly to the presenters in a more informal and less Academic manner. Expected attendance at actions requiring in person participation such as workshops, were higher than the actual. This could be due to the fact that targeted audience and stakeholders are, in most of the cases, not used to attend events including lectures and other educational and academic-based information events. This was rather obvious in rural areas.

The evaluation of the project's impact on the citizens' perception with regards to the benefits of the N2K Network and the valorisation of its outputs will most probably turn up in the long term. However, the participation of the public to awareness-raising activities and the distribution of informational guides to stakeholders and target groups will provide a clue about its success. Moreover, we hold the ambition that the project has contributed in raising public acceptance of the NATURA 2000 protection framework and in decreasing the misperception on decision-making and detrimental actions within SACs and/or SPAs due to ignorance of fallacies in the regulations arising from the ‘Birds’ and ‘Habitats’ Directives. In the long term, the success of this awareness-raising campaign with regards to the benefits of the NATURA 2000 Network and its value to the local economies should be assessed by the numbers of people influenced by the project not only during its implementation, but also after the end of the project’s life-cycle since the media-kits developed (i.e. YouTube channel and TV documentaries) may be considered timeless.

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Where do red deer come from and where do they go?

Thomas Rempfler

Keywords

red deer, GPS collar, migration, protected area, management

Introduction

At the end of the 19th century, red deer (*Cervus elaphus*) immigrated into the Engadine from Austria (HALLER 2002). The population grew rapidly. Repeated occurrences of extreme winter mortality in the 1950's to 1970's indicated high numbers of red deer in the region of the Swiss National Park (SNP). Adaptations in management strategies were adopted including red deer being strictly protected inside the SNP and the hunting season outside the protected area being limited to 21 days in September.

For red deer, the SNP is well suited as a summer habitat, but not as a winter habitat (BLANKENHORN et al. 1979). Since the 1990's, small protection areas around the SNP were implemented to encourage more even red deer dispersal. In that way, other attractive summer habitats were created besides the SNP (HALLER & JENNY 2014). A second main adaptation was an additional hunting period in winter habitats for a maximum of 10 half days in November and December to fulfil the annual hunting quota.

In the project 'Ingio via?' the Hunting and Fisheries Department of the canton of Grisons in collaboration with the SNP maps home ranges and migration routes in the Lower Engadine based on telemetry data. Modern wildlife management requires knowledge about seasonal red deer habitats, the routes they use to reach their summer feeding grounds, the exchange across country borders, the use of protected areas and traditional behaviour year after year.

Method

Since 2015, we have radio-collared 32 red deer (14 male, 18 female) with locations recorded every hour (GPS Plus collars, VECTRONIC Aerospace GmbH). In anticipation of traditional behaviour, we captured them in 5 different winter habitats. This way, we expected to capture the highest variability in habitat use. In this analyses, we focused on the use of 4 types of protection areas. The first type is areas without any protection. The second is 'Swiss National Park', where no management is allowed, i.e. neither hunting nor any disturbance of wildlife. The third type is 'Wildlife Protection Areas', where hunting is generally prohibited. The fourth type is non-hunting zones, where hunting is prohibited in September, but allowed on the additional hunting days in November and December.

Results

In 2 years, we collected a total of 239'411 validated GPS 3-D positions. Of these locations, 81 % were outside any protection area, 10 % inside the SNP, 8 % inside a Wildlife Protection Area and 2 % inside a September non-hunting zone. However, when relative use was corrected for the total area of each protection category, red deer used non-protected areas only 0.88x as often as would be expected if relative use was distributed randomly. On the other hand, the SNP was used 1.91x as often as expected by chance, Wildlife Protection Areas 3.2x and September non-hunting zones 3.57x. Relative use of the SNP was high from June to September and peaked in July, while use of Wildlife Protection Areas was low from January to March, peaked in September and decreased towards the end of the year. As only a few individuals used the September non-hunting zones, no trend was apparent here.

For 19 individuals (7 males, 12 females) data were available for at least 1 year. All of these individuals returned to the same wintering areas where they had been captured the year before. Migration routes were repeated the following year and some migration dates were almost identical. Collared red deer from Martina – Seraplana (2 male, 2 female) did not migrate over long distances, but crossed country borders. They did not use protection areas except for one non-hunting zone, mainly from May to July. Collared red deer from Ramosch – Vnà (2 male, 2 female) showed different habitat use between sexes. Males migrated over long distances and crossed country borders to Austria in the north and east, while females migrated over shorter distances and stayed in Switzerland. They all used protection areas, but not the SNP. All collared red deer from Sent – Scuol (3 male, 3 female) migrated to summer habitats in the SNP. They remained there mainly from June to September and also showed intensive use of the Wildlife Protection Areas, but individually for different periods of time. Collared red deer from Ftan – Tarasp (4 female) showed varying habitat use. Two females used their habitats homogenously and did not migrate. One of them used a Wildlife Protection area in November and December, while the other repeatedly used a part in the north of the SNP throughout the year. This was not the typical summer habitat inside the SNP that other individuals used during this study, among these the two remaining females of this group. A collared red deer from S-charl (1 female) was captured next to the SNP and used it also mainly as a summer habitat from June to September. In that season she used a Wildlife Protection Area too.

All in all, red deer seasonally preferred protected areas. Relative abundance of locations in September showed at an hourly scale that red deer preferred protected areas especially during daytime. However, all individuals remained outside protected areas during daytime too, except for one individual out of ten.

Discussion

Our data show that individuals from the same winter habitat migrate to different summer habitats and vice versa. Exchange between red deer occurs at a large scale and across country borders. This has to be considered in terms of diseases such as the currently occurring tuberculosis in western Austria, caused by *Mycobacterium bovis* or *Mycobacterium caprae*. Data show further that the mosaic of protected areas stimulates the summer dispersal of red deer. In addition, migration dates and routes of some individuals remain the same between years. This means that traditional behaviour exists. Based on the fact that red deer seasonally prefer protected areas and are distributed both inside and outside them during the hunting season in September, and also outside during daytime, we conclude that management adaptations since the 1990's have been successful. However, management strategies have to remain adaptive because new traditions in red deer behaviour can develop over the years. Therefore, red deer management is optimised by a network of protected areas, as well as short and flexible hunting seasons, but they have to be based on knowledge about species and locally specific behaviour.

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Springs in Gesäuse National Park - Hotspots of biodiversity

Christina Remschak

Abstract

Over ten years research on springs and headwaters in Gesäuse National Park (Styria, Austria) produced an overview on biodiversity in the area. Many species found represent first records for Austria or new species. This knowledge will guide to understand distribution of species and their demands on habitats as a base for future conservation. In the course of these investigations, a case study focussing on water mites, black flies, and caddis flies, allowed to get insight into the process of first colonization of a newly originated spring. This habitat is now going to be covered with gravel again. The results can give an insight of how spring fauna react to changes.

Keywords

Biodiversity, spring habitats, newly originated habitat, succession

Introduction

Over ten years of research on spring habitats and headwaters in the Gesäuse National Park helped to fill a huge gap in our knowledge of the water fauna of the Austrian Alps: A large-scale approach allowed the documentation of more than 100 springs and headwaters, in addition about 70 stream sectors and 32 standing water bodies were also studied. In spring habitats, a total number of eight species new to science, and much more than 100 previously unknown for the Austrian fauna were detected. The still ongoing inventory helps to understand altitudinal zonation, zoogeography and ecology. Furthermore, it provides a thorough base for future monitoring of potential environmental change under the stable conditions of a protected area. This paper gives a survey of the composition of the spring fauna in the area, and provides a case study of first colonization of a newly originated spring habitat. This part of the study concentrates to three groups of invertebrates strongly differing in biology and relationship to spring habitat:

1. Water mites (Hydrachnidia and Halacaridae) are insect parasites at the larval stage and predators as nymphs and adults. Many species have a particular relationship to spring habitats as crenobionts or crenophiles.
2. the filter feeding larvae of black flies (Diptera Simuliidae: adults are blood sucking parasites) are generally considered as untypical for spring habitats. Due to their nutrition style, many species are crenoxenes and their presence in springs may indicate particular water quality condition. However, several very interesting species have specifically adapted to this type of habitat.
3. An insect order including a wide variety of taxa with diverging habitat preferences are the caddis flies (Trichoptera). A considerable number of species has a particular preference for headwaters and springs. Here, due to their wide range of adaptations Trichoptera communities are extremely suitable as ecological indicators.

Methods

Springs in the Gesäuse National Park are small biotopes covering in average seven sqm, the half of them less than two sqm. As, due to mosaique-like microhabitat structures Surber sampling would produce little representative results and lead to long lasting damage (GERECKE et. al. 2012), hand net sampling was applied, spot checking submerged benthos from representative small sectors differing in microhabitat quality. In order to complete biodiversity documentation, emerging and flying insects were hand-netted in the surrounding of springs (GERECKE et. al. 2012).

At selected sites, emergence traps were placed for a one-year-period and emptied twice the month. They are equipped with data loggers for temperature of water and surrounding air.

Results

Over 100 of the more than 600 registered springs were investigated by changing groups of specialists during yearly organized research meetings. In parallel, 70 stream sectors and 32 standing water bodies were also studied. Until now much more than 100 species new for the fauna for Austria could be detected including eight species new to science.

About 300 species of Diptera were found, with some described at first time worldwide (See Fig. 1). 110 species of chironomids are registered with more than 25 new for Austria (Reiff, pers. comm. Feb. 2016). More than 60 stone flies (Plecoptera) were detected with one new species. Caddis flies (Trichoptera) are wide spread with about 80 and mayflies (Ephemeroptera) with 13 species. From more than 10.000 studied specimens of mites 110 species could be determinate including one halacarid new to science

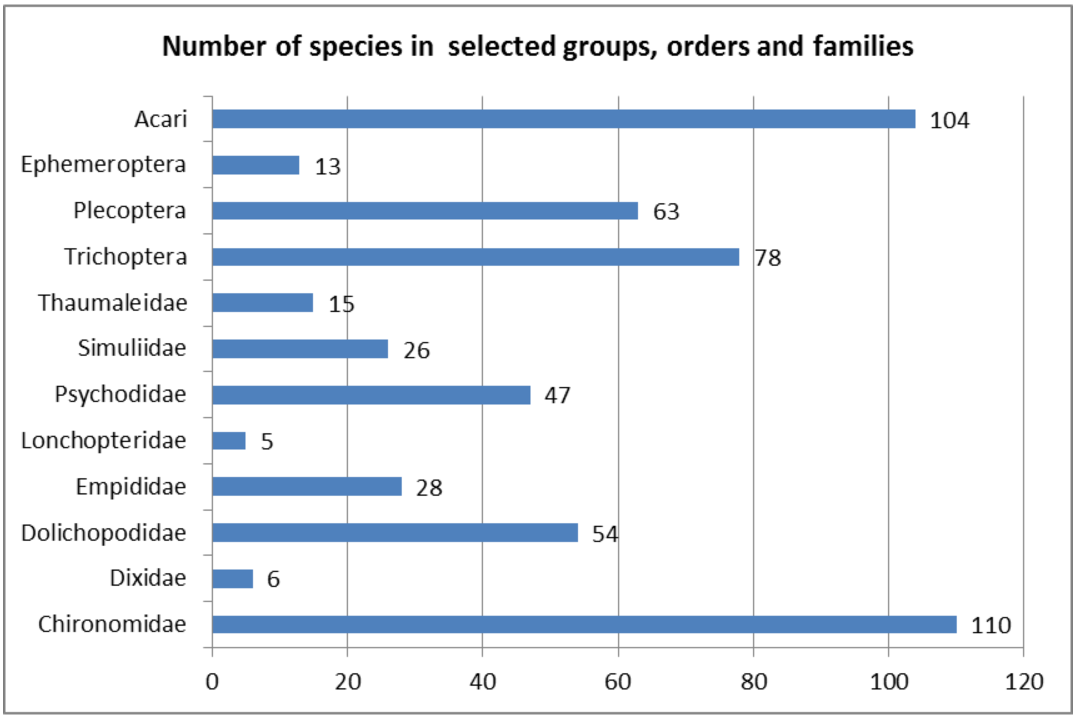

Fig 1: Species numbers in selected taxonimic groups in springs of the Gesäuse National Park.

Special case: GSENG spring - primary colonization of a newly developed spring habitat

The spring in GSENG is situated in an abandoned gravel-pit and existed in 2008 as pure groundwater outflow. The location had been stable, but composition and position of substrata continuously shifted due to excavation works. Monitoring started in 2009 with seasonal insect net collection. Since 2012 annual benthos samplings were made and an emergence trap equipped with data logger for temperature of air and water was installed (See Fig. 2). During that time vegetation grew up with mosses, willows and higher plants. In May 2014 substrata in the surrounding area began to get instable and covered a part of the spring and in consequence the emergence trap too (See Fig. 3). This process of continuously shifting is still going on. In August 2017 the trap was totally covered by gravel and had to be removed.

Figure 2: Primary colonization of GSENG Spring - only some mosses and algae are growing. Picture: H. Haseke, 2012

Figure 3: Situation in 2017 - mosses, willows and higher plants form a rich spring habitat - which is covered by gravel from both sides. Picture: C. Remschak, 2016

Results

Regarding the number of individuals chironomids dominate in all years (see Fig. 4). The numbers of stone and caddis flies (Plecoptera, Trichoptera) rised first but are reduced since 2014, when spring and emergence trap began to be covered by gravel.

1. Only one water mite species (*Sperchon thienemanni)* is dominant, while six other species were found in single individuals.
2. Totally seven species of black flies (Simuliidae) were detected. Their appearence showed an sucession (see Fig.5).
3. In total five species of caddis flies (Trichoptera) were found. In 2013 four species emerged, 2016 only two.

Discussion

With regard to its number of endemic taxa (70, among them 46 endemic animal species), the Gesäuse National Park has a leading position in Austria (Rabitsch & Essl 2009). High diversity and density of endemites are best explained by the situation of the area during and after the last ice age, when it was situated at the east edge of the gigantic alpine glacier (Gerecke 2012).

Springs are attractive for species with particular ecoligical needs. They are:

1. refuges for species with a specific habitat preference (stable flow and temperature conditions, particular electrolyte composition.
2. island habitats for terrestrial species bound to a particular degree of humidity (wood- and grassland insects e.g. of the families Mycetophilidae, Sciaridae, Syrphidae). Many semiterrestrial representatives of several dipteran groups prefer the surrounding of springs or wet wood submerged in spring waters (Dolichopodidae, Chironomidae, Psychodidae, Stratiomyidae).

In GSENG spring pioneer colonization takes place since 2008. Initially water appeared at the spring mouth without any vegetation, gradually a spring habitat etablished. Recently a process of natural covering by gravel began. The colonization process is documented in three examples:

1. Water mites: Quick appearance and mass development of *Sperchon thienemanni* which is parasitic on chironomid diptera. The species build up a stable population since the first investigation, other species were found as casual single individuals only (Gerecke, pers. comm. 2017).
2. All species of black flies (Simuliidae) are typical for hypocrenal or epirhithral streamsectors (Seitz 2017, pers. comm.). They showed a strong succession from year to year. After a first, quick colonization by different species, *Simulium cryophilum* and *S. beltukovae* became eudominant. Two species which are rare in the area appeared later: *S. aureum*-group and *S. petricolum*, a species only known from one other spring in the National Park. In 2014 species number and population size of black flies were found reduced, maybe due to covering of gravel over the spring.
3. The caddis fly (Trichoptera) fauna was counted four species in 2013, with *Wormaldia copiosa* dominating. *Drusus monticola, Wormaldia copiosa* and *Micropterna sequax* disappeard in 2014 and *Plectrocnemia geniculata* dominated. In 2016 *Allogamus uncatus* appeared for the first time. This data suggest a succession process: After a first quick colonisation by different species, diversity is reduced to a few species after covering the emergence trap by gravel.

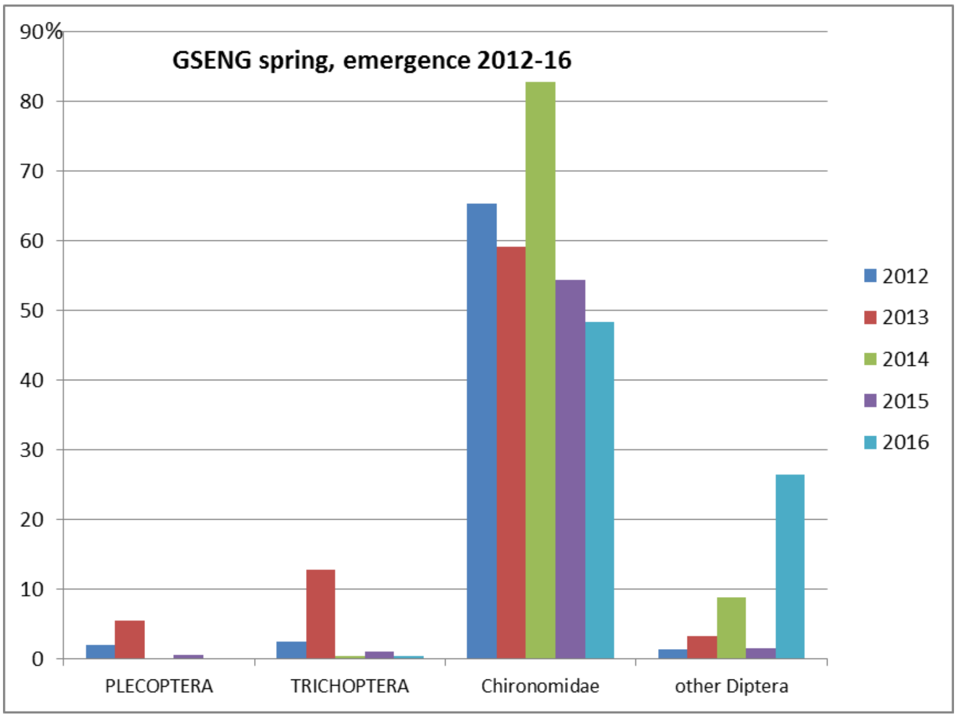

Figure 4: Composition of the emerging insect fauna (Plecoptera, Trichoptera, Chironomidae, other Diptera) in GSENG spring 2012-16 based on number of individuals in percent.

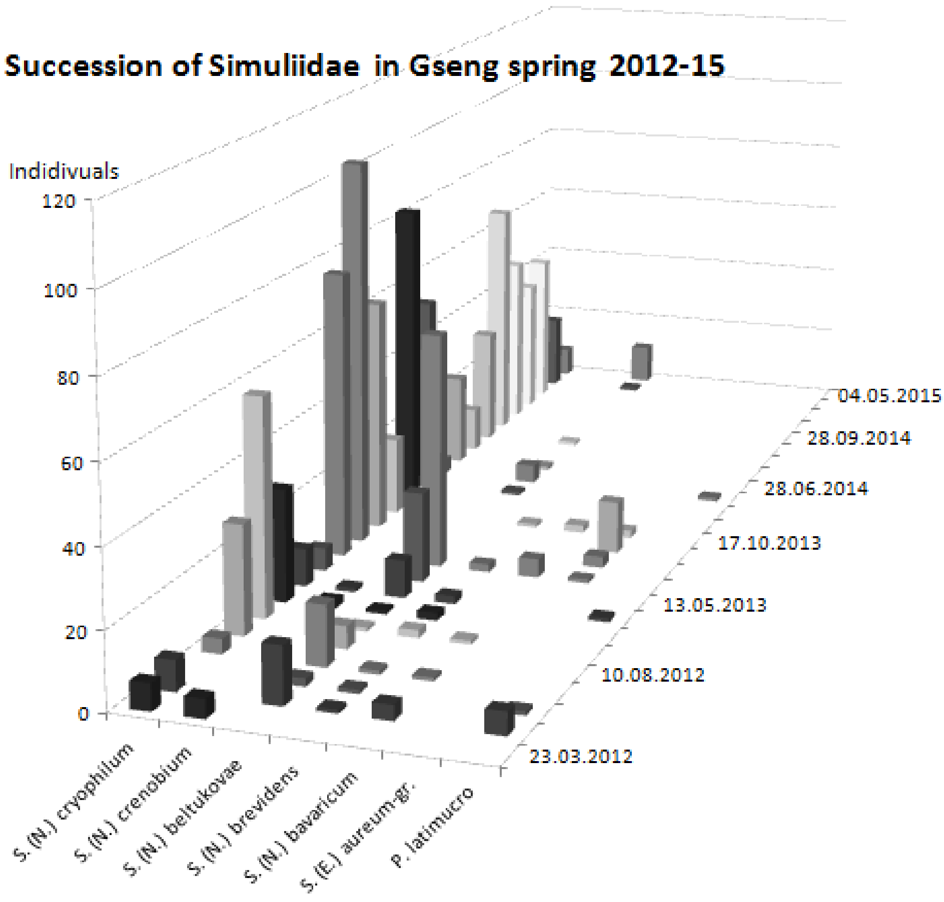

Figure 5: Succession of black flies species (Simuliidae) in GSENG spring from 2012-15. Data: G. Seitz, Grafik: C. Remschak, 2017.

Conclusion

The main topics of spring research in Gesäuse National Park are:

1. A zoogeographical interpretation at minor and larger scales.
2. An ecological analysis of species distribution patterns along transects from springs to streams may lead to better understanding of habitat preference (crenobiont, crenophile, crenoxene species).
3. Providing ecological data from case studies
4. Providing faunistic data for future monitoring (changes in species composition, longitudinal and altitudinal zonation)

In order to gain more data from a wide geographic range a spring monitoring should be installed inside the network of Alpine National and Natural Parks. Documentation with standard methods should become established also in protected areas of other European mountain ranges and on other continents. Due to lack of documentation, our knowledge on potential faunal exchange between, and recolonization of springs is extremely scanty. The special case of GSENG spring may give answer to how springs react on (natural) changes.

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Assessing small mammal community diversity with minimally invasive field methods - examples from the Nationalpark Gesäuse (Austria)

Stefan Resch & Christine Blatt

Keywords

Small mammals, live-trapping, minimally invasive field methods

Introduction

Small mammals (Muridae, Cricetidae, Soricidae, Talpidae, Gliridae and Dipodidae) are amongst the most challenging groups for mammalogists mainly based upon their small body size in connection with a concealed and mostly nocturnal activity. They inhabit a diversity of habitats, from lowlands to alpine regions and their lifestyle reaches from semi-aquatic over subterranean to arboreal. Based on this preconditions each research question demands a specifical methodology and in the past decades, a broad range of techniques has been invented, developed and refined (Tab. 1).

Live-trapping is a widespread and common method for surveying small mammals (BARNETT & DUTTON 1995; GURNELL & FLOWERDEW 2006) and its application covers abundancy as well as community and population studies through individual data. Nevertheless it is important to include into considerations that trapping success depends on various factors e.g. species and functional group (JENSEN 1975) as well as used trap type (O`FARRELL et al. 1994; TORRE et al. 2004; ANTHONY et al. 2005) resulting in a risk of under- or oversampling as well as there are rare species that can hardly be captured e.g. *Sicista betulina* (MEINIG et al. 2015). Furthermore, it is expensive in time and effort and inevitably disturbing to the population and survey area. As long as primarly the presence of species is questioned, there is a variety of less invasive alternative methods.

Nest tubes and boxes

Nest tubes are suited for presence and long-term surveys of *Muscardinus avellanarius* (CHANIN & WOODS 2003) and other Gliridae like *Glis glis* (PILĀTS et al. 2009) or *Dryomys nitedula* (JUŠKAITIS & KETURKA 2017). We successfully used this method for surveying the potential presence of Gliridae in 2 different habitats in the Nationalpark Gesäuse in 2013. In a 25000 m² patchy mixed forest site and along a natural avalanche track seamed with young mixed vegetation we used 80 nest tubes and 20 nest boxes. During 2 controls we captured 7 individuals of *G. glis* and 4 *M. avellanarius*. On a second site 9 of 10 boxes were used by *G. glis*, *M. avellanarius* seemed to be absent. The results gave insight into habitat preferences and population structure (BLATT & RESCH 2013).

Hair tubes

Another method for surveying large areas on ground level and arboreal is the use of hair tubes (SUCKLING 1978). These are constructed of a simple plastic-tube in varying diameter and length (depending on intended species) and loose rolls with adhesive paper on each side that must be passed by small mammals in order to run through. Collected hair material can be determined to genus and even species level in many cases (DEBROT et al. 1982; TEERINK 1991; MEYER et al. 2002). In 2012 this method was successfully used in the Nationalpark Gesäuse and led to 58 identified small mammal records (6 species) in addition to 203 captures from live-trapping (4 species) (BLATT & RESCH 2012).

Bait tubes

Bait tubes are particularly suitable for collecting presence data of *Neomys* sp. by analysing the remains of aquatic invertebrates in scats (CHURCHFIELD et al. 2000). Baited tubes can help to concentrate live trapping efforts on positively tested areas. In the Nationalpark Gesäuse in 2013 we used 40 tubes to survey 10 lines with 50 m length along the river Johnsbach for 2 weeks to survey for *Neomys* sp.. Through subsequent live-trapping on 3 sites with positive results it was possible to verify the presence of *Neomys fodiens* on 2 sites (RESCH & BLATT 2013).

Nests surveys, food remains, burrows and tracks

Muscardinus avellanarius produces highly distinctive signs on *Corylus avellana* nutshells therefore the search for signs is a common method for presence studies (BRIGHT et al. 2006). Also, nest surveys (*Muscardinus avellanarius*, *Micromys minutus*), dropping boards (EMLEN et al. 1957), track tubes (GLENNON et al. 2002) and the search for burrows (e.g. Cricetus cricetus) can help identifying promising study sites. The collection of dead animals and the analysis of owl pellets (VAN STRIEN et al. 2015) can provide an overview over the regional small mammal community.

Camera traps

Camera traps are cost-effective and flexible and are gaining considerable popularity in mammal research (MCCALLUM 2013). As a result of the advanced technical capability (increased image quality and detection rate) they are very promising for species that can hardly be detected with conventional methodology e.g. *Sicista betulina* (KRAFT et al. 2016; RESCH & BLATT 2017; van der KOOIJ & MØLLER 2017).

Method	Especially suitable for	Less suitable for	Recommended FFH-Species	Main survey objective	Advantage	To consider
Live trapping	Muridae, Cricetidae, Soricidae	Gliridae, *Sicista betulina*	*Cricetus cricetus, Spermohilus citellus, Microtus oeconomus mehelyi*	Presence data, Population and Community studies, Individual data, parasites, etc.	High quality individual data	Labour and cost intensive, high disturbance of population and survey area
Nest boxes and tubes	Gliridae, tubes especially *Muscardinus avellanarius*	Tubes: *Dryomys nitedula* , *Glis glis*	*Dryomys nitedula, Muscardinus avellanarius*	Presence data, Population studies	Cost-effective, long term use, individual capture possible	High acquisition costs for nestboxes, regular checks and maintenance
Camera traps	Most Muridae, Arvicolinae, Gliridae, Soricidae, especially *Sicista betulina*	Burrowing and ground dwelling	*Sicista betulina, Dryomys nitedula, Muscardinus avellanarius*	Presence data	Cost-effective, long term use	High acquisition costs, no population data. Limited species determination
Hair tubes	Muridae, Arvicolinae, Gliridae, Soricidae	Burrowing and ground dwelling	*Dryomys nitedula, Muscardinus avellanarius*	Presence data	Acquisition inexpensive	Determination often limited to genus, analysis is time intensive, overrepresentation of common species
Baited tubes	Soricidae especially *Neomys* sp.,	Insufficiently tested	-	Identifying *Neomys* sp. study areas	Acquisition inexpensive	Limited species determination, Further analysis required
Nest or nutshell surveys	Especially *Muscardinus avellanarius* , *Micromys minutus* only nests	-	*Muscardinus avellanarius*	Presence data	citizen science projects	Labour intensive through personell, not recommended as main survey method
Burrow survey	*Talpa europaea* , *Arvicola* sp., *Neomys* sp., *Cricetus cricetus* , *Spermophilus citellus*	-	*Cricetus cricetus* , *Spermohilus citellus*	Identifying study areas	Inexpensive	Misinterpretation possible, not recommended as main survey method
Track tubes	*Erinaceus* sp., Gliridae	-	*Dryomys nitedula, Muscardinus avellanarius*	Presence data	Acquisition inexpensive	Often limited to genus, overrepresentation of common species
Owl pellets	Muridae, Arvicolinae, Gliridae, Soricidae, Dipodidae	-	*Muscardinus avellanarius* , *Dryomys nitedula, Sicista betulina*	Presence data	Reliable species determination	Overrepresentation of Arvicolinae, restrictions depending on habitat type, limited localisation, collection and analysis is time intensive
Random collection (Roadkill, cat prey,...)	Common Species	-	All	Presence data, Individual data	Reliable species determination	Time intensive, not recommended as main survey method

Table 1 : Comparison of small mammal surveying methods

Discussion & Conclusion

All methods mentioned above have advantages and disadvantages depending on the survey question, the habitat type and the target species. Although live trapping remains the first choice for gaining high quality individual data, there is a risk of over- and underestimation as well as overlooking rare species. The accompanying or preceding use of minimally invasive methods has high potential, either for cost reduction and disturbance minimization on populations and survey sites, as well as for improving overall species detection rate. If combined with genetic sampling, minimally invasive studies like hair traps or baited tubes do overcome even the main disadvantage of limited species determination potential.

We conclude that in national parks more consideration should be given to minimally invasive methods as a way for reducing cost and disturbance and improve data quality in single species studies as well as in community studies. Especially the camera trap method has high potential for small mammal monitoring tasks and presence studies as well as for elusive species and should therefore further be developed.

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Geomorphological Trails in Austria

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Keywords

nature trail, geomorphosite, geosite, Austria, geomorphology

Summary

Structure, content and quality of nature trails in Austria are marked by heterogeneity, which results (i) in the fact that no general overview of Austrian geotrails is available, and (ii) in a remarkable lack of corresponding research in Austria. By focusing on 'geomorphology' within the description of various nature trails, one can conclude that there are no geotrails in Austria dealing with geomorphological topics.

Therefore, this diploma thesis investigates what the term geological nature trails (respectively geotrail) in Austria stands for and what kind of information is transported. Additionally the literature on Geosites and Geomorphosites is analyzed and related to Austrian nature trails. In the following the geomorphological content in general as well as for elected nature trails in detail is examined. Finally the thesis addresses the practical problems that occur when an attempt is made to list and classify these trails.

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Monitoring Permafrost at Hoher Sonnblick, Hohe Tauern, Austria

Claudia Riedl & Stefan Reisenhofer

Abstract

The Sonnblick Observatory at the summit of Hoher Sonnblick is an outstanding research station established in 1886. The initial motivation for permafrost monitoring at the summit of Hoher Sonnblick was the instability due to permafrost degradation that threatened local buildings and the associated stabilization work. The distribution of permafrost and its changes are under constant investigation at the Sonnblick and on the adjacent hill slope Wintergasse.

An extensive observation network for ground surface, shallow and deep borehole temperatures and geophysical measurements is established.

Keywords

Permafrost monitoring, borehole measurements, mountain permafrost, Hoher Sonnblick, geophysics

Introduction

Permafrost is soil, rock or sediment that is frozen for more than two consecutive years. In areas not constantly covered by ice, it exists beneath a layer of soil, rock or sediment, which freezes and thaws annually and is called the 'active layer'.

The distribution of permafrost and its changes are under constant investigation at the Sonnblick and on the adjacent hill slope Wintergasse since 2006. An extensive observation network for ground surface, shallow and deep borehole temperatures, snow monitoring and geophysical measurements is established (Schöner 2012).
The main research questions are:

- spatial and seasonal distribution of the permafrost depending on altitude, slope inclination and exposition and subsoil
- changes in permafrost and possible impacts on the rock stability
- influence of mainly topographic parameters (altitude, slope inclination, exposition, vertical and horizontal curvature) as well as the lithological characteristics on the permafrost body
- effects of permafrost degradation on changes of rockfall events

Due to the heterogeneity and complexity of the surface and the subsoil characteristics of the alpine permafrost a multiple method approach is needed to determine the current permafrost distribution. To provide an accurate picture of the underlying processes and changes in the frozen soil the combination of different measurement methods from the projects PERSON-GCW, ATMOperm and SeisRockHT (Seismic Rockfall Monitoring in the Hohe Tauern Region (ÖAW ESS)) is applied.

Methods

Continuous temperature recordings from three 20 m deep boreholes located at the southern slope of Hoher Sonnblick are available since 2007, which represent the longest series of its kind in Austria. The 20 m deep boreholes are equipped with thermistor chains and geophones.
Within the investigation area 'Wintergasse' measurements of 'Near Surface Temperature' (NST) 'Ground-Surface Temperature' (GST) and 'Bottom Temperatures of the Snow cover' (BTS) are measured. NST and GST are measured with different kinds of temperature data loggers (e.g. UTL1, iButton, onset) and in order to measure temperatures in the uppermost layer of the ground and avoid heating by direct solar radiation the loggers were buried a few centimetres into the ground or installed in boreholes at depths between 2 cm and 140 cm. Each of the NST borehole openings is closed up with insulating foam to protect the measurements from atmospheric influences.
Furthermore, data from seismic and geoelectric measurements, terrestrial laserscanning and extensive meteorological observations are available at the Sonnblick Observatory.

Results

Results of our measurements are available at: www.sonnblick.net

Conclusion

The measurements in a high alpine terrain are posing a great challenge due to harsh weather conditions. Improving the data quality is still work in progress, requires man power for repairing the instruments around the observatory and for the correction of the measured data. An innovative method for the correction of the measured temperature of the active layer was developed within the ÖAW ATMOperm project (HEINRICH 2017).

Acknowledgements

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Using an aggregated remote sensing-based habitat quality index for the identification of spatially targeted conservation measures

Barbara Riedler & Stefan Lang

Abstract

The effective assessment and monitoring of habitat quality is important for conservation management decisions, especially in protected areas. To support these tasks we present a remote-sensing based index not only for the spatially explicit assessment, but at the same time for the identification of suitable conservation measures to improve habitat quality. As a case study the riparian forest of the Salzach - a Natura 2000 site near Salzburg, Austria - was chosen as riparian zones are ecosystems with a high biodiversity, but are at the same time highly threatened. Four indicators derived from a very high resolution satellite image and LiDAR data were used to assess habitat quality: (1) Tree species composition, (2) Horizontal forest structure, (3) Vertical forest structure and (4) Water regime. They were aggregated to a statistically sound composite indicator, providing an easy overview of the spatial distribution of habitat quality and highlighting cold-spots where conservation measures may be needed. Decision processes are further supported through the decomposability of the provided habitat quality index into its underlying indicators and identifying conservation measures based on the indicator(s) with the least share. Findings of this study emphasise the importance of tree species composition for the habitat quality. While in high-quality areas the occurrence of favourable tree species is mainly responsible for the good status, in low-quality areas the lack of such characteristic species, combined with poor hydrological conditions, is mainly responsible for the poor status. Suitable and spatially targeted conservation measures would thus primarily aim at restoring a more favourable tree species composition in combination with improvement of the water regime. We consider the presented methodology as a suitable complementary option to traditional methods for assessing and monitoring habitat quality, the facilitation of decision-making on spatially explicit conservation measures as well as the evaluation of such applied measures.

Keywords

Habitat quality, remote-sensing based indicators, composite indicator, riparian forest

Introduction

Management of protected areas requires detailed knowledge about the quality of occurring habitats. For assessing habitat quality the use of single indicators, but also their integration into an index is used (e.g. GEBUREK et al., 2010). Earth Observation (EO) data and remote sensing-based indicators can thereby compliment in-situ data and support the monitoring of protected areas through their advantage of area-wide coverage and the option of regular, cost-efficient updates (DURO et al., 2007; GILLESPIE et al., 2008).

Here we present a remote-sensing based index to describe the habitat quality of riparian forests. Through the integration of single indicators into a statistically sound composite index (NARDO et al., 2008), the number of single parameters are reduced while the underlying information is kept (SAISANA & TARANTOLA, 2002). As such it provides an easy to grasp overview of the spatial distribution of habitat quality. Additionally it offers the opportunity of decomposability into the single indicators. For management purposes this is especially important, as it can provide the basis for suitable targeted conservation measures.

Methods

This study was conducted in the semi-natural Natura 2000 site Salzachauen (Salzburg, Austria; UL: N 47°56'12" / E 12°56'24"; LR: N 47°52'17" / E 13°00'22"). Based on detailed literature review four indicators describing riparian forest quality and that can be derived from EO data were identified (Tab.1; RIEDLER et al., 2015; RIEDLER & LANG, in press).

These indicators were integrated into a composite indicator, representing habitat quality. For the delineation of patch boundaries the novel approach of geons was used. Thereby homogenous spatial units (geons) are built through regionalizing a multiple indicator set, thus directly representing in this case habitat quality (LANG et al., 2014; RIEDLER & LANG, in press). For illustrating the decomposability of the index, categorical classes depending on the share of the underlying indicators were formed with a threshold value of 60%.

Indicator	EO data	Derived information
Tree species composition		
Tree species	VHR satellite image (WorldView-2 [1])	object-based single tree detection including classification of main occurring tree species (PACCAGNEL, 2013; STRASSER et al., 2014) accounting for the naturalness of forest systems (sensu ELLMAUER, 2005; GEBUREK et al., 2010)
Horizontal forest structure		
Spectral heterogeneity	VHR satellite image (WorldView-2 [1])	number of classes within a 3x3 kernel moving window defined by scene-component analysis reflecting different habitat and feature types (RIEDLER et al., 2015; RIEDLER & LANG, in press) accounting for habitat heterogeneity and structural features typical for alluvial forests (sensu ELLMAUER, 2005)
Vertical forest Structure		
Canopy roughness	LiDAR data[2] Canopy height model	standard deviation of the canopy height model within a 5x5 kernel moving window (RIEDLER et al., 2015; RIEDLER & LANG, in press) accounting for differences in height and a complex vertical forest structure (sensu NOSS, 1999)
Old trees	LiDAR data[2] Canopy height model	kernel density of tree height and detection of local maxima resampling single trees (RIEDLER et al., 2015; RIEDLER & LANG, in press) accounting for old living trees
Water regime		
Terrain roughness	LiDAR data[2] Digital terrain model	standard deviation of slope within a 5x5 kernel moving window (RIEDLER et al., 2015; RIEDLER & LANG, in press) accounting for the microtopographic relief (sensu UNGER & MUZIKA, 2008)

Table 1: Remote-sensing based indicators describing habitat quality of riparian forests (modified from Riedler and Lang, in press)

Results and Discussion

The spatial distribution of the habitat quality index allows a good overview of hot-and cold spots, revealing that areas of high habitat quality are primarily found along water bodies, the main river Salzach or perennial streams in the flood plain. Maybe even more important for management purpose is to know what indicators are responsible for the either good or poor habitat quality. The decomposability of the habitat quality index offers the possibility to identify these underlying indicators (Fig.1).

Areas with good habitat quality are – independent of their location - mainly characterized by a favourable tree species composition. These findings match and are in congruence with literature, where hydrological conditions are one of the main aspects for riparian forests itself and additionally strongly influence the characteristic tree species composition (DÖRINGER & TOCKNER, 2008; ELLMAUER, 2005).

Areas with low habitat quality on contrast are mainly forest plantations, characterized by a low share of the indicator Tree species compositions - in the example of the dark blue patch on the upper left the share is even 0, as it is a forest plantation of *Picea abies* and thus no characteristic tree species can be found. Also the Water regime is below 6%, indicating that no distinct micro-topographic relief exists. Thus, for such areas suitable conservation measures can easily be identified - here logging of *Picea abies* and subsequently reforestation with characteristic tree species together with water restoration measures for a more favourable hydrological conditions.

Conclusion

Complementary to traditional in-situ based assessments of habitat quality, the presented index is a suitable method for objective and repeatable assessment and monitoring of riparian forest quality. It can not only discover areas that are especially relevant for management decisions, but also identify spatially targeted conservation measures and support the evaluation of such applied measures. The approach additionally offers a unique opportunity for the integration of field and EO data, and allows for easy transferability to similar habitats.

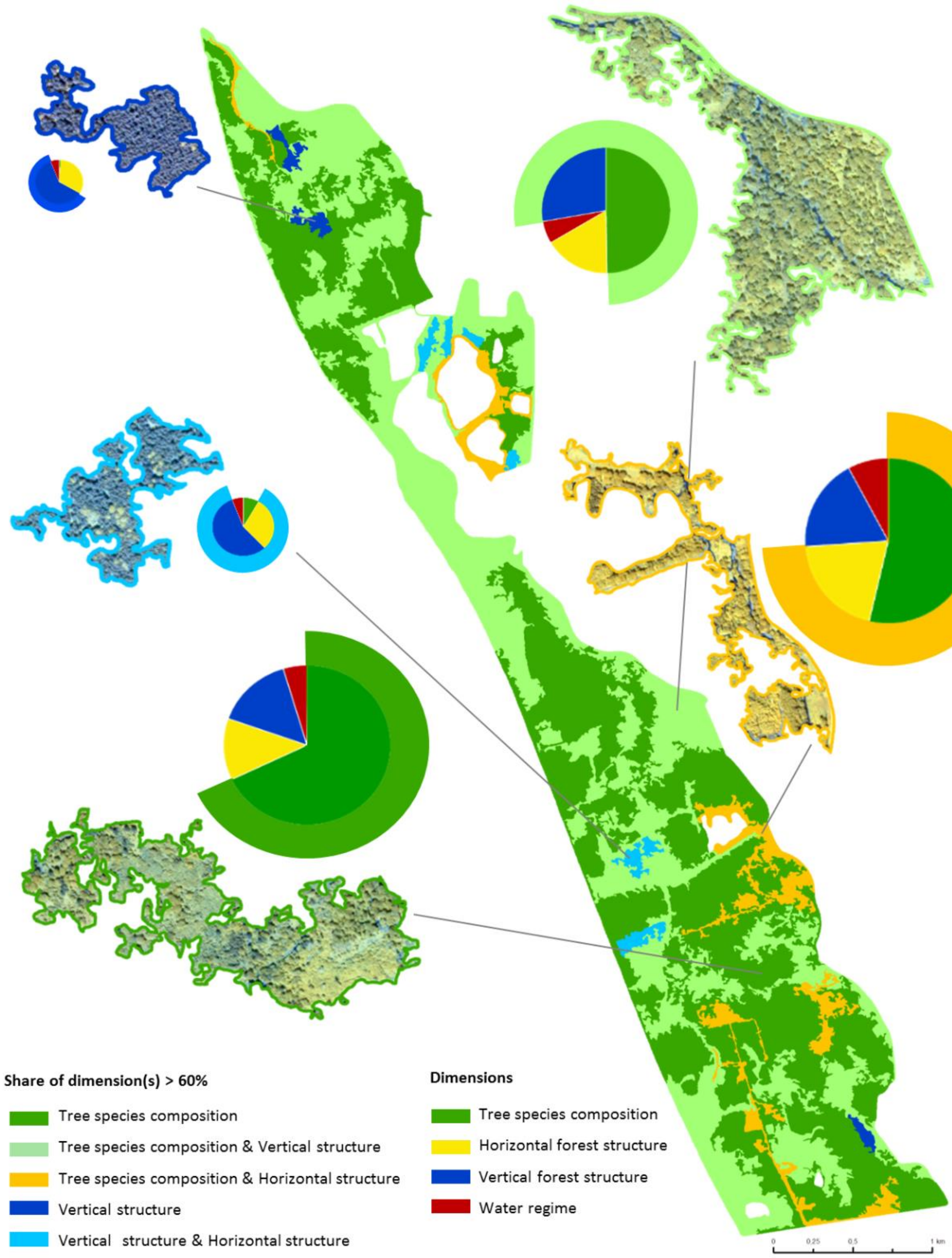

Figure 1: Decomposability of the habitat quality index. In the overview, categorical classes defined by a combined share of indicators > 60% are visualized. In the pie-chart diagrams additionally the actual contribution of each indicator is show. The size of pie charts is proportional to the habitat quality (from RIEDLER, 2015)

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Long-term changes in alpine tundra vegetation: 25 years of the International Tundra Experiment ITEX

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Keywords

Arctic, Monitoring, Open Top Chambers OTCs, Plants, Warming experiment

Summary

The International Tundra Experiment ITEX is a scientific network of experiments focusing on the impact of climate change on selected plant species in tundra and alpine vegetation. Currently, research teams at more than 40 circumpolar sites carry out similar, multi-year plant manipulation experiments that allow them to compare annual variation in plant performance with respect to climate conditions.

Switzerland is taking part in the global data analysis and maintains its own site in the country. It also sends researchers to ITEX sites in other countries, such as Alexandra Fjord in the Canadian Arctic. The Swiss ITEX site is located in the Park Ela, Grisons. It was set up in 1994 and has been maintained by the WSL Institute for Snow and Avalanche Research (SLF) in Davos since 2009.

In this experiment, alpine vegetation is warmed with passive warming chambers (OTCs). The vegetationconsists of alpine cushion plants, dwarf willows, grasses, and sedges. Researchers at the SLF investigate changes in the vegetation within warmed and control plots over a period of time. As ongoing climate change is expected to affect alpine vegetation, the SLF plans to continue maintaining the Swiss ITEX site.

The ITEX research model combines long-term and short-term experimentation with monitoring and has the elegance and simplicity called for to understand ecosystem response and vulnerability to change. The experiment is designed to examine the effects of temperature change on individual plant species on as broad a geographical base as possible and by limiting technical and equipment requirements.

In control plots across all study sites, it was found that changes in vegetation height and the abundance of growth forms were largely consistent with predictions based on warming experiments. Comparisons with other sites indicated that shrubs (particularly deciduous shrubs) increased over time, primarily in sites that were warming rapidly over the study period. But this pattern was only apparent in locations already quite warm. In contrast, vegetation in the coldest tundra sites was relatively insensitive to climate warming.

Figure 1: Swiss ITEX site in Park Ela, Val Bercla, Mulegns, Grisons, Switzerland

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Automatic Glacier Monitoring in the Hohe Tauern National Park, Austria

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Keywords

Glacier, remote sensing, SAR, OBIA, classification, Sentinel-1/2, Hohe Tauern National Park

Introduction

Glaciers are amongst the best natural indicators of climate change, with an increase in ablation season temperature often corresponding to a reduction in glacier area (ZEMP et al., 2008). Earth Observation (EO) data are often favoured for monitoring of glaciers due to their large spatial and temporal coverage. Clean ice can be robustly identified from multispectral imagery due to the difference in reflectance values between the visible and shortwave infrared (SWIR) portions of the electromagnetic spectrum. Debris-covered ice is, however, more difficult to identify due to its spectral similarity to paraglacial material and surrounding bedrock, and as such, many investigations use manual image interpretation to map debris-covered ice. Some recent papers have used synthetic aperture radar (SAR) coherence (the persistence in scattering behaviour between two radar images) to identify debris-covered ice based on the assumption that ice will flow between the two acquisitions, resulting in a loss of coherence (FREY et al., 2012, ROBSON et al., 2015). Although a promising method, the costs and technical skills associated with SAR processing mean that classifications have typically used temporally inconsistent datasets. The Copernicus missions provide free access to high-resolution SAR and optical imagery. In this study, we combine Sentinel-1 SAR imagery with Sentinel-2 optical imagery and a LiDAR based digital elevation model (DEM) within object-based image analysis (OBIA) to semi-automatically map clean and debris-covered ice within the Hohe Tauern National Park (HTNP), Austria. This study builds on the work of ROBSON et al. (2015) where we used SAR coherence generated from ALOS PALSAR with Landsat 8 data to map debris-covered glaciers in the Nepali Himalayas, and (ROBSON et al., 2016) where we used Landsat data and a DEM to calculate glacier changes within the HTNP from 1969 to 2013.

Data and Methods

In order to make our method as transferable as possible, we aimed to create a simple and robust method that uses automatically derived thresholds, fuzzy logic, and contextuality. The data used was a Sentinel-2 image from the 26th of August 2016. SNAP 6.0 was used to generate a coherence image from two Sentinel-1 images (2nd and 26th August 2016). Additionally, a DEM (10 m) based on LiDAR data from between 2006 and 2013 was used. All the classification was conducted in eCognition 9.0.

Image segmentation

The segmentation of raw pixels into near-homogenous objects is one of the most important steps in OBIA. It is often found that a hierarchy of multiple object levels, where each level is based on the segmentation of the objects in the level beneath (BLASCHKE et al., 2014). The Sentinel-2 image was segmented twice using a multiresolution segmentation on the Blue, Green, NIR, Red and SWIR-1 bands, as well as the slope, and a ratio between the NIR and SWIR-1 bands. A third segmentation also used the SAR coherence and the Normalized Difference Vegetation Index (NDVI) to help create image objects that resembled the supraglacial debris.

Classification of clean ice and debris-covered ice

The disadvantage of many classifications is that they rely on subjective, user-chosen thresholds. In this study we opt to use an automatic histogram-derived threshold to classify clean ice using a band ratio between the near-infrared and shortwave infrared bands. This makes the classification transferable between different satellite images or different glaciated regions. Following the classification of clean ice, objects were assigned to be debris-covered ice, if they bordered clean ice, had low coherence values, gentle slopes, and contained little vegetation. The classified objects were merged, smoothed, and exported as a shapefile.

Results

138.5 km² of glacier ice was mapped. Note that due to the Sentinel-1 data not covering the entire HTNP, the easternmost portion of the national park was not included in this analysis. We then focused in on the Grossglockner massif which contains an assortment of clean and debris-covered ice. Tab. 1 shows the total ice area of the massif between 2016 and 1969 using data from ROBSON et al. (2016). The fastest melt rates occurred between 1999 and 2003 which coincided with the 2003 European heatwave (PAUL et al., 2005). The presence of seasonal snow at higher elevations on the 2013 satellite image results in an exaggerated rate of glacier loss between 2013 and 2016. Nevertheless, our results indicate an increase in glacier loss rates relative to the second half of the last century. Between 1969 and 2016 the total glacier area reduced by 32.3% (Fig. 1).

Year	Glacier Area (km²)	Mean Annual Change (%/yr)
2016	39.4	-0.67
2013	41.4	0.02
2003	41.2	-3.00
1999	53.2	-0.15
1985	55.3	-0.18
1969	58.2	

Table 1: The total glacier area of the Grossglockner massif between 1969 and 2016.

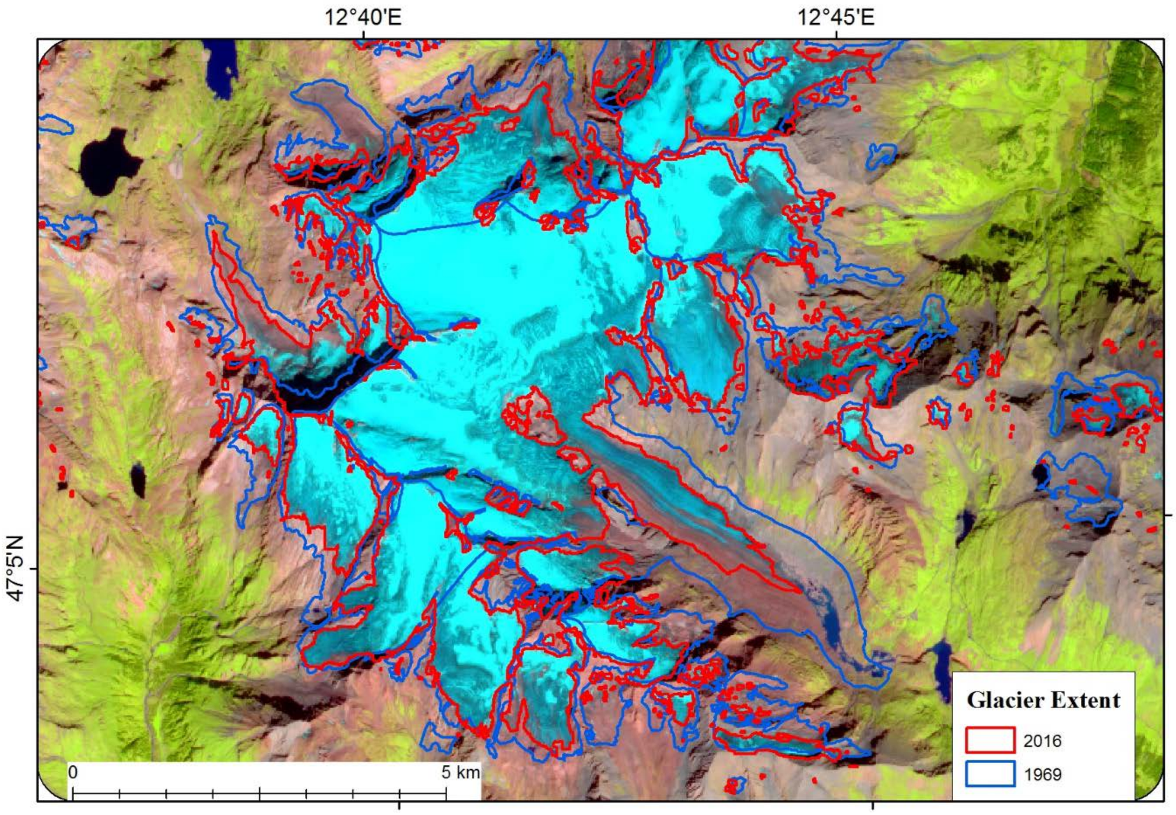

Figure 1: Glacier area change between 1969 and 2016.

Discussion and Conclusion

There are considerable advantages to using Sentinel-1 and 2 data to delineate glaciers. Firstly, the use of Sentinel data allows creating temporally consistent glacier inventories. Additionally, the higher spatial and temporal resolutions of the Sentinel-2 mission as opposed to the Landsat missions offer new possibilities for investigating glaciers. Unlike previous classification methods, we believe that our method is transferrable and can be used effectively in other glaciated regions to robustly map clean and debris-covered ice.

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A regional assessment of functional diversity in heterogenous grassland with different agricultural management

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Keywords

functional diversity, remote sensing, grassland management

Summary

The characteristics, range, and relative abundance of plant traits present in a given community, are key parameters in quantifying ecosystem properties and derived ecosystem services. Capturing this diversity in differently managed grasslands at landscape scale remains challenging because of limited data availability. To overcome this issue we inverted a physical-based radiative transfer model with remotely sensed Sentinel-2 multispectral datasets of the Swiss National Park that has been free from anthropogenic influence for the last 100 years, and a cultural landscape with agricultural management in its surroundings.

Introduction

Functional diversity based on plant traits controls mechanisms in grassland particularly important for ecosystem service delivery and ecosystem service vulnerability (LALIBERTÉ et al., 2012; SONNIER et al., 2012; GRIGULIS et al., 2013). However, only around 2% of vascular plant species have any trait measurements available at a landscape scale (JETZ et al., 2016) and functional diversity indices are so far for the majority defined on local observations and measured from field samplings (MOUCHET et al., 2010, ROCCHINI et al., 2016). Moreover, the dependency between the indices and spatial resolution is unexplored. Earth observation techniques may provide a solution to overcome the above-mentioned limitation (OLLINGER, 2011; HOMOLOVÁ et al., 2013). The advent of freely available multispectral Sentinel-2 data (DRUSCH et al., 2012) with their high spatial and temporal resolution, as well as optimization of the inversion process of a physical-based model (RIVERA et al., 2013), should provide a valid approach for the quantification of physiological plant traits in grassland. This allows us to study the impact of anthropogenic practices on landscape functional diversity.

Methods

The study was conducted across an approximately 900 km^2 area and includes protected grassland, and grassland subject to organic as well as traditional agricultural management in the Swiss canton of Grisons.

A total of 39 reference plots were established on the different agricultural management areas. In each plot plant trait data were collected once during the vegetation period between end of June and mid of September. The field work was divided into two separate years, 2016 and 2017. Plant trait sampling was conducted in 25 equidistant locations along a 10-m-long transect (GAUCHERAND & LAVOREL, 2007). Standardized trait measurement (CORNELISSEN et al., 2003) were used to quantify specific leaf area (SLA) and leaf dry matter content (LDMC).

To predict plant traits from the remotely sensed data across our study area we took advantage of the inversion of the PROSAIL radiative transfer model (JACQUEMOUD et al., 2009). Parameters of the model are, amongst others, leaf dry mass per unit area (Cm), leaf water mass per unit area (Cw) and leaf chlorophyll content (Cab), where SLA = 1/Cm, and LDMC = Cm/(Cw + Cm).

As model input we used Sentinel-2 atmospherically corrected data with 20 m spatial resolution and 10 bands acquired on the same day as the field samples. An inversion of the model is needed if the trait data is the desired output: a look up table of reflectance spectra (LUT) was randomly generated by running the model multiple times in the forward mode, varying the input parameters in each run. To find the solution to the inverse problem each modeled reflectance spectrum of the LUT was compared to the remotely sensed spectrum and the one providing the smallest deviation, evaluated by a cost function, was selected. SLA, LDMC and Cab values that generated the selected spectrum were the solutions of the inversion process. Multiple solutions and cost functions, as well as the addition of gaussian noise were tested to optimize the inversion results. The modelling and optimization process was carried out using the ARTMO (Automated Radiative Transfer Models Operator) GUI toolbox (VERRELST et al., 2011).

Functional diversity indices on a landscape scale were calculated for each management zone by performing multiple runs and increasing each time the number of randomly selected pixels. Single trait indices, the functional divergence (MASON et al. 2003) and functional regularity (MOUILLOT et al. 2005), multitrait indices, the functional richness and evenness (VILLÈGER et al. 2008;) were determined based on three standardized physiological traits captured by the radiative transfer Model (i.e., SLA, LDMC, Cab). Furthermore, functional diversity was calculated for different landscape scenarios by leaving one management practice each time out and with the others equally sized.

Results

The optimization of the inversion process enabled the comparison of estimated trait values with measured values. Especially the estimated SLA from the model showed a strong quantitative agreement with the field measurement (R^2=0.68). Less accuracy was achieved for the LDMC (R^2=0.43). For the proposed model configuration, SLA explains around 40% of the output variance in the Red Edge (Band 6 and 7) and the leaf water content, used to calculate LDMC, around 30% in the SWIR (Band 11).

Due to the utilization of multiple solutions it was possible to indicate an accuracy measure for both traits, based on the coefficient of variation (RIVERA et al 2013). Only a poor quantitative estimation was possible for extreme trait values and the estimation inaccuracy of the model was positively correlated (ρ=0.52) to single trait functional diversity indices. Management practices resulting in high trait values (e.g., heavy fertilization) and high functional diversity (e.g., mowing and slight fertilization) delivered less accurate results. We could conclude that two major aspects contributed to the model inaccuracy and deviation from infield measured values: (i) saturation effects of the model and (ii) heterogeneity of the target (i.e., grassland).

Functional diversity indices and mean trait values on a landscape scale showed statistically significant differences (p<.001) between the different management types. Post hoc testing revealed that protected grassland with no management equals summer grazed pasture in case of water and dry matter content of the leaves. Higher values of chlorophyll content were present in the National Park area instead. Overall, protection acts as a distinguishable practice, producing intermediate levels of mean trait values compared to all other managements on a landscape scale. Concerning the single trait indices, the variance of Cab was the highest for the National Park among all management types. The functional richness was growing with the analyzed area for all management zones. On an area of 20 km^2, protected grassland showed a functional richness value slightly higher than heavy fertilized meadows. When simulating different landscape scenarios the lowest functional richness was found in the scenario without protected grassland and the highest values in a landscape without heavily fertilized meadows. Functional evenness for each management practice was slightly decreasing with larger area, with the heavily fertilized meadows decreasing even more rapidly.

Discussion

Grassland management is known to affect plant traits (QUÉTIER et al., 2007). Fertilization increases SLA and Cab and decreases LDMC. Different grazing intensities seem to have a lower impact reducing just the LDMC for high grazing intensities (LALIBERTE et al., 2012).

Consequently, the accuracy of trait estimation through model inversion depends on the management practices in each field. The underestimation of extreme trait values (i.e., values close to the upper limit of the model) can be attributed to a saturation effect (FRAMPTON et al., 2013) and is pronounced in areas with high community weighted mean values. Heterogeneity in a canopy cannot be simulated by the PROSAIL model, which assumes the canopy to be a turbid medium (DARVISHZADEH et al. 2007). It emerged from our results that heterogeneity, from a spectral perspective, is better explained by functional trait indices than the number of species. Taking into account that trait variations influence the spectral response of plant communities (LAUSCH et al., 2016) our results are consistent and lead to the conclusion that less accurate trait estimations are to expect for areas with higher functional trait diversity.

While trait values are clearly influenced by the management, this is not always the case for functional diversity (NIU et al. 2014). In our study the effects of land use intensification are more highlighted on a landscape scale than on a plot level, where fertilization seems not to be the key driver for functional diversity. The observed decline of functional evenness with increasing area in highly fertilized meadows leads to noneffective utilization of available resources, a decrease in productivity and increased opportunities for invaders (MASON et al. 2005).

Differing trait values between protected and managed grassland and the high value of Cab variance in the protected area can be attributed to selective grazing pressure by wildlife (SCHÜTZ et al. 2003), whereas cattle apply a more general grazing behavior which is limited to the summer months. Currently, we can not exclude that higher Cab values and their variance in certain areas of the Swiss National Park depend on the bedrock composition. Nonetheless, the fact remains that the Swiss National Park has a high diversity of habitats in terms of different chlorophyll content. Moreover, diversity is the relevant factor influencing functional richness of a landscape. The presence of protected grassland could therefore act as a buffer to environmental fluctuations (PATCHEY 2003) and contribute towards higher ecosystem service supply on a landscape scale (DE BELLO et al., 2010).

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Climate-driven range dynamics and potential current disequilibrium in Alpine vegetation

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Abstract

Recent climate change is shifting species' elevational ranges. Yet, most research effort has concentrated on the uppermost occurrences of species and little is known about changes to species' rear edges, optima and abundances. However, only the simultaneous consideration of these range attributes allows for assessing the fate of mountain plants under climate change. Instead of using exactly localizable plots, we re-surveyed over 1500 semi-permanent historical vegetation relevés spread over the European Alps to overcome these shortages. Based on this dataset we evaluated recent range dynamics along the elevational gradient, traits associated with particular responses to climate, and the emergence of dispersal limited distribution patterns and extinction debts.

Keywords

mountain, biodiversity, climate change, range shift, plants, re-survey

Summary

As climate warms plant species are shifting their elevational ranges and climatic trends appear the most plausible drivers of these dynamics in many cases (CHEN et al. 2011). Although expectations and observations match by trend our current knowledge about the impacts of a warming climate on species distributions and biodiversity patterns is still limited in many respects. However, understanding these processes is vital for accurate predictions of changes in biodiversity patterns and effective adaptions of conservation efforts in protected areas.

The current knowledge suggests that species have responded idiosyncratically to climatic trends (WILLIAMS & JACKSON 2007). The velocity of elevational range shifts vary considerably, with variation within taxonomic groups being even more pronounced than variation among them (CHEN et al. 2011): While some species seem to be able to follow climatic changes without delay, many others lag behind climatic shifts more or less pronouncedly, entailing a disequilibrium between climatic conditions and current distributions. The causes of this variation are barely understood. On theoretical grounds, species should track changing climates the faster the higher their dispersal capacities, and the wider their ecological niches (ANGERT et al. 2011). Indeed, some recent studies found support for this hypothesis (ANGERT et al. 2011) but the relationships remained weak throughout and trait-based predictions about species-specific threats under climate change are thus still hardly possible.

Furthermore, there is hardly any report of recent range dynamics that does not document unexpected downward displacement of at least some species' ranges (LENOIR et al. 2010, Chen et al. 2011). In some cases, these 'surprises' seem to be driven by the intervening effects of other climatic factors like precipitation changes (CRIMMINS et al. 2011), by land use dependent habitat modification (HÄTTENSCHWILER & KÖRNER 1995) or may involve changing biotic interactions (BROOKER 2006). Mostly, however, the reason(s) remain contentious.

Apart from interspecific variation, range attributes of a single species may respond inconsistently to climate. As yet, most studies have concentrated on leading edge shifts despite the obvious importance of contracting rear edges in a conservation context (HAMPE & PETIT 2005). In particular, there are few studies that have considered both range limits simultaneously and still less that also included shifts of range optima and changes in abundance. For plants, rear edge dynamics are supposedly associated with longevity and persistence ability which might enable remnant populations to survive at sites no longer climatically suitable for decades (ERIKSSON 2000). In addition, climatic gradients are steep in alpine terrain and, hence, geographical distances among climatically distinct habitats small, fostering mountain plants in tracking climatic changes relatively easy (ENGLER et al. 2011). As a consequence, leading edges are thought to shift faster than rear edges (HITCH & LEBERG 2007, CHEN et al. 2009) but the generality of this pattern remains to be tested. As a corollary, species richness of local plant communities should tend to increase because the colonisation by new species occurs faster than the extinction of resident plants. Such a transient increase has been reported by re-surveys in temperate mountain ranges during the recent decades (PAULI et al. 2012). However, in the course of an apparently irreversible climatic trend, the involved remnant dynamics imply the build-up of an extinction debt (JACKSON & SAX 2010) that will have to be paid off after a more or less extended delay. Indeed, an accumulating extinction debt has been predicted to arise in alpine plant communities (DULLINGER et al. 2012).

With respect to plants in alpine terrain, progress in studying these issues is constrained by the limited focus of most empirical work conducted so far: research interest has yet mostly been concentrated on changes in species composition of mountain top plant assemblages (e.g. Pauli et al. 2012). This restricted focus follows from the prevailing research strategy of re-surveying exactly localizable historical plots which are few, geographically clustered and topographically biased. More importantly, the focus on mountain tops does not allow for assessing whole range dynamics or for getting indications of possible disequilibria and extinction debts. To overcome these limitations we re-located and subsequently re-surveyed over 1500 historical vegetation relevés spread over the European Alps based on their topographic information. The data was used to evaluate species' range dynamics at rear edges, optima, leading edges and changes in abundance during the last decades, the traits potentially associated with responses to climate, and the emergence of dispersal limited distribution patterns and extinction debts.

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Shifting protected area strategies to evidence based governance and management

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Abstract

Protected area governance is dealing with 'public goods' targeted to balance conservation and development. Their exceptional assets and high community-development potential ask for innovative deliberative 'evidence-based governance' which are multilevel, pluralistic, reflective, trans-border, ecological, dynamic and open to changing constraints. Mobilizing the region's potential and applying methods stimulate economy, knowledge development and community interactions. The UNESCO World Heritage sites Swiss Alps Jungfau-Aletsch (CH), Dolomites (IT), Idrija (SLO), and Biosphere Reserves Entlebuch (CH) and Wienerwald (A) represent examples of protected areas with inclusive management approaches in different governance systems.

Keywords

World Heritage, Biosphere Reserves, governance, management, change processes, deliberative democracy, evidence based systems, integrated approaches, regional development methodologies

Introduction

The studies focus on identifying the state-of-the art, bottlenecks and solutions to optimize the UNESCO World Heritage (WH) and Biosphere Reserves (BR) sites' conservation and sustainable development processes. The safeguarding of nature is mainly implemented by legal measures and protective management systems. The increasing pressure in and around protected areas is mainly due to the increasing land use (e.g. agriculture, energy production), need for resources, enlarging settlements, ecosystem changes due to climate change and others. The legal foundations or governance systems are often insufficient and the political decision processes long, corrupted or delayed. Protected area governance systems, whether state-run, private or mixed, are dealing with 'public goods' targeted to balance conservation and socio-economic development. Their main challenge is to establish new deliberative, multi-level governance models taking into account the territorial evidences and the opportunities for local development.

The objective of the current research is to study innovative approaches of 'evidence-based governance' in heritage sites and protected areas which have to be multilevel, multifunctional, pluralistic, reflective, transnational in capacity, ecologically aware, and dynamically open to shifting constraints. The main challenge is to elaborate and share strategies of participative processes including all relevant governance levels, public and stakeholders. Transferable governance models have furthermore to guarantee heritage conservation and the creation of increased socio-economic benefits. Mobilizing the area's potential stimulates the economy, knowledge development and community interaction. The added value consists in generating innovation and contributing to smart, sustainable and inclusive growth.

Mainly UNESCO and International Union for Conservation of Nature (IUCN)/Ramsar designated sites follow international frameworks and represent the uppermost multilevel governance system, from international to local. In addition, they are requested to establish management systems and plans. In November 2015, new sustainable development strategies for WH sites and BRs were adopted, opening a new dimension for integrated territorial approaches. The strategies encompass knowledge-based development, involvement of civil society, available resources and area's social, cultural and environmental specificities. The EU Commission identified new regional Strategies (e.g. EUSALP for the Alpine Space), and the need to build sound and efficient transnational governance models.

Methods

In the EU project CHERPLAN (2011–2014) (ZRC SAZU 2014, RUOSS & ALFARÈ 2013) and the Global Regions Initiative (RUOSS 2013, 2016, 2017) a total of 33 natural and cultural heritage sites in South-Eastern Europe and the Alpine Space with over-used and unused development opportunities were studied. The investigations were based on the WH Convention's and BR's nomination files, management plans and related documents. Websites of the sites and the documents of the WH Centre of the 2nd Periodic Reporting Cycle (2012–2015) were analyzed as was the Final Report for the Europe Region and Action Plan (UNESCO/MAB 2017; WHC 2017). Further empirical information was collected during visits, consultation activities and meetings with site managers.

Results

The legal governance systems evaluated, show the heterogeneity of the approaches aiming at heritage conservation and sustainable development (Tab. 1). The WH sites Swiss Alps Jungfrau-Aletsch (CH) and Dolomites (IT), are examples of ongoing governance processes towards more coherent interregional and integrated management systems. SAJA has elaborated in participatory processes a management strategy, which mandates the conservation and development tasks to its management centre. Dolomite WH management has the task to supervise and promote the serial WH property and to coordinate the activities of the municipalities and actors in the area. Idrija (SLO) has achieved a model role as a site with integrated development strategies, establishing public private partnerships (PPPs) under the lead of the municipality thanks to a committed mayor and the engagement in EU programs.

Protected area	**PA Type**	**Governance type**	**Members**
Swiss Alps Jungfrau Aletsch SAJA (Switzerland)	Natural World Heritage site	Public Foundation	23 Municipalities in two Cantons
Dolomiti - Dolomites (Italy)	Serial Natural World Heritage site	Private Foundation	5 Provinces in 3 Regions representing 85 Municipalities in the WH property
Idrjia (Slovenia)	World Heritage of Mercury Almadén and Idrija	Public body	Municipality Idrija
Entlebuch Biosphere Reserve (Switzerland)	Biosphere Reserve	Association of Municipalities	7 Municipalities
Wienerwald (Austria)	Biosphere Reserve	Management GmbH (company with limited liability)	2 Regions representing 51 Municipalities and 7 Municipal Districts

Table 1: Protected areas governance systems studied in the Alpine Space

The Entlebuch Biosphere Reserve was established by municipal referendums, since the population is directly involved in decision taking. The Association of Municipalities with its board and management, represents a public body governing and managing the large protected area on behalf of 8 municipalities. With the participation of the site's management, three PPPs for the tourism promotion and the marketing of local products have been established. The Wienerwald Biosphere Reserve is managed by a private company under the governance of the two regions. In both sites the municipalities together with the local population and business are the main driver of activities to conserve and develop the area.

Discussion

The examined protected sites possess a fair amount of social and environmental capital. Their assets are exceptional natural values with high community-development potential. Often they are less favored due to their remoteness, the risks related to climate conditions, a vulnerability rooted in natural hazards and disadvantaged socio-economic development. The complexity of multilevel governance systems from international to local realities is hindering development. Varying governance approaches, different legal, institutional and financial conditions, difficult public and stakeholders involvement lead to discrepancies. New deliberative governance approaches for protected areas including local sustainable development is central in overcoming the obstacles.

Facilitating a sustainable development in and around protected areas, thus creating deliberative governance systems involving stakeholders and civil society, could significantly create new job opportunities, added values and income for indigenous people. The balance between protection and local development will increase knowledge, awareness and responsibility of the actors and decrease pressure on the wilderness.

Evidence based territorial governance encompasses the three dimensions Top-down, Bottom-up, Outside-in (Fig.1). International and national bodies have to lead the Top-down process defining the overarching norms, principles and objectives, facilitate the elaboration of evidence frameworks, and delegate authority and accountability to the operative level. The international organizations may facilitate standard setting, knowledge dissemination and transfer, and transnational harmonization. The national authorities are required to provide legal and evidence frameworks, deliberative policy instruments and coherent funding as basis for efficient territorial governance.

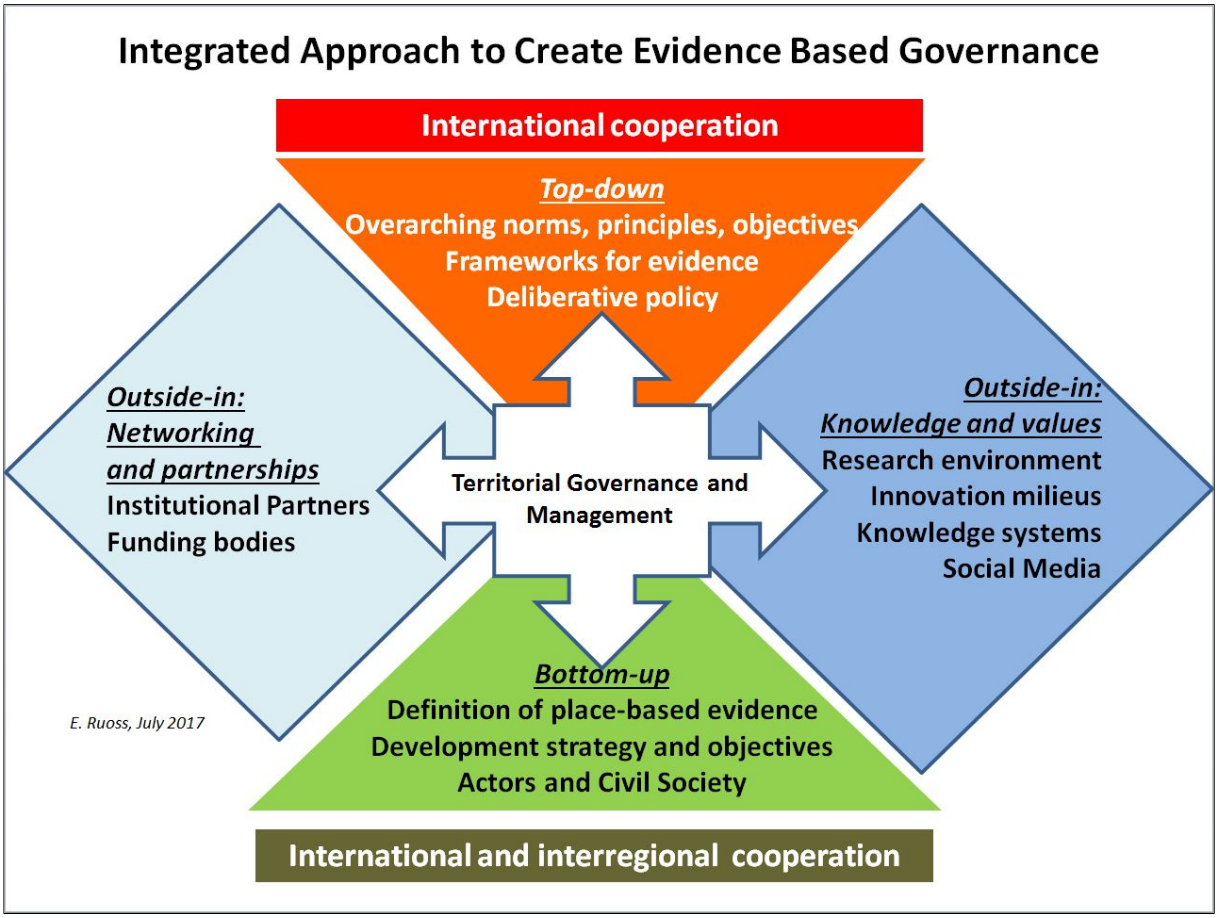

Figure 1: The holistic approach of territorial governance is based on local evidences engaging the three dimensions Top-down, Bottom-up, Outside-in.

Local policies have to focus on Bottom-up processes defining strategies and objectives based on local place-based evidences such as resources and needs as well as to support decision taking and the area management. The local population will, not only participate, they will profit from the share of benefit and added values as a return of their investments and increasingly exchange and cooperate internationally.

The public and private institutions providing knowledge, funding, networking, and facilitate the environment for research and innovation as well as the communication systems will have a key role in the Outside-in processes.

The results show the diversity of legal and organizational frameworks, their transformation needs, processes and new approaches tested so far in protected areas. Innovative governance and management frameworks and methodologies such as the Outcome-Oriented Public Management (SCHEDLER & PROELLER 2010), the Social-Ecological Systems (SES) (MCGINNIS & OSTROM 2014), SDI method (RUOSS 2007), NEXUS methodology or the Sustainability Profile Matrix (GLØERSEN et al. 2016) have paved the way to adopt new integrated territorial governance approaches.

Conclusion

Integrated governance approaches of protected areas including sustainable development strategies aim at knowledge-based development involving local society, adapted to available resources and area's social, cultural and environmental specificities. The protected areas studied represent examples with inclusive management approaches in different governance systems. All the governance models still show their roots in the traditional top-down approaches with a management system focused on coordination and have not yet adopted integrated evidence based approaches with holistic participation and decision processes.

Future research will have to facilitate mutual learning and exchange among different multilevel governance systems and explore ways and methods of shifting to evidence-based governance models. The interactions of the three dimensions will further contribute to the efficiency of mitigation and adaptation to future challenges such as climate change, migration, social transformation and globalization.

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Linking habitat dynamics and population cycles of small mammals in different mountainous forest types in Austria

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Keywords

small mammals, seed rain, habitat dynamics, population cycles, old-growth forests, long-term monitoring

Summary

Scientific research in protected areas such as the Wilderness Area Dürrenstein (WAD) is of particular importance to gain a better understanding of ecological relationships in the absence of human influences (LANG & NOPP-MAYR 2012). Within the WAD occur about 400 ha of primary old-growth forests constituting an optimal reference area to compare with other forest types (LEDITZNIG 2013). According to the protection status of the area as a strict nature reserve (IUCN category Ia) one of the management aims is to give free rein to ecological processes (process protection) including natural disturbances, such as windthrows and avalanches (LEDITZNIG 2013). Those events of natural disturbance led to early stages of forest succession resulting in different species composition and abundance patterns of small mammals and other taxa. Our study focuses on the relationship between small mammal activity and seed rain of mast-seeding trees in the light of different forest types. We conducted live trapping of small mammals since 2002. We commenced with two study areas and included further areas in subsequent years. Currently we are working on 5 different study areas. Two sites of natural disturbance (avalanche: AV; uncleared windthrow: WT); two sites in primary old-growth forests (POF1, POF2) and one site in a managed forest (MF). Live trapping of small mammals was done on a 15 x 15 m grid with two traps per grid point. On study areas POF1, POF2, MF and WT we installed 50 traps on a square grid. On AV 88 traps were placed on an elongated rectangular grid. We used different combinations of traps, exploring differences in trapability (wooden box traps, Ehlert & Partner, Niederkassel-Rheidt, NRW, Germany; plastic traps: FIELD TRIP TRAP Alana Ecology, Bishop´s Castle, Shropshire, GB and TUBE TRAP MKI BioEcoSS Ltd., Bridgnorth, Shropshire, GB; Sherman traps, H.B. Sherman traps, Tallahassee, Florida, USA). In most years trapping was carried out twice a year in June and August for 2-5 consecutive nights. Individuals of *Apodemus* sp. and *Myodes glareolus* were unambiguously marked. We recorded morphometric parameters and released all individuals at the point of capture. We further measured seed rain of the most common tree species (European beech *Fagus sylvatica*, Norway spruce *Picea abies* and silver fir *Abies alba*) within POF1 and POF2 since 2003. Therefore 81 seed traps were installed on a 1 ha square grid on each location. Seeds within the traps were counted twice a year. Mean number of available beechnuts/m² significantly correlated with overall capture success of small mammals per year ($r_s = 0.62$, $p = 0.028$). We detected 3 population peaks of *Apodemus* sp. and *Myodes glareolus* in 2004, 2008 and 2012. Further investigations will be conducted to discover driving factors for small mammal abundance in different forest types (see poster).

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Let's cooperate: How collaborative governance approaches can help to address institutional fit in protection areas

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Abstract:

One challenge in environmental governance is to reach a good 'institutional fit' that is to ensure that the governance structures put in place are spatially and temporally well-aligned to the ecosystems and ecosystem services they are meant to govern. In this context, we analyzed how collaborative governance approaches, involving partnerships between public, private, and civil society actors, can address and mitigate institutional misfit. The analysis was done based on empirical research in three European protection areas: the Biosphere reserve Spreewald, Germany, the Nature park Jauerling-Wachau, Austria, and the Berg en Dal region as part of the National Landscape Gelderse Poort, Netherlands.

Keywords

ecosystem service governance, institutional fit, public-private-civil partnerships, social-ecological systems

Introduction

One critical challenge in environmental governance is to reach so-called 'institutional fit', which means to ensure that the established governance structures by a social system are spatially and temporally well-aligned to the ecosystems and ecosystem services in the given ecological system they are meant to govern (e.g. COX, 2012, EKSTROM & YOUNG, 2009). Only then ecosystem services and biodiversity conservation can effectively be provided to society (cf. FREMIER et al., 2013). This seems particularly important in protection areas, designated in locations with high potentials for the provision of a multitude of different ecosystem services and as crucial hot spots for biodiversity protection. In this context, we analyzed the potential of so-called collaborative governance approaches to alleviate issues of institutional misfit, since such approaches have gained in importance in governance more recently (cf. LOFT et al., 2015) when compared to two other common approaches in governance, hierarchies and markets (VATN, 2010). Thereby, we define collaborative governance as the vertical (across different scales) and horizontal (across different sectors of society) cooperation of multiple actors, involving partnerships between the public, private, and civil society sphere of society. In specific, we investigated the following research question: Through which distinct features can collaborative governance approaches help to address and mitigate institutional misfit?

Methods

The analysis was done employing quantitative and qualitative empirical research methods in case studies from three European countries, which all represent protection areas: the Biosphere reserve Spreewald, Germany, the Nature park Jauerling-Wachau, Austria, and the Berg en Dal region as part of the National Landscape Gelderse Poort, Netherlands. For the analysis we used a mixed method approach, combining the Net-Map tool (SCHIFFER & HAUCK, 2010) for social network analysis (MCKETHER et al., 2009), semi-structured interviews (e.g. BOYCE & NEALE, 2006), and workshops with focus group discussions (FREITAS et al. 1998).

Results

First, the specific features of the analyzed collaborative governance approaches are presented against the different background settings in the selected case studies, both in view of their communalities and differences. Analyzed features include, for instance, the type of actors (e.g. public administrations employees, staff of the protection areas, land owners and managers, locally active NGOs and associations, etc.) who are involved into each approach, the roles that these actors assume in the governance arrangements, and how these actors interact with each other. Interactions include sharing of information, leveraging funding, spurring trust and mitigating conflicts. Furthermore, actors' motives, their influence and power in decision making procedures, as well as their obtained benefits are presented.
Second, these features are related to the potential of each approach to help in addressing and mitigating institutional misfit in reference to our research question.

Here, the following features seem most relevant:

- Collaborative governance often emerges as a response to a governance deficit, such as the absence of any governance approach (regulatory gap), an insufficient implementation of an existing governance approach, or a lack in stakeholder participation in an existing governance policy, which can all be interpreted as some sort of misfit.
- Since collaborative governance emerges problem-driven based on the given deficit, it is in general open to the voluntary engagement of all concerned stakeholders, and thus typically forms according to the magnitude and spatial extend of the perceived problem rather than political boundaries, as opposed to hierarchical approaches which are based on mandates and authorities typically linked to certain administrative units and jurisdictions, not congruent with the scale at which the problem manifests itself.
- Because of its problem-oriented nature, collective governance is also more time-sensitive: it forms in response to a vexing problem for concerned actors, but also dissolves again, after the problem has been adequately addressed and solved.
- As many different actors are involved, usually interests and motives are versatile, but despite this fact, often win-wins can be realized due to the actors' high levels of individual motivation for solving the problem.
- Also, collaborative governance often allows access to additional resources held by the different actors, which can be critical in properly addressing a problem, e.g. in terms of the local knowledge the actors possess, the voluntary engagement for specific activities they offer, or their ability to raise additional funding for addressing their cause.
- Finally, collaborative governance supports more flexibility as procedures are not as prescriptive when compared to hierarchical and market-based approaches, which gives more leeway to the actors to establish procedures that are better aligned to the specific context of the problem at hand.

Discussion & Conclusions

In summary and in response to our research question, we found evidence that collaborative governance often takes the form of ‚tailor-made' approaches to existing problems and hence supports a better alignment and fit between the established governance structures and the environmental problem addressed. However, collaborative governance can also have some limitations, since participatory and often decentralized decision making is more time-consuming in general. And due to deviant interests of actors, decisions made often constitute rather a compromise (least-common-denominator solutions) that all actors can live with, than an optimal solution for the problem (COGLIANESE, 1999). And, if power imbalances exist between actors, also in collaborative governance insufficient participation of less powerful actors can occur (RUNHAAR et al., 2016).

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Visitors' use of national park services and their affinity to the Gesäuse National Park

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Keywords

affinity to national parks, information sources, services, new media in national parks, winter visitors, Gesäuse National Park

Introduction

Protected areas register due to their recreational value and the existence of natural landscapes increasing visitor numbers. In the last decades, the popularity of these areas led to an enhancement of peripheral regions and a stimulation of the regional economy (LUCKER & KÖLSCH 2009; HASSE et al. 2009; JOB et al. 2009; HENNIG 2003). Furthermore, they have the potential to change current conventions of society and present new perceptions of traditional views on nature by showing the applications of resources apart from their economic advantages (MÜLLER et al. 2008; MAYER et al. 2010; HAMMER & SIEGRIST 2008).

On the other hand, protected areas had to face an impairment of their carrying capacity due to an augmented use, which led to conflicts with their aim of protecting ecologically sensitive areas (HENNIG & GROßMANN 2008; JOB et al. 2008). In addition, particularly in the designing phase of new national parks, residents were usually not included enough in the planning and had to deal with use restrictions causing low acceptance of the national parks amongst them. But as Winiwater stated: 'Regional and local identification is a precious resource for planning a sustainable future, especially in rural areas' (HASITSCHKA et al. 2014, p.5 [translation by the author]). To solve these conflicts the former philosophy of top-down management of protected areas has been amended to a bottom-up philosophy where all concerned stakeholders are invited to take part in the planning process. Besides, the visitor information and environmental education obtained an important role in the management of protected areas to show and establish environmentally compatible behavior (JOB et al. 2013; WOLTERING 2012; HASSE et al 2009; REVERMANN & PETERMANN 2002; HAMMER 2003).

Meanwhile, there are many different offers for recreation, information and education in protected areas available, e.g. guided excursions, exhibitions, brochures, theme trails or guidance systems with signs (HENNIG 2003). With the rise of new information and communication technologies in broad sectors of population, protected areas started to supply offers using the so-called 'new media' like homepages or applications for smartphones (ARNBERGER et al. 2014; HENNIG 2014).

However, inventing, designing and provisioning a broad variety of offers for visitors are time and resource consuming. The precondition for the successful development of useful offers is the knowledge of the various interests, expectations and demands of the different brackets of visitors, which are surveyed with one-time questionnaires or periodic socioeconomic monitoring. Currently, the latter is less often implemented than ecological monitoring. Nevertheless, it has been better structured and systematized in the recent years (REVERMANN & PETERMANN 2002; MUHAR et al. 2002, BUER et al. 2013).

The concept of affinity to national parks has been already used in different scientific contexts. Namely, to estimate the economic value of protected areas for the municipalities surrounding a national park (JOB 2008; MAYER et al. 2010) or to examine the association between the affinity of visitors to national parks and their attitudes towards management measures, like semi-natural forest management or restrictions of recreational use for protection of ecologically sensitive areas, implemented by the national park administration (ARNBERGER et al. 2012; MÜLLER et al. 2008).

The present thesis was considering the interface of environmental education offers, their resonance among the visitors and the affinity of visitors to the Gesäuse National Park (GNP). In particular, the following research questions are adressed:

- Do visitors catch up on the GNP? If yes, which sources are used?
- Which offers of the national park are perceived and get used?
- Is different utilization of offers related to sociodemographic and visit-related characteristics of the visitors?
- What is the percentage of visitors with an affinity to the GNP in winter?
- Is there any difference between affine visitors and regional visitors concerning the knowledge and the use of offers?

Methods

The study was carried out in the GNP with a structured questionnaire based on former surveys of ARNBERGER et al. (2009) and ARNBERGER et al. (2012) in winter 2006/2007 and summer 2007/2008 to allow a direct comparison. The questionnaire consisted of seven parts (modalities of the trip, affinity to the GNP, special part I: search for information, special part II: use of services and offers provided by the GNP, special part III: smartphone application of the GNP, attitudes to the GNP and his services, visitor structure).

In total 293 questionnaires were collected, 17 questionnaires were excluded due to insufficient answering. The questionnaire was distributed by addressing visitors personally in a restaurant in the valley of Johnsbach, a standardized welcoming and information text was read for each participant.

Analysis was made with the IBM SPSS Statistics 21 software, with the following tools to analyze data: descriptive statistics, relative frequencies, cross tables, multiple answer sets, diagrams and non-parametric tests. Chi-square tests and non-parametric tests were carried out to analyze relations between the previously stated variables and the affinity towards the national park, socio-demographic features as well as characteristics concerning the national park trips of the surveyed visitors.

Results

Visitor characteristics: the average age was 47 (youngest 12, oldest 80 years old), people between 41-60 years made 60% of all, 34% were female, most of the visitors came with car (99%) from Styria, Lower or Upper Austria (each around 30%). 35% attained a degree of university or similar level, 30% completed a high school. 61% were daytime visitors, 29% overnight visitors with an average of 2,8 nights of stay and 10% residents of the region.
Most of the visitors used the internet, tour guides and the homepage of the GNP as information sources. The most common recreational offers were information boards and the visitor centers 'Weidendom' and 'National Park Pavillon'. 80% of the visitors had heard about these offers, but more than half of them hadn't used any of them. In the winter season 2014, only a few visitors knew the smartphone-app of the GNP.

The percentage of visitors with an affinity towards the national park was 21%. The affinity to the GNP played a minor role regarding the use of information sources and recreational offers of the national park. In contrast, socio-demographic features and characteristics concerning the trips of the visitors were more often associated with the use of information sources and recreational offers of the national park. Most of the visitor services are better known amongst residents and visitors who are regularly in the national park. The protection status as 'national park' played a role for first-time-visitors to come to the region. This group of visitors are mainly using brochures, internet and the homepage of the national park, while information boards are rarely used. The visitor centers as well as printed media were particularly used by women. For older visitors theme trails and the magazine of the GNP were interesting. Younger visitors (<30) more often use the internet or the homepage of the national park. This is also true for guests who are coming just during the winter time; this visitor bracket is in general not easily reached by the offers of the GNP.

Discussion and conclusion

The findings of the study were in line with former investigations concerning the knowledge and use of offers from the national park provided for visitors in the GNP although around 3-5 years had passed meanwhile (ARNBERGER et al. 2009; ARNBERGER et al. 2012). Particularly the winter guests are not very well reached by services of the national park. In order to provide visitors with important information, new approaches have to be developed. WASEM & MÖNNECKE (2006) 'point towards the importance of informing users about visitor management as early and as detailed as possible using so-called information gates such as sport shops or touring books' (STERL et al. 2010, p. 36,37). The latter (2010) suggested the integration of important information in touring guide books and on websites, which is along the findings of this study. Furthermore, the authors state that ski tour guides, teachers in ski touring courses (e.g. organized by alpine associations) could also share information. As national organizations like 'National Parks Austria' offer their own media and usually have a broader coverage, they play an important role in communicating the effects of recreational activities on wildlife (STERL et al. 2010).

This leads to the conclusion that the services still need to be more adapted to the demands, expectations and needs of the visitors and that new ways of communicating important information have to be found. Regular socioeconomic monitoring can function as a basis for planning and adapting the services provided by national parks.

Limitations of the study were the location of the survey, the chosen timeframe of 3 weeks in the winter and some methodological inelegances.

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Contrasting top down effects of amphibians and stocked fish in Austrian alpine lakes

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Abstract

Stocking fishless alpine lakes dates back to medieval times, but with the use of helicopters stocking activities have increased in the past decades. We present several cases of subalpine and alpine lakes in the Austrian Alps with contrasting impacts of amphibian and fish predators. Introduced fish eradicated natural plankton and amphibian communities. Once the stocked fish started to reproduce, the metazoan plankton communities changed from large, pigmented crustacean species to a dominance of rotifers. Fish preyed heavily on eggs and larvae of natural amphibian species.

Keywords

Alien species, amphibians, alpine lakes, fish stocking, plankton, top down

Results

Case Study 1

Fish stocking in Lake Dreibrüdersee (1643 m a.s.l.) in the Totes Gebirge massif failed in the 18th century and Alpine newts (*Ichthyosaura alpestris*) are still free to exploit the habitat. The calanoid copepod *Arctodiaptomus alpinus* was an important prey item for adults and larvae. The feeding pressure of the alpine newt population was estimated and found to be low compared to introduced fish. Gastric evacuation rates and daily food consumption of adults and larvae are considerably lower than in salmonids. Additionally, adult newts only exploit the habitat during summer at the lake bottom, have lower body mass than fish, and comparatively low fecundity (Schabetsberger 1993; Schabetsberger & Jersabek 1995; Jersabek & Schabetsberger 1996; Schabetsberger et al. 1996).

Case Study 2

Two pairs of neighboring alpine lakes located in the Northern Calcareous Alps of Austria were investigated: Großer Feichtauersee (1387 m) and Kleiner Feichtauersee (1394 m) in the National Park Kalkalpen and Schwarzsee (1414 m) and Karsee (1434 m) in the Dachstein massif. Each pair comprised a deeper lake containing European minnows (*Phoxinus phoxinus*), and a corresponding shallower lake harboring Alpine newts as top predators. Plankton successions within fish and amphibian lakes differed markedly from each other. Throughout the year rotifers numerically dominated within the stocked lakes, while pigmented copepods (Genera *Heterocope, Acanthodiaptomus, Arctodiaptomus, Mixodiaptomus*) and *Daphnia* were predominant in the amphibian lakes. We argue that size-selective predation by minnows was the ultimate reason for this predominance of smaller zooplankton (Schabetsberger et al. 1995, 2006).

Case Study 3

The zooplankton community of Alpine lake Seehornsee (1,779 m) was studied over a period of 13 years. In 1994, a typical high-altitude zooplankton community, consisting of two calanoid copepods (*Mixodiaptomus laciniatus, Arctodiaptomus alpinus*), one cladoceran (*Daphnia rosea*), and two rotifers (*Keratella quadrata*, *Synchaeta pectinata*) coexisted with infertile charr hybrids, which had been introduced in 1969 and again in 1974. When the aged fish were removed by intensive gill netting, they had fed predominantly on aquatic insects. After a fish-free period of 4 years, 2000 fertile juvenile Alpine charr (*Salvelinus umbla*) were stocked in 1998 and again in 1999. They preyed on benthic (chydorids, ostracods, cyclopoid copepods, chironomid larvae and pupae) and planktonic prey (diaptomid copepods, Daphnia). Between 2004 and 2006 charr successfully reproduced. Nine years after stocking of fertile charr, the two calanoids had virtually disappeared, and *Daphnia rosea* had notably declined in abundance. In concordance with the size efficiency hypothesis, the newly appearing and smaller cladoceran *Ceriodaphnia pulchella*, together with the two resident, and two emerging species of rotifers (*Polyarthra luminosa*, *Gastropus stylifer*) dominated the zooplankton community (Luger et al. 2000; Schabetsberger et al. 2009).

Case study 4

During ten years of research in the Austrian Alps we characterized the zooplankton communities of 101 alpine lakes and ponds. Forty-eight of the water bodies could be classified as lakes. Of these 48 lakes 24 contained fish. Of the 24 fishless lakes 15 were inhabited by one, two or three large crustacean zooplankton species. The remaining 9 fishless lakes were not populated by diaptomid copepods or daphnid cladocerans. However, these ultraoligotrophic lakes were situated on granite bedrock at an altitude above 2200 m and did not support a diverse zooplankton fauna. Twenty-two of the stocked lakes contained only small-bodied cyclopid copepods and chydorid cladocerans, and the zooplankton community was dominated by rotifers (JERSABEK et al. 2001).

Case Study 5

Lake Sulzkarsee (1450 m) in the National Park Gesäuse has been stocked with salmonids (*Salvelinus fontinalis*, *Oncorhynchus mykiss*) and minnows (*Phoxinus phoxinus*) in the 1970s. After piscivorous salmonids were removed by intensive gill netting in 2005, *Daphnia longispina* was driven to extinction by the minnows. Accordingly, the proportion of phytoplankton to zooplankton biomass changed from 0.5 in 2005 to 4.7 in 2015. In an ongoing project we are trying to eliminate minnows from the ecosystem by draining the entire lake through siphoning. Intensive fishing on minnows in 2016 resulted in successful spawning of numerous common toads (*Bufo bufo*).

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Conclusion

Fish introduction has detrimental effects on the natural communities in high-altitude lakes. Action should be taken to remove alien fish from lakes within protected areas.

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Soil succession in relation to vegetation on a subalpine forest fire site in the Northern Limestone Alps

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Keywords

forest fire, Northern Limestone Alps, soil succession, carbon stocks, vegetation

Summary

The study investigates secondary soil succession on a steep subalpine site in the Northern Limestone Alps of Austria after substantial vegetational and soil losses induced by a stand replacing forest fire in 1950. The main objectives were (1) to estimate the extent of soil development in relation to different kinds of vegetation, (2) to quantify macroscopically visible charcoal in these soils and (3) to test the potential of FTIR-analysis to identify the vegetational litter sources of the humus layers for subsequent identification of typical patterns of succession. The field survey, which took place in 2013, included the firesite and an undisturbed reference site. Sampling design was stratified by vegetation (grasses, heather, larch, spruce, mountain pine) and included morphological soil profile descriptions as well as volumetric soil samples. Total belowground organic carbon and nitrogen stocks were estimated including litter/soil, deadwood, charcoal and roots. According to the results, with an average total of 3.7 kg C m^{-2} and 0.1 kg N m^{-2} the soils of recolonized patches at the firesite so far have recovered by around 40 % as compared to typical site potentials (reference site: 8.4 kg C m^{-2} and 0.30 kg N m^{-2}). Soil layer analysis reveals that largest regeneration discrepancies occur in the soil/litter stocks of the Oh-horizons with a regeneration of soil C < 25 %. Total sequestration varies considerably depending on the kind of vegetation with hitherto heather showing the highest regeneration potential comprising a total of 5.8 kg C m^{-2} belowground, compared to 3.5 kg C m^{-2} for grasses as well as for spruce, 2.8 kg C m^{-2} for mountain pine and 1.8 kg C m^{-2} for larch. The comparatively high C stocks for heather are characterised by remarkably high stocks comprised in dense root layers (~2 kg C m^{-2}). The amount of charcoal in the soils of the firesite is low with an average of 60 g m^{-2}, probably due to heavy erosion. The intended FTIR approach for identifying the vegetational source material of the humus layers proved to be too complex in the course of this study, however potentials for further research were highlighted.

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Managing externally caused impacts on protected ecosystems in a long-term perspective – lessons learnt from the Swiss National Park

Thomas Scheurer

Keywords

impacts, ecosystem, protected areas, adaptive management, monitoring

Even if the Swiss National Park (SNP) is strictly protected (IUCN Ia) since more than 100 years, this near-natural area and its ecosystems have been influenced and even altered by impacts caused outside the Park. Experiences over a long period show, that specific strategies have to be developed for managing externally caused impacts in order to mitigate or control them.

A short chronology of conflicting impacts in SNP

Serious conflicts raised after 30 years of protection, when red deer population in the region grew constantly and obviously altered vegetation in the Park and in adjacent regions. Simultaneously the project to use the river Spöl for hydropower production was launched and, finally, the planed dams were constructed from 1960 to 1970 (Tab 1.). These two conflicts have been very much present in the public discussion for many decades and influenced the image of the Park, until appropriate management practices have been implemented. Later, in the 1960-ies and 1970-ies the number of Park visitors and the traffic on the main road crossing the Park (the only road linking the Engadin with Val Müstair over the Pass dal Fuorn) increased constantly. Consequently, the road was extended and straightened, and infrastructure in the Park (parking, trails, resting areas) was installed or improved. Additionally, a new road from the Park to Livigno, a customs-free tourist destination in Italy, was constructed jointly with the Spöl dam at Punt dal Gall. Since, traffic is increasing constantly until today, whereas visitor frequencies remained in a constant belt of fluctuation since the 1990-ies. Another concern are effects of environmental change. Since the 1970-ies, scientific research stated relevant environmental effects on the Parks ecosystems and populations due to atmospheric depositions, increasing temperatures and drought periods, and related natural hazards.

Issue	main external impacts	detection	basic studies	Measures (selection)	management principles (outside / inside Park)
Red deer migration	vegetation (plants, forest), nutrients	since the 1940ies	1954-1978 1990ies	feeding in winter time, few shootings in the SNP	wildlife management and control by Grisons based on revised cantonal hunting law 1989: hunting outside SNP
Hydro-power (Spöl)	river ecology, sediments	since 1960	1990. 2000-2003	artificial floods & monitoring (since 2000)	adaptive management of residual flow based on new regulations and agreements 2012 & 2016 between SNP, Research Council and Hydropower Company
Traffic	noise, salt, artificial banks, barrier effects	since 1960ies	some few, punctual after 2000	improving security at parkings and trail crossings	
Visitors	trail erosion, disturbance of wildlife, waste	since 1970ies	1985-1995	new parkings and resting places, monitoring of visitors	restoration of existing infrastructure
Deposition	acidification, deposition of nutrients and pollutants	since 1970ies	Since 1970ies	monitoring of immissions and its effects	observe evolution
Climate	temperature precipi-tation, vegetation period, immigration of new species, morpho-dynamic	since 1980ies	since 1950ies, after 1980	monitoring climate and relatetd effects, research , control of invasive biota	observe evolution

Table 1: Overview on externally caused impacts in the Swiss National Park 1914 - 2016 and related research and management

From problem detection to management

The first important concern for Park authorities was a long lasting conflict (from the 1950ies until late 1980ies) related to the increasing population of red deer (JENNY & FILLI in BAUR & SCHEURER 2014). Main issues were obvious effects on Park vegetation, damages in pastures and forests outside the Park, and large amounts of dying animals in strong winters during the 1950ies. As red deer stayed in the Park during hunting period in autumn, the Park was seen as a main reason for increasing numbers of red deer and damages caused by it. At that time hunting in the Park was seen as a necessity by large parts of the local population. To avoid hunting in the Park, Park authorities initiated (between 1954 and 1979) a series of scientific studies on the migration and distribution patterns of red deer in the larger Park area.

Based on the ecological and biological findings of these studies, the canton of Grisons developed a management concept after 1980, that aimed at controlling red deer populations mainly with a better distribution of red deer by creating new 'quiet zones' and by introducing an additional hunting period in November, when red deer normally has left the Park. Like that, hunting in the Park could be avoided and the needed reduction of the population controlled. This system was legally fixed by a revision of the cantonal hunting law (1989). The adapted wildlife management was very effective in the Park region. After 1990 the population decreased and criticism concerning impacts caused by high densities of ungulates became rare.

Another challenge was the construction of equipments for hydropower production along Spöl and Inn (KUPPER in HALLER et al. 2013). The Park was affected mainly by two dams in the Spöl river, just outside the Park. Even if some land compensation and a higher flow of residual water during summer (for tourists) were negotiated, the damage for this river ecosystem was catastrophic. When hydropower production started in 1970, the Park did not pay attention to this 'lost area'. During a technical needed flood in 1990, a group of scientists from the Parks Research Council had the opportunity to investigate the effects of this artificial flood (SCHEURER et al. in BAUR & SCHEURER 2014). The flood caused, that the shallow water areas behind lateral sediments were transformed to streaming water again, and ecological integrity of fauna and flora was enhanced. Based on these striking results an alternative residual water management was developed: basic flow is reduced and saved water is used for annual artificial floods. Ten years passed until this concept could be implemented officially in 2000 and another 12 to 16 years passed until a legal fundament for an adaptive management was established. Since 2000 the Park, the cantonal authority and scientists decide annually on number and amounts of floods aiming at improving the ecological integrity of the river.

Currently, regarding the Swiss National Park, wildlife management and residual flow management are established and under control, while impacts from traffic and in some areas from visitors have to be tackled basically in future. On the other hand, influence of environmental change on natural processes is a framework condition that has to be tolerated, but used to understand better how nature adapts to such changes by itself.

These examples show, that the handling of externally caused impacts on the Parks strictly protected nature was case specific, as well as the result obtained. But the way from problem detection to management actions is following some principles: In all cases, scientific studies helped to become aware of an issue and in given cases (hunting, residual water management) to develop evidence based management tools. Yet, the time from problem detection to gaining evidence differs from 10 to 40 years a lot between the presented issues. For finally developing a legal framework for a common management, another 10 to 15 years have to be calculated. These time frames illustrate that finding management solution with concerned external authorities claims for institutional strategies that are valid for more than a generation in Park administration.

Managing externally caused impacts: lessons learnt

Regarding the presented causes and impacts, some lessons learnt during the last decades can be summarised in the following five points:

1. The Park has not the authority to manage external impacts and its causes by its own. Cooperation with external authorities are needed, as well as the understanding of opportunities and limits of the existing legal system related to the problems to be solved. Building up needed competences in the Park administration can be helpful.
2. In principle, all external impacts have to be monitored in a long-term (impact monitoring), in order to quantify external effects on natural processes and to provide data for evidence-based management and for scientific research.
3. Not all external impacts can be controlled, as depositions or climate change. Efforts have to be concentrated on relevant impacts, which can be mitigated or adapted in a long-term perspective.
4. Solutions for management can be successful, when they are legally anchored and binding (law, directive, agreements). To establish and implement such solutions will take some 10 to 15 years (in the Swiss legislation context). Therefore, long-term and evidence-based strategies are needed.
5. Most effective are solutions which are implemented by an adaptive management process supported by a monitoring programme, in order that management can respond to changing impacts or conditions or to failing measures.

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Participatory modelling for understanding consequences of management choices on ecosystem services and biodiversity in protected areas

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Abstract

Complex ecological and socio-economic processes as well as management decisions influence ecosystem services (ES) and biodiversity, through complex chains of cause and effect. To facilitate a better and shared understanding of the complexities in protected areas, we propose a participatory modelling approach based on system thinking and system dynamics. We developed generic and open models for provisioning and cultural ES, using the interactive platform Insight Maker, to support to managers in involving stakeholders and developing together dynamic models of 'their' social-ecological system.

Keywords

System dynamics, participatory modelling, ecosystem services, management strategy

Introduction

Urbanisation, agricultural intensification, and industrialisation are affecting natural environments and associated ecosystem services (ES), defined as the benefits human populations derive from ecosystems (MEA, 2003). The importance of protected areas in conserving biodiversity and providing crucial ES, especially regulating and cultural services, is therefore growing (LARSEN et al., 2015). ES are co-produced by the ecosystems and human interaction through labour, technology or financial capital and depend on the socio-ecological system (PALOMO et al., 2016). Complex ecological and socio-economic processes as well as management decisions influence ES, through complex chains of cause and effect (PARTELOW et al. 2016), which may lead to unexpected results and failure of governance focused on short period. Some of these relationships are common among protected areas, others are more distinctive of specific social-ecological systems. In addition to a deeper understanding of the specific socio-ecological system, tools to evaluate possible consequences of management choices, for example introducing Payments for Ecosystem Services (PES), are needed to successfully managing ES and biodiversity on the long term, considering social network interactions and linkages among multiple ES (BENNETT et al. 2009). A key aspect is the involvement of local stakeholders accounting for their preferences and values; for example, by applying participative methodologies that allow conducting effective discussions with different stakeholder groups and supporting the decision-making process (ANTUNES et al., 2006).

Although research on ES and related methodologies has been growing rapidly, only recently, ES approaches were integrated with participatory modelling approaches. Thus, we propose a participatory modelling approach based on system thinking and system dynamics (SD) to facilitate a better and shared understanding of the complexities in protected areas and to support governance of protected areas related to ES and biodiversity. For this aim, we develop a generic and open model for recreational ES, using the interactive platform Insight Maker, which can serve as a basis for simulating different management scenarios. We discuss shortly how this model can support protected area managers in governance of ES and biodiversity, also together with local stakeholders.

Materials and methods

System dynamics modelling

SD modelling is a method to analyse feedback relationships and simulate the effects of alternative scenarios or policies to obtain insights about the causal relationships of a system and to identify management options (FORRESTER, 1994). With SD, causal loop diagrams can be developed in order to capture the dynamics of a specific system and to communicate important feedback loops (STERMAN, 2000), highlighting the variables of a system and the linkages. To improve the decision-making in protected areas by understanding the complexity of the social-ecological system and including preferences and values of local stakeholders, SD models can be developed and discussed together with the stakeholders in a 'group model building' (GMB) project (ANTUNES et al., 2006).

Developing SD models for ES

Based on common knowledge from scientific literature, experts, existing models, and experiences from the project LIFE+ Making Good Natura (www.lifemgn-serviziecosistemici.eu), we developed generic SD models for managing ES in protected areas (SCHIRPKE & SCOLOZZI, 2015; SCOLOZZI & SCHIRPKE, 2016). These models aimed to represent main variables influencing ES provision, to visualise feedbacks between management measures and system variables, to provide managers with basic but systemic information to support the development of specific models for their sites. In contrast to the previous models, here we included PES as a management option for recreational values. The model was published in the web platform Insight Maker, which is an open web-based, general-purpose simulation and modelling tool (FORTMANN-ROE, 2014).

Results

Fig. 1 depicts the SD model for assessing management choices related to recreational values in protected areas. An explanation of the single variables can be found in the interactive online version. Fig. 2 illustrates a hypothetical development under two management scenarios.

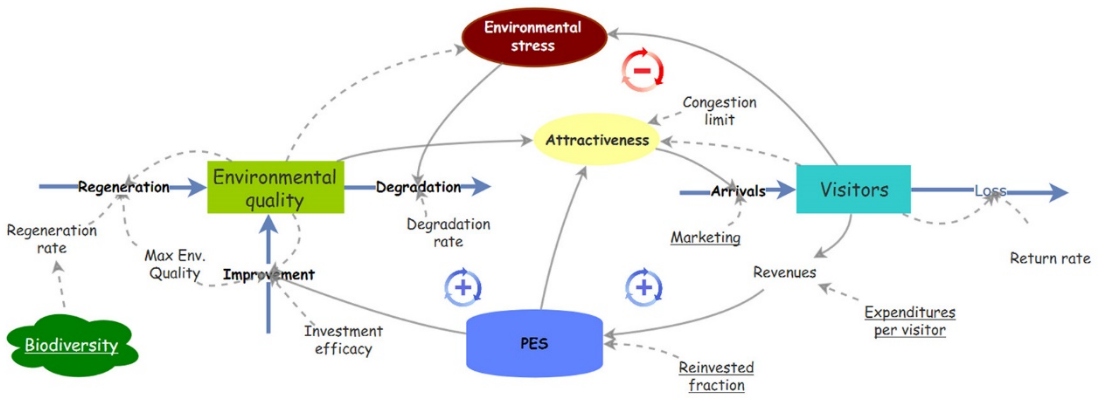

Figure 1: SD model for assessing the impacts of management choices related to recreational values in protected areas. The interactive model is available at https://insightmaker.com/insight/43840/Recreational-ES-in-Protected-Areas.

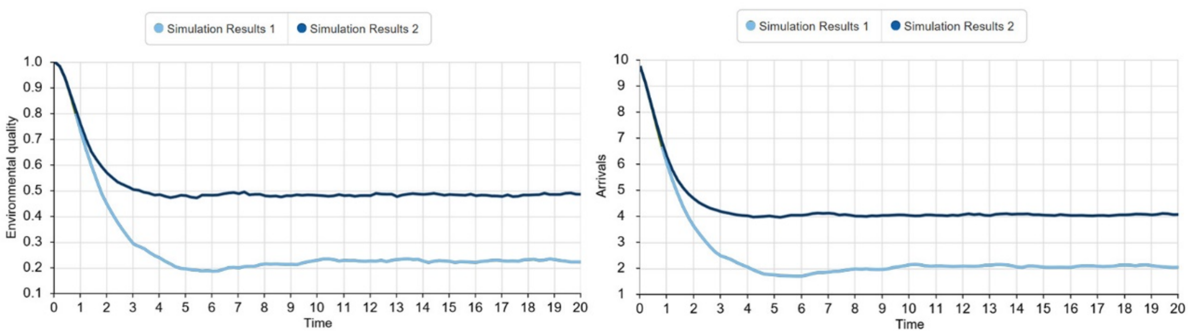

Figure 2: Development of environmental quality (left) and visitor arrivals (right) over time under two management scenarios: simulation 1 depicts the development without PES and simulation 2 assumes a reinvested fraction of 30%.

Discussion and conclusions

The understanding of the complex relationships of the underlying social-ecological system is essential for the successful management of protected areas (PARTELOW et al. 2016). We proposed a basic SD model of recreational ES to improve the understanding, communication, and management of recreational ES and biodiversity. The variables of the model represent only qualitative information, allowing to remain general enough to model ES regardless of the site, but realistic enough to help further developments at the local level, e.g. by a local panel of experts and stakeholders. The model should be further adapted to the protected area in question, as the developed model is hypothetical and generic. Thus, it need to be calibrated and verified with real data and maybe integrated with new variables. The model can be improved through GMB involving experts and stakeholders, allowing to understand and share local knowledge, to assess the dynamics of the specific system under various conditions, and to identify the impacts of management choices (VOINOV AND BOUSQUET, 2010). Stakeholders may provide knowledge, values or preferences for an initial phase, develop and discuss alternative scenarios and contribute directly to the decision-making process (LYNAM et al., 2007). Our model was presented through the storytelling tool of Insight Maker, which facilitates the understanding of the consequences of scenarios by updating the variables and showing immediately the outcomes. Next steps include the testing for operational use of the SD modelling to evaluate with real data their potential for protected area governance.

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Capturing the effects of the Danube River incision on the potential natural vegetation of the Donau-Auen National Park

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Abstract

This study aims to investigate how the incision of the Danube has effected the potential natural vegetation (PNV) of the Donau-Auen National Park and its hydrological habitat parameters. It compares a mapping of the present PNV of a study site to a mapping from 1975. The change of flood characteristics and groundwater table is modelled in ArcGIS and R. The outcome of the study shows no habitat rejuvenation and only a minor change of PNV types. The hydrological regime, on the other hand, has changed distinctively.

Keywords

Terrestrialization, Hydrogeomorphology, Floodplain modelling, Disturbance regime

Introduction

Natural rivers are characterized by a dynamic disturbance regime. The varying water flow and sediment and woody debris load creates, in interaction with landscape and vegetation, an ever-changing mosaic of habitat patches (Beechie & Bolton 1999). River-floodplain systems are hotspots of biodiversity (Ward 1998). Over the past centuries most Europe's rivers have been regulated and floodplains have been greatly reduced. The Donau-Auen National Park protects Austria's the largest remnant, located between Vienna and the Slovakian boarder. The pre-regulated state of the Danube featured a dynamic equilibrium between erosion and sedimentation. Historic maps show the Danube with braided and meandering channels, islands, gravel and sand bars and oxbow lakes (Hohnesinner 2009). In the late 19th century the Danube was channelized. This led to the erosion of the river bed. The construction of several hydropower plants accelerated the incision rates, because sediments accumulate in the retention basins causing a deficit downstream (Klasz et al. 2016). The floodplain is further disconnected from the river by the aggradation at the levees (Klasz et al. 2014). This study investigates how river incision and levee aggradation have affected the inundation of the floodplain during flood events as well as the distance to groundwater during the vegetation period. It further assesses how the potential natural vegetation (PNV) has changed over the past 40 years. The outcome of this study was presented at the 6th Symposium for Protected Areas in the session theme 'Protected forest areas – lessons learned from long-term research'.

Methods

The study was conducted on an area of about 1 km², located between river-km 1899 and river-km 1898, on the left river bank of the Donau-Auen National Park (Fig.1). Polygons were identified based on homogeneity of topography, soil and vegetation during field assessments in 2015 and assigned to a PNV type. The polygons were mapped on an aerial photo and digitized in ArcGIS. The historic map by Margl and Müller (1975) was digitized as well. Using a digital elevation model (DEM), the delineation of the polygons was modified. The change of PNV types from 1975 to 2015 was calculated based on aerial balances. A floodplain age map was created based on historic maps. Landscape units were identified on the maps, digitized and intersected. The change of hydrological conditions in the floodplain was modelled based on river incision, floodplain aggradation and historic water levels of the Danube at the local gauging stations. The levee of the study site was modified with the site-specific aggradation rate of 7.5 mm/a by Klasz et a. (2014).

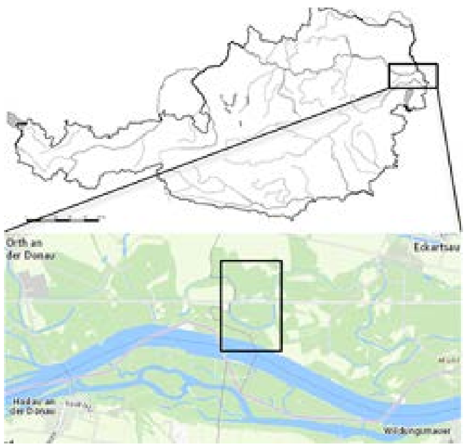

Figure 1: Study site (Geoland; modified)

The mean groundwater table for historic years was modelled based on a linear regression equation found between mean water level of the Danube in Hainburg and the groundwater level at the local gauging station Eckartsau, Bl 1897.3. (data source: via donau). The distance to groundwater was calculated for several historic years by subtracting the elevation of the groundwater table from the terrain elevation of the time-specific modified DEM. Annual incision rates were calculated from historic regulation low flow levels of Orth a.d. Donau. The water column of flood events of different annuity was modified for historic years by using the incision rates. The water column was projected onto the modified DEMs. Areas, which had a lower elevation than the water column but were isolated from the river by surrounding higher elevated areas, were redefined as non-flooded.

Results

The field assessment of the PNV identified the same PNV types as previously mapped by MARGL and MÜLLER (1975), except for one landscape unit located at a former point bar of the isolated meander bend. While the unit was mapped as the PNV type 'Black poplar woodland' 40 years ago, it has now progressed to the next stage of succession 'Dry poplar woodland'. The study site features predominately late stages of succession characterized by *Quercus robur* and *Fraxinus excelsior*. Earlier stages are found at the river bank ('Fresh willow woodland'), at the area between the Danube and a flood runner in the western proximate floodplain ('Fresh poplar woodland and Wet poplar woodland') and in depressions ('Reed and Wet willow woodland') (Fig.2). Historic maps of the Danube document the landscape dynamics over time. Whereas especially the right river bank is characterized by geomorphic dynamics such as channel migration and island formation, the study site has remained relatively stable. Most of its landscape is at least over 240 years old. Small areas, located on a former side arm and in the migration corridor of a meandering side arm are 142 – 240 years old (Fig.3). The hydrology of the study site shows distinct changes. The groundwater table lowered by about 40 cm in a 30-year period from 1970 to 2010. Modelled flood inundation maps show a reduction of flooded area and depth of inundation at the study site. In 1970 the 2-year flood inundates 67.12% of the floodplain, whereas only 12.89 % are inundated in 2010. The area inundated by water column of over 2 m also decreases from 19.04 % in 1970 to 9.02 % in 2010 (Fig. 4).

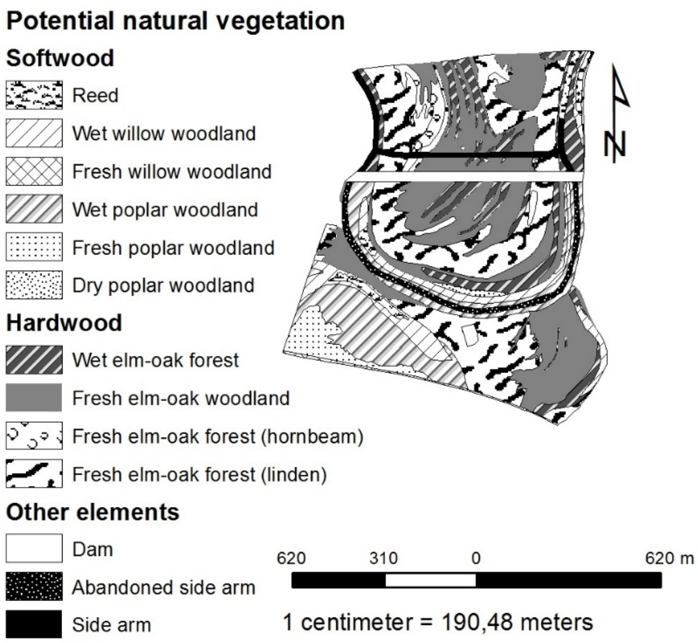

Figure 2: PNV map 2015

Discussion

Over the past 40 years no habitat rejuvenation has been initiated at the study site. In floodplains rejuvenation is driven by flood events, which act as mechanical disturbances and stress, as the impact the metabolism during the period of the flood inundation (EGGER et al. 2009). The modelled flood maps illustrate how the lowering of the Danube and the sedimentation at the levee mitigate the effect of flood events in the floodplain. Over the years the area of inundation as well as the depth of inundation strongly declined. This not only affects the habitat turnover but also decreases the transport of nutrients across the floodplain (JUNK et al. 1989). Groundwater level fluctuated with the water level of the Danube. Thus, distances to groundwater increase while river incision. Lotic water bodies and their species assemblages are especially sensitive to the river incision as they are less frequently recharged by flood water and the rising groundwater table (BAUMGARTNER 2014). Most of the floodplain forest of the study site is in a late successional stage. There is a lack of pioneer habitats, which feature particularly high biodiversity (EGGER et al. 2009). The floodplain age map shows that the study site has been comparatively stable even before the regulation of the Danube. Most of the floodplain is over 240 years old. Succession in established elm-oak forests is a slow process, compared to the quick progression of successional phases in the early willow and poplar stages (EGGER et al. 2009). The stable and old floodplain areas on the left river banks are characterized by thick layers of silty soil, with high nutrient and water holding capacities (MARGL 1973). This soil properties might buffer the effect of the hydrological changes on the floodplain vegetation.

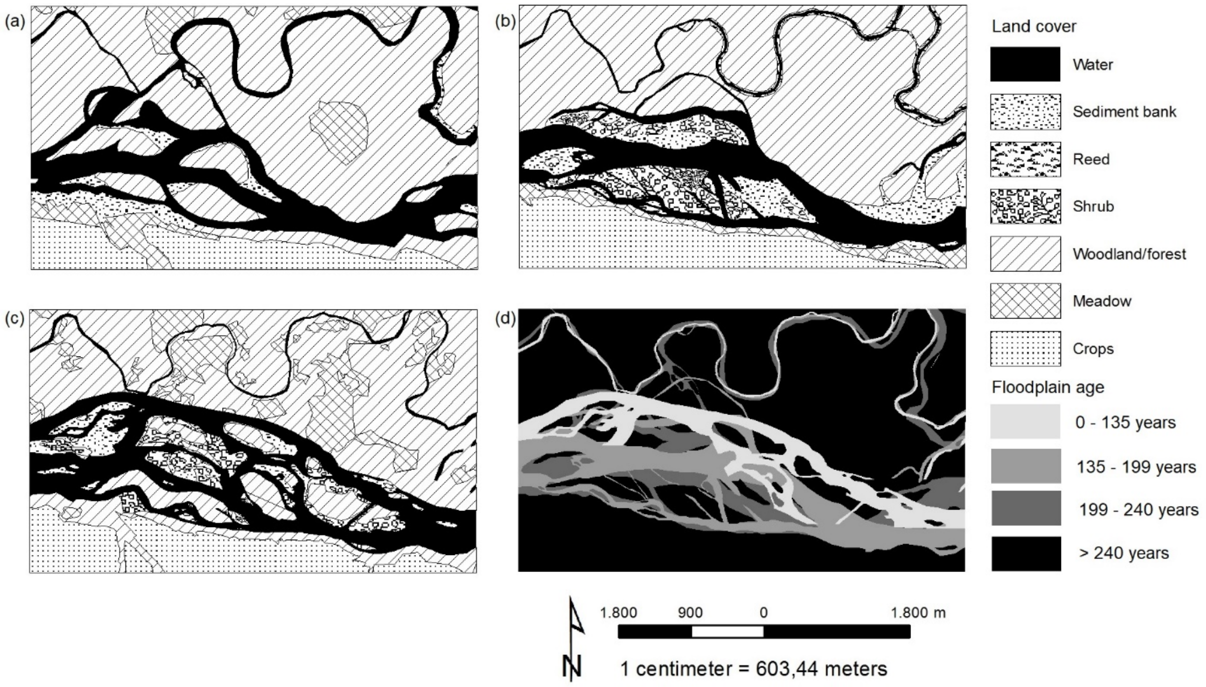

Figure 3: Historic maps of the study site (a) 1778, (b) 1816, (c) 1873, (d) floodplain age

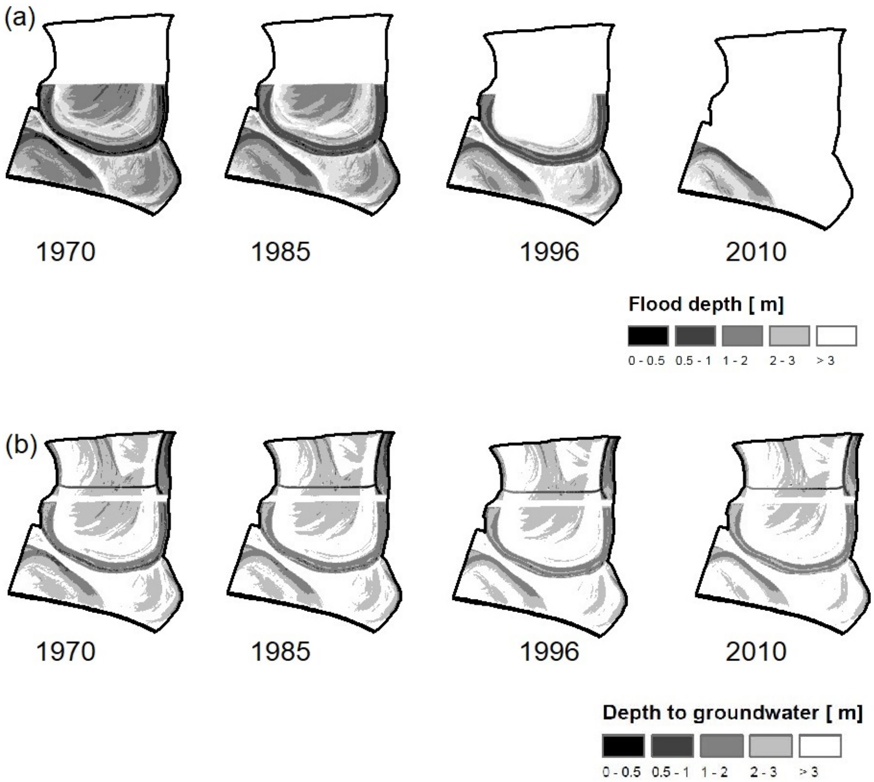

Figure 4: Modelled maps (a) 2-year flood, (b) groundwater

Conclusion

River incision accelerates the trajectory towards terrestrialization in the floodplain of the Donau-Auen National Park. Pioneer vegetation and lotic water bodies are particularly threatened by this development.

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The potential of UAV-data for surveying sediment dynamics - A case study in the Gesäuse National Park

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Keywords

Sediment dynamics, Gesäuse National Park, UAV, SfM-MVS, TLS, DEM of Difference

Summary

This contribution summarizes the main aspects of a master thesis that dealt with the potential of UAV-data for surveying sediment dynamics. The thesis was submitted at the Department of Geography and Regional Science Graz and was supervised by Wolfgang Sulzer and Oliver Sass.

Unmanned aerial vehicles (UAV) in combination with relatively new photogrammetric processing techniques, namely Structure from Motion Multi View Stereo (SfM-MVS), have a huge potential for environmental monitoring and the acquisition of high resolution geodata not only in fluvial environments. This has been demonstrated by several studies (e.g. Whitehead et al. 2014; Pajares 2015; Smith et al. 2016). However, the analysis and especially the validation of this datasets can be challenging.

The master thesis tries to evaluate the usability of UAV data for surveying sediment dynamics based on a case study in a fluvial environment. For that purpose, a test area (Langgriesgraben) in the Gesäuse National Park was selected. The Langgriesgraben is a side channel of the Johnsbach river. Due to the surrounding brittle dolomite bedrock, the climatic conditions and the relief energy, a huge amount of sediment is available in the catchment. The torrent has only episodic discharge, but a lot of sediment is transported during flood events. Flood events typically occur after snowmelt in spring and during heavy precipitation events in summer. As many areas in the Gesäuse the study site can be described as an area with very high geomorphic activity.

For the study, in a first step, high resolution UAV images (mean ground sampling distance 2-3 cm) of the river bed had to be acquired. In total three UAV missions (31.07.2015/ 22.09.2015/ 22.10.2015) were carried out. The aerial images were taken with a consumer grade camera mounted on a hexacopter. The flying height in the missions was between 60-100 m above ground. The planned image overlap was 80% along track and 60% across track.

The acquired aerial images were used to derive digital point clouds, digital terrain models and orthophotos of the channel using the SfM-MVS method. Processing was performed with the photogrammetric software package Agisoft Photoscan Professional. The georeferencing of the datasets was performed indirectly via ground control points. A network of ground control points was established for that purpose. All ground control points were measured with a GNSS and were marked in the field during the UAV campaign. From the point clouds, digital terrain models with different spatial resolutions (5 cm 10 cm and 20 cm) and an orthophoto mosaic was computed.

In the following step, the derived products were validated. The height accuracy from the digital terrain models and the planar accuracy of the orthophotos were estimated from GNSS measured check points. The achieved accuracy (e.g. height accuracy DTM: 4-7cm RMSE) is in the expectable accuracy range found in literature (e.g. Smith et al. 2016). Hillshades of the digital terrain models were computed for further visual data inspection. Shadow areas in the aerial images and areas covered by dense vegetation were leading to areas with higher uncertainty in the derived models. In future UAV missions, more emphasis should be put on the lighting conditions during image capture. Most of the area of interest in this study is free of vegetation. In this case, higher uncertainties or missing ground information related to dense vegetation cover is not a big issue.

For one timestep the UAV datasets were also compared with almost simultaneously acquired TLS data. The comparison of the datasets was performed with three different methods: (a) cloud to cloud comparison (b) cloud to mesh comparison (c) DoD comparison. For the comparison two test plots in the channel and one test plot on a slope close to the main channel were selected. The comparison was performed with CloudCompare and ArcGIS. The deviation between UAV and TLS is 6-12cm (95^{th} percentile of the deviation) depending on the method used for the comparison and test site.

Through the UAV terrain models from different timesteps it was possible to calculate surface changes in the channel. The DoD (DEM of Difference) method with a minLOD (minimum level of detection) was used to accomplish that task. This is a widely used method in fluvial geomorphology (e.g. BRASINGTON et al. 2003). Based on the calculated minLOD (14cm) a significant change could only be estimated at 12% of the total area. In the observed period (53d) the deposition (295m³) predominates the erosion (163m³) of sediment. This is consistent with the TLS measurements by (RASCHER & SASS 2017). The results show that the used method SfM-MVS in combination with an UAV can detect bigger rates of change. Smaller changes, however, are not detectable due to the reached accuracy.

Acknowledgements

Without the big support of several people and institutions this work wouldn't have been possible. First, I would like to thank the Gesäuse National Park. Secondly, I would like to thank several people at the Department of Geography and Regional Science Graz namely, Gernot Seier (UAV-pilot), Eric Rascher (TLS), Wolfgang Sulzer (Supervisor) and Oliver Sass (Supervisor). Thirdly, I would like to thank Tímea Mareková and Josef Schöttl for their support during field work.

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Diversity measures indicating environmental change in alpine river ecosystems

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Abstract

Environmental conditions under change strongly affect alpine streams and their benthic communities by altering ecosystem structure and function. Adequate methods for the evaluation of these cause-effect relationships have rarely been developed. Biological indices are known as reliable tools for ecosystem characterization but hardly any experiences have been gained for their application in the alpine zone. We selected 69 established biological indices, grouped them into five categories according to their expressiveness and verified 43 of them as theoretical suitable for alpine stream assessment. Using invertebrate assemblages from 159 quantitative benthic samples from 18 alpine stream sites, at three sampling occasions, the validation and suitability of each individual index was tested. Our analyses suggest best index performances when evaluating: i) alpha diversity (Q Statistic), ii) evenness (Smith & Wilson B), iii) disparity (Harrison 2) and iv) assemblage changes (Harrison 2) in alpine streams. We also identified and depicted potential for development of common index models for the evaluation of the v) ecological function of alpine aquatic ecosystem, which are based on species level classifications. Our results demonstrate that theoretical preparatory work regarding the methodology of alpine freshwater studies is inevitable in order to reveal expressive results.

Keywords

alpine stream diversity, biological index, benthic invertebrates, monitoring

Introduction

Environmental changes due to anthropogenic or climatic influences are the main driving forces for worldwide ecological modifications (Lento et al. 2013). Especially alpine streams and the inhabiting benthic communities will be affected by climate change effects like accelerated glacial retreat, oscillating discharges, reduced habitat stability, altered water chemistry, decreasing nutrient availability, and finally, increasing water temperatures (Jacobsen et al. 2012, Khamis et al. 2014). These environmental modifications will affect the diversity of benthic communities in alpine freshwater ecosystems, dominated by Chironomidae, Ephemeroptera, Plecoptera, Trichoptera and some infrequent other Diptera species (Lods-Crozet et al. 2001). The larvae of these insects are relatively immobile and therefore directly exposed to the environmental conditions (Füreder 2007). Former studies revealed narrow species-specific range of occurrences of these highly adapted benthic insects, qualifying them as suitable base for alpine freshwater ecosystem and community diversity characterization (Füreder 1999, Robinson et al. 2010).

Biological indices are most appropriate for depicting general community conditions and changes in a simplified and comparable way (Carlo et al. 1998). However, most common indices were published for low land ecosystems (Carlo et al. 1998) and hardly any of these mathematical models proved to fit the demands of alpine streams. Brown et al. (2009) already pointed out these failings and demonstrated the possibilities biological indices burrow as early warning signals for environmental change and for long-term monitoring programs. The search for adequate indices, evaluating the holistic alpine freshwater diversity is inevitable and overdue.

In this study, we critically examined the most common used biological index models regarding their applicability for alpine freshwater ecosystems in three steps: 1) Index collection: collection and grouping of indices according to their prediction by analyzing relevant literature. 2) Theoretical index validation: preselection of index models from step 1 regarding their theoretical applicability for alpine benthic communities and 3) index computation and statistical verification. For the last step, three major abiotic driving forces on benthic species (water temperature, distance from the glacier snout and percentage of glaciation of catchment) were used to evaluate the best indices.

Methods

Sampling took place within the project PROSECCO.Alps (Proglacial stream ecohydrology and climate change over the Alps) in two catchments located in the Großglockner and Goldberg regions, Hohe Tauern NP, Austria. 18 sites along an environmental harshness gradient, nine in each region, were sampled in July, August and September 2011. Four sites were solely spring fed, the other 14 sites were glacially influenced. At each site and sampling, three replicate Surber Samples (100µm mesh size, 0.09m², immediately preserved in 75% Ethanol) were taken and water temperature was measured. Benthic insects of all 159 samples (one stream ran dry in September) were determined to the lowest possible level using adequate determination keys (e.g. JANECEK 1998, LUBINI et al. 2000, BAUERNFEIND & HUMPESCH 2001, WARINGER & GRAF 2004). Water temperature was measured with a WTW multi parameter measurement. Distance from the glacier (G_{Dist} [m]) and percentage of glaciation of catchments (%GC) was measured using the online geographic services of the states Carinthia (http://www.kagis.ktn.gv.at) and Salzburg (www.salzburg.gv.at/sagis). In the first two working steps, commonly used indices were gathered by analyzing relevant literature (69 indices found) and grouped according to their definitions: group i) habitat diversity/alpha diversity (16 indices); group ii) evenness (16 indices); group iii) beta diversity: (17 indices); group iv) assemblage changes along a stream/beta diversity (20 indices) and group v) ecological function & nutrient content (17 indices). In a second step, the 69 indices were theoretically validated by analyzing their mathematical background whether they are suitable for the evaluation of alpine freshwaters. In the third working step the remaining indices from step 2 were computed for all sampling sites in both regions and their performance statistically checked. Linear regression analyses were used to evaluate the index performance of group i), ii) and v). Index values of group iii) and v) were directly evaluated and discussed. For the calculation the three parallel samples of each site and sampling season were added. The two regions and the three tested abiotic conditions were treated separately to double check the performance of the tested indices. An adequate measure has to perform superior in both of our sampling regions and for all three abiotic factors in order to be suitable for all alpine freshwaters around the world.

Extracted results – group i) alpha diversity

In step 1, 16 commonly used alpha indices were gathered. Working step 2 showed, that only 12 measurements are theoretically suitable to assess the alpine freshwater diversity due to their mathematical background. As with decreasing environmental harshness the diversity should be linearly increasing, suitable alpha diversity indices must show this pattern. The index with the highest R^2 value performs best in our study and is therefore the best measurement for alpine stream diversity (Tab. 1).

Index	Großglockner-region			Goldberg-region		
	T [°C]	G_{Dist}	%GC	T [°C]	G_{Dist}	%GC
Brillouin D	0.29	0.77	0.57	0.44	0.29	0.57
Fisher`s Alpha	0.05	0.11	0.14	0.75	0.94	0.72
Margalef D	0.23	0.45	0.34	0.77	0.94	0.72
McIntosh D	0.04	0.00	0.01	0.25	0.07	0.38
Menhinick D	0.07	0.05	0.05	0.55	0.75	0.64
Q Statisitc	0.27	0.67	0.62	0.76	0.90	0.58
Shannon Wiener	0.20	0.66	0.47	0.44	0.29	0.57
Simpson	0.02	0.20	0.13	0.39	0.19	0.43
Species Number	0.43	0.67	0.54	0.79	0.91	0.68
%Chironomidae	0.22	0.23	0.55	0.45	0.53	0.43
%Diamesinae	0.00	0.09	0.02	0.46	0.60	0.53
%EPT	0.05	0.04	0.00	0.42	0.51	0.38

Table 1: R^2 values of the 12 theoretically suited alpha diversity indices for both regions and all three abiotic conditions (water temperature T [°C], G_{Dist} and %GC).

Some indices, e.g. Menhinick D and Fisher`s Alpha, reached very low R^2 values in the Großglockner-region but high coefficients of determination in the Goldberg-region. Simpson and Shannon Wiener index – the two most often used alpha diversity indices in modern ecology - have quite low R^2 values in both regions. The Q Statistic index has the highest R^2 values for all three abiotic conditions and in both sampling regions and seems to fit the alpine conditions best.

Discussion & Conclusion

Statistical analyses showed that not all 12 theoretically suited indices from working step 2 were able to successfully measure the occurring diversity pattern in the sampled alpine streams. The two most often used indices in ecological surveys, Simpson and Shannon Wiener, showed inhomogeneous, low R^2 values. Therefore, we cannot recommend to use these indices for assessing the diversity in alpine freshwater ecosystems. The best alpha diversity index in our study is Q Statistic (KEMPTON & TAYLOR 1976) with the highest R^2 values across all abiotic drivers and in both regions. Our study brought up suitable indices of all five investigated measure groups (Tab. 2).

Group	Best Index	Author(s)
Group i) alpha diversity	Q Statistic	Kempton & Taylor 1976
Group ii) evenness	Smith & Wilson B	Smith & Wilson 1996
Group iii) beta diversity	Harrison 2	Harrison et al. 1992
Group iv) regional beta diversity	LZI (LängsZonalerIndex)	Zelinka & Marvan 1961
Group v) ecological function & nutrition content	BMWP/(M)BMWP	BMWP 1987

Table 2: The best diversity measures of all five index groups

This set of indices is best suited to evaluate the diversity of alpine freshwater ecosystems. In times of environmental change, measures with the highest sensitivity are needed to detect even the smallest alterations. For reliable results in studies and long term monitoring projects, the selection of analysis tools is at least as important as the sampling itself. Only by thoroughly picking the most suitable analysis tools, the full potential of a data set is exploited. Therefore, we suggest to use our recommended indices for alpine stream diversity assessment in order to ensure reliable and comparable results.

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Unexpected larval development in a highly glaciated headwater

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Abstract

Glacier-fed alpine headwaters are inhabited by few insect species (mainly *chironomid* subfamily *Diamesinae*). Despite their regular occurrence, nothing is known about their life-cycle strategies in these relatively cold freshwaters. Over the summer months in 2015, samples were taken at the Schlatenbach in vicinity of the glacier Schlatenkees in the Hohe Tauern National Park, and the benthic larvae biometrically analyzed. We observed unexpected development patterns, indicating more favorable living conditions for key taxa closer to the glacier, expressed by larger larval size, biomass and biovolume.

Keywords

life-cycle, *Diamesa*, biometric analyzes, glacier retreat

Introduction

Glacier-fed streams are one of the most endangered (HANNAH et al. 2007) and extreme natural freshwater ecosystems with year-round low water temperature, fluctuating discharge, low channel stability, high turbidity and usually low nutrient availability (e.g. FÜREDER et al. 2005). Stream stretches close to the glacier snout are usually located in the high alpine zone and therefore additionally influenced by low air temperatures during summer, a short snow free season and scarce surrounding vegetation (e.g. BROWN et al. 2015). The community of cold adapted insects colonizing these harsh aquatic environments, dominated by the *chironomid* order *Diamesa* (ROBINSON et al. 2014), has to face and master the inhospitable conditions of glacially influenced streams. The life cycle strategies, cause effect relationships of these extreme environmental conditions on the benthic larval growth as well as the key factors limiting the larval life in kryal streams, are still unknown.

Former studies from temperate streams showed, that especially water temperature but also nutrient availability are important factors for benthic larval growth and development (e.g. REYNOLDS & BENKE 2005, SAND & BRITTAIN 2009). Many of these studies were set up as laboratory experiments, where an increase of the water temperature and/or a staggered nutrient availability lead to improved larval growth or faster development compared to the control conditions.

Based on this knowledge we hypothesized that i) water temperature and organic matter/nutrient availability will be higher with increasing distance from the glacier and ii) along a harshness gradient, *chironomid* key species will show higher larval size.

Methods

Sampling was performed within the project 'Gletschertod und Gewässergeburt' at the Schlatenbach, a river draining the Schlatenkees, the largest glacier in the Venediger Gruppe, Hohe Tauern National Park (East Tirol, Austria). Three stream stretches in close vicinity to the glacier snout (Tab. 1) were sampled six times from August to September 2015 (for sampling dates see Tab. 2).

	Coordinates		**Altitude [m.a.s.l.]**	**Distance from glacier [m]**
	N	**E**		
Site 1	47°06`51.9``	12°24`36.7``	2166	20
Site 2	47°06`50.7``	12°24`40.2``	2158	55
Site 3	47°06`50.8``	12°24`46.1``	2150	90

Table 1: Sampling site characterization

At each expedition and site, three replicate semi-quantitative Surber Samples (900cm², 100µm mesh size) were taken and water temperature was measured using a WTW multi sensor probe. Benthic insect *larvae* and *pupae* were handpicked from the samples and determined to the best taxonomic level using relevant identification keys (JANECEK 1998, LANGTON 1991 and SCHMID 1993). Densities of the two species *Diamesa cinerella* (Meigen) and *Diamesa steinboecki* (Goetghebuer) were sufficient for growth and development analysis. For morphometric measurements, each larva was photographed laterally, then the head capsule was cut off and photographed dorsally. Using the software 'Jens Rüdigs Makroaufmaßprogramm'
(version 0.9.2; http://ruedig.de/tmp/messprogramm.htm) head capsule width, larval length and larval volume were measured for each individual. Larval weight was estimated following NOLTE (1990).

The remaining gravel material from the benthic samples was placed in weighed aluminum dishes, dried (60°C, 24h), weighed, burned (450°C, 2h) and weighed again to define the amount of benthic organic matter respectively available food for the inhabiting larvae. Mann Whitney U tests were used to check for significant differences of abiotic conditions between the three sampling sites. ANOVA with LSD Post-Hoc test was computed to discriminate *chironomid* sizes.

Preliminary results

Abiotic measurements showed a trend of increasing water temperature with increasing distance from the glacier (Tab. 2). Mann Whitney U tests showed that temperatures at site 1 are statistically significantly higher than at site 3 (U=73.0, p=0.005). Benthic organic matter follows the contrary tendency with a decreasing amount of organic material with larger distance from the glacier (Tab. 2). Statistical comparisons with Mann Whitney U tests reveal that samples from site 1 contained significantly more organic matter compared to samples from site 2 (U=60.0, p=0.001) and site 3 (U=24.0, p=0.000). Samples from site2 also had a significantly higher amount of organic material compared to site 3 (U=68.0, p=0.003).

Sampling	Site 1		Site 2		Site 3	
	OM [g]	T [°C]	OM [g]	T [°C]	OM [g]	T [°C]
11. Aug	0.269	1.2	0.043	1.3	0.019	1.5
	0.226	1.2	0.030	1.4	0.019	1.5
	0.150	1.0	0.032	1.2	0.068	1.4
19. Aug	0.380	0.7	0.020	1.0	0.014	1.0
	0.199	0.7	0.019	0.9	0.027	1.0
	0.020	0.6	0.023	0.9	0.014	0.9
26. Aug	0.441	1.3	0.040	1.2	0.019	1.4
	0.284	1.1	0.047	1.3	0.206	1.4
	0.512	1.0	0.053	1.0	0.019	1.2
01. Sep	0.403	0.8	0.061	0.9	0.025	1.0
	0.234	0.9	0.494	1.0	0.022	1.1
	0.271	0.7	0.036	0.8	0.008	0.9
24. Sep	0.822	0.4	0.266	0.5	0.033	0.9
	1.457	0.4	0.801	0.6	0.010	0.9
	0.427	0.2	0.024	0.4	0.014	0.8
08. Oct	1.195	0.3	0.151	0.5	0.628	1.0
	0.131	0.4	0.040	0.5	0.027	0.9
	1.518	0.2	0.428	0.4	0.017	0.8

Table 2: Single measures of water temperatures (T) and benthic organic matter in the samples (OM)

Head capsule widths of the latest larval instar (L4) of *Diamesa cinerella* throughout the sampling period were biggest at sampling site 1, followed by larvae of site 2 and site 3 (Fig. 1). ANOVA with following LSD Post-Hoc test displayed significant differences of larval head capsule width between site 1 and site 2 (p<0.000), site 1 and site 3 (p<0.000) and site 2 and site 3 (p=0.001). Head capsule widths of *Diamesa steinboecki* had the same tendency of decreasing head capsule width with increasing distance from the glacier. Size differences were only significant between site 1 and site 3 (p=0.026).

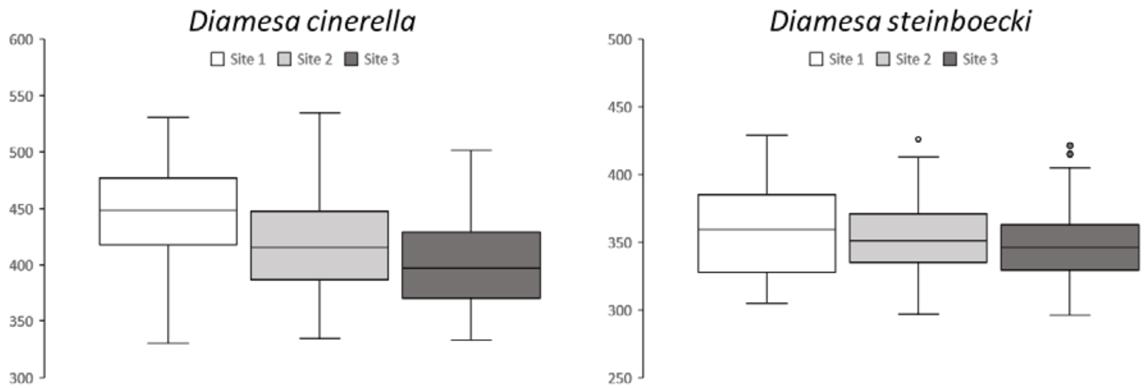

Figure 1: Comparison of L4 head capsule width of *D. cinerella* (left) and *D. steinboecki* (right) at the three sampling sites

Larval length, larval weight and biovolume show the same trend of decreasing values with increasing distance from the glacier snout for both *Diamesa* key species.

Discussion & Conclusion

We expected that water temperature and organic matter increased with growing distance from the glacier. Statistical analysis confirmed our hypothesis for water temperature but proved the opposite for the organic material. Nutrient availability was highest at the glacier snout and significantly decreasing within the sampled stream stretch of about 90 meters. The high amount of organic material in the samples from site 1 and partially from site 2 is due to the presence of *Hydrurus foetidus*, a *Chrysophyceae*, known to occur in glacially influenced streams. Benthic larval size was highest at site 1, which is closest to the glacier and characterized by the lowest water temperatures but highest nutrient availability. With increasing temperature, but decreasing organic matter, larval size decreased for both key species. Our results show, in contrast to laboratory studies for temperate species (e.g. REYNOLDS & BENKE 2005), that nutrient availability and not water temperature seems to be the limiting growth factor for *chironomid* larvae in glacially influenced streams.

Acknowledgements

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Anthropogenic influence on primary succession: A comparative study of 3 glacier forelands of the Central -Alps, Austria

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Abstract

Glacier forelands are ideal ecosystems to study community assembly processes. Previous research has shown that these processes are mainly driven by stochastic events, like the occurrence of safe sites and seed availability.
This study focuses on possible anthropogenic influences on these primary successions.

Floristic data of three glacier forelands show that anthropogenic influences in form of (i) grazing sheep and (ii) hiking trails are creating patterns, visible in the floristic community composition and in change of species numbers. (iii) Additionally, it was found that the special protected area 'Inneres Untersulzbachtal', where grazing has been absent for decades didn't show any of these patterns, underlining the importance of process-protection in glacier forelands, as one of the last truly wild ecosystems in central Europe.

Keywords

Glacier foreland, primary succession, anthropogenic influence, grazing, wilderness

Introduction

Spatially ordered chronosequences provide scientists with unique insights into processes of primary succession, like community assembly (WHITTAKER 1993; STÖCKLIN & BÄUMLER 1996; NIEDERFRINIGER 2000; RAFFL & ERSCHBAMER 2004; ERSCHBAMER 2007; ERSCHBAMER et al. 2008). Previous studies have shown that community assembly on glacier forelands is driven by stochastic events (Del Moral et al. 1995) where the availability of safe sites and seed occurrence (DEL MORAL et al. 1988; STÖCKLIN & BÄUMLER 1996) play a major role, leading to a patchy and chaotic fine scale vegetation structure (BURGA et al. 2010). Considering that Central Europe mostly consists of anthropogenically modified landscapes, glacier forelands, that recently have become ice-free, represent one of the last examples of unaffected natural environments, which might qualify as wilderness (DUDLEY 2008; WILD EUROPE 2013). Nowadays, sheep are roaming in the mountains by themselves during the summer months, exert some grazing pressure on those pristine locations even in protected areas. Due to a lack of shepherds there is little control over grazing location and intensity (SPANGENBERG-RESMANN 1978). Free access to glacier foreland sites may have tremendous effects on plant community composition (AUGUSTINE & MCNAUGHTON 1998; AUSTRHEIM & ERIKSSON 2001; EVJU et al. 2006; AUSTRHEIM et al. 2008). HODKINSON et al. (2003) have pointed to a shortfall of previous research on glacier forelands: 'One factor that is almost invariably overlooked when studying glacial chronosequences is the impact of additional external factors such as animal influences on ecosystem development (VAN DER WAL et al. 2001; WOOKEY et al. 2002). The present study aims to analyse mechanisms of community assembly processes, while accounting for the effects of sheep grazing on the proglacial areas. Therefore, following questions have been examined: (i) does grazing and (ii) do hiking trails have effects on the community structure of succession sites? (iii) Does the ungrazed special protected area 'Inneres Untersulzbachtal' (National park Hohe Tauern Salzburg) show different patterns of community assembly processes than the grazed sites 'Viltragental' and 'Frosnitztal' (National park Hohe Tauern Tyrol)?

Material and methods

Study area

In summer 2016 plant surveys were conducted on three glacier forelands of the Venediger Mountain Range (Salzburg and Tyrol, Austria, 47° 6′ N, 12° 20′ E), namely in the 'Viltragental' (Viltragenvalley), 'Frosnitztal' (Frosnitzvalley) and 'Untersulzbachtal' (Untersulzbachvalley).

Methods

Plant relevés (DIERSCHKE 1994 after BRAUN-BLANQUET 1964) were selected by a stratified random sampling approach. On every glacier foreland, six transversal transects with eight 1m² plots each (RAFFL & ERSCHBAMER 2004; RAFFL et al. 2006) where studied. Around every survey plot a 3x3m area was investigated for signs of trampling and damage caused by grazing. Faeces were recorded and determined and the number of dung piles noted.

Statistical analysis

Community structure

To get insights into processes shaping communities on glacier forelands, species data of all relevés and data of every single glacier foreland were ordinated by distance-based-redundancy-analysis (dbrda).
For the full model, the glacier and the transect number were set as random factors, in comparison, for all sub-models only the transect number was set as random factor.

Species numbers

To analyse how different processes affect the number of species in different succession stages of glacier forelands, regression analysis of species numbers for all relevés and for the three subsets (every single glacier foreland) were performed, using Generalized Linear Mixed Effect Models (GLMM).

Results

Results of community structure (dbrda) and species numbers (GLMM) are summarized in Tab. 1. Special attention should be paid to the importance of distance to hiking trails explaining community structure and species numbers of different models.

	Community structure	Species numbers
Full-model	(glac/tra)	(glac/tra)
Distance to hiking trails	0.002**	<0.001***
goodness of fit	0.07	0.35/ 0.64
Untersulzbachvalley	(tra)	(tra)
Altitude	0.006**	-
goodness of fit	0.07	0.04 / 0.44
Frosnitzvalley	(tra)	(tra)
Distance to hiking trails	0.094.	<0.001***
Altitude	0.074.	
Soil-type		0.05*
goodness of fit	0.07	0.63 / 0.80
Viltragenvalley	(tra)	(tra)
Distance to hiking trails	0.002**	
Altitude	0.002**	
Soil-type		0.02*
goodness of fit	0.15	0.04 / 0.42
. p<0.1, * p<0.05, ** p<0.01, *** p<0.001		

Table 1: this table shows significant results for the four different (sub-)models. All results are corrected by Holm-Bonferroni method. Depicted are results of the analysis of community structure, (dbrda based on a Bray-Curtis-dissimilarity index) and the analysis of the species richness (GLMM). Brackets show the random factor(s) of the models (glac: glacier, tra: transect number). Goodness of fit refers to the cumulative proportion of explanation given by the first two axes of the dbrda (Community structure), while for the GLMM (Species numbers) values are accounting for marginal and conditional R^2 values.

Effect of hiking trails

The number of sheep faeces significantly drops with increased distance to hiking trails in the Viltragenvalley ($p<0.001$, 89 samples) and in the Frosnitzvalley ($p=0.004$, 15 samples). No sheep faeces were found in the Untersulzbachvalley where domestic animals have been excluded since many decades.

Discussion

The impact of herbivores on the primary succession of glacier forelands is almost invariably overlooked when studying chronosequences (HODKINSON et al. 2003).

The present study found that anthropogenic influence is discernible in the plant community structure of two glacier forelands, to which sheep had free access, whereas in the special protected area ‘Inneres Untersulzbachtal’ no anthropogenic influence was found.

The distance to the hiking trail is the most important factor of the full model explaining differences between relevés in both, community structure and species numbers. Distance to hiking trail is also one of the significant predictors explaining community structure of the Viltragenvalley, while in the Frosnitzvalley distance to hiking trail shows a trend explaining community structure and is the most important predictor for differences in species numbers.

Results of the special protected area 'Inneres Untersulzbachtal' show that neither community structure nor species numbers were affected by distance to hiking trails.

Looking closer at the factor 'distance to hiking trails', results from faeces counts give indications that sheep favour areas closer to hiking trails or even use them (GANSKOPP et al. 2000 after VALLENTINE 1974). This behaviour would reduce their energetic costs of movement (BAILEY et al. 1996) and would be in line with the optimum foraging hypothesis after MACARTHUR & PIANKA (1966). This kind of behaviour was also observed while sampling in the field.

Additionally, the Frosnitzvalley is located at the border of the so called 'Tauernfenster', where different geological strata arise at the southern boundary of the glacier foreland, while the hiking trail is located at the northern side of the proglacial area. Vegetation pattern show a decrease in species numbers with distance to hiking trails. This result cannot be explained by the influence of basic rock (which should lead to an increase in species numbers (e.g. GOUGH et al. 2000)) and further supports the hypothesis of a biotic influence (e.g. grazing, trampling or fertilization) on the vegetation.

To sum up, anthropogenic influences of (i) grazing sheep are obviously affecting the primary succession of investigated glacier forelands and (ii) they are most prominent along hiking trails. And (iii) the special protected area 'Inneres Untersulzbachtal' did show different pattern for community structure and species numbers which can be attributed to the absence of anthropogenic influence. These findings underline the sensibility of the primary succession on glacier foreland sites to grazing pressure by domestic animals and emphasise the importance of process protection in one of the last wild areas in central Europe.

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Five Years of Glaciological Monitoring of Venedigerkees, Hohe Tauern National Park, Austria

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Abstract

Glacier mass balance is a sensitive indicator of climate change, and an important part of the hydrological regime of glacier covered basins. Changes in glacier mass result from ablation and accumulation and are directly related to prevailing atmospheric conditions. Since glacier mass balance governs glacier runoff, it is a valuable parameter for numerical runoff modelling and has various climatological and hydrological applications.

The spatial and temporal storage of water as snow and ice has a significant impact on the stream flow of Alpine head waters. Glacier mass balances are vital for gauging the extent of changes in ice, firn and snow in various mountain regions for specific glaciers. In our case study, we measure mass balance directly and record a separate winter and a summer balance. Direct glacier mass balance monitoring is an opportunity to see and measure changes directly on the object of interest in a cautious manner in protected areas. The direct mass balance measurements on Venedigerkees were initiated in 2011/12. The results show a high variability of the annual specific mass balances during the last 5 years. It is also apparent from the data that the glacier behaviour is mainly driven by the ablation in summer. Future investigations will tackle the mass balance and its reaction to current glacier disintegration.

Keywords

Mass balance, glacier, monitoring, runoff, Venedigerkees

Study site

The Venedigerkees is located in the Venediger range in the core zone of Hohe Tauern National Park, Austria. The upper part of Venedigerkees is north-exposed while the lower part, and especially the tongue, is exposed to the south-west. In 2012 Venedigerkees covered an area of 1.99 km².The elevation range of this typical valley glacier is from about 2480 m up to 3400 m, with Großvenediger the highest summit in the area at 3662 m.

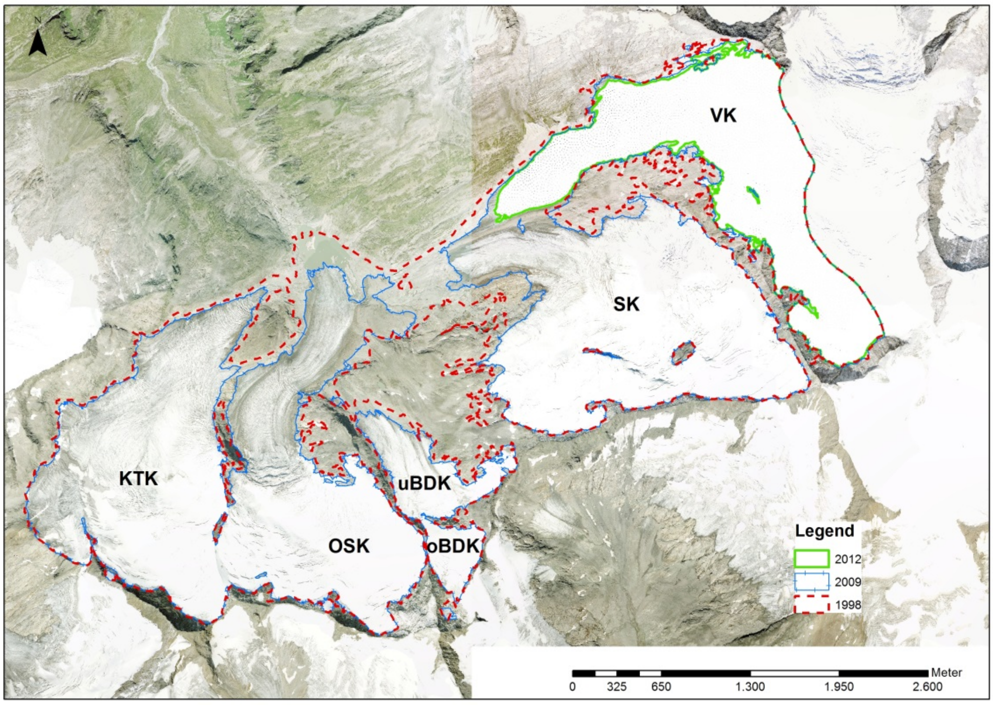

Figure 1: VK- Venedigerkees; SK- Sulzbacherkees;uBDK- unteres Bleidächerkees; oBDK- oberesBleidächerkees; OSK-Obersulzbachkees; KTK-Krimmlertörlkees;

Introduction

The time series started in 2011/12 without any data gaps. The direct mass balance (HOINKES 1970) is based on direct measurements in different areas on the glacier. The time frame for the measurements is the hydrological year, which runs from 1 October to 30 September. In this time period, ablation and accumulation were measured annually.

Mass balance is measured by determining the amount of accumulated snow, and later measuring the amount of snow and ice removed by melting and sublimation. Mass balance is reported in snow water equivalent (SWE). This represents the average thickness gained (positive balance) or lost (negative balance) from the glacier during that particular year.

The mass change of the whole glacier area within a hydrological year is calculated by extrapolation of point measurements to the total glacier area. Ablation stakes are used to measure mass loss directly. We currently use 15 ablation stakes, which are drilled 8 to 10 m deep into the ice.

For monitoring mass gain, volume and density of the accumulated snow is measured in three snow pits. These snow pits have to be in the same place every year and have to be representative for particular surroundings. The snow pits have to be as deep as last year's glacier surface was. The density of the measured snow weight lets us know the snow water equivalent (SWE) for each snow pit.

The results from these two kinds of measurements, plus additional probings, are used to create maps of SWE isolines. The calculated difference of annual net mass balance and winter mass balance is the summer balance.
To get the exact date of the ablation maximum und the ablation patterns, we also use three automatic cameras, which take three pictures per day. These cameras show most parts of the glacier, with a particular focus on detecting the snowline at the date of the maximum ablation.

Results

The mean annual specific glacier mass balance during the past 5 years was -747 mm w.e. (water equivalent), but shows great variance, from -1567 mm w.e. to -152 mm w.e.. A comparison of the annual summer and winter mass balances suggests that the annual mass balances of this glacier mainly depend on the ablation season (Tab. 1). This means that the state of Venedigerkees is mainly driven by summer temperatures and summer snowfall events at the glacier. Snow accumulation during the accumulation season can be seen as the basis for the annual result, as it affects the length of the ablation season.

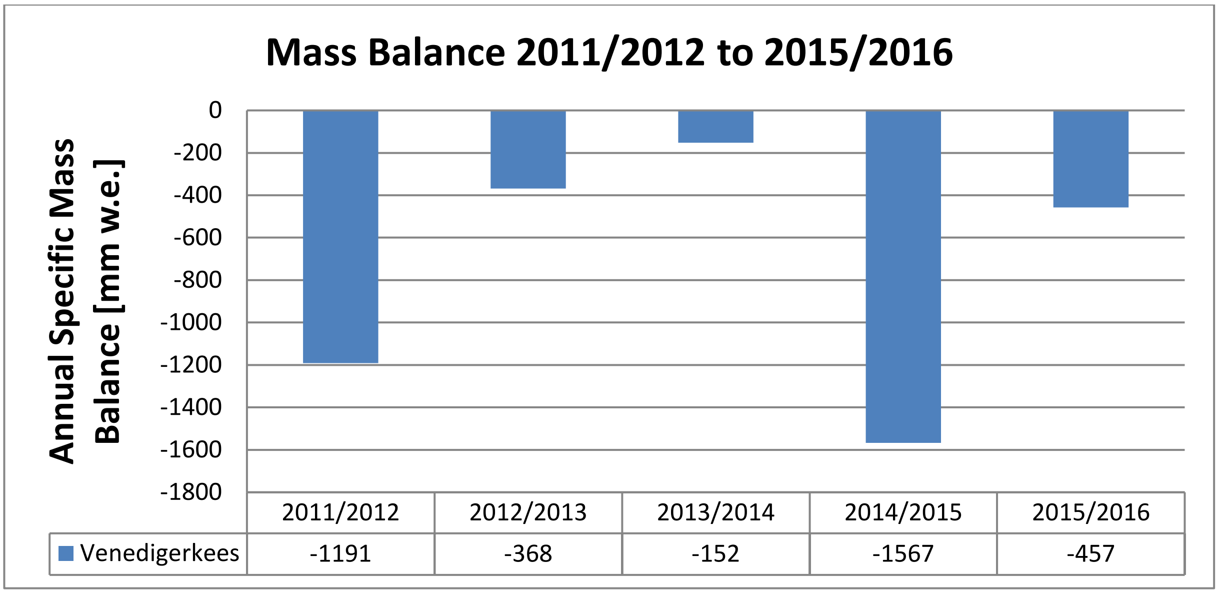

Figure 2: Annual specific mass balances for the last five years.

	b [mm]	bw [mm]	bs [mm]	ELA [m.a.s.l]
2011/2012	-1191	1323	-2515	3086
2012/2013	-368	1310	-1678	2929
2013/2014	-152	1317	-1469	2810
2014/2015	-1567	1297	-2864	3110
2015/2016	-457	1116	-1573	2946

Table 1: Key results of Venedigerkees mass balance measurements. ELA Equilibrium Line Altitude

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Waste management in mountain protected areas

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Abstract

Mountainous protected areas are increasingly popular tourist destinations. This increases the amount of waste generated, which is particularly difficult to manage because of remoteness, difficult terrain and extreme environmental conditions. The 'Waste Management Outlook for Mountain Regions - Sources and Solutions' report finds that waste in mountains deserves further attention from scientists, protected areas managers, policy makers and tourists. The poster 'Waste management in high altitude protected areas' will present key findings of the report relevant to both scientists and protected areas managers, as well as suggestions for how to jointly address these issues by concerned actors.

Keywords

protected areas, tourism, recreation, waste, pollution, waste management, mountains

Introduction

Mountains cover 23 per cent of the world's total land surface and represent 32 per cent of the extent of the world's terrestrial protected areas (PAs) (Spehn et al. 2005). Due to the high geodiversity of mountains, these ecosystems are associated with the high biodiversity and species endemism (Thorsell & Hamilton 2002). Many mountain PAs are experiencing a growing solid waste problem from increasing tourism, but options do exist to prevent and manage waste in mountain environments, in ways that protect mountain ecosystems and prevent problems from flowing downstream.

Methods

The poster 'Waste management in mountain PAs' presents the main findings of the report 'Waste Management Outlook for Mountain Regions - Sources and Solutions' (Alfthan et al. 2016) as part of a series on waste management issues by UN Environment and its International Environmental Technology Centre (IETC). The report was developed based on desk research and a consultation meeting at the World Mountain Forum in Mbale, Uganda in 2016 with stakeholders from mountain regions in Africa, Latin America and Europe. An advisory board consisting of waste and mountain experts, representatives of national ministries, regional and international organizations including the International Centre for Integrated Mountain Development (ICIMOD), provided additional input. The Outlook applies a definition for mountains which combines elevation and slope angles (Kapos et al. 2000).

Results

PAs in mountain regions are increasingly popular tourist destinations (Thorsell & Hamilton 2002). For example, the number of foreign visitors to the Huascaran National Park, Peru increased from 10,678 in 2011 to 48,971 in 2015, representing an almost fivefold increase in visitor numbers. The growth in tourists in popular mountain PAs is accompanied by increasing waste issues. Factors such as seasonality of mountain tourism, and lack of infrastructure, makes it difficult to manage waste. For example, up to 140,000kg of solid waste is estimated to remain in the Sagarmatha National Park in Nepal after 60 years of mountaineering expeditions to reach Mount Everest (Kelliher 2014). During the peak tourist season, the amount of waste generated there can reach double the amount of waste generated during the rest of the year. In this National Park and its buffer zone, waste generation ranges from 4.6 tons per day during the peak season to 2 tons per day at other times of the year (Manfredi et al. 2010).

Discussion

The most common forms of waste from mountaineering are human waste (excreta and urine), other solid waste material associated with equipment and supplies (for example, tin cans, oxygen bottles, batteries, plastic bags, etc.), as well as waste from pack animals (UNEP, 2007). Waste from pack animals, coupled with human waste, increases eutrophication, algal growth and toxicity of water bodies (DERLET et al. 2008). In parts of some mountain PAs, such as in the Huascaran and Aconcagua National Parks in Peru and Argentina, pastoralism adds to the environmental stress and waste issues. Bacteria and other pathogens associated with human waste contaminate waterways and soil surfaces and can persist in these environments despite the extreme conditions (DERLET et al. 2008; GOODWIN et al. 2012). Gravity and rivers also enlarge the footprint of mountain waste, given the potential they have to transport and carry this waste downstream. Therefore, inadequate treatment or disposal of waste in mountains, not only creates risks for ecosystems and humans in mountains, but also pose impacts for regions downstream.

For PAs in the developing world it is particularly difficult to address the surge of litter from tourists. Remoteness, difficult terrain, low temperatures and other extreme environmental conditions, poor socio-economic conditions, and vulnerability to natural hazards, makes waste management in mountains more challenging than in lowland areas. Removal of waste from remote areas, such as with fly-out systems and the use of advanced technologies for on-site treatment at high altitudes, is often very expensive (ROBINSON 2010; GOODWIN et al. 2012). Lower temperatures at higher altitudes also result in slower rate of decomposition of organic matter (COOPERBAND 2002). The most common practice for waste disposal adopted by mountaineers in remote alpine environments is to leave the waste behind, buried in soil or snow, or dropped in glacier crevasses (DERLET et al. 2008; PICKERING & BARROS 2015).

In line with the polluter pays principle, the mountain tourism industry and tourists themselves should contribute and bear some of the responsibility for financing the management of their waste. PA authorities should also share and bear this responsibility as part of their mandate to protect. Partnerships between tourism operators and PAs should be encouraged. Waste management should be integrated in the tourism industry, such as bring-back-your-waste policies and re-directing fees (e.g. entry fees) into waste management. Tools such as Corporate Social Responsibility and tourism eco-labels should be considered for the mountain context. Global mountaineering organizations such as the International Climbing and Mountaineering Federation (UIAA) and the International Federation of Mountain Guide Associations (IFMGA), as well as national organizations should revise procedures, guidelines, training and certification practices to integrate awareness for waste issues in mountains. Mountaineers should also actively engage in the broader policy and management discussions to bring their experiences to the decision-making table both in PAs and in national policy.

Conclusion

Studies indicate that the composition and volume of waste in mountain PAs across the globe can change rapidly, when these areas experience increasing numbers of visitors. However, in many cases there has still not been the necessary behavioral and policy changes to address the associated problems. Major knowledge gaps exist in terms of waste generation and treatment solutions in mountain regions and PAs in particular. Research is also needed to better understand the relationship between different waste streams and their biophysical impacts on sensitive mountain environments as well as on downstream areas. Applied and participatory research with PAs is particularly important to better understand existing attitudes to waste and how to best trigger behavioral change among mountaineers and other visitors as well as technical solutions suitable to challenging environments and different socioeconomic conditions.

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Whatsalp Wien – Nizza 2017. Eine Fußreise durch die Alpen und ihre Großschutzgebiete

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Keywords

Alpen, Großschutzgebiete, Alpenkonvention, Wildnis

Summary

Wie verändert sich das Bild der Alpen im Laufe der Jahrzehnte? Welche Spuren hinterlassen Menschen und Naturereignisse in der Landschaft? Unter dem Namen Whatsalp wanderte zwischen Juni und September 2017 eine Gruppe von Fachleuten von Wien nach Nizza durch den Alpenbogen. Sie besuchte dabei eine grössere Zahl von National- und Naturparks, Biosphärenparks, UNESCO-Gebieten und Wildnisgebieten in Österreich, der Schweiz, Italien und Frankreich. Ihre Reise zu Fuss galt den Wandernden gleichsam als Methode, indem sie damit entlang einer vorab festgelegten Route den aktuellen Zustand und den Wandel der Alpenregionen und ihrer Großschutzgebiete dokumentierten. Dabei ging es um die Schönheit und die Zerstörung der Alpen, um die Übernutzung und Unternutzung der alpinen Kultur-und Naturlandschaften und um die Lebensbedingungen der Bevölkerung. Nicht zuletzt wurde auch ein Vergleich mit 1992 hergestellt, als der Autor im Rahmen des Projektes 'TransALPedes' diese Route bereits einmal wanderte.

Während seiner Alpendurchquerung erwanderte das Whatsalp-Team unterschiedliche Natur- und Kulturlandschaften in Großschutzgebieten und traf sich mit den Verantwortlichen zu Diskussion und Gedankenaustausch. Erörtert wurden Fragen im Zusammenhang mit den sich wandelnden Rahmenbedingungen und den aktuellen Herausforderungen von alpinen Großschutzgebieten sowie den entsprechenden Handlungsmöglichkeiten der Managements. Die Ergebnisse wurden in Schrift, Bild und Ton dokumentiert und nun einer interessierten Öffentlichkeit vorgestellt. Ein besonderer thematischer Schwerpunkt ist dem Thema des Umgangs mit 'Wildnis' in alpinen Großschutzgebieten gewidmet. Hier stellt sich die Frage, ob der Wildnisbegriff für die Schutzgebietsmanagements eine geeignete Kategorie darstellt, um ihre Ziele im Rahmen des Prozessschutzes und der freien Naturentwicklung besser erreichen zu können.

Im Abendvortrag fasst Dominik Siegrist die wichtigsten Erkenntnisse von Whatsalp hinsichtlich der alpinen Großschutzgebiete zusammen und präsentiert diese in Wort, Bild und Ton.

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Large predators in protected areas – risk or chance

Leopold Slotta-Bachmayr

Abstract

Large predators already have returned or are returning to Central Europe. Conflicts between man and these species are preassigned. In this paper I try to describe the possible role of protected areas helping to solve these conflicts and to enable a coexistence of man and wolf, bear and lynx in a cultivated landscape.

Keywords

large predators, human dimensions, human/wolf conflict

Introduction

Bear, wolf and lynx have returned to the Alps. Whereas lynx has been native in the Alps for a longer time, bears use the Alps only sporadic and primarily on their edges (KACZENSKY et al. 2013). In contrast after more than 150 years the wolf has come back more or less comprehensive. Starting in the Abruzzo Mountains the wolf has discovered the Alps from the west and in the meantime there is a connection to the Balkan population also. Population have continuously increased since the 1990-ties and it is obvious that distribution as well as population in the Alps will increase further during the next decade (SCHNIDRIG et al. 2016).

Especially from bears attacks on life stock are already known. Larger conflicts are apprehended by wolves and are the same in the Alps as in other parts of its range all over the world (SKOGEN et al. 2017):

- fear of people being attacked by wolves.
- attacks on life stock.
- negative consequences for hunting game.

Central Europe primarily consists of cultivated landscapes created and preserved by man. This is one of the main arguments against the return resp. the remain of wolves in Central Europe. Certainly protected areas may try to conserve the last existing natural landscapes resp. try to conserve extensive cultural landscapes too. Therefore it would contradict the aims of the areas if the establishment of wolves, as original part of the ecosystem, is not allowed in these natural landscapes. On the other hand the wolf also was part of the extensive cultivated landscape resp. managing the wolf was part of the cultural heritage which guarantees the preservation of these landscapes. It is also known that protected areas in general are too small to inhabit a viable wolf population. In best case there is only room for one pack, whereas establishing or remaining of a wolf population is only possible in a large area (SCHNIDRIG et al. 2016). But do have protected areas, which are sometimes a crystallization point for the return of the large predators, an important role in the harmonic coexistence of large predators and man?

Possible roles of protected areas

Even in protected areas measures to protect life stock are necessary because one of the largest problems are attacks on life stock especially by wolves. These attacks are also possible in protected areas and if there are no appropriate actions wolves there can learn, that life stock is an easy prey. Further on they use this knowledge outside protected areas and avoid protective measures as guard dogs or fences. In this respect the protection of life stock in protected areas is as important as outside of these refuges. Consider it as a chance that the management of protected areas has to develop protective measures against large predators too. These experiences are important for further actions on a larger scale.

Model regions

Knowledge, skills and basis for the protection of life stock was lost in some areas e.g. breeding of guard dogs. In protected areas these skills could be revitalized and developed. 150 years ago when the wolf disappeared from Central Europe the utilization of the landscape was quite different from today. Today the landscape not only provides us with food and primary products it is also very important for recreation. Structure of agricultural services and keeping of farm animals have changed essentially too. Therefore the traditional methods of protecting life stock has to be developed to guarantee the newly originated function of landscape resp. it has to be proven that for the effective protection of life stock even a structural change in agriculture is necessary. As an example guard dogs are known as aggressive towards wolf and man and the general opinion is, that only an aggressive guard dog is able to protect its flock. In former times guard dogs had to be aggressive towards man to defend the sheep against stealers. Hopefully the time of sheep stealers is gone and modern guard dogs have to ignore hikers at least. This is possible because guard dogs are only skeptical against people, they are not aggressive towards man in principle (SCHOKE 2003). For a modern guard dog these skills have to be developed or there has to be a selection of these dogs to avoid conflicts between protection of life stock and touristic interests. It is possible to discover and test a lot of these measures especially in protected areas.

Solution of conflicts

Comparing conflicts in different parts of the wolves range always show the same pattern. Primarily conflicts between wolf and life stock breeders enlarge and become conflicts between wolf and hunters. In the end there is a general discussion about problems of the society in principle. Conflicts about wolves are more than the fear of being attacked or losing life stock, mostly it addresses problems of the society in principle (SKOGEN et al. 2017).

Protected areas often have to act in the field of conflict between man and nature. On one hand they should protect nature, on the other hand they have to deal with people living in the area. Affected by protective measures these people guarantee the existence of the characteristic landscape in these protected areas too. Therefore protected areas have had to acquire competences in solving conflicts between nature and people and these competences can also be used to solve the conflicts between large predators and man.

Transfer of knowledge and skills

Protected areas act in a network where appropriate concepts, materials and experiences can be exchanged. This can be an important action for an effective management of conflicts between large predators and man.

Conclusion

Some of the large predators are back in Central Europe and some like the wolf will return for sure. Connected conflicts are preassigned. It is necessary to develop measures to ensure the coexistence between large predators and man otherwise these conflicts will escalate. In this respect the network of protected areas can play an important role because in some cases concepts have been developed already and experiences were made. These experiences have to be exchanged on a large scale to make a coexistence between large predators and man possible.

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Land use in German Biosphere Reserves and its ecological impact

Ulrich Stachow, Claudia Bethwell

Abstract

Biosphere Reserves aim to be model regions for sustainable development, including land use. We analyse the agriculture within the transition zones with respect to the farming systems and recent developments. We then assess the functions of agriculture in terms of biodiversity conservation at the example of farmland birds and buffering environmental impacts of agriculture on protected areas.

Keywords

Biosphere Reserves, agriculture, ecosystem services, transition zones

Introduction

Biosphere Reserves (BRs) aim to be model regions for sustainable development, including land use. At the same time, BRs aim at the conservation of valuable habitats and species. To be able to integrate these aims, each Biosphere Reserve has three zones, each with different focus: Core zones primarily to conserve biological diversity and no human land use, buffer zones in which land use can be conducted if in line with the conservation goals, and transition zones, in which land use systems should be developed which support the main goals of transition zones, i.e. sustainable land use, including the conservation of habitats and species, buffering sensitive habitats and habitat connectivity.

While agricultural land use in buffer zones is typically regulated through restrictions, it is unclear if agriculture in transition zones does meet the required standards. Therefore, as a first step, we conducted a survey of agricultural land use in transition zones in three terrestrial German BRs ('Spreewald', 'Schorfheide-Chorin' and 'Flusslandschaft Elbe Brandenburg') and inferred some relations to the conservation of biodiversity, using bird species as example, and made assessments about the spatial relations between arable land in transition zones and protected areas.

Methods

Case study regions

The three terrestrial German BRs are located in the Federal State of Brandenburg in the eastern part of Germany. The BR 'Spreewald' is a unique landscape within a part of the wide valley of the river Spree and is characterized by a network of small artificial watercourses, a mosaic of meadows and riparian forests (GRUNDMANN 1994). The dominating land use within the transition zones is agricultural grassland and arable land. The BR 'Schorfheide-Chorin' is a landscape of glacial origin with an undulating surface and home of more than 200 lakes, cattle holes, riparian habitats, fens, old beech forests with international recognition as well as valuable dry grassland sites (FLADE et al. 2006). The BR 'Flusslandschaft Elbe Brandenburg' is part of the larger BR 'Flusslandschaft Elbe' along the river Elbe with its characteristic habitats, like the floodplain forests and complex grasslands, and wildlife, e.g. white storks and beavers. Land use is mainly agricultural with arable land (31%) and grassland (29%).

Analyses

We used geodata, like data on arable land use, soil fertility and protected areas and habitat types, as well as statistical survey data on agriculture, like shares of cultivated crops, farm sizes and farm types etc. We processed the data using GIS with three aims: i) to characterize the agricultural production (cultivated crops and regional management practice including intensity and typical agricultural activities), ii) to assess potential interrelations of protected habitats on-site and off-site the agricultural fields with the farmland use, iii) to assess the suitability of farmland for typical farmland birds.

To evaluate the protected habitats and their requirements in terms of agricultural management we used habitat mapping results, habitat descriptions, including the appropriate management for conservation, sensitivity to agricultural impacts, and geoprocessing. To assess the suitability of farmland for typical bird species we applied a habitat suitability model (GLEMNITZ et al. 2015).

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Interactions, challenges, and management issues at the fringe of National Parks: The case of the Riding Mountain Biosphere Reserve

Christoph Stadel

Abstract

This paper is focused on the complex ecological, demographic, cultural, socio-economic and political-administrative relationships and interactions between Riding Mountain National Park and the adjacent municipalities, since 1986 forming the Riding Mountain Biosphere Reserve. Many challenges characterize the multiple linkages between Riding Mountain National Park and its fringe realm. Baskets of mutual opportunities and benefits contrast with diverging interests and potential sources of friction. In recent times, improved relationships between the federally governed National Park and the surrounding provincially and locally administered municipalities have contributed to move closer to the dual goals of the Biosphere Reserve, environmental protection and sustainable regional development.

Keywords

Riding Mountain Biosphere Reserve (RMBR), Riding Mountain National Park (RMNP), Municipalities, First Nation Reserves, linkages and interactions, environmental protection, regional development

Introduction: Regional setting, research focus, methods

The Riding Mountain Biosphere Reserve (RMBR) in Manitoba, established in 1986, is one of currently 18 Biosphere Reserves (BRs) in Canada. The core area represents Riding Mountain National Park; the surrounding 'area of cooperation' includes 15 Municipalities, as well as three First Nation Reserves.

Key agendas of this research address the duality between the conservation goals of RMNP and the often diverging mandates and development priorities of the Municipalities and communities outside the confines of the National Park. Congruences and cooperation between the two realms of the RMBR are contrasted with disparities and conflicting interests.

The research presented is rooted in the long-term familiarity of the author with this area. Various papers have been published on this topic (STADEL 1996; STADEL 2005; STADEL 2015; STADEL & SELWOOD 1996) and other published documents have been consulted (BORGFJORD 2010; CANADIAN COMMISSION FOR UNESCO & CANADA/MAB 2001; CANADIAN PARKS AND WILDERNESS SOCIETY 2004; PARKS CANADA 2011; RIDING MOUNTAIN BIOSPHERE RESERVE 2014).

Results and discussion

The research linkages and interactions first emphasize the nature of the various forms of interlinkages and interactions within the RMBR, more explicitly between RMNP and its adjacent Municipalities and First Nation Reserves (Fig. 1). RMNP since 1933 is an area of environmental protection. However before, various forms of resource use have been carried out in Riding Mountain, haying, grazing berry-picking of native people, and forestry and milling operations, as well as recreational land uses. With the establishment of the National Park, indigenous populations were evicted from the National Park (PECKETT 1999; SANDLOS 2008). Only recently they were given back a small parcel of land inside the National Park and regained some rights for hunting and fishing. Rapid and profound has been the landscape change of the realm adjacent to Riding Mountain. The combination the systematic land survey system, the establishment of a dense network of colonization railways, and the ensuing massive influx of European settlers transformed the former eco-zones into a zone of large-scale agriculture, dispersed farmsteads and a network of hierarchically organized service centres. In this way, a distinct landscape contrast and a duality of functional orientation emerged between Riding Mountain proper and its surrounding regions. The rather arbitrarily drawn limits of the National Park mark a sharp administrative boundary between the Federal Lands of the Park and the provincial and local jurisdictions of the Municipalities and First Nation Reserves. While the prime management objective of the National Park is nature conservation and biodiversity protection, the goals of the adjacent lands is primarily oriented towards a strengthening of local and regional economies and a fostering of the economic and social viability of communities. Whereas agricultural activities are restricted to the Municipalities, recreation and tourism are important economic pillars within the entire RMBR (Fig.2, Fig. 3). In summer, vacationers flock to the numerous small lakes, and choice scenic lakeshore- and forest lands have been converted into residential subdivisions of cottages, secondary homes or permanent residences. While this may be seen as a welcomed complement to the traditional agricultural function strengthening the rural tax base and the vitality of small service centres, it has also resulted in environmental problems of sewage- water- and waste disposal management threatening the conservation goals of the RMBR. In addition, the population influx of a largely urban population with its recreation-oriented outlook has not always harmonized with the mentality, aspirations and priorities of the long-term residents of the rural municipalities.

The following most important concrete achievements of the RMBR in the last few years have been the Aquatic Invasive Species Programme to prevent the intrusion of harmful zebra mussels into local lakes; programmes relating to wildlife issues, water conservation and soil management; programmes with the objective of strengthening the viability of small communities; and educational and public awareness activities. In terms of cooperative initiatives of RMNP and the neighbouring municipalities, shared infrastructures and services have been established between the National Park and the Municipality of Harrison Park at its southern fringe: a joint volunteer Fire Department and an open landfill- and recycling site, and more recently a project to provide drinking water from Clear Lake in RMNP to the commercial establishments, school and cottages of Harrison Park. Fig. 4 summarizes and generalizes the linkages between RMNP, the Municipalities and the First Nation Reserves.

The RMBR is facing a number of challenges and problems which can be summarized as following: Diverging goals, priorities, and management agendas between the federally administered National Park and the local interest and development goals of the Municipalities and First Nations; lukewarm support of the RMBR by the National Park, First Nations and some Municipalities; unsatisfactory consultation process between the National Park and the Municipalities and First Nation Reserves; deficient public awareness level of the Biosphere Reserve; lack of adequate funding and personnel.

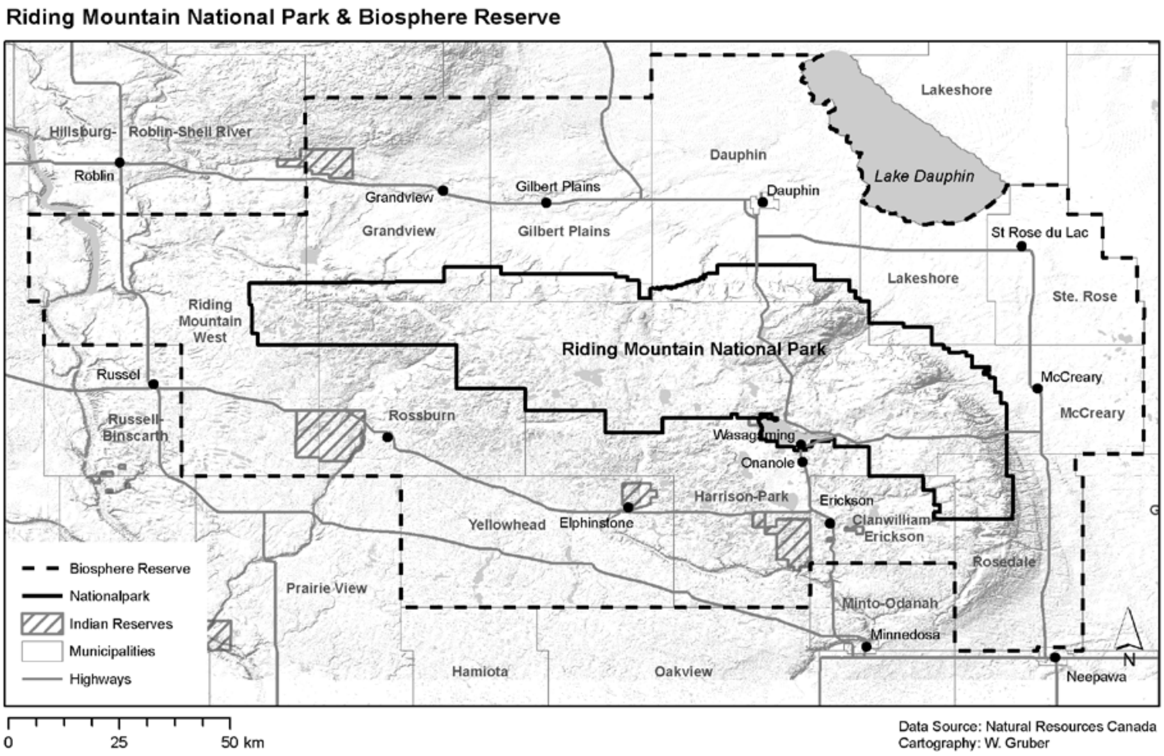

Figure 1: Riding Mountain Biosphere Reserve, Manitoba, Canada

Figure 2: Riding Mountain National Park - a recreational destination (Photo credit: Stadel)

Figure 3: Wheat combining in the Municipality of Harrison Park, Manitoba (Photo credit: Stadel)

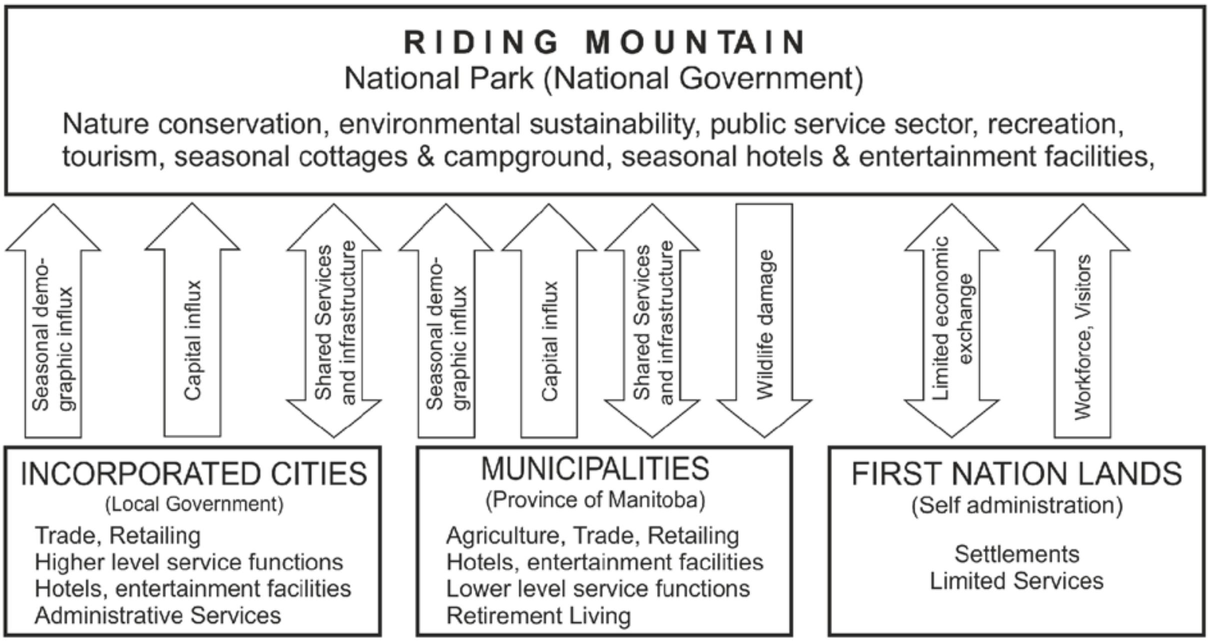

Figure 4: Interactions between Riding Mountain National Park, the Municipalities and the First Nation Reserves, Manitoba

Future perspectives

It has been shown that the RMBR is a distinct and highly complex ecosystem and human environment. It is also an evolving and very dynamic area calling for adaptive and innovative approaches to the challenges, new opportunities and problem areas. One of the challenges for the RMBR was the establishment of a protected area in a region of long-term human livelihoods and settlements. A different type of challenge for the RMBR is the rapid and in places excessive growth of the recreational function coupled with voracious land consumption, an inflation of real estate prices, the dangers of land and water contamination, and a potential "erosion" of traditional local cultures. Therefore, the principal goal of the RMBR appears to be of finding a balance between enhancing biodiversity and conservation, supporting a healthy agricultural sector, strengthening lively communities, maintaining attractive recreational environments, and in general fostering a sustainable regional development: '*Biosphere Reserves should strive for innovative ways in which to showcase sustainable living practices in the light of dominating unsustainable patterns of growth and human consumption. This can be achieved through real local- and community –based processes*' (STOLL-KLEEMANN & O'RIORDAN 2017: 89).

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Shifting composition and functioning in alpine plant communities – Evidence of climate warming effects from 14 years biodiversity observation in the Northeastern Alps

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Abstract

Climate-driven vegetation shifts are expected to occur globally and were detected on mountains across Europe. Due to low growth rates and the long-lived nature of alpine plants, changes occur slowly, but continuously. Here we attempt to identify sensitive functional traits, such as leaf traits, plant height and ecological indicator values of alpine plant species to assess climate-driven community shifts in two GLORIA regions (National Park Gesäuse, Hochschwab). Changes in community trait weighted means are used to discern impacts of changes in temperature, snow cover duration and water availability.

Keywords

climate change, high mountain plants, alpine zone, vegetation change, plant functional traits, ecological indicator values, long-term monitoring, thermophilisation, GLORIA

Introduction

European alpine vegetation experienced pronounced thermophilisation during the past decades, i.e. an increase of warmth-demanding species with a synchronous decrease of cold-adapted species (GOTTFRIED et al. 2012). Plant functional traits (PFTs) are key to a species' ability to cope with the alpine climate on the one side and competition on the other side (KUNSTLER et al. 2016). Therefore climate-related directional changes in alpine plant biodiversity are expected to coincide with compositional changes of plant functional traits within alpine plant communities (VENN et al. 2014). Specific Leaf Area (SLA), Leaf Dry Matter Content (LDMC) and Plant Height (PH) will be used here to show recent vegetation changes in the Northeastern Austrian Alps. SLA is related to potential growth rate and provides information about a plant's water strategy (PÉREZ-HARGUINDEGUY et al. 2013). LDMC is roughly negatively correlated to SLA. It is a proxy of water availability and resistance to physical hazards. PH is related to a species' competitive ability for light and is further connected with biomass as well as moisture (COUSINS & LINDBORG 2004) and temperature gradients (SIEFERT et al. 2015; GUITTAR et al. 2016).

Methods

The two study regions in the Northeastern Alps, Hochschwab (established 2001) and National Park Gesäuse (established 2009), are part of the GLORIA network (www.gloria.ac.at), which uses the same internationally standardised monitoring method. Hochschwab includes four summit sites, located between 1910 to 2255m a.s.l. and Gesäuse three summit sites between 1856 to 2116m. Hochschwab was resurveyed in 2008 and 2015, Gesäuse in 2015. Hochschwab has restrictions in pastoralism due to water protection status (water protection area) and Gesäuse is a national park in the IUCN category II.

GLORIA 1m x 1m permanent plot data from all cardinal aspects of each summit was used to calculate community weighted mean trait values (CWMTs) of the following PFTs: SLA, LDMC and PH. PFTs of all species, comprising 90% cover in a 1m x 1m permanent plot were used for calculations of CWMTs. PFTs were measured, following the protocol of PÉREZ-HARGUINDEGUY et al. (2013).

Additionally, the thermic vegetation indicator, based on the altitudinal distribution of all species present in a plot (GOTTFRIED et al. 2012) as well as Landolt indicator values for soil moisture and continentality (LANDOLT et al. 2010) were used to show community based changes in both regions.

Results

Preliminary results show that CWMTs of SLA tended to decrease in both regions. This was more pronounced on Hochschwab, where LDMC showed an inverse pattern. Changes in CWMTs of PH, of the thermic vegetation indicator and of ecological indicator values were less consistent or indifferent.

Discussion

Decreasing SLA would indicate a transformation of plant communities adapted to conditions of lower water availability. Specifically, it means that species with more xeromorphic leaves were either increasing in cover or were newly entering the study plots, as previously reported from other alpine regions (SOUDZILOVSKAIA et al. 2013). LDMC is usually negatively related to SLA (PÉREZ-HARGUINDEGUY et al. 2013), which was indicated by our data from Hochschwab. Directional changes in leaf traits can be interpreted as response to trends of decreasing

precipitation, especially during the growing season, or result from a combined effect with rising temperatures. Atmospheric warming alone, however, may already cause changes in leaf traits, due to higher rates of evapotranspiration. At least over a longer term, leaf trait responses should be consistent with the thermic vegetation indicator. The latter showed an increase across Europe's GLORIA sites already after a period of seven years (GOTTFRIED et al. 2012), which is a rather short time-span in the context of slow growth rates of alpine plants. The much smaller subset from the Northeastern Alps, did not yet show significant thermophilisation, being most likely an effect of the limited number of data from permanent plots and/or a too short time span of observation, respectively.
Data of PFTs were not yet available for all species involved. Therefore, the preliminary results cannot be discussed in more detail at the current stage of analysis.

Conclusion

– Preliminary results suggest that PFTs, combined with permanent plot monitoring data, can build powerful indicators of climate change-induced vegetation changes.
– Especially directional shifts in the species composition and abundance proportions are expected to be detectable by using sets of PFTs and ecological indicator values (CWMT-approach) even in sub-decadal time spans.
– The significance of the CWMT-approach, especially over shorter periods, however, requires both trait data of all species that build the plant communities as well as a sufficient number of permanent plots. Although GLORIA long-term monitoring sites are already established in over 130 mountain regions, of them 12 in the Alps, new sites are still a priority matter, particularly in the Central Eastern Alps, Southeastern Alps and in the French Alps.
– Also it is of very high importance to secure the long-term operation of vegetation monitoring in permanent plots. Effective long-term commitments through national and international funding institutions as well as cooperation with and support from protected area authorities are needed.
– High resolution regional climate data can further improve the CWMT-approach, as regional climate, especially precipitation, can diverge from large scale patterns substantially (BARRY 2008).

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Detecting a change in diversity of vascular plants in the natural forest reserve 'Gaisberg' – a comparison of a systematic and representative sample approach

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Abstract

In the natural forest reserve 'Gaisberg' (Vienna Woods) a vegetation survey was carried out including the Representative Vegetation Survey (RVS) and the Systematic sample Plot Cluster method (SPC). Focusing on the herbal layer, both methods are compared. Thus, it is possible to estimate the information value regarding changes in species composition and vegetation dynamics.

Both methods detect a significant loss in species. However, it is more pronounced in the systematic sampling. According to the large plots of the representative sampling more rare and high dispersed species were assessed compared to the small systematic plot clusters. Thus, quite a number of species had higher frequencies in the representative plots which favour statistical analysis. However, a generalization of the representative approach is not possible, because the results are not area-related. Moreover, the selection process probably discriminates sites characterized by inhomogeneous vegetation structure with high dynamics.

Keywords

natural forest reserve, biosphere park Vienna woods, vegetation survey, monitoring, sample design, decreasing diversity.

Introduction

The Austrian Natural Forest Reserve Programme was initiated in 1995. Today it consists of 195 reserves with a total area of 8400 ha. One of these protected areas is the natural forest reserve 'Gaisberg', which is also part of the 'biosphere park Vienna Woods' (Biosphärenpark Wienerwald). It is 29 ha in size and is located 20 km southwest of Vienna. In the course of the establishment a vegetation survey based on representative sample plots was carried out in order to document and characterize the occurring forest communities (STEINER & KARRER, 2003). To detect vegetation dynamics additionally a systematic survey was conducted. Both, representative and systematic method were repeated after a certain time span, assessing changes in the occurring vascular plant diversity of the herbal layer. Comparing the results of these methods, strengths and weaknesses in detecting diversity and vegetation dynamics are outlined.

Methods

The study area is dominated by a beech forest community (*Cyclamini-Fagetum*). Another occurring community is an oak-hornbeam forest (*Galio sylvatici-Carpinetum*). Both associations are rich in species and can be differentiated into two sub-associations (Tab. 1) due to their species composition.

Two different methods of vegetation survey are compared (Fig. 1, Tab. 1).

A **Systematic sample Plot Cluster method (SPC)** with 27 cluster plots was carried out on a 100 x 100 m grid. On each intersection 8 sub-plots of 1 m² were placed in 5 m distance according to the 8 cardinal points. For each sub-plot the presence of each vascular plant species was assessed and thus a scale of frequency classes from 1 to 8 could be defined. The observing interval is 15 years. For statistics, surveys from 1998 and 2013 were analyzed.

The **Representative Vegetation Survey (RVS)** was applied including 27 plots á 100 to 500 m² (on average 296 m²). The observing interval is 20 years using data from the 1997 to 2017 survey period. The selection process of them is based on expert considerations regarding soil type, vegetation structure and species composition (BRAUN BLANQUET, 1964). The estimation of the plant species cover distinguishes 8 different categories, following WILLMANS method (1989). These are:

1. 1 to 5 individuals ;
2. 6 to 50 individuals ;
3. > 50 individuals in which categories 1, 2 and 3 respectively have less than 5 % of plant surface cover;
4. 5-15% plant surface cover;
5. 16-25%;
6. 26-50%;
7. 51-75%; and
8. 76-100% plant surface cover disregarding frequencies.

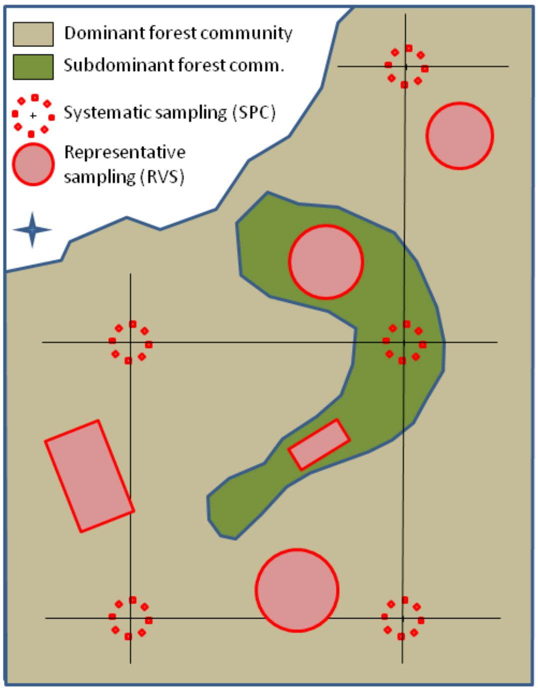

Figure 1: Schematic diagram of the representative (RVS) and systematic (SPC) sampling design.

Method	SPC	RVS
Total number of Galio sylvatici-Carpinetum cluster plots	4	12
Galio sylvatici-Carpinetum typicum sub-association	2	4
Gal. sylv.-Carp. primuletosum veris sub-association	2	8
Total number of Cyclamini-Fagetum cluster plots	17	15
Cyclamini-Fagetum typicum sub-association	12	8
Cyclamini-Fagetum seslerietosum sub-association	5	7
Unclassified	6	0
Total number of plots	**27**	**27**

Table 1: Number of sample plots per method and forest community.

Results

During both periods, the total number of vascular plant species present in all plots and plot clusters was assessed. Using SPC method, 161 species were present in period 1 and decreased to 135 species in period 2. The RVS method also showed a decrease from 193 to 171 species (Tab. 2).

With regard to the single plot or plot cluster, the average species number decreased from 28,8 to 18,7 using SPC method and from 52,6 to 46,1 with RVS method respectively. Both results were significant according the paired t-Test (TRAXLER, 1997) and a significance level of 99%. Referring the forest communities the loss of diversity was highest in the beech forest sub-association *Cyclamini-Fagetum typicum* (Tab. 2).

Both methods show obvious differences in the frequency of the occurring species. Due to the larger plot size, the frequency of quite a number of species, like some orchids (*Cephalanthera* spp.), martagon lily (*Lilium martagon*), wild cherry (*Prunus avium*) and february daphne (*Daphne mezereum*), is significantly higher in the RVS method than in the SPC method.

Furthermore, the distribution of the sample plots within the forest communities influences presence and frequency of the species. Due to the higher number of RVS plots in the oak-hornbeam forest (*Galio sylvatici-Carpinetum*), the number of species related to this community are more abundant.

The Wilcoxon's median comparison test (significance level 95%) (KÖHLER et al., 1995) reveals a decrease for 16 species using SPC data. With RVS data such a decrease is significant even for 40 species.

A particularity is the frequency change of ash (*Fraxinus excelsior*). For this tree species an increase was significant for SPC data only.

Method	SPC		RVS	
Period	1	2	1	2
Average number of species				
Galio sylvatici-Carpinetum	31,3	24,0	55,4	48,6
Galio sylvatici-Carpinetum typicum	37,0	29,0	68,8	62,5
Galio sylvatici-Carpinetum primuletosum veris	25,5	19,0	48,8	41,6
Cyclamini-Fagetum	24,2	15,5	50,4	44,1
Cyclamini-Fagetum typicum	22,8	13,6	39,8	33,9
Cyclamini-Fagetum seslerietosum	27,6	20,2	62,6	55,9
Unclassified	40,3	24,2	-	-
Total number of species within the sample	161	135	193	171
Average number of species per plot	28,81	18,7	52,6	46,1
standard deviation	2,66	2,57	3,04	3,54

Table 2: Number of species assessed using the systematic (SPC) and representative (RVS) method in respect to the forest communities.

Discussion

In this natural forest reserve within the last 15 years a decrease of vascular plant species is obvious.

It is suggested that this loss is caused by a continuously denser canopy due to the lack of human intervention. For SPC data it seems more severe, because there are more plots located in young stands with high dynamics.

For statistical analysis a certain number of sample plots per species or community is essential. Thus it is more likely to find changes using RVS method than SPC method.

Although ash is one of the most abundant species, its increase could not be confirmed with RVS method. This may be traced by its rough scale. Only the small sub-plots of SPC made a change in frequency category visible.

Conclusion

The information value of the RVS data is limited, due to the not area-related plot selection process. Moreover, inhomogeneous sites with high succession rates might be discriminated. In this case vegetation dynamics are underestimated. Hence it is not possible to generalize the results of this method.

The smaller the plot, the lower is the number of species for which changes can be detected. This is also valid to assess rare species.

Small plots are more sensitive to detect changes in populations of high abundant species.

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10 years of glacier mass balance monitoring on Mullwitzkees (Hohe Tauern)

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Keywords

glacier, surface mass balance, Mullwitzkees, Großvenediger

Summary

In 2006, a mass balance monitoring programme was started on Mullwitzkees glacier (47.09°N, 12.38°E) within the core zone of Hohe Tauern National Park. The investigations on Mullwitzkees record the annual surface mass balances and interpret them in the light of the local weather conditions. The glacier is mainly exposed to the south and located on the south side of the main Alpine ridge, which is a weather and also a climate trend divide (AUER et al., 2007). Winter, summer and annual mass balances are determined for the hydrological years by using the direct glaciological method with ablation stakes, snow pits and snow depth soundings (HOINKES 1970, CUFFEY & PATERSON 2010). The glacier covers an area of almost 3 km² within an elevation range between 2700 m and 3400 m (FISCHER et al., 2015).

The mean annual specific glacier mass balance during the past 10 years was -820 mm w.e. (water equivalent), but shows great variance, from -1599 mm w.e. in one year to an increase of +117 mm w.e. in another. These extreme differences in mass balance were observed within two successive years 2013/14 and 2014/15 (Fig. 1, Tab. 1), resulting in an increased interannual variability, in contrast to earlier publications (STOCKER-WALDHUBER et al. 2013). A comparison of the annual summer and winter mass balances suggests that the annual mass balances of this glacier mainly depend on the ablation season (Tab. 1). This means that the state of Mullwitzkees is mainly driven by summer temperatures and summer snowfall events at the glacier. Snow accumulation during the accumulation season can be seen as the basis for the annual result, as it affects the length of the ablation season. The first ten years of measurements on Mullwitzkees revealed that the glacier state is close to equilibrium if the accumulation area ratio is close to 50% (Sc/S ≈ 0.5), a condition which was almost reached in 2013 and even exceeded in 2014.

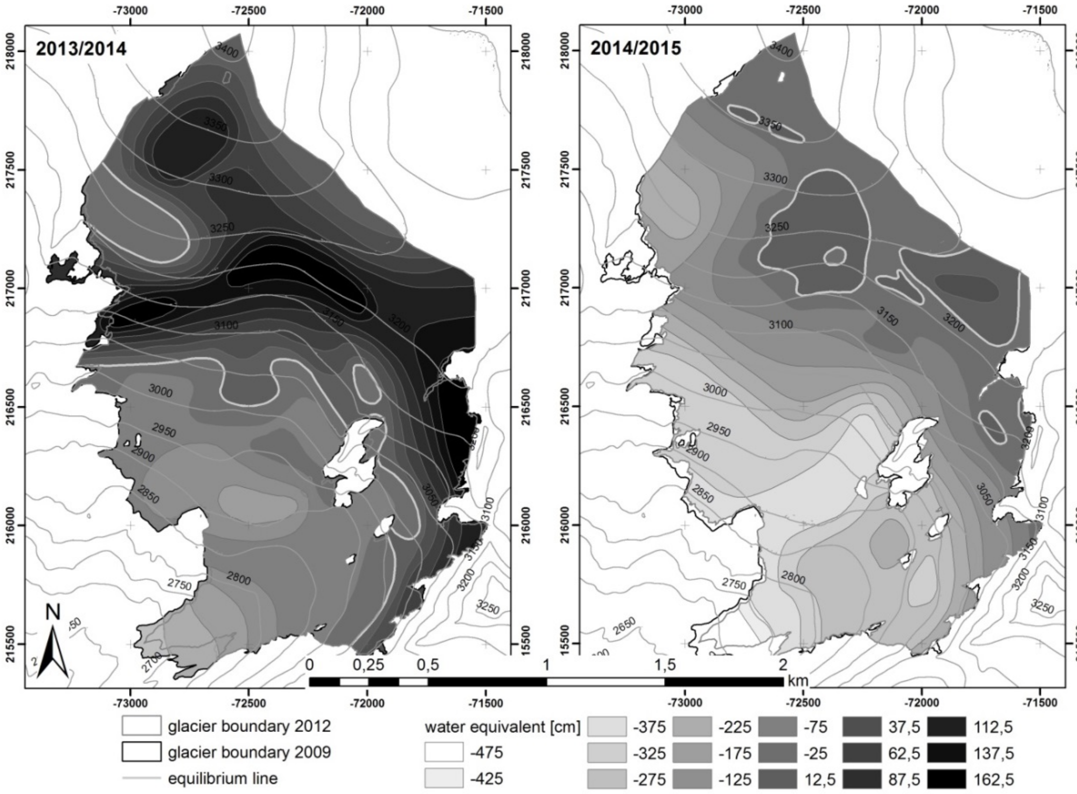

Figure 1: Spatial distribution of the most positive (left Fig.) and the most negative (right Fig.) annual mass balance during the first ten years of direct mass balance measurements on Mullwitzkees. The mass balance is coloured gradually in 50 cm w.e. increments within the ablation zone and in 25 cm w.e. increments within the accumulation zone.

	S_c km^2	B_c $10^6\ m^3$	b_c mm	S_a km^2	B_a $10^6\ m^3$	b_a mm	S km^2	B $10^6\ m^3$	b mm	b_s mm	b_w mm	ELA m	S_c/S
2006/07	0,639	0,436	682	2,444	-4,897	-2004	3,083	-4,461	-1447	-2121	674	3187	0,207
2007/08	1,220	0,932	764	1,864	-2,912	-1562	3,084	-1,980	-642	-2052	1410	3115	0,396
2008/09	1,110	0,452	408	1,916	-1,926	-1005	3,026	-1,474	-487	-2006	1519	3116	0,367
2009/10	1,003	0,424	423	2,023	-1,906	-942	3,026	-1,481	-490	-1797	1307	3105	0,332
2010/11	0,431	0,107	248	2,501	-3,926	-1570	2,931	-3,820	-1303	-2127	824	$> GN$	0,147
2011/12	0,326	0,064	197	2,605	-3,806	-1461	2,931	-3,741	-1276	-2772	1496	$> GN$	0,111
2012/13	1,207	0,618	512	1,725	-1,256	-728	2,931	-0,639	-218	-1664	1446	3119	0,412
2013/14	1,727	0,134	776	1,205	-0,998	-829	2,931	0,343	117	-1044	1161	3044	0,589
2014/15	0,238	0,047	143	2,471	-4,523	-1830	2,798	-4,476	-1599	-2966	1367	$> GN$	0,117
2015/16	0,631	0,205	325	2,145	-2,587	-1206	2,776	-2,382	-858	-1894	1036	3196	0,227

Table 1: Characteristic numbers of summer, winter and annual mass balances on Mullwitzkees (STOCKER-WALDHUBER et al. 2016); S: area, B: total mass balance, b: specific mass balance, ELA: equilibrium line altitude, Sc/S: accumulation area ratio; indices: c: accumulation, a: ablation, s: summer, w: winter; >GN: above crest level.

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Ferns in the spray: the pteridophyte flora of the Krimml Waterfalls

Oliver Stöhr

Abstract

In 2016 a survey of the fern flora at the Krimml Waterfalls was carried out on behalf of the National Park Hohe Tauern / Salzburg. In the course of this mapping, 36 taxa and 5 hybrids of fern allies were detected, including some notable taxa such as *Polystichum braunii*, *Dryopteris lacunosa* and *Lycopodium clavatum subsp. monostachyon*. On this basis it can be concluded that the area of the Krimml Waterfalls is very significant for the fern flora and is highly representative within the central alpine chains of the Eastern Alps.

Keywords

Austria, ferns, floristic mapping, pteridophytes, Krimml Waterfalls

Introduction

Around 12,000 species of fern plants are known worldwide, of which, according to current knowledge, approx. 90 species and subspecies occur in Austria. Up to now, about 70 native fern species and subspecies were detected in the province of Salzburg (see FISCHER et al. 2008). Although these numbers are manageable and therefore one may assume that our ferns are well-known, the native fern flora is not fully explored yet. For instance, only limited data were available for the area of the Krimmler Waterfalls, an area which is promising due to the 'fern-friendly' shady and permanently moist site conditions. A complete and systematic examination of the fern flora has not been carried out yet – quite in contrast to the local moss flora, which is described at lenght by the work of GRUBER et al. (2001). Against this background, the author was commissioned to carry out an extensive survey about the fern flora of the area around the Krimmler Waterfalls in 2016. The results are presented in a 152-page final project report (STÖHR 2016).

Methods

In an investigation area, which stretches over approx. 102 ha, fern-allied plants (i.e. clubmosses, horsetails and ferns) and their abundances were recorded in defined habitats.

In addition, rare and significant species for nature conservation were pinpointed precisely and shoots or stocks were counted.

Results and discussion

In the course of this mapping, 36 taxa (= species and subspecies) as well as 5 hybrids of fern allies were detected. Of these, 4 taxa belong to the family of the clubmosses, 1 species to the family of the moss fern plants, 6 species to the family of horsetail plants, 25 taxa and 5 hybrids to the class of the ferns. Compared with to data from other sources, i.e. official biotope mapping, literature and unpublished findings out of Peter Pilsls database (query status: August 2016), not only the previously known taxa were confirmed, but also eight taxa and hybrids were detected additionally. Particularly noteworthy is the occurrence of *Polystichum braunii*, *Dryopteris lacunosa* and *Lycopodium clavatum subsp. monostachyon*.

Polystichum braunii – a very old species with a worldwide but fragmented distribution with relict character – was already described in the area in 1864 by the great alpine botanist A.E. SAUTER. Although the number of new findings in Salzburg has recently been increased, it still is a relatively rare, potentially endangered species in this province, since the known occurrences are usually not rich in individuals and suitable habitats are restricted to small areas. In the area of the Krimml Waterfalls, the sites of this species are concentrated almost exclusively on the very humid, spray misty forest areas close to the waterfalls, where the fern even reaches a moderate number of individuals.

Dryopteris lacunosa is a triploid plant from the difficult *Dryopteris affinis*-aggregate, which was first described in 2011 (JESSEN et al. 2011) and therefore is still unknown to many botanists. In Austria only five sites from Salzburg, Vorarlberg and Tyrol were documented so far. With the two single records in vicinity to the Krimmler Waterfalls, this species was now detected in the Hohe Tauern for the very first time.

Lycopodium clavatum subsp. monostachyon is a rare arctic-alpine clubmoss, which was first discovered in the Eastern Alps by TEPPNER in 1975. Since then, there are a number of records from the central Alps in Salzburg, which show that these subspecies is somewhat more widespread on sites with silicate soil (especially acidic debris and block-mound edges, gappy dwarf shrubs heathers and secondly on forest road banks). In the area of the Krimmler Waterfalls this clubmoss is quite rare – only in two biotope areas at the southern end of the study area five individuals could be detected on the edge of silicate block mounds.

Among the hybrids the supposed, but not yet cytologically verified proof of *Dryopteris* × *sarvelae* (= *Dryopteris expansa* × *dilatata*) is worth mentioning. It could be regarded as a first record for the Eastern Alps and Austria. Furthermore, a hitherto unknown, taxonomically still not classified plant of the *Dryopteris carthusiana*-aggregate, which is provisiory named *Dryopteris* 'Krimmler Waterfall type' was discovered; it remains to be examined whether it is even a new species to science.

Special 'hot spots' of the fern flora are found in the following three places in the study area; they partly overlap with the most valuable areas for the mosses (see Gruber et al. 2001):

1. Spray-affected, block-rich spruce and gray alder forests at the lower waterfall orographically left and right: This area contains, regarding the fern flora, the most biodiverse forest parts of the study area (Fig. 1, Fig. 2) including a high occurrence of *Polystichum braunii* and the two sites of *Dryopteris lacunosa*.
2. Spray-affected, block-rich spruce forests and green alder bushes at the lower waterfall orographically left: This much smaller area is characterised by the second partial area of *Polystichum braunii*.
3. Sparsely wooded to woody block-mounds above the upper waterfall orographically right: This area is characterised by small occurrences of *Lycopodium clavatum subsp. monostachyon*, which spread along the driveway.

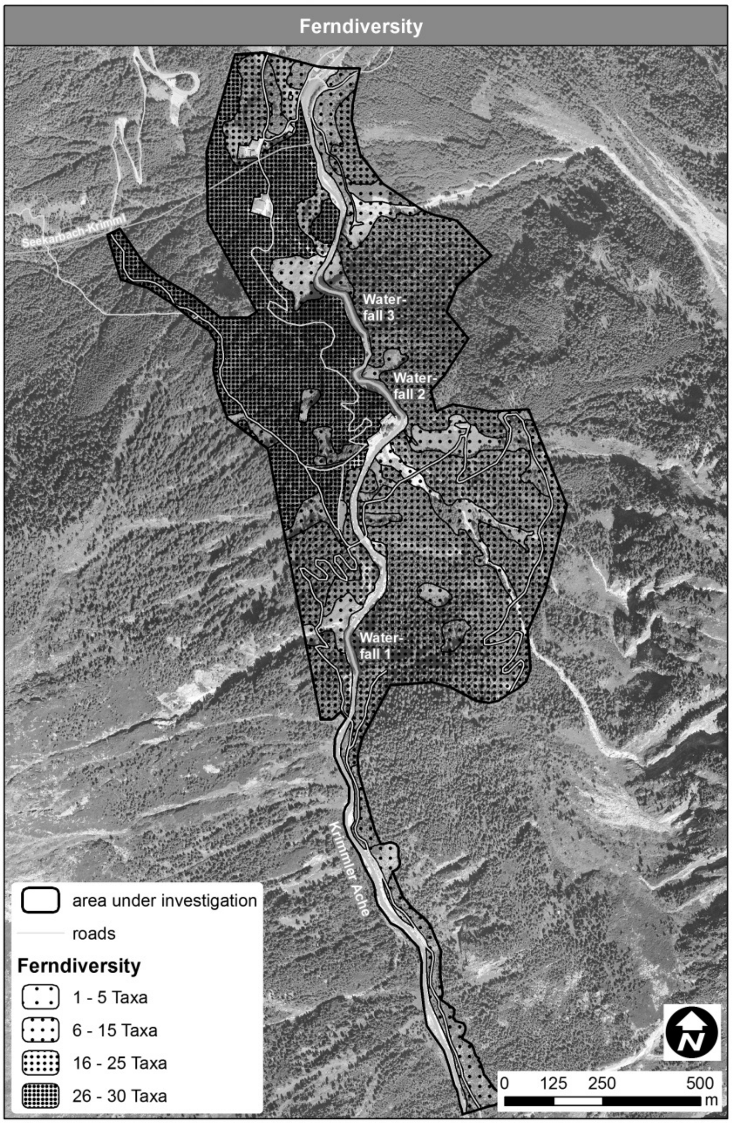

Figure 1: Map depicting the diversity of fern flora in the study area (cartography: M. Lumasegger / REVITAL)

Figure 2: Fern-rich spruce forest at the lower waterfall (credits: O. Stöhr)

Conclusion

Based on the carried out survey it can be concluded that the area of the Krimml Waterfalls is very important to the fern flora and also highly representative within the central alpine chain of the Eastern Alps. This is based on the following arguments:

1. Proven occurrence of 36 species and subspecies of vascular spore plants, which are around 50% of species and subspecies of the fern flora in Salzburg and approx. 40% of the Austrian fern flora.
2. Detection of five hybrids and an apparently evolving 'hybrid zone'.
3. Abundant occurrence of remarkable species, such as *Polystichum braunii*, *Dryopteris lacunosa* or *Lycopodium clavatum subsp. monostachyon*.
4. Typical ferns of montan-subalpine silicate habitats are highly present.
5. Detection of a taxonomically still unexplained, possibly new fern taxon (*Dryopteris* 'Krimmler waterfall type').

The fact that the area of the Krimmler waterfalls has such a remarkable fern flora is undoubtedly due to the waterfalls themselves, which act as local climate regulators (especially permanent high humidity) on the vegetation. Many ferns thrive well in this humid, spray-misty environment.

In conclusion, despite the high visitor and tourist appearance especially in summer, as a habitat for ferns the area still is in good condition. In particular the set visitor guidance measures, which mainly comprise signs and barriers to canalise the visitors to the area of the so-called 'Wasserfallweg', but still leave unobstructed views to the natural drama of the Krimml waterfalls as well as to the fern-rich forests orografically to the left.

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Integrated planning of national parks and adjacent areas – possibilities and limits in cooperation for nature-based tourism and place making

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Abstract

In Norway, there have traditionally been a segregated approach to management of national parks, focusing on protecting nature from human activities. However, in recent years, we have seen tendencies toward a more integrative approach, focusing on integration of nature based tourism, place making and nature conservation. The aim for this paper is to highlight some preliminary results, based on an ongoing research from the Varanger Peninsula National Park and its adjacent areas in the far north of the Norwegian mainland.

Key words

National park management, local planning, network arrangements, nature-based tourism, place making

Introduction

Nature conservation are taking new directions in several countries, where protected areas are increasingly being viewed in a wider regional context (MOSE 2007; HAMMER et al. 2012), i.e. as a tool for tourism development and place-making. HAMMER et al. (2016:19) emphasis that the majority of European parks today 'are no longer nature reserves but have the character of living or working landscapes'. To a certain extent, the Norwegian nature protection policy has also been undergoing similar changes in recent years (HAUKELAND et al. 2013). In Norway, the management responsibility for a number of national parks and other large protected areas has since 2010 been delegated from the County Governor (the state representative in the Norwegian counties) to inter-municipal boards. The boards consist of local politicians from the concerned municipalities, primarily local mayors, as well as County Council politicians. A locally based national park manager, appointed by the County Governor, acts as secretary to the board. Another trend is to develop visitor strategies for national parks and other large protected areas. Our case study area, Varanger Peninsula National Park (Fig. 1) was one of the Norwegian pilot parks. A third trend is establishment of regional parks, inspired by other European parks. A major objective for regional parks is to develop comprehensive strategies for tourism and place making (GAMBINO & PEANO 2015). In our case area, the park 'Varanger Arctic Norway', is now in progress.

Most of the infrastructure projects related to tourism activities in protected areas take place in the adjacent areas outside the national parks´ borders (EAGLES & MCCOOL 2001). This implies an obvious challenge in coordinating the management of the areas inside and outside of the protected border in a consistent manner, due to different legal frameworks of land use planning within and outside the border (ibid.). This is particular true for Norway, where protected areas are basically wilderness areas excluding permanent settlements and cultivated land.

Our first research questions is: What are the experiences with the management of Varanger Peninsula National Park and it`s visitor strategy? Our preliminary impression is that the municipal land use planning have none or limited focus on the adjacent areas to the National Park, and therefore limited integration capacity with the park management. Thus, our second research question is: What are the possibilities and constraints in order to improve the level of integration, and what role can the regional park, Varanger Arctic Norway, take?

The paper is based on the BIOTOUR-project (From place-based natural resources to value-added experiences: Tourism in the new bio-economy – project no. 255271). The project is funded by the Norwegian Research Council and the BIONÆR-programme, started in 2016 and ends in 2020. Norwegian University of Life Sciences (NMBU) is lead-partner of BIOTOUR in co-operation with four Norwegian and five international partner organizations.

Varanger Peninsula and its National Park

Varanger is a region in the east part of Finnmark County in Northern Norway, with the Barents Sea as neighbor and close to the Russian border. There region consists of the municipalities Berlevåg, Båtsfjord, Vardø, Vadsø, Nesseby and Sør-Varanger (Fig. 1). The road along the Varanger fjord from Varangerbotn to Hamningberg (appr. 160 km) is established as a National Scenic Route. The region is multicultural with Norwegian, Saami and Finnish settlements. The total population in the region is appr. 15.000.

Figure 1:The Varanger region and Varanger Peninsula National Park (Varangerhalvøya nasjonalpark)

Fishing, small-scale agriculture and reindeer husbandry are the main traditional livelihoods. The Barents Sea have one of the world richest fish resources, and many communities and small towns as Vardø have traditionally been depending on fishing and fish processing industry. The Saami population is active in traditional reindeer husbandry in the area, together with small-scale fishing. The last years, nature-based tourism, particularly related to bird watching, is increasing. Salmon and sea trout fishing in the rivers and fishing along the coast is also important tourist activities.

The inner part of the Varanger Peninsula was designated National Park in 2006 (Fig. 1). The Park is relatively difficult to access, with a large-scale landscape, changing weather conditions and with limited facilitation. The management responsibility was delegated from the state (the County Governor) to an inter-municipal Board with local and regional politicians in 2009. A locally based national park manager, appointed by the County Governor, act as secretary to the Board. A visitor strategy for the Park was made in 2015, as on the pilot project among three selected National parks in Norway.

Methods

The study includes qualitative semi-structured interviews with key actors in the region, conducted in the beginning of May 2017. The following informant were interviewed; the National Park Manager, the administrative head of Vadsø municipality, the leader of Varanger Business Centre and the Regional Park (Varanger Arctic Norway), the leader of Varanger Saami Museum and the tourism division of the County municipality of Finnmark (located in Vadsø). We also interviewed local small-scale tourist operators in two selected communities; Nesseby and Vestre Jakobselv (see Fig. 1). In addition, a workshop with representatives from these two communities were conducted. The interviews and summary of the workshop were audiotaped and transcribed.

Preliminary results and discussion

A main impression from the interviews is that there is a very limited integration between the National Park management and municipal land use planning for the adjacent areas, despite the fact that these areas are considered to have much of the same qualities as the National Park. The visitor strategy identifies four gateways into the Park. In these areas, there are some cooperation between the Park management, the municipalities and voluntary organizations. However, this cooperation is largely based on the National park regulations. Proactive land use planning for these areas is lacking due to lack of capacity in the municipalities and a tradition to focus mainly on the built up areas (towns and larger villages). In order to integrate conservation, nature-based tourism and place making, we find it necessary to include the adjacent areas and nearby communities in a much more consistent way.

Up to now, the regional park plan for Varanger Arctic Norway has a very limited focus on the National Park, which hampers synergies between conservation, nature-based tourism and community development. At the same time, the manager for the National Park have only limited contact and knowledge about the regional park. Applying a stronger link to European regional park models may have the potential to bridge nature and culture, conservation and nature-based tourism and place making across the National Park border (GAMBINO & PEANO 2015). An active landscape perspective based on the European Landscape Convention, where landscape is 'an area as perceived by people', can provide a common arena across legal and administrative boundaries on Varanger peninsula, and include a broad spectrum of actors from the municipalities, local inhabitants, industries and nature-based tourism entrepreneurs.

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Surface change modelling of small scale debris flow dynamics (Mühlsturzgraben, National Park Berchtesgaden, Germany)

M.J. Stumvoll, J. Götz, J.W. Buckel

Abstract

Frequency and magnitude of debris flows are influenced by a combination of predisposition factors and variable disposition factors. Both decide whether and when extrinsic or intrinsic thresholds for the initiation of debris flows are reached. Related knowledge is of particular interest if human settlements or infrastructure are potentially affected. The small but steep catchment 'Großer Mühlsturzgraben' (GMSG) experiences frequent high-runoff events with the activity of debris flows due to both, lithologic preconditioning and location-specific high rainfall intensities at the northern fringe of the Alps. Former studies suggested a local precipitation threshold of 2 mm/10 min to induce debris flows in the area. To test the validity of this threshold the GMSG and the adjacent 'Kleiner Mühlsturzgraben' (KMSG) have been monitored using terrestrial laser scanning (TLS) since August 2015. Climate stations provided local weather data to analyse triggering thresholds of rainfall intensity.

Keywords

Debris Flow, Terrestrial Laser Scanning (TLS), Precipitation Threshold, Surface Change Modelling, Protected Areas

Introduction

Frequency and magnitude of debris flows are influenced by a combination of predisposition factors (e.g., relief, geology, tectonics, climate) and variable disposition factors (e.g., sediment availability, precipitation, snow deposits), whereas both decide whether and when extrinsic or intrinsic thresholds (e.g. slope angle, infiltration capacity, runoff) are reached and debris flows are initiated (ZIMMERMANN et al. 1997). Therefore debris flow triggers and dynamics are still not fully understood.

Debris flow events of high magnitude and frequency occurred in the small but steep GMSG catchment after massive rockfall events in 1999 (216 000 m³), which were investigated by Langenscheidt (2001b; 2002). Based on 11 events in the year 2000, this study suggests a precipitation threshold of 2 mm/ 10 min (so-called 'Rote Ampel' value) for triggering debris flows in the area, which is situated in the Klausbach valley (National Park Berchtesgaden), a popular and highly frequented tourist destination (Fig.1).

This study focusses therefore on i) the quantification of recent surface dynamics in the GMSG catchment, ii) the system parameters controlling debris flow dynamics, iii) the variability of location specific weather parameters, and iv) on the validity of the suggested threshold for triggering debris flows in recent times.

Study Area

The GMSG can be characterized as highly active alpine area due to the local

- geomorphologic characteristics (A = 0.45 km², Δh = 1250 m, mean slope = 33°; LVG 2009),
- climatic conditions (annual precipitation = 1500 – 2600 mm, intense precipitation events; KONNERT 2004, KRALLER et al. 2012), and
- tectonic setting (Ramsau-Dolomite and Dachstein Limestone on top of ductile Haselgebirge, high tectonic stress, high degree of fractures and faults, susceptible to weathering; LANGENSCHEIDT 1988 and 2001a, FISCHER 2005).

Since the lower Ramsau dolomite is highly susceptible to frost weathering, largest amounts of debris in the GMSG are provided from this unit - predominantly via small-scale rockfall. Intense rainstorms and/or snowmelt are responsible for the initiation of frequent debris flows flushing out the sediments (across the road) into the main Klausbach valley. In contrast, the overlaying massive Dachstein limestone tends to release larger scale rock and blockfall. If such events hit snow avalanche deposits (which often last for several months in the study area) major debris flows can be triggered spontaneously through liquefaction (LANGENSCHEIDT 2001b).

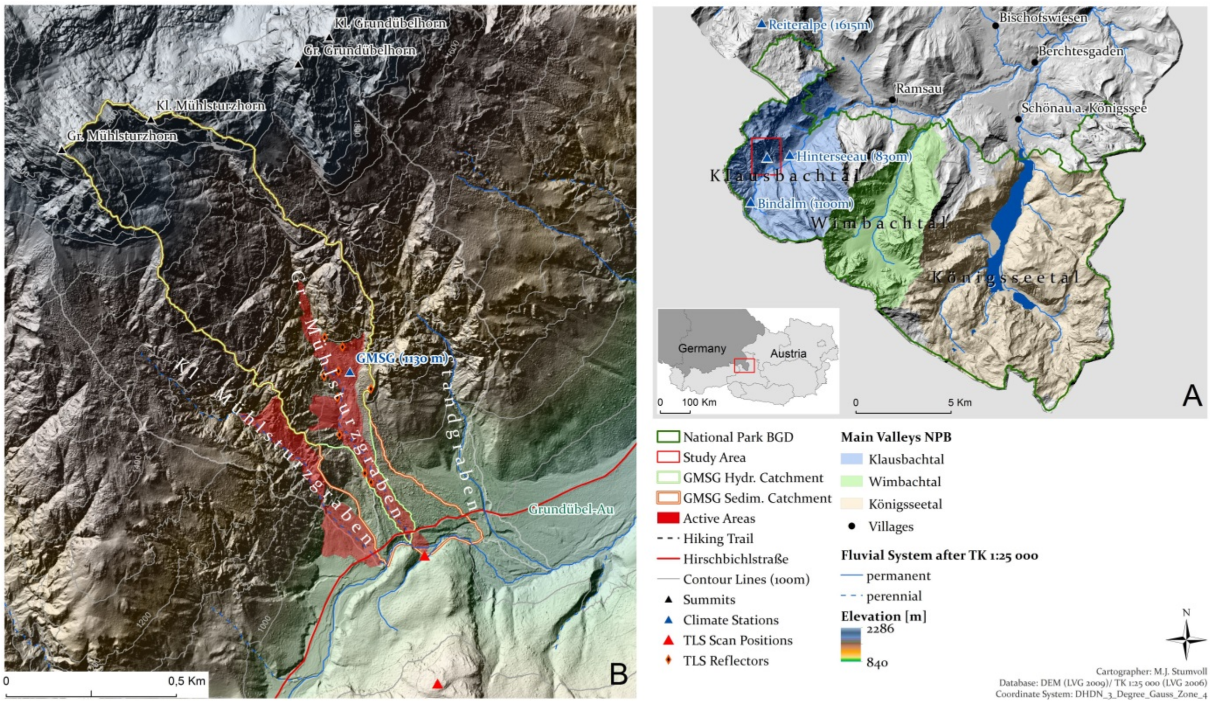

Figure 1: A: Study area in the National Park Berchtesgaden (Database: DEM LVG 2009/ LVG 2006). B: the GMSG (~ 0.055 km²) is situated west of the KMSG (~ 0.042 km²). Active areas (red) correspond to the area surveyed via TLS. Both scan positions, nine reflectors and the weather stations are indicated (STUMVOLL 2016).

Methods

To investigate recent sediment dynamics in the GMSG and the KMSG, surface models were generated using terrestrial laser scanning (TLS) (Riegl LMS Z620i) and compared with each other as well as with a digital elevation model from 2009, based on airborne laser scanning (ALS) (LVG 2009). Five TLS campaigns took place since August 2015, each with two scan positions (Fig.1B). These were registered using both reflectors and an iterative closest point (ICP-) algorithm called Multi Station Adjustment (MSA) (RiSCAN Pro). To compare TLS and ALS data, the project was transferred into a global coordinate system and (fine) registered via a second MSA. After filtering and triangulation of the data, mesh-based surface change volumes were calculated for different time slices (Fig.3; Tab.1). Resulting surface changes are interpreted with respect to external and internal triggering factors such as precipitation events or internal system dynamics. To investigate local precipitation variability, a weather station was installed within the GMSG and the data compared with two nearby climate stations operated by the National Park Berchtesgaden (Fig. 1, Fig. 2).

Results and Discussion

Weather data show a high local variability during the course of the day and year with respect to both magnitude and timing of precipitation as well as temperature range. During summer 2015 high-magnitude precipitation events predominated, reaching the GMSG up to one hour after the surrounding weather stations ('Hinterseeau' and 'Bindalm' located 1.2 and 2.5 km apart; Fig.1A) but always with the highest magnitude. Precipitation events of lower magnitude were registered in autumn 2015, which overall was unusually dry (Fig.2A). The highest mean daily temperature of all weather stations was reached in the GMSG, reflecting the south-eastern exposition of the catchment. This relation and the deviation from the other stations successively increased towards the end of the year.

According to the TLS data no debris flow events occurred in the active area (0.05 km² of 0.45 km²) of the GMSG between August 2015 and June 2016, although 10 heavy precipitation events exceeded the 'Rote Ampel' threshold suggested by LANGENSCHEIDT (2001b; 2002) (all between 15 August and 11 September 2015). The maximum recorded 10-minutes precipitation sum amounts to 5.2 mm (3 September 2015); the maximum hourly total reached 11.9 mm (21 August 2015), whereas in this hour the 'Rote Ampel' threshold was exceeded five times in a row (Fig.2B).

Although no debris flows occurred, sediment dynamics could be detected via surface comparison (Fig.3; Tab. 1). A volumetric error of ±0.25 m ('no change') was taken into account for each time period, considering inaccuracies arising from TLS data acquisition and post processing.

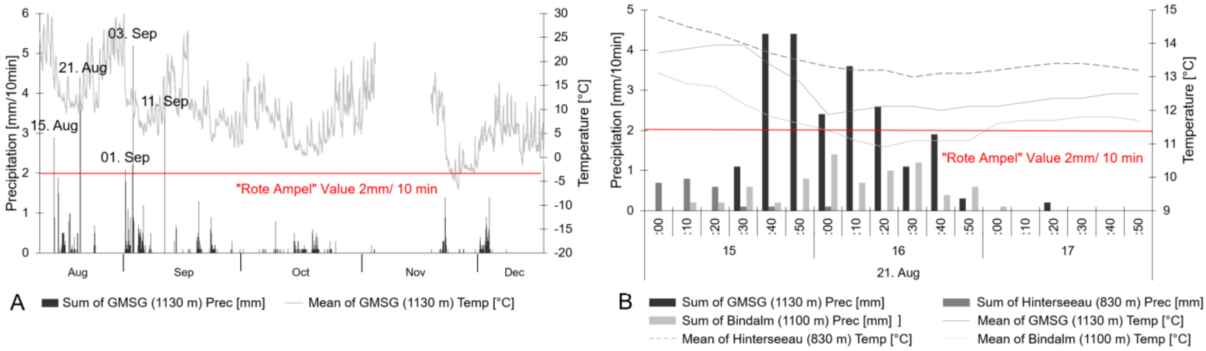

Figure 2: Precipitation and temperature in the GMSG. A: 10 min values between 11 August and 15 December 2015. B: 10 min values on 21 August 2015 between 3 and 5 pm (all three climate stations) (STUMVOLL 2016).

Sediment redistribution occurred with specific patterns in the debris flow channel of the GMSG, which can be identified clearly, and on the debris cone at the foot of the KMSG. Between 2009 and 2015 (ALS I) erosion overbalanced deposition in the GMSG (net loss of ~ 5 000 m³), whereas a net gain of ~ 13 000 m³ was observed in the KMSG (Fig.3A; Tab. 1). The 6 year sediment transfer patterns and the respective areas affected which are visible in the long-term comparison using ALS data are also visible using recent TLS data (Fig.3B, D-G), especially in the more active KMSG. On the debris cone of the KMSG different events of erosion and deposition can be distinguished (Tab. 1). The GMSG on the contrary experiences mainly internal sediment redistribution, with the areas mostly affected today being situated at the transition zone between rock face and debris covered area (rockfall/ avalanche deposits) as well as on a debris cone at the orographically right side of the debris flow channel, which repeatedly gets undercut in the case of debris flow events (sediment supply). Specific events are visible looking at details. Between October and December 2015 (TLS III) rockfall deposits can be detected in the GMSG, accounting for ~ 2 000 m³ (Fig.3F). Snow deposits of ~ 8 000 m³ are visible in the same area considering the time slice between December 2015 and June 2016 (TLS IV) (Fig.3G).

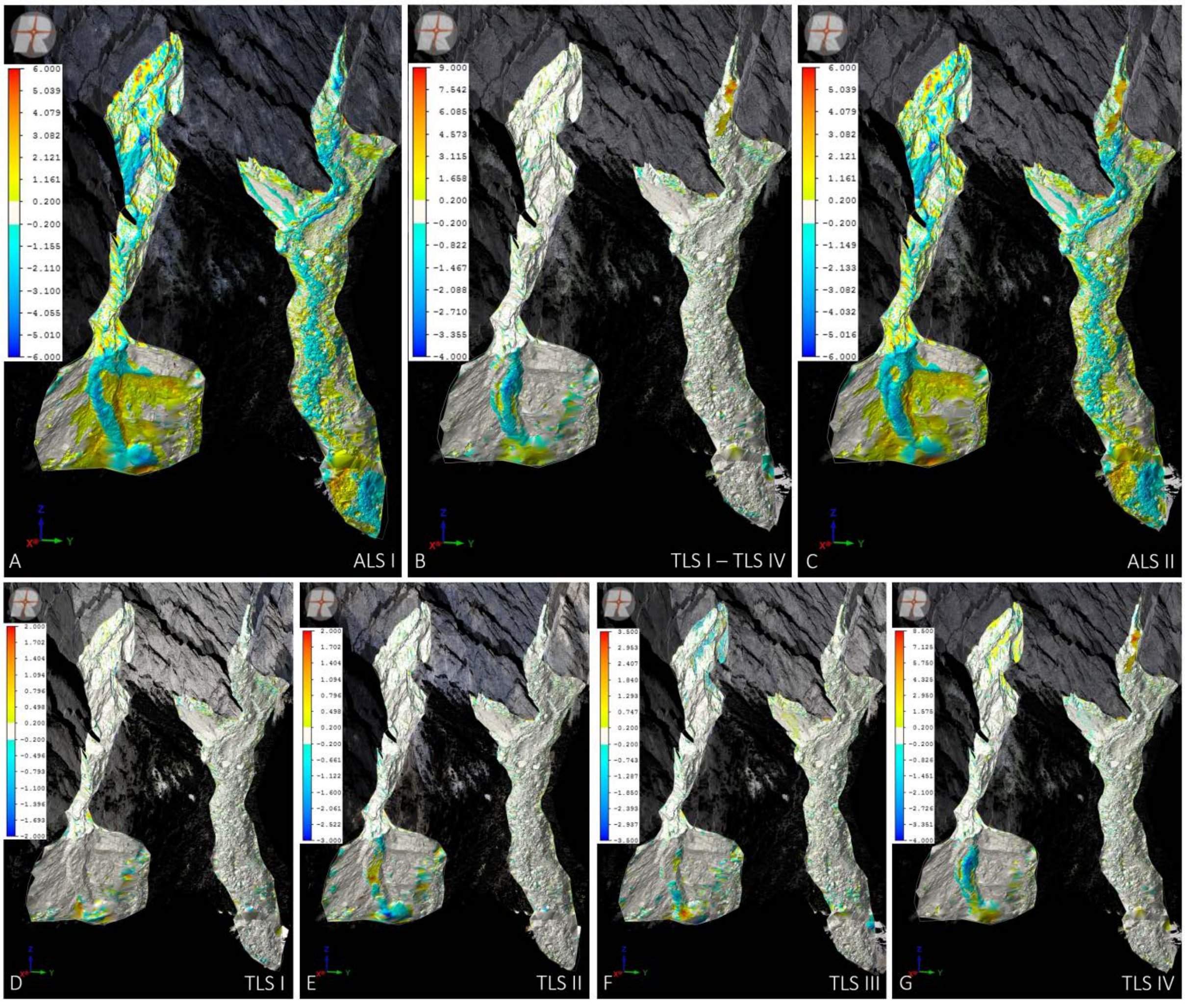

Figure 3: Volumetric surface comparison of ALS and TLS data for different time periods. The KMSG is situated on the left, the GMSG on the right side of the figures. Note the different colour scales. For time periods and surface change volumes see Tab. 1 (STUMVOLL 2016).

Reference to Fig.3	A ALS I	D TLS I	E TLS II	F TLS III	G TLS IV	B TLS I - TLS IV	B TLS I - TLS IV	C ALS II
time period	ALS 2009 - TLS 21.08.2015 approx. 6 years	TLS 21.08.2015 - TLS 29.08.2015 8 days	TLS 29.08.2015 - TLS 12.10.2015 44 days	TLS 12.10.2015 - TLS 15.12.2015 64 days	TLS 15.12.2015 - TLS 28.06.2016 196 days	TLS 21.08.2015 - TLS 28.06.2016 add up 312 days	TLS 21.08.2015 - TLS 28.06.2016 calculation 312 days	ALS 2009 - TLS 28.06.2016 approx. 7 years
Precipitation		*33mm; 5 RA*	*160mm; 3 RA*	*125mm; 0 RA*				
GMSG Fill [m³]	14 643	1 448	1 128	2 803	11 150	16 529	11 884	21 969
GMSG Cut [m³]	19 529	1 666	1 087	1 381	1 768	5 902	1 470	16 476
Difference	*-4 886*	*-218*	*41*	*1 422*	*9 382*	*10 627*	*10 414*	*5 493*
KMSG Fill [m³]	26 370	1 153	1 174	1 212	2 853	6 393	1 799	29 189
KMSG Cut [m³]	13 354	1 175	1 950	1 958	2 696	7 779	3 195	14 290
Difference	*13 016*	*-22*	*-776*	*-746*	*157*	*-1 386*	*-1 396*	*14 899*
KMSG DC Fill [m³]	*7 831*	*564*	*656*	*493*	*1 671*	3 384	*1 156*	*7 457*
KMSG DC Cut [m³]	*4 061*	*554*	*1 319*	*750*	*1 805*	4 428	*2 235*	*4 832*
Difference	*3 770*	*10*	*-663*	*-257*	*-134*	-1 044	*-1 079*	*2 625*

Tab. 1: Volumetric surface comparison of ALS and TLS data for different time periods, see Fig. 3. RA means 'Rote Ampel' threshold; DC means debris cone (calculated separately for the KMSG) (STUMVOLL 2016).

Comparing the surface change models calculated for the time slices ALS I, ALS II and TLS I – TLS IV (Fig.3A-C; Tab. 1) underlines the importance of short-term measurement intervals: Although the overall sums remain the same the composition of the resulting values strongly varies. This was most pronounced regarding the avalanche deposits within the GMSG, lasting there up to six months of the year (~ 8 000 m³ in June 2016) and distorting the results when measuring only once a year. Even considering only the TLS measurements, the calculation of TLS I – TLS IV gives the same final totals but the fill and cut values are assembled differently once the individual TLS time slices are considered and added up (see Tab. 1B: add up/ calculation).

Conclusion and Outlook

The study highlights the temporal variability of precipitation thresholds for triggering debris flows. After the disturbing rockfall events in 1999 the GMSG responded with a high frequency debris flow activity. With decreasing sediment availability as a variable disposition factor, triggering precipitation values have increased between 2000 and 2016 and the GMSG system might have reached a new form of steady state.

Long lasting avalanche deposits are supposed to strongly control debris flow dynamics in the GMSG. However, their influence concerning runoff intensification and sudden liquefaction through heavy rockfall are so far barely investigated. Future measurements will help to better understand these links. The interaction of thermal stress and rockfall activity has been also just barely investigated but may play an important role in this area (e.g. COLLINS & STOCK 2016).

The combination of high resolution digital terrain models (TLS/ALS) and weather data proved to be a suitable monitoring design for analysing debris flow triggers and dynamics in alpine catchments. However, the spatial and temporal variability of both, precipitation (events) and sediment availability are major challenges demanding for short TLS measurement intervals.

To investigate future dynamics in this highly active system, the so far relatively short time series (one year) will be continued. Furthermore, photogrammetric analysis of historic air photos will help to reconstruct past sediment dynamics for several decades.

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Participatory Management of Protected Areas in Slovakia: Reconciling nature conservation and local development

Juraj Švajda, Heino Meessen, Thomas Kohler

Abstract

Slovakian

Tento dokument predstavuje interdisciplinárny projekt, ktorý zahŕňa účasť všetkých zainteresovaných strán (stakeholderov), regionálny rozvoj a manažment chránených území. Výskum sa uskutočnil v kontexte úsilia Štátnej ochrany prírody Slovenskej republiky rozvíjať a zlepšovať metodiku pre participatívne riadenie veľkoplošných chránených území v Karpatoch. Súčasťou interdisciplinárneho výskumu bolo, že tím zložený zo slovenských a švajčiarskych výskumníkov, vypracoval základné hodnotenie vybraných chránených území zahŕňajúce oblasť ekológie, spoločnosti a ekonomiky. Osobitná pozornosť bola venovaná rozdielu medzi odľahlými a vyľudňujúcimi sa slovenskými Karpatmi s ich bohatstvom prírodných zdrojov a mestskými centrami s ich dynamicky sa transformujúcou ekonomikou z centrálnej na trhovú. Interdisciplinárny výskum sa tiež zameral na participatívne procesy so stakeholdermi vo vybraných veľkoplošných chránených územiach a vytváranie spôsobov na prepojenie ochrany prírody s hospodárskym rozvojom (pozri Obr. 2). Okrem toho Program švajčiarsko-slovenskej spolupráce umožnil slovenským projektovým partnerom implementovať malé inovatívne projekty navrhnuté lokálnymi stakeholdermi, tzv. Seed Money Actions (životaschopné aktivity). Očakáva sa že prinesú konkrétny a trvalý prínos lokálnym stakeholderom, predovšetkým poľnohospodárom pôsobiacim vnútri a v okolí chránených území. SMA reprezentovali úsilie o ochranu prírody (napr. kosenie lúk) (pozri Obr. 3a, Obr. 3b). ale aj projekty na zlepšenie turistickej infraštruktúry a iné aktivity navrhnuté miestnymi starostami alebo skupinami stakeholderov. Náš výskum poukázal na to, že takýto prístup môže byť novou produktívnou formou spolupráce medzi správami chránených území a miestnym obyvateľstvom, čo môže pomôcť vyššej akceptácii ochrany prírody medzi miestnymi obyvateľmi. Zároveň ponúka slovenským poľnohospodárom v horských oblastiach viac konkrétnych výhod plynúcich z blízkosti chránených území.

English

This article presents transdisciplinary 'action research' approach integrating stakeholder participation, local development, and protected area management. The research was carried out in the context of efforts by the State Nature Conservancy of the Slovak Republic to develop and improve its methodology for participatory management of large protected areas in the Carpathians.

As part of the transdisciplinary research, a joint team of Slovak and Swiss researchers carried out baseline assessments of selected protected areas concerning their ecology, society, and economy. The specific research approach adapted to the transition context of Slovakia also included facilitation of participatory processes (see Fig. 2) with stakeholders in selected large protected areas to negotiate ways of linking nature conservation with economic development (see Fig. 1).

Moreover, a joint Slovak-Swiss financing mechanism enabled Slovak project partners to implement small innovative projects proposed by local stakeholders – so-called Seed Money Actions (SMAs) (see Fig. 3a, Fig. 3b).They are expected to bring tangible and lasting benefits to local stakeholders, mostly farmers, within and around protected areas. SMAs included landscape conservation efforts such as mowing of pastures, as well as projects to improve tourism infrastructure or other actions proposed by local mayors or stakeholder groups. Our research shows that this could be a fruitful new form of cooperation between protected area managers and local populations, as it may ultimately lead to a higher acceptance of nature conservation among locals while offering Slovak mountain farmers more tangible benefits from nearby protected areas.

Keywords

Transdisciplinary research; participatory management of large protected areas; Parks and people; Seed Money Actions (SMAs); Scaling-up to protected areas in Slovakia and to the entire region of the Carpathian Convention

Research questions

1. What potential exist for reconciling nature and landscape conservation and local sustainable development in Slovakian Large Protected Areas?
2. What could be the specific transdisciplinary research methods aiming at the implementation of Seed Money activities 'on the ground'?
3. What are the specific Institutional challenges – local to national to transboundary level?

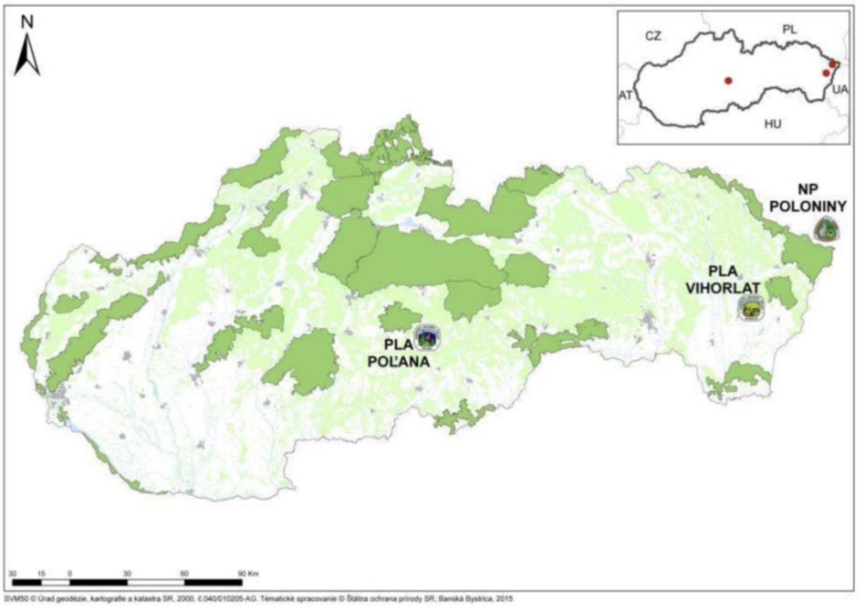

Figure 1: Location of the Pilot-Protected Areas assessed with Slovakia (colored – black/white)

Results

The transdisciplinary research approach facilitated participatory processes with stakeholders in selected large protected areas of Slovakia (see map). Stakeholders with a forum process negotiated ways of linking nature conservation with economic development. Moreover, a joint Slovak-Swiss financing mechanism enabled Slovak project partners to implement small innovative projects proposed by local stakeholders – so-called Seed Money Actions (SMAs) (see Fig. 3a, Fig. 3b).

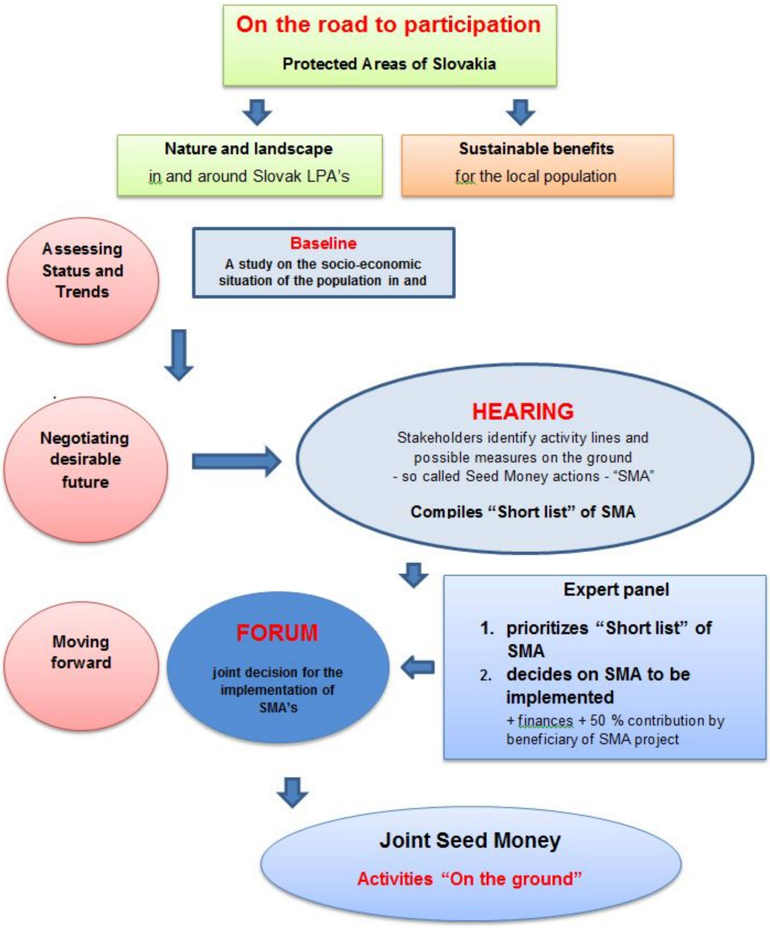

Figure 2: Procedure during 'Forum-Process' The Forum Process aiming on concrete action on the ground: Linking the national objectives of nature conservation with the local interests of a long-term development perspective.

Discussion and preliminary conclusions

People are not part of the problem, they are part of the solution or to say it in the words of Nelson Mandela, former President of the Republic of South Africa

'*Ultimately conservation is about people. If you don't have sustainable development around these parks, the parks will not survive.*'

Recommendations and future perspectives

for innovative transdisciplinary research strategies on 'parks and people' could be summarized within the following seven basic steps:

1. Carry out baseline study on LPA
2. Cooperate with stakeholders – identify local needs for and beyond conservation (FORUM process)
3. Find areas of common interest
4. Implement Seed Money Actions (SMAs) (see Fig. 3a, Fig. 3 b)
5. Document the results
6. Elaborate Manual on lessons learnt for the specific context of participatory management challenges
7. The way forward – transboundary (see Fig. 4, Fig. 5)

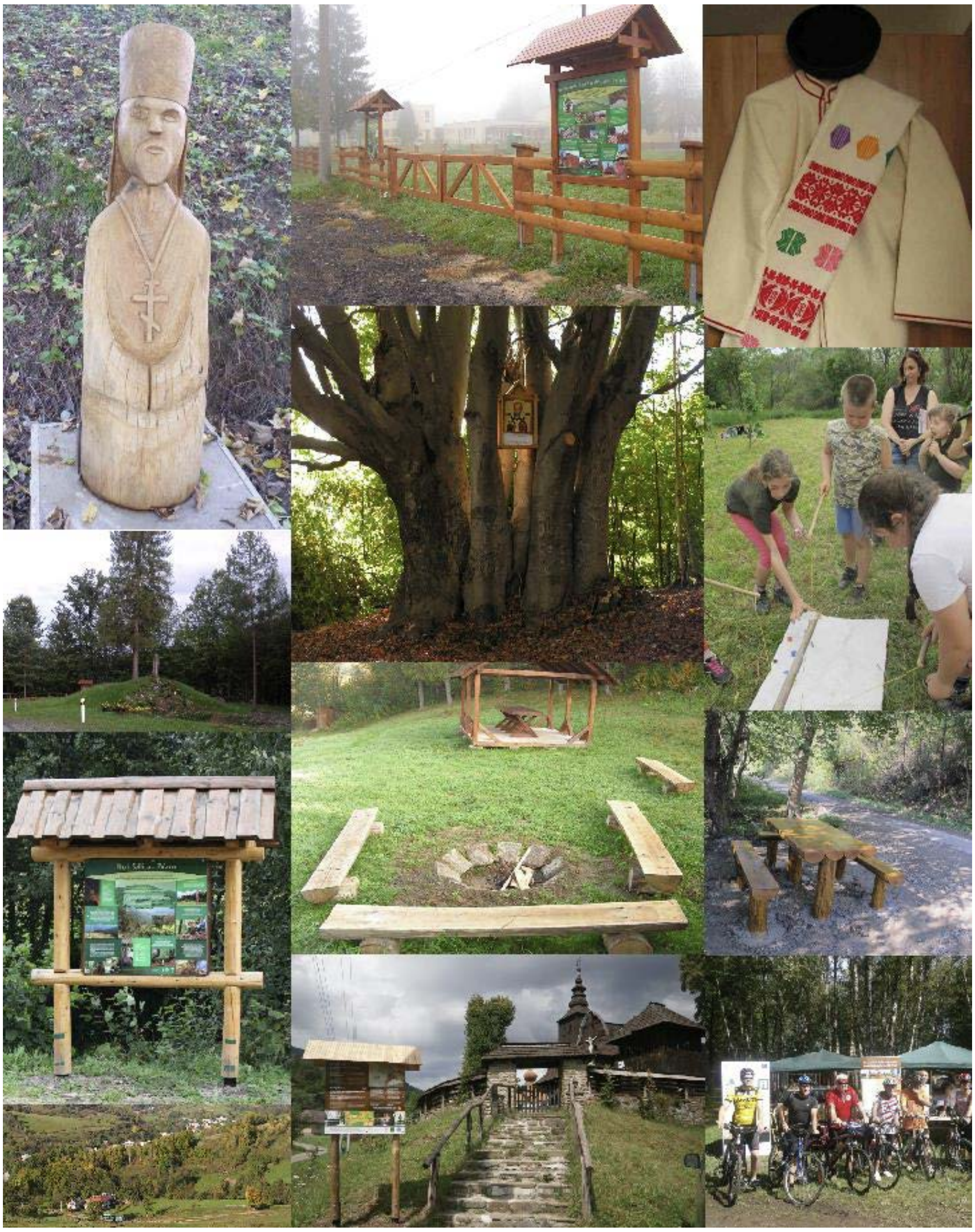

Figure 3a: Examples for Seed Money Actions (SMA) in the fields of local infrastructure (including sustainable tourism) development – in close cooperation of the LPA – administration and local mayors or other stakeholders

Figure 3 b: Example of SMA in the Pol'ana Biosphere Reserve implemented for landscape conservation in the buffer zone of the Reserve (Joint implementation by the LPA Administration and local farmers)

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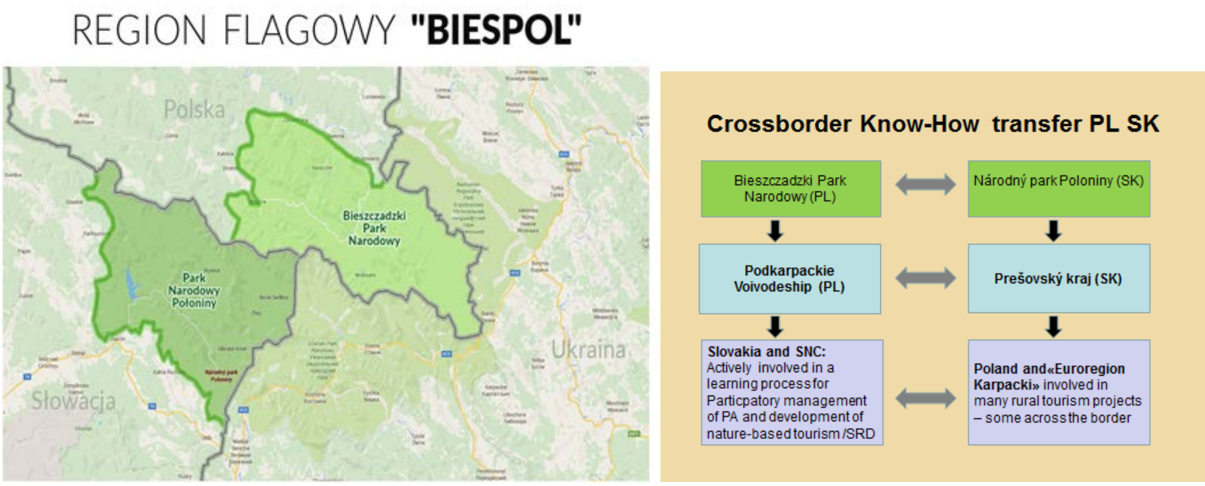

Figure 4: The way forward aiming at transboundary nature conservation in two National Parks in the flagship region of BIESPOL

Figure 5: Polish – Slovakian Bieszpol team on the border of Bieszczady and Poloniny National Parks (May, 5 – 2016) discussing on site how to reconcile nature conservation with local development. Team consists of: Director and experts of Poloniny NP Admin – Project leader of Slovak SNC – NGO local development of Winicki district (PL) – Representatives and director of Euregion - Mayors concerned with concrete project ideas from Slovakia (Obec of Ubl'a, Zboj and Topol'a plus one Ukrainian observing Mayor from Velikij Bereznij)- EU-consultant active in INTERREG as adviser for planned joint proposals SK-PL in this program and CDE /University of Bern

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Mountain lakes in National Park 'Sutjeska' – Evolutionary self-development

Emir Temimović, Muriz Spahić, Haris Jahić

Abstract

Sutjeska National Park, besides the eponymous river and its valley, includes mountain morphostructures of Zelengora, Volujak and Maglic, situated in southeastern Bosnia and Herzegovina. These morphostructural units are also known as morphological region of southeast part of the Bosnian highlands or also as 'Roof of Dinarids', as popularly called in the geographical literature. This morphological highland on a mountain Maglic is the highest point in Bosnia and Herzegovina (2386 m). Mountain Zelengora vault over 1000 m above sea level, with its highest peaks above 2000 m.

At the morphological vault of Zelengora there are 8 lakes (Orlovacko, Stirinsko, Kotlanicko, Donje Bare, Gornje Bare, Bijelo, Crno and Kladopoljsko Lake) which have polygenetic origin with dominant karst, glacial and fluvial-denundation impacts. Evolution of the lake basin has a natural self-development character, which can be monitored by so called 'jezerina' that explains the parched lake basin. It is a consequence of the dual natural processes that work simultaneously on the disappearance of lacustrine stability. Natural fluvial detritus entering the inflow zone so it uplifts lake bed. Due to this reasons there are many examples of decreasing the volumes of the lakes. By the regressive erosion of river lake, river bed has been continually deepened and occupies more lake water that finally leads to the drying of the lake. This is particularly pronounced in lakes Gornje i Donje Bare (Upper and Lower Ponds). Besides the natural, in the basin of Zelengora there are examples of creating artificial reservoirs named after the owners of these lakes. Self-development of evolution of lake basin on Zelengora are affected by the special protection regime because they belong to the National Park of Sutjeska.

Keywords

Nationaln park 'Sutjeska', lakes, Zelengora, lake genesis, lake evolution, fluvial detritus, regresive erosion, lake drying, reservoirs.

Introduction

Zelengora seizes the southeastern Bosnian highlands between two large river basins: Neretva, on the southeast and Drina in the east and northeast. Considering the morphostructural and other physical-geographical characteristics of the mountains, Zelengora makes one quite unique orographic unity with Lelija and Tovarnica. This morphostructure is distinguished by sharp separated crossings in the north, while the southern parts of Zelengora between Dumos, Kalelija and Lelija are consisting of karst plateau with valleys, deep valleys and dry scattered paleovalleys.

These orographic morphostructures are made of tectonic and orographic vault elevated in the terciary. They are vertically dissected with the surface watercourses of the Drina river basin in the northeast. Zelengora borders with the Sutjeska valley in the southeast and east towards Maglic and Volujak mountains. In the southeast, towards the Treskavica mountain, Zelengora borders with the valley of the river Ljuta. The largest part of Zelengora mountain belongs to the National Park (NP) 'Sutjeska'.

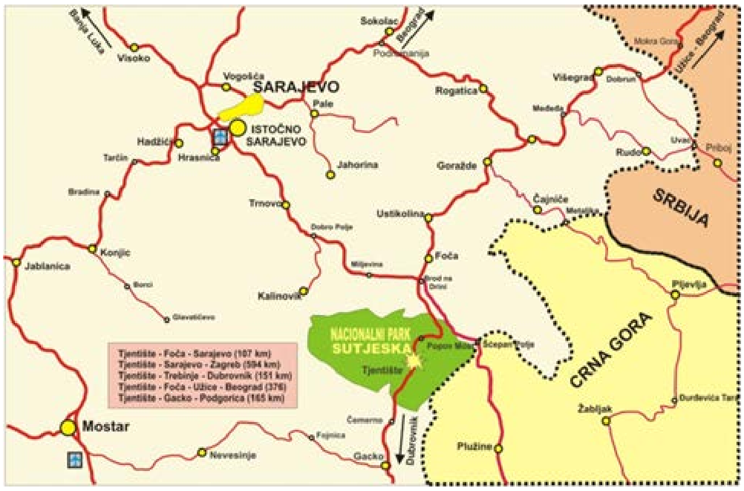

Figure 1: The traffic-geographical position of the National Park 'Sutjeska' Source: http://www.npsutjeska.info/?page_id=66 (accessed: 08/05/2017)

The NP was named after the river Sutjeska, the right tributary of Drina, which drains the waters of Zelengora from its western and southwestern morphological facade. National Park 'Sutjeska' is the oldest NP in Bosnia and Herzegovina. The Parliament and the Government of Bosnia and Herzegovina passed the law on proclamation in 1952. and with the decision of the National Institute for the Protection of Monuments of Bosnia and Herzegovina the NP is placed under the protection of monuments of culture and natural values in 1954. on an area of 175 km² (MIHIĆ 1978). Within the NP there is a forested district Perucica, which was placed under the state protection as a nature reserve. Inside the Perucica there is an magnificent waterfall Skakavac, 81 m high. The development of the NP in the past was largely based on historical events from the Second World War (TEMIMOVIĆ et al 2015). In this area, at Tjentiste, a memorial in which the mortal remains of 3301 partisans were buried was built. A monumental monument and memorial house of the Battle of Sutjeska are located near the memorial. National Park 'Sutjeska' is included in IUCN, an international list of national parks (SPAHIĆ et al. 2014).

Physicalogeographic position of mountain lakes in the National Park of Sutjeska

Zelengora is a mountain that contains the highest number of mountain lakes in the Bosnian-Herzegovinian Dinarides. In an area where surface waters end in the karst underground, these lakes are representing a special hydrographic oasis of clean and clear waters, which mountaineers popularly call 'mountain eyes' (TEMIMOVIĆ et al. 2015). There are eight of them: Kotlanicko, Stirinsko, Orlovacko, Crno (Black), Bijelo (White), Donje Bare, Gornje Bare, Kladopoljsko lake. There is also an artificial lake called Jugovo lake. All these lakes are morphostructally belonging to the eroded-corroded scalp of paleozoic antiform shale and mesozoic limestone with features of reverse pulling. There is a complex of metamorphic crystalline rocks with a carbonate roof drawn over a flysch complex, located in the Neretva valley, in the southwest. The geological superposition defines that secondary permeable limestone and dolomite of ansian floor are lying over the clastite. This phenomenon acts as a hydrological isolator. At the contact of these hydrogeologic members, water sources, hot springs of limited capacity and at the same time sinks can often be found (PERICA 2008).

The basin of Kotlanicko lake was formed at the contact of ladin and anisian floors, and the basin of Orlovacko lake at the contact of the lower trias deposits and the ladin floor. These almost identical geological and hydrogeological relations also occur in the basins of Crno, Bijelo, Kladopoljsko, Gornje Bare and Donje Bare lakes. Zelengora with other mountains of Dinaric system makes a natural barrier to maritime influences from the south and continental influences from the north. Through Zelengora, which is gradually falling towards the north, and stepwise to the south, there is an abundantly exchange of warm and cold air masses. Its southern parts are the windiest in the Adriatic's air flow and receive a higher amount of precipitation compared to the northern or continental parts.
The climate diagram data show that the average rainfall peaks on the windy and non-windy sides do not appear in the same months. This phenomenon is conditioned by the position of Zelengora, where both maritime and continental influences are strongly expressed. Precipitation are almost evenly distributed throughout the year. Snowfall starts in mid-October, dissolve at the end of May, and the snow in the sinkholes and deep valleys not before the beginning of June. The more months retention of snow is a consequence of a very low temperature during the cold season of the year. According to the data of the climate diagram, the continuity of negative temperatures is noted from December to March. Considering this continuity of low temperatures, Zelengora in the thermal regime can be divided into two annual periods: cooler which starts from November and lasts until March and a warm period from June to October (SPAHIĆ 2001).

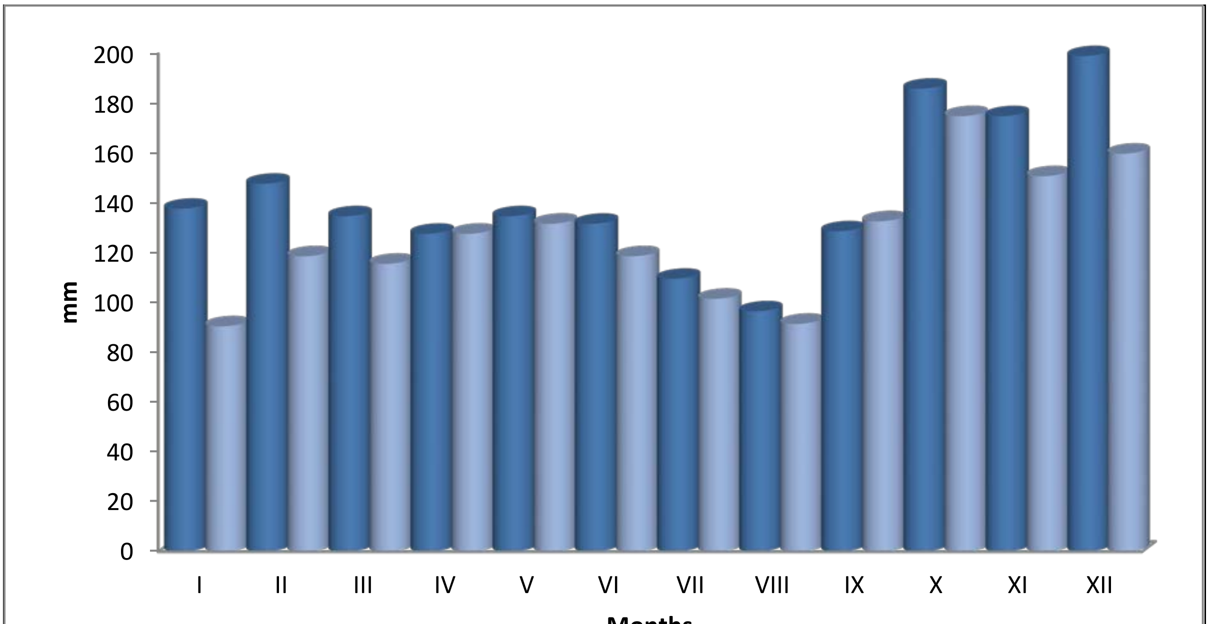

Figure 2: Diagram of precipitation on the south part-windy side (darker columns) and on the north part-non windy side (brighter columns) of Zelengora Mountain. Source: SPAHIĆ, 2001

According to the altitude belt, Zelengora belongs to the forest belt, and its highest peaks make the transition from the subalpine beech and distorted pine into the grassy floor. Except of lake basins of Orlovacko, Crno, Bijelo and Donje Bare lake in wich the beech-fir forest dominate, other lake basins have no forest biocenosis. They are obviously devastated in a favor of pasture.

Discussion – genesis and evolution of lake basins of Zelengora Lakes

Genetic phase of the development of lake basins

Lake basins were mainly formed in the area of paleozoic shales and mesozoic limestone with characteristic of reverse pulling. In them, massive and conglomerated carstic and watertight limestone of aniscinian period lean on the lower trias waterproof deposits of verfen, represented by clastic layer of liscuit shales, sandstones and quartz sandstone. Besides that, some lake basins, such as the Kotlanicko lake basin, were formed in a lithologic waterproof ladinic series: limestone with cherts, clays, tuffs, sandstones, diabase and spilite, to which the anisian floor is attached, whose contact is accomplished through a minor tectonic fault on the island side of the lake. Around most of Zelengora lakes the processes of gravitational collapse and dropping has been developed. This detritus is transported by canals and ends at the bottom of the lake basins through deluvial cones. Cones are most often grown together in deluvial deposits and conglomerates. Canals in the lake basins of the lake Gornje Bare below the Ugljesin peak, lake Orlovacko beneath Orlovac peak and Bijelo lake in the foothills of Orlovaca mountain, most commonly serve as an avalanche canal during the winter.

The indirectly lake basins are sprinkled by valleys that end in the direct lake basins. With their morphology they look like karstified waves, what the previous researchers often led to the conclusion of complete development of glacial processes. These valleys are sprinkled by caps and heads, which were later splited by deep sinkholes. Karstified sinkholes and dry valleys end in the bottom of the lake basin. Based on the morphological form of dry valleys, it can be concluded that the karstification occurred in the posttectonic phase of development. The lake basins are usually the lowest floors in the valley system and lie in the contact hydrological layer, this is why the karstification is kept at the level of that contact (SPAHIĆ 2001). The islands of the Zelengora lakes have a fluvio-denudational character and their harmonization is directed towards the sinking zone. Most of the lake basins have been created as a consequence of karst-corrosion processes, this is why karst processes have a special place in the morphogenesis of lake basins.

In current geographical literature, it is generally accepted that almost all lakes in Bosnia and Herzegovina have a natural origin. It was assumed that the higher mountain lakes are glacial, and the lower of fluvioglacial origin. Earlier researchers have completely ignored the impact of karst-corrosion, karst-contact and tectonic, fluvial and other physical factors, as well the human impact on the formation of mountain lakes. There is no doubt that Zelengora lakes are tectonic predisposed. They contain overprecipitaded sandy and clay-mud deposits that are eroded, transported and accumulated along the lake area. These masses are represented by renzini, rankerers, reddish limestone soils and black fores humus. Each lake has one or two proluvial-accumulation plane along to the lake, mainly on the tributary side of the lake, and often laterally in relation to the lake's water flow or the sinking zone. Upstream of the tributary areas, there are deep valleys and dry valleys, from which with the help of water during the rainy period the eroded masses are transferred into the lake.

From indirect lake basins, colluvial, proluvial, deluvial and defluctual depositions or their combinations are directed to the mountain lake basins. Lake coasts are usually formed in deposits of different genetic affiliations or are in the parent substrate. The coasts are most often built of colluvial, deluvial, eluvial and defluctual deposits. Flood deposits have the form of abrasion-lacustrine plane (SPAHIĆ 1988). The karst-corrosion characteristics of the lake coast are expressed in the contact zones of carbonate and clastite, especially around the sink of the water. Mountain lakes in Bosnia and Herzegovina are younger than the holocen. Since the surroundings of the lake basins have no peatland, the previously stated claim confirms that they belong to younger lake forms dating back to the period of upper subatlantics (SPAHIĆ 1988).

The evolutionary phase of the development of lake basins

The development of lake basin can be closely linked to the recent development of fluvial and karst processes. The karst processes lower the lower karst erosion base, which is evident on the island sides of all laks of Zelengora. On the island sides of some lakes, such as Stirinsko, Kotlanicko and Donje Bare, there are limestone sections where the karst openings at different levels can be found. This represents the succession of lowering of the lower karst erosion base. Its level and the capacity of the karstic crack caused the level of the lakes. Today's level of the lakes is at the level of the karst sinking (SPAHIĆ 2001). The evolution of the lake basins has a natural self-development character, which can be explained by the name ‘jezerina’ and means a dried lake basin. It is a consequence of a dual natural process that simultaneously acts on the disappearance of lake stability. The natural inflow of the fluvial detritus from the water flow zone raised the lake bottom, what reduced the volume of the lake. On the other hand, the drainage of the water from the lake deepens the river bed of the water drainage system, what ultimately leads to loss of water and the lake dries up in the end. All these phases are accompanied by an increased production of swamp vegetation. All together initially leads to the transformation of the lake into a swamp, and then to its complete disappearance. Almost all lakes in Zelengora are in some phase of evolutionary disappearance, and this phenomenon is particularly pronounced at lake Donje and Gornje Bare.

Thus, the disappearance of lake basins can occur naturally without the participation of the human factor, which is becoming more and more current today. Self-development of natural processes and phenomena takes place without a human impact. An example of this are the final stages of existence of lake basins in protected conditions like those in the NP ‘Sutjeska’.

Figure 3: Gornje Bare lake (right on the picture). Next to it is a basin of a dry lake, which has no hydrological function. It is a natural evolutionary sequence without the influence of a human factor

Conclusion

The evolution of the lake basins has a natural self-development character, although in all other circumstances, outside of NP it would be attributed to an anthropogenic negative factor. The self-development of lake basins is a consequence of simultaneous action of the natural and anthropogenic process on its disappearance. The most often are karst processes of lake basins disappearance, they occur in the drainage zones of the lake basin. They are caused by the expansion of drainage system and by lowering the lower karst erosion base through which a lot of lake water flows out. The second most frequent disappearance process is the fluvial, in which large amounts of eroded deposits enter the drainage system, and by the rise of the lake bottom the lake becomes shallow. Through backward pulling of the drainage system it is getting more and more cut into the bottom. This increases the flow out of the water from the lake. In conclusion, the lakes of the explored area are increasingly covered by aquatic vegetation, and because of this, they are transformed into wetland hydrological facilities.

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Indicators for good management of protected areas

Urs Tester

Keywords

Protected area, management, indicator, evaluation

Summary

Protected areas all need specific objectives, and managers need indicators to evaluate whether these objectives have been achieved. For scientists, good indicators should meet scientific standards. For managers of protected areas, rapid analysis of the management objectives is critical.

The Swiss conservation organisation Pro Natura was founded in 1909. Through ownership and contracts with other landowners, Pro Natura has secured 696 protected areas with a total surface area of 267 km2. 130 of these areas, with a total surface area of 107 km2, are part of regional nature parks or World Heritage Sites. In 474 protected areas, Pro Natura is involved in or responsible for the whole management. In these protected areas, the management objectives, and the indicators for monitoring their effectiveness are defined in a management plan. Every protected area has its own specific objectives. In some of them, the main objective is protecting the ecosystem by allowing natural processes to develop freely. In some of the sites, management interventions are used to favour specific habitat conditions. A third group of protected areas focuses on habitats with a high species richness which has developed as a result of traditional agriculture. The management activities promote the species richness by imitating these traditional activities (PRO NATURA 2005). Because of the differences in the objectives, each protected area needs specific indicators to evaluate the management.

In numerous protected areas, Pro Natura uses indicators based on methods for scientific monitoring of species populations, species groups and plant communities (BRUCKHAUS et al. 1997, HEYER et. al. 1994, POLLARD 1982). For species which are difficult to detect, Pro Natura also uses genetic detection methods (HOLDEREGGER et al. 2016).

The following three examples show typical use of scientific methods: the protected site ‘Latschgetweid’ is a dry grassland formerly used as a cattle pasture. When farming ceased, the grassland became covered by shrubs and trees, and some of the species-rich grassland was lost. To favour the dry grassland Pro Natura cleared the growing shrubs and trees and the grassland was mowed regularly instead of having cattle grazing on it. In 1984 a monitoring program was initiated. At first, the development of the plant communities on fixed test squares was counted every year. In 1994 the method changed to monitoring a higher number of smaller test areas selected by chance (WEBER et al. 1995). After 2004 the plant community was assessed only every 5 years. Since 1994 the number of butterfly and grasshopper species have also been counted. The vegetation reacted to the removal of shrubs very quickly: there were more species and more typical dry grassland species. For the next 30 years, the vegetation didn’t change significantly. The butterfly and grasshopper populations have been highly dynamic from year to year, with a slight increase over the 20 years of monitoring.

The ‘Burgmoos’ is a Swiss moor of national importance. Because of the expansion of tall plant species such as the common reed (*Phragmites australis*) the moor was mowed by hand every autumn. In 2004, a cattle pasture with Galloways was set up on one part of the mire to reduce the levels of common reed. The Swiss Federal Research Institute’s moor vegetation monitoring program analysed the influence of the cattle on the vegetation (KÜCHLER et al. 2004, KÜCHLER et al. 2009). In the grazed areas, the number of bog species decreased, but the abundance of transitional moorland species stayed the same. Grazing had only a weak effect on common reed density.

The Aletsch forest is an alpine protected site. Since 1933 the forest has been left to develop freely. It is part of the World Heritage Site Swiss Alps Jungfrau Aletsch, a popular spot for summer tourists. Because of the possible influence of tourism on the management objectives, a scientific study of the effects of visitors was established in 2007 (FURRER 2009). The results showed that the number of visitors has remained constant during the last 13 years, but that their preferred routes have changed. At one picnic area the visitors often used to stop outside the designated area.

For scientists, good indicators for nature protection are those which use scientific methods and deliver results that can be analysed statistically (HOFER 2016). Because most Pro Natura site managers have a scientific background, they like indicators to be based on scientific monitoring methods. However, although scientific monitoring indicators need a significant investment of time and money, these indicators also have disadvantages. Managers of protected areas need quick analysis in relation to the objectives of the site so that they can improve their management. Unfortunately, some species and species groups react very slowly to changes in their habitat, and negative effects are therefore only detected after a long period. The observed number of species and population levels can also vary because of different weather conditions from day to day or from one year to the next, hiding the effects of the management.

In my own long-term monitoring of European tree frogs, the number of calling males can differ from one night to another by 197% despite selecting only those nights with good weather conditions during the mating season. Species with a high reproduction rate (r-strategy) can have a high natural fluctuation in the population from year to year so that the population trend is difficult to observe. Populations of species with a low reproduction rate (K-strategy) react only slowly to habitat change, so that there can be a long period before any effect of the management will be significant. Because of these disadvantages, Pro Natura also uses 'quick and dirty' empirical indicators for evaluating site management, for example photos or expert opinions.

The only two changes to the management of the 'Latschgetweid' are based on empirical indicators. Although the monitoring of the vegetation indicated a good development of the site, the comparison of aerial views from 1991 and 2000 showed that the area of dry grassland was reduced by new growth of bushes and trees. (see Fig. 1). The situation was improved by cutting down the shrubs and trees again. On the expert opinion of a butterfly specialist, Pro Natura reduced the number of cuttings of the dry grassland to improve the situation for butterflies and other insects. At 'Burgmoos', damage to bog vegetation due to cattle hooves had already been observed during a management tour two years before the scientific results were published. At 'Marais des Pontins', another Swiss moor of national importance, comparing photos from before and after the management measures showed that the intervention had been successful. In the Aletsch forest the rangers indicated that more visitors bring a dog. Most of the dogs are not under control and probably affect the wildlife in the reserve.

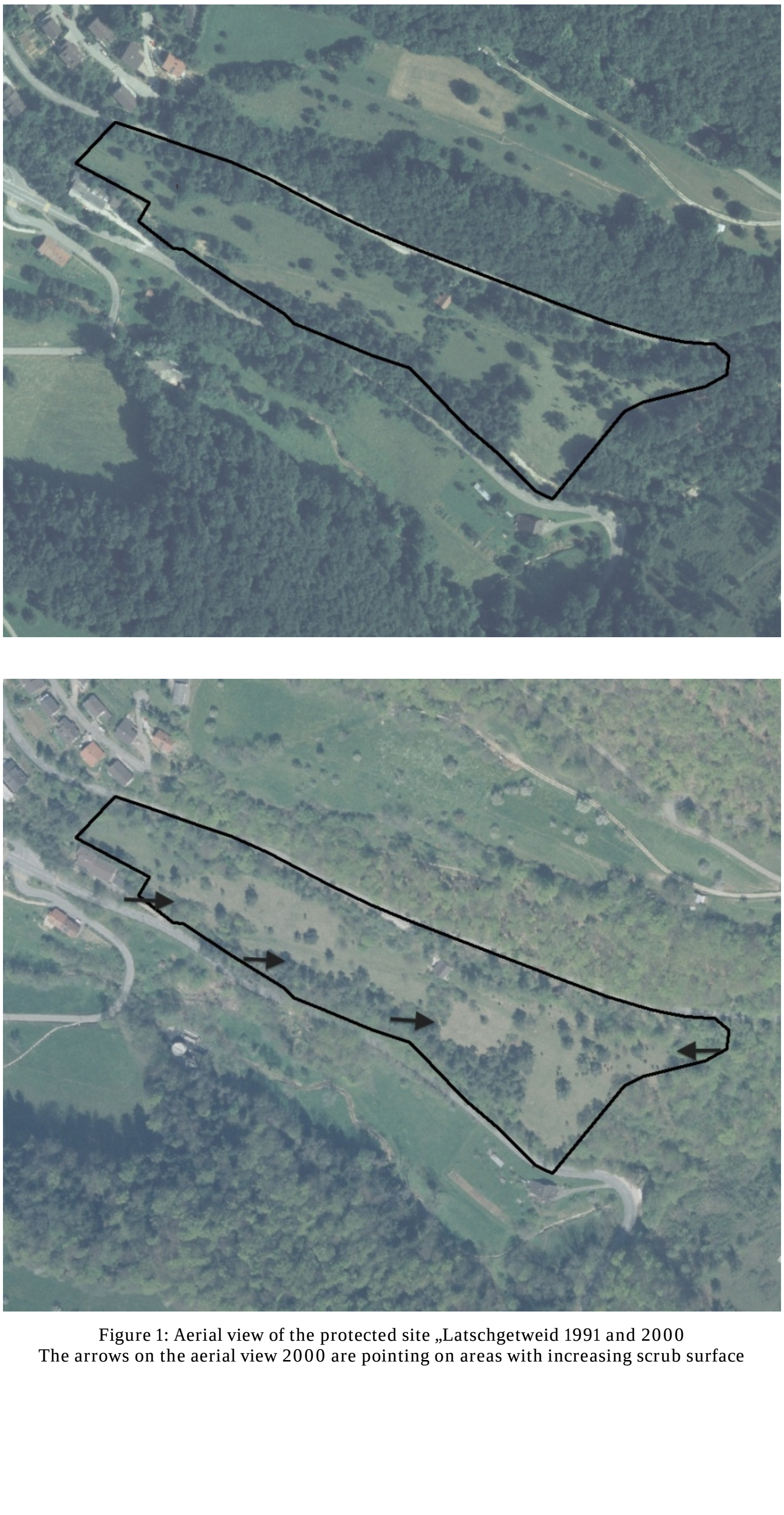

Figure 1: Aerial view of the protected site „Latschgetweid 1991 and 2000
The arrows on the aerial view 2000 are pointing on areas with increasing scrub surface

As with medical doctors, managers of protected sites rely not only on scientific indicators, but also on their experience and on empirical indicators, when coming to their decisions. If you as a scientist don't trust your eye when comparing aerial views, modern geoinformatic techniques transform optical information into scientific data sets (see Tab. 2).

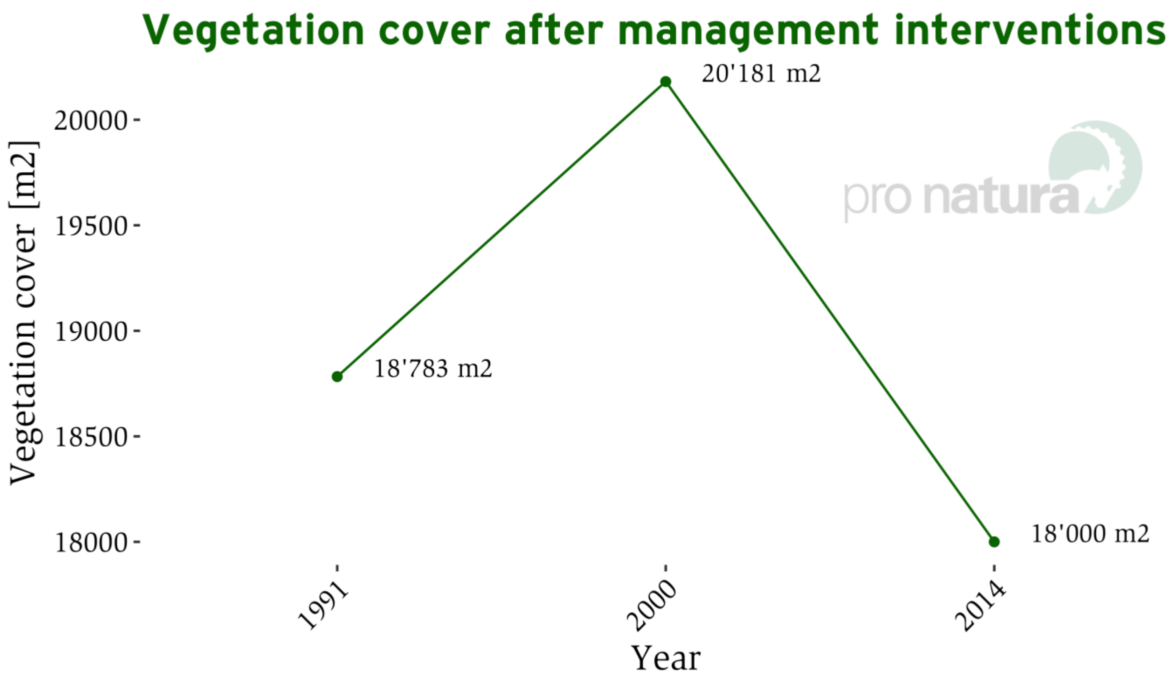

Table 2: Wood and scrub cover in the protected site „Latschgetweid' 1990, 2000 and after management interventions 2014

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Disturbance impacts on forest succession, biodiversity, and ecosystem services in a changing world

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Keywords

autonomous adaptation, biodiversity, climate change, disturbance, ecosystem services, forest ecosystem management, forest ecosystem dynamics, iLand, modelling, succession

Summary

Forest ecosystems are dominated by long-living organisms with limited ability to migrate in space and time. Rapid changes in the climate system cause an increasing maladaptation of forests to their environment. Besides the direct impacts of climate change on forest ecosystems, climate change also modifies natural disturbance regimes. During the last decades, disturbance activity has significantly increased in many parts of the world, and a further increase as a result of climate change is very likely. Yet there is high uncertainty about the impacts of climate change and disturbance on the conservation of biodiversity and the provisioning of ecosystem services to society.

This thesis aimed to reduce this uncertainty by (i) synthesizing the effects of natural disturbances on biodiversity and ecosystem services in a global literature review, (ii) assessing the long-term development of tree species under varying climate and disturbance regimes by means of process-based landscape modelling, and (iii) investigating the role of climate change and disturbances on a wide range of forest biodiversity indicators in space and time.

I found strongly diverging disturbance impacts on forests: while disturbances increased biodiversity, they decreased ecosystem services provisioning. Simulations of Kalkalpen National Park indicated that tree vegetation and associated biodiversity take centuries to adapt to changed climatic conditions, but also revealed a catalyzing effect of disturbances accelerating adaptation to a changing environment.

I conclude that disturbances create opportunities for ecosystems to reorganize themselves with positive implications for the biodiversity and resilience of future forest ecosystems. Management should focus on the diversification of forests to provide ecosystems with the flexibility to react on changes of the environment and safeguard biodiversity and ecosystem services provisioning in a changing world.

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Long term monitoring of natural regeneration in natural forest reserves in Austria

Harald Vacik, Herfried Steiner, Georg Frank, Herwig Ruprecht

Abstract

Research in natural forest reserves provides insights about the natural dynamics that can serve as basis for sustainable forest management. The research project ELENA studied the natural regeneration in unmanaged mountain forests in six natural reserves (Goldeck, Laaser Berg, Schiffwald, Hutterwald I and II, Kronawettgrube) in Austria. The study design and results of a comparative analysis of the regeneration on 197 long-term monitoring plots allows drawing conclusions on natural regeneration processes of Homogyno alpinae-, Athyrio alpestris- and Adenostylo glabrae-Piceetum mountain forests. The first investigation of the natural regeneration processes in natural forest reserves allow an evaluation of the forest dynamics and the identification of the driving factors for successful establishment of natural regeneration. It was found that the numbers of individuals in the natural regeneration and their distribution among different categories vary greatly between the natural forest reserves (between 766 n*ha-1 in Hutterwald and 15869 n*ha-1 in Krimpenbachkessel). The growing stock lies between 334 and 725 m³*ha-1 and the coarse woody debris volume (lying and standing dead wood) summaries up to 44.2 and 120.2 m³*ha-1 (10-26% of the growing stock). The analysis focuses on the relation between the occurrence of natural regeneration and the availability of coarse woody debris. It is shown that the number of seedlings established and saplings depend on the amount, type and distribution of coarse woody debris strongly.

Keywords

natural regeneration, natural forest reserves, Norway-spruce, long-term monitoring, coarse woody debris

Introduction

Undisturbed forests are valuable objects to study vegetation structure and dynamics (MAYER et al. 1987; LEIBUNDGUT 1982). The Austrian 'Natural Forest Reserves Program' was launched in 1995 to support the in-situ conservation of rare and endangered forest types and the study of natural dynamic processes, including the effect of natural disturbances and catastrophes (FRANK & MÜLLER 2003). The natural forest reserves also serve as references for biodiversity assessments and ecological monitoring, as they are not subject to any human activities (FRANK & KOCH 1999; FRANK et al. 2005).

The primary target of natural forest reserves, where the forests are excluded from active management, is the maintenance of the biological diversity being characteristic for the different forest communities in Austria. No particular forest conditions shall be conserved, but the dynamics of natural processes shall develop without intervention (FRANK & KOCH 1999). The majority of the natural reserves cannot be seen as true remnants of virgin forests, but most of them had a very less intensive management over the past decades or even centuries. This was mostly caused by the inaccessibility or bad suitability for timber production due to difficult terrain and soil conditions. The historical land use patterns explain why most of the reserves were formerly established in the montane and subalpine belts of the Austrian Alps (FRANK & KOCH 1999). The minor anthropogenic interferences in these areas enable however promising research studies on natural forest structure and undisturbed forest development.

The University of Natural Resources and Life Sciences, Vienna started in 2008 in cooperation with the Austrian Federal Research and Training Centre for Forests, Natural Hazards and Landscape (BFW) the ELENA project (in German: 'Empfehlungen für die Naturverjüngung von Gebirgswäldern') to address the above mentioned aspects and to develop recommendations for natural regeneration of mountain forests. The research project aimed to study the dynamics of natural regeneration on the basis of unmanaged mountain forests and to apply the findings subsequently for the development of guidelines for concepts focusing on minimal intervention silviculture. Light ecology, competitive factors, site and stand conditions as well as the degree of human influence was analysed for the phases of germination, seedling establishment and sapling growth. Additionally the role of deadwood and woody debris, which has been proved to be of special importance for the natural regeneration in some forest communities already in several studies (e.g., STÖCKLI 1995), was considered within the study.

This contribution presents the study design and results of a comparative analysis of the regeneration on 197 long-term monitoring plots of in total six natural reserves to draw conclusions on natural regeneration processes of Homogyno alpinae-, Athyrio alpestris- and Adenostylo glabrae-Piceetum mountain forests. The objectives were to identify the primary influencing factors for the initiation of natural regeneration seedlings and saplings in the forest communities.

Methods

For the long term monitoring circular permanent sample plots, 300m² in size, were established systematically on a 100x100m grid in each of the natural reserves (RUPRECHT et al. 2012). Trees taller than 1.3m were documented on the whole 300m² plot measuring their position, DBH, tree height, crown height and size. Additionally, damages were accessed. Standing and lying deadwood >10cm DBH/mid diameter was recorded through full enumeration on the study plot. For lying deadwood (<10cm in mid diameter) the total dominance was estimated for the sample plot. In addition, general characteristics as altitude, aspect, slope gradient, geology, micro and meso relief and dominance of the tree layers have been assessed on each of the plots. To assess the tree age of the different layers within the plot increment cores (Ø 5mm) were taken from 1-3 trees of different diameter classes of the main tree species spruce, fir and larch if present on the study plot. No cores were taken from trees with a DBH < 15cm.

Within each of the circular sample plots 16 subplots (category A), 0.25m2 in size (0.5x0.5m), were placed systematically, with clusters of four subplots in 4m distance of the plot center all four main directions. Within these subplots the tree regeneration was counted (seedlings and saplings) separately for the different tree species. For the saplings >15cm in height the tree height, height increment of the preceding year and diameter at root collar were measured. Additionally the vitality, damages and micro relief of the sapling position was accessed. The clusters of small subplots were surrounded by three 1m² large subplots (category B) in 3, 5 and 6m distance of the plot center. In the subplots of category B no seedlings were counted, but saplings and measured if larger than 15cm (Fig. 1).

Tree regeneration with heights larger than 30cm was measured within the whole sample plot and their approximate location was documented on a sketch. The positions of the subplots were marked permanently with a stick at 5m distance from the plot center in each of the four directions. Additionally the plot center was marked the same way and the closest large tree from the center was labelled with the plot number.

Additionally site parameters were investigated on each circular plot. Within each of the subplots of category A and B - no matter seedlings or saplings have been found on the subplots or not - the site parameters aspect, slope gradient and microclimate (e.g., cold or humid air, exposure to wind or snow accumulation) have been recorded. To deduct the area not suited for regeneration (e.g., stones, living trees) and to record the dominance of the ground vegetation, the ground cover was estimated by a frame (0.5x0.5m) with a rectangular grid for each of the subplots. The ground coverage (%) was recorded separately for vascular plants, mosses, lichens, deadwood (>10cm mid diameter), branches, living trees, litter, mineral soil, boulders and rocks. Additionally the mean height (cm) of the dominating ground vegetation was noted. The humus type, the mean thickness of the organic layer and the soil depth were measured and type, texture, hydrology and humidity of the soil have been assessed. To measure the direct and indirect radiation available for germination and growth of the natural regeneration hemisphere photos were taken with a single lens reflex camera (SLR) during homogenously covered sky, in 0.9m height over the category A subplot cluster and in 1.3m height at the plot center.

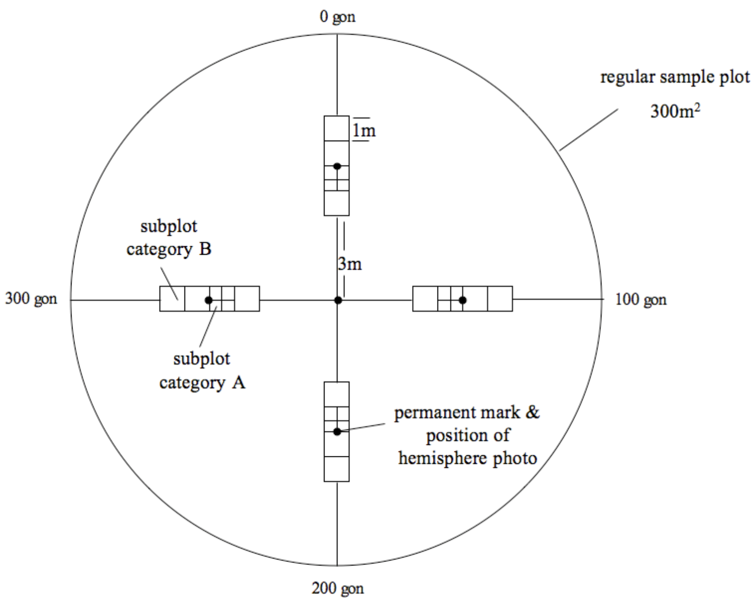

Figure 1: Sampling design on the permanent sample plots in the natural reserves (RUPRECHT et al. 2012).

Results

Natural Regeneration

It was found that the numbers of individuals in the natural regeneration and their distribution among different categories vary greatly between the natural forest reserves. The number of seedlings varies between 6574 n/ha in Schiffwald and 661531 n/ha in Hutterwald. For the saplings the numbers vary between 766 n/ha in the Hutterwald and 12288 n/ha in Goldeck. Norway Spruce is the dominating species in all reserves in the height category '30.0-129.9cm', other tree species play only a minor role. Details are given in Tab. 1.

The browsing impacts vary as well. The highest percentage of browsed individuals in the height category 15.0-129.9cm was found in the Goldeck natural forest reserve (75%), followed by Hutterwald and Kronawettgrube with 48%, Schiffwald with 19% and Laaserberg with 12%. The broadleaves are the most affected species. In the Goldeck natural forest reserve, damages caused by inter- and intraspecific competition as well as insects and mites were observed; in Hutterwald, damages from fungi and the competition with the herb and shrub layers are more frequent.

Natural reserve	Tree species	Natural regeneration category							
		seedlings		saplings		15.0-29.9cm		30.0-129.9cm	
		n/ha	%	n/ha	%	n/ha	%	n/ha	%
Goldeck	Spr.	15612 ±15707	95.9	10834 ±22740	88.1	196 ±794	64.7	369 ±745	93.6
	Con.	590 ±2051	3.6	228 ±573	1.9	-	0.0	22 ±69	5.6
	Brl.	84 ±456	0.5	1226 ±1544	10.0	107 ±365	35.3	3 ±10	0.8
	Σ	16286 ±16270	100	12288 ±23208	100	303 ±862	100	394 ±778	100
Hutterwald	Spr.	661444 ±876460	100.0	322 ±1045	42.0	227 ±1083	33.2	463 ±970	85.3
	Con.	-	0.0	-	0.0	25 ±133	3.7	22 ±49	4.0
	Brl.	87 ±464	>0.1	444 ±981	57.0	431 ±1065	63.1	58 ±127	10.7
	Σ	661531 ±876772	100	766 ±1377	100	683 ±1544	100	543 ±1075	100
Schiffwald	Spr.	5034 ±13168	76.6	1045 ±1817	15.1	211 ±630	48.4	461 ±668	78.5
	Con.	643 ±1776	9.8	134 ±646	1.9	11 ±61	2.5	111 ±213	18.9
	Brl.	897 ±2942	13.6	5732 ±9060	83.0	214 ±761	49.1	15 ±32	2.6
	Σ	6574 ±14383	100	6911 ±9524	100	436 ±979	100	587 ±788	100
Laaser Berg	Spr.	17702 ±19956	45.1	994 ±1366	80.0	232 ±693	97.5	360 ±373	87.2
	Con.	21519 ±17005	54.9	248 ±909	20.0	6 ±19	2.5	53 ±111	12.8
	Brl.	-	0.0	-	0.0	-	0.0	-	0.0
	Σ	39221 ±28515	100	1242 ±1694	100	238 ±693	100	413 ±431	100
Kronawettgrube	Spr.	139315 ±94175	100.0	7623 ±9294	93.8	55 ±130	100.0	183 ±275	100.0
	Con.	-	0.0	-	0.0	-	0.0	-	0.0
	Brl.	250 ±770	>0.1	500 ±1173	6.2	-	0.0	-	0.0
	Σ	139565 ±94233	100	8123 ±9325	100	55 ±130	100	183 ±275	100

Table 1: Amount of natural regeneration in the natural reserves

Deadwood

The amount of dead wood found in the natural reserves varies between 73.2 m^3 / ha (Hutterwald) and 44.2 m^3/ha (Schiffwald). The share of deadwood in relation to the amount of the living growing stock is between 10 and 20% (Tab. 2). Norway Spruce has the highest share (72-100%) of the total volume of deadwood, except in the Laaserberg Nature Reserve (were 48% of the deadwood was not able to clearly assigned to a certain species). The proportion of stumps (tree stumps below 1.30 cm height and ≥5.0 cm diameter) of the deadwood volume is between 1-18%. The standing deadwood (≥5.0 cm dbh) has the largest share of the deadwood volume (82% and 64% respectively) in the reserves of Schiffwald and Kronawettgrube, for the three other natural forest reserves the share of deadwood is lower (56-67%).

Natural reserve	Tree species	standing deadwood [≥5.0cm]	lying deadwood [≥10.0cm]	stumps [≥5.0cm]	Σ deadwood	Growing stock volume	share of deadwood of volumen
		m^3/ha	m^3/ha	m^3/ha	m^3/ha	m^3/ha	%
		%	%	%	%		
Goldeck	Spr.	14.2 ±48.5	32.5 ±37.1	3.1 ±4.7	49.8 ±66.8	573.1 ±310.4	**9**
	Con.	3.5 ±9.5	3.6 ±7.4	0.3 ±0.6	7.4 ±12.2	148.9 ±193.8	**5**
	Brl.	0.2 ±0.5	0.3 ±1.1	>0.1	0.5 ±1.2	2.8 ±6.6	**18**
	ot.	0.4 ±2.2	10.1 ±27.8	1.1 ±2.0	11.6 ±27.5	-	**-**
	Σ	18.3 ±51.6	46.5 ±52.4	4.5 ±5.1	69.3 ±79.5	724.8 ±311.0	**10**
Hutterwald	Spr.	21.6 ±29.5	39.1 ±81.9	1.9 ±3.6	62.6 ±89.0	265.4 ±207.1	**24**
	Con.	1.5 ±4.8	4.8 ±18.6	-	6.3 ±19.0	96.2 ±90.5	**7**
	Brl.	>0.1	-	-	>0.1	0.1 ±0.5	**20**
	ot.	-	0.6 ±1.9	3.7 ±5.2	4.3 ±6.1	-	**-**
	Σ	23.1 ±29.4	44.5 ±98.0	5.6 ±6.3	73.2 ±104.3	361.7 ±216.8	**20**
Schiffwald	Spr.	27.8 ±62.3	6.2 ±12.5	0.7 ±5.6	34.7 ±64.2	288.2 ±157.3	**12**
	Con.	8.5 ±15.3	0.4 ±2.2	-	8.9 ±15.4	55.9 ±63.8	**16**
	Brl.	-	-	-	-	1.1 ±4.8	**0**
	ot.	-	0.5 ±3.5	0.1 ±0.6	0.6 ±3.5	-	**-**
	Σ	36.3 ±63.8	7.1 ±13.2	0.8 ±5.6	44.2 ±66.1	345.2 ±170.7	**13**
Laaser Berg	Spr.	11.1 ±16.4	7.0 ±11.8	0.7 ±2.3	18.8 ±24.2	402.0 ±205.3	**5**
	Con.	4.3 ±10.7	6.1 ±18.2	1.3 ±2.5	11.7 ±20.4	135.7 ±144.9	**9**
	Brl.	0.2 ±0.9	0.1 ±0.2	-	0.3 ±1.1	-	**-**
	ot.	-	20.0 ±20.9	8.4 ±16.2	28.4 ±26.5	-	**-**
	Σ	15.6 ±22.0	33.2 ±28.3	10.4 ±16.0	59.2 ±38.0	537.7 ±301.4	**11**
Kronawett-grube	Spr.	45.2 ±47.5	24.5 ±61.8	0.4 ±1.6	70.1 ±87.9	477.4 ±199.6	**15**
	Brl.	0.1 ±0.6	-	-	0.1 ±0.6	0.5 ±1.7	**20**
	Σ	45.3 ±47.4	24.5 ±61.8	0.4 ±1.6	70.2 ±87.8	477.9 ±199.7	**15**

Table 2: Stumps, standing and lying deadwood in the natural reserves (Spr. – Norway Spruce, Con. – coniferous tree species; Brl. – broadleaves; oth. – other species, unidentified)

Discussion and Conclusion

In general, the numbers in the natural regeneration are in the range or above those of other spruce-dominated natural forest reserves and virgin forests. It is striking that the figures calculated by BACHOFEN (2009) are reached up to a height category of <20cm in all examined natural forest reserves. From a height class about 20cm the Kronawettgrube reserve is the only one below the formulated target numbers from Switzerland. In general, the number of individuals in the natural regeneration for this study is lower at these high-altitudinal grades compared to lower elevations (KORPEL 1995 and BACHOFEN 2009).

Based on the analysis the most important success factors for the establishment and early growth of the seedlings and saplings in the natural regeneration have been studied. The examination of the light ecology and intraspecific competition, the role of site and stand factors, the importance of coarse woody debris as well as the human influence allowed drawing conclusions on natural regeneration planning. The parameters to be significant (e.g. indirect and direct site factor, herbaceous ground vegetation, ground cover, slope factor, moisture) differentiated between the forest associations and the natural reserves. Single parameters have a high significance, although the interrelations are sometimes contrary. As a consequence no unique guideline for regeneration planning in mountain forests can be proposed. However, it can be assumed that a variety of site factors and forest structures will lead to the most promising results. The standardized concept for the data investigation will support the long term monitoring with the Austrian natural reserve program as well.

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A Fagetum in the natural forest reserve Luxensteinwand - a rare element in the Waldviertel region

Harald Vacik, Birgit Steininger, Herfried Steiner, Georg Frank

Abstract

Huge parts of the natural forest reserve Luxensteinwand are covered with deciduous forests representing a rare element in the coniferous dominated Waldviertel region. Changes in species composition and forest structure were investigated based on long term observations originating from 1990. Permanent sample plots and transects allowed to characterize the forest structure, stand volume, deadwood and natural regeneration. It was found that the standing volume and tree number/ha has increased and a change in tree species composition occurred due to wind disturbances and bark beetle infestations. The share of Norway Spruce decreased, whereas the share of European Beech (*Fagus sylvatica*) increased. Subsequently, interventions took place to stop the bark beetle outbreak and avoid further damages in the very close spruce-dominated forest. Apart from the mortality of very old trees, there was an accumulation of large dead wood observed in the NFR. In the total area more the 210m³/ha were found, where as the share of deadwood in relation to the living stand volume is 32%. Due to the existence of data from the years 1990, 2004 and 2015 it was possible to describe the changes in forest structure and the development of the natural reserve over a periode of 25 years.

Keywords

Natural forest reserve, disturbances, natural regeneration, deadwood, *Fagetum*

Introduction

Research in natural forest reserves provides insights about the natural dynamics that can serve as basis for sustainable forest management. The Austrian 'Natural Forest Reserves Program' was launched in 1995 to support the in-situ conservation of rare and endangered forest types and the study of natural dynamic processes, including the effect of natural disturbances and catastrophes (FRANK & MÜLLER 2003). Currently 195 natural forest reserves are included in the program and they allow to study natural dynamics of different forest communities being representative for Austrian forest ecosystems. The natural forest reserves serve as references for biodiversity assessments and ecological monitoring, as they are not subject to any human activities (FRANK & KOCH 1999; FRANK et al. 2005). A primary target for all natural forest reserves monitoring is the maintenance of the characteristic biological diversity for the different forest communities in Austria.

In this context huge parts of the natural forest reserve (NFR) Luxensteinwand are covered with deciduous forests representing a rare element in the coniferous dominated Waldviertel region close to the border with the Czech Republic. The owner of the 34 hectare area is the Fürstenberg Forst- und Güterdirektion Weitra. Most of the NFR are covered with deciduous forests. This represents a rare exception in the Waldviertel region, where otherwise Norway spruce (*Picea abies*) are prevalent. During the summer of 1990, the area was the object of extensive investigations for the first time. Large amount of data about the forest structure, vegetation and soil were collected and analysis of the forest structure were carried out. After 1990 the commercial harvesting was excluded from the area.

In 2004, the area of 'Luxensteinwand' was included into the so-called 'Natural forest reserve Program', an international reserve networking program of Austria. Since then, the Austrian Research Centre for Forests has been responsible for the research work in the reserve. Therefore, changes in species composition and forest structure were investigated based on long term observations originating from 1990. In 2004 a reinvestigation of the NFR was done, which formed the basis for the next documentation, which took place in 2015.

Methods

Apart from the usual measurements about the forest structure, extensive documentation of deadwood, natural regeneration and the occurring vegetation was carried out. It was possible to make qualitative state descriptions and quantify the dangers in forest structure. Permanent sample plots and transects allowed to characterize the forest structure, stand volume, deadwood and natural regeneration.

For the long term monitoring circular permanent sample plots, 300m² in size, were established systematically on a 100x100m grid in each of the natural reserves. Trees taller than 1.3m were documented on the whole 300m² plot measuring their position, DBH, tree height, crown height and size. Additionally, damages were accessed. Standing and lying deadwood >10cm DBH/mid diameter was recorded through full enumeration on the study plot. In addition, general characteristics as altitude, aspect, slope gradient, geology, micro and meso relief and dominance of the tree layers have been assessed on each of the plots. Tree regeneration was counted (seedlings and saplings) separately for the different tree species. Additionally site parameters were investigated on each circular plot.

Results

Due to the special blocky terrain an intensive commercial harvesting was never possible in the past. Parts of the NFR were also situated in a former deer enclosure which was already established in 1842. Since 1990 it did not exist anymore. The area is divided into two forest communities: The *Galio odorati-Fagetum* presents 85% of the area. Subdominant is the *Luzulo luzuloidis-Piceetum*.

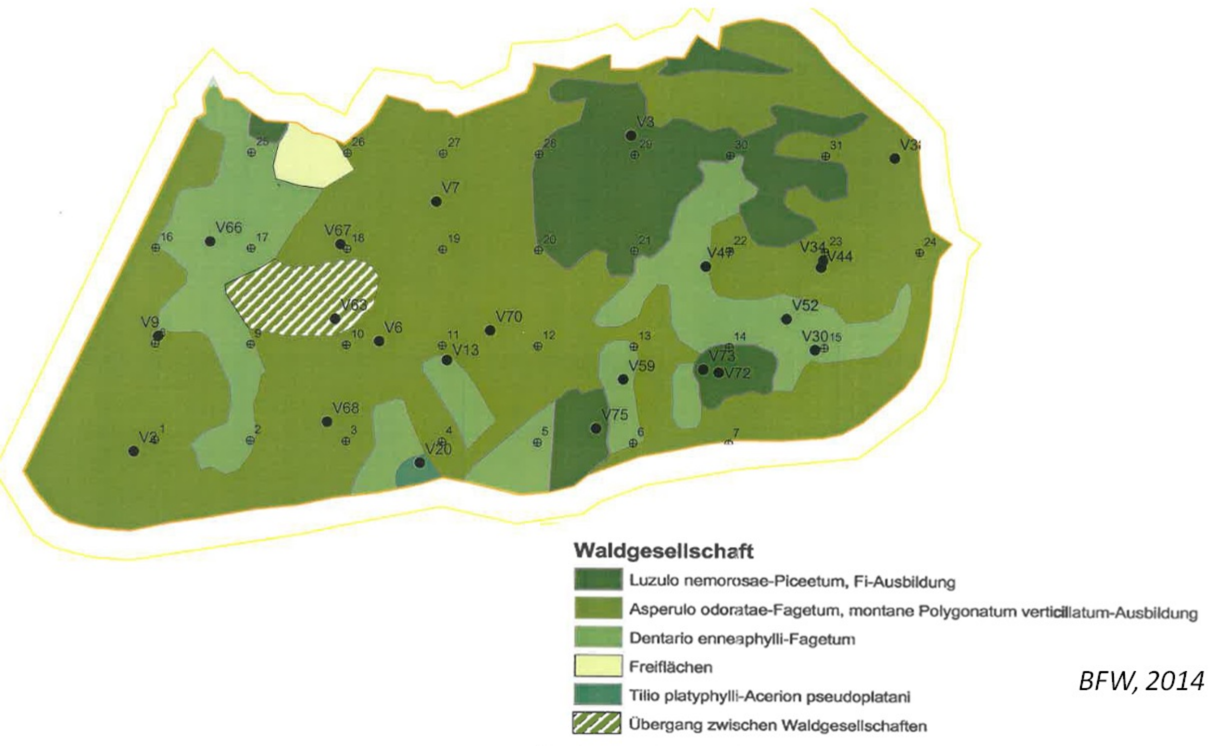


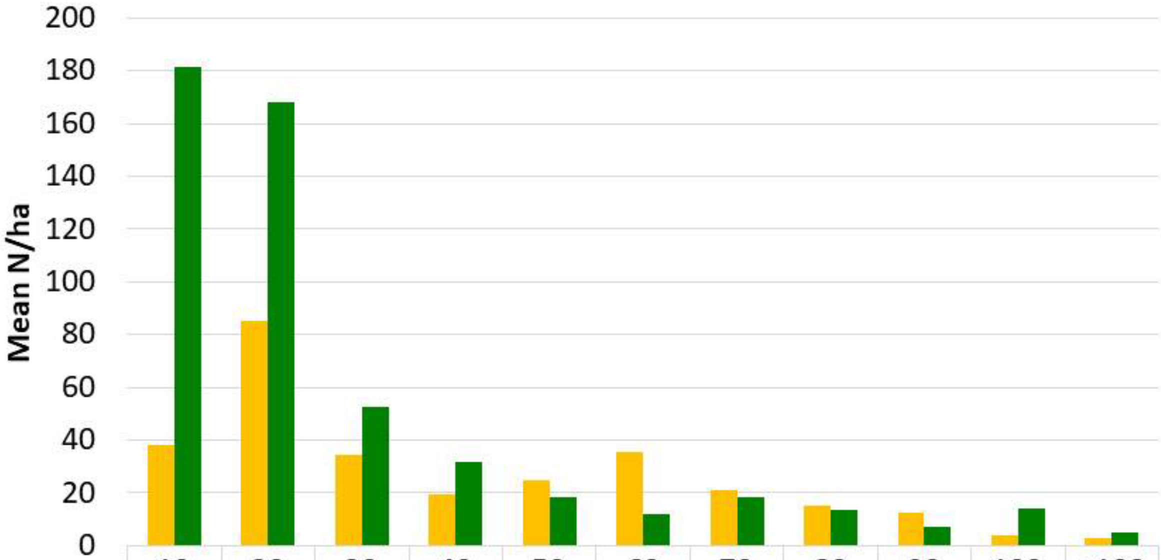
Figure 1: Map of the forest associations in the natural reserve Luxensteinwand

Between the two documented years, 2004 and 2015, a change in the forest structure and tree species composition had occurred due to wind disturbances and bark beetle infestation. Subsequently, interventions took place to stop the bark beetle outbreak and avoid further damages in the very close spruce-dominated forest. The share of Norway Spruce decreased, whereas the share of European Beech (*Fagus sylvatica*) increased.
With the collected data a growing stock volume of 650 m^3/ha was calculated for the present conditions. (*Fagus sylvatica* 60%; *Picea abies* 30%; *Acer platanoides*, *Acer pseudoplatanus* and *Betula pendula* 10%). The number of trees/ha was estimated with 1660/ha and especially the smaller diameter classes had a large increase in stem numbers (Fig. 2). Fagus sylvatica is dominant in all tree diameter classes.

Apart from very old trees, there was an accumulation of large dead wood in the reserve which is now influencing the structure of the NFR too. The average amount of dead wood is 202 m^3/ha whereas the share of deadwood in relation to the living stand volume is 32%. Because of the wind disturbances and bark beetle infestations more than 60% of the dead wood is *Picea abies*.

Due to the existence of data from the years 1990, 2004 and 2015 it was possible to describe the changes and the development of the forest reserve over 25 years. Between 1990 and 2015 there was a 10%-increase of the growing stock volume. Also the tree numbers/ha changed: + 78% over 25 years (Fig. 3).

Without the deer enclosure since 1990 there is less pressure on the trees. Now the older parts of the reserve are actually in the regeneration phases. Beside the increasing amount of growing stock volume the number of seedlings and saplings is raising. Over the 25 years the tree diversity is changing. The volume of *Acer platanoides, Acer pseudoplatanus, Tilia platyphyllos, Abies alba* and *Betula pendula* are decreasing. The forest will become more and more a mixture of *Fagus sylvatica* and *Picea abies*, which further stresses the importance of this natural reserve in the Waldviertel region dominated by coniferous tree species. Through the establishment of the natural reserve it was possible to serve as a node in a wider network of protected areas .



	10	20	30	40	50	60	70	80	90	100	>100
1990	38,1	85,4	34,3	19,4	24,8	35,2	21,0	15,2	12,4	3,8	2,9
2015	181,	168,	52,4	31,7	18,3	11,9	18,1	13,6	7,3	14,3	4,8

Figure 2: Distribution of the mean stem numbers for the diameter classes in the year 1990 and 2015

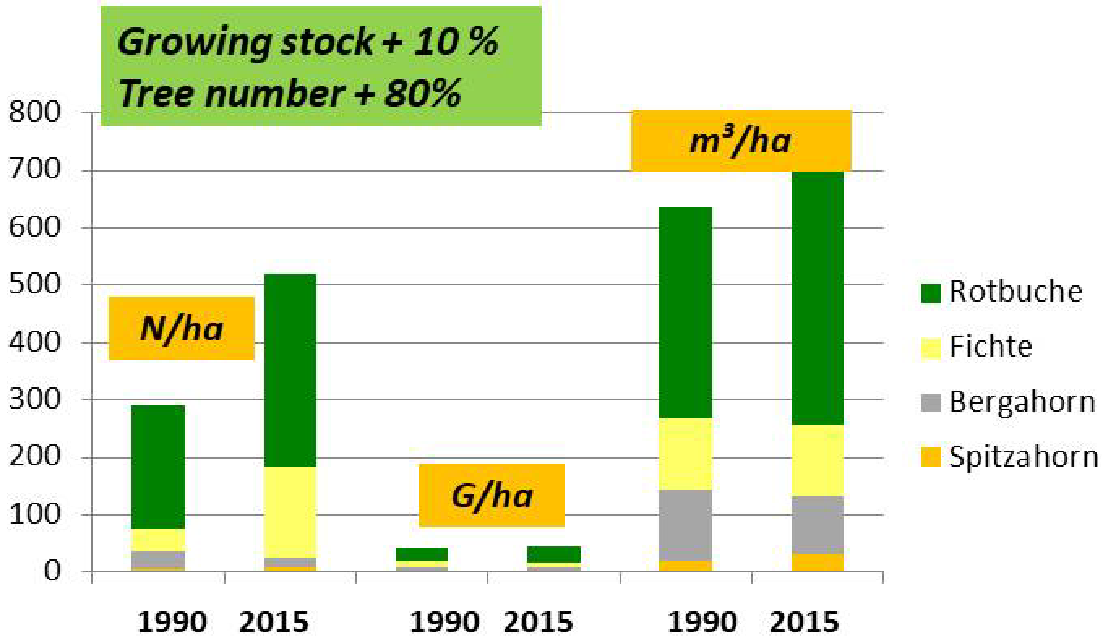


Figure 3: Change of growing stock, stem number and basal area

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Wilderness is a unique laboratory – Science and Wilderness in Europe

Vlado Vancura

European Wilderness Society

Keywords

Wilderness, unique laboratory, self-rewilding, European Wilderness Society, European Wilderness Network, Wilderness and Science in Europe

Figure 1: Wilderness represents a vital element of Europe's natural and cultural heritage. ©European Wilderness Society

Background information

What is wilderness?

Wilderness represents a vital element of Europe's natural and cultural heritage. In addition to its intrinsic value, it offers the opportunity for people to experience the emotional quality of nature in the widest experiential sense. This experience goes beyond mere physical and visual attributes, and has particularly also a psychological impact.

The qualities of Wilderness are predominantly defined by Naturalness, Undisturbedness, Undevelopedness and Scale. The quality of potential Wilderness areas need to be audited, using the European Wilderness Quality Standard and Audit System, developed by 230 Wilderness advocates in 2012 to have a clear understanding of the strengths, weaknesses, opportunities and threats in relationship to the European definition.

The European Wilderness definition:

Natural processes govern Wilderness core zones meeting the European Wilderness Quality Standard and Audit System "Gold- or Platinum Standard". They are composed of native habitats and species, and large enough for the effective ecological functioning of natural processes. They are unmodified or only slightly modified and without intrusive or extractive human activity, settlements, infrastructure or visual disturbance.

The definition of Wild Areas:

Wilderness core zones meeting the European Wilderness Quality Standard and Audit System "Bronze- or Silver Standards" are wild areas that have a high level of predominance of natural process and natural habitat. They tend to be individually smaller and more fragmented than the "Gold- or Platinum Standard" Wilderness areas, although they often cover extensive tracts. The condition of their natural habitat, processes and relevant species is however often partially or substantially modified by past human activities such as livestock herding, hunting, fishing, and collecting berries and mushrooms.

Wilderness thus means:

- **no human extraction, including:**
    - no hunting
    - no logging
    - no mineral collections
    - no mining
    - no deadwood collection
    - open ended undefined natural dynamic processes

- **no human intervention, including:**
    - no disease or insect control
    - no invasive alien species control
    - no restoration measures
    - no fire control

Wilderness has in general three zones: the Wilderness zone (where there is no human intervention, no extraction and natural dynamic processes govern), the restoration zone (where restoration and/or expansion is undertaken) and the transition zone (where further expansion of the Wilderness is planned).

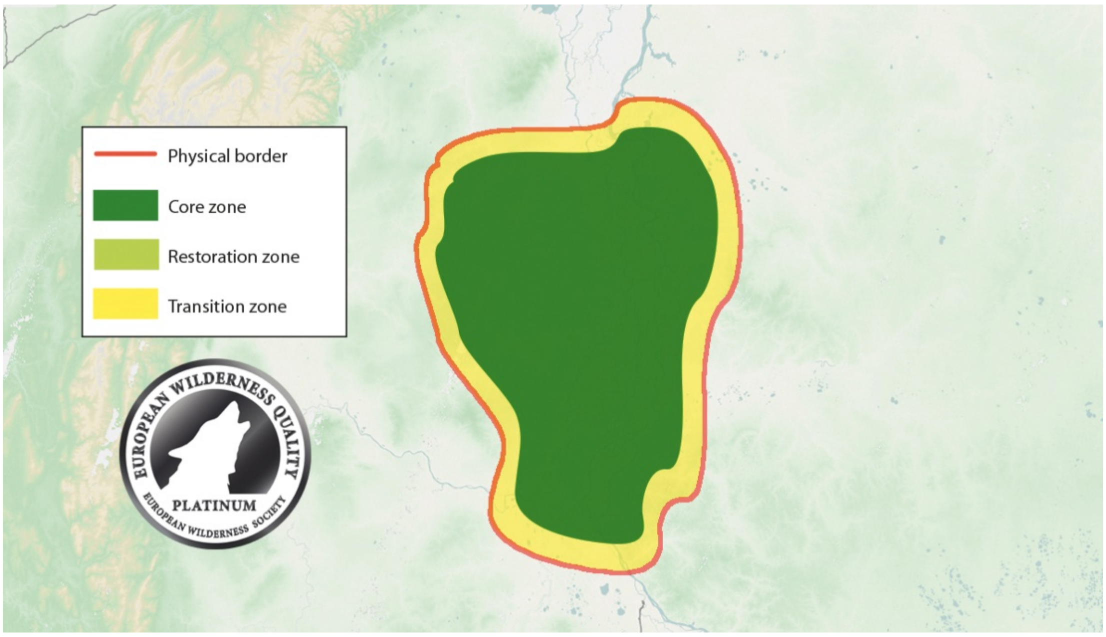

Figure 2: In a fully developed Wilderness (Platinum), the restoration zone is fully incorporated in the Wilderness core zone. The Wilderness has expanded to its physical border and remains surrounded by the transition zone.
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In the Wilderness zone, all scientific work has to be non-invasive and non-extractive. For example, scientists are not allowed to use intrusive methods, like taking samples, probes or collect plants and animals.

In the restoration and transition zones, all scientific work has to employ minimal invasive and extractive research techniques. For example, the number of scientists allowed to take small samples, taking probes, collect plants or animals must be limited.

The European Wilderness Continuum is a tool to assess the quality of European Wilderness, closely based upon the European Wilderness Quality Standard. The Wilderness Continuum is a way to overcome identify and protect European Wilderness and with low anthropogenic impact. These areas are providing an opportunity to protect biodiversity, study and interpret the natural dynamics and processes as well as limited opportunities for recreation and solitude!

The Wilderness quality is measured by using 9 principles, 53 criteria and more than 300 indicators, defined in the European Wilderness Quality and Audit System habitat independent. This standard is applicable to WILDForests, WILDRIvers, WILDIslands and WILDCoasts. They assess for example the level of human modification (e.g., extractive use), attributes of remoteness and its visual naturalness, all impacting the Wilderness quality. This approach permits a precise assessment of the Wilderness, revealing those factors, which contribute to or compromise Wilderness quality.

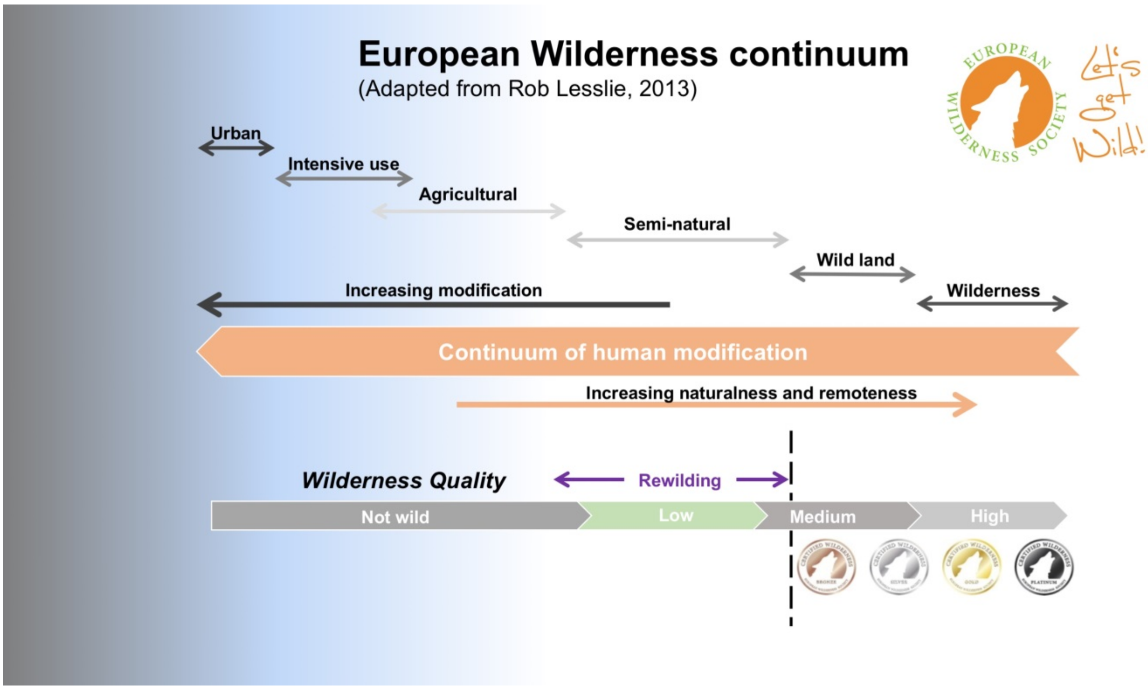

Figure 3: The Wilderness continuum describes the different stages between urban areas and true Wilderness.
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Wilderness is a unique laboratory

1. Displays natural rewilding processes without human interference

Natural rewilding of Wilderness, also called self-restoration, is the natural process how Wilderness restores itself in Europe! It offers scientific opportunities to study the transformation from human impacted ecosystems to natural ecosystems. For example, we can observe how nature reclaims the former military grounds of Königsbrücker Heide Wilderness, Germany. Or how former grazing areas transform into wild alpine meadows in Kalkalpen Wilderness, Austria.

2. Governed by dynamics of open ended undefined natural processes

Wilderness is creating the unique chance to study how nature develops in a self-willed mode (i.e., dynamics of the ecosystems, self-regulation principles, spontaneous dynamics of population). For example, how peat bogs in Cepkeliai Wilderness in Lithuania continue to develop by themselves in Estonia. Or how populations of different species develop in the beech forests of Central Balkan Wilderness, Bulgaria.

3. Currently there are more than 20 different Wilderness habitats across Europe, covering more than 300,000 hectares, meeting the European Wilderness Quality Standard

The European Wilderness Network is a network of European Wilderness areas meeting the same European Wilderness Quality Standard and stewarded for preservation in their natural condition. This objective is an international effort of many European countries to provide undeveloped habitats for threatened or endangered species. These areas not only open new horizons for scientific research, but also provide an opportunity to apply the gained knowledge to other Wild areas. It offers the opportunity to perform comparative studies, for example on the effect of climate change across different habitats from the European Wilderness Network and in different European climate zones. For example, how do terrestrial areas like Soomaa Wilderness in Estonia, marine areas like Archipelago WILDCoast in Finland, WILDRivers like Mala Uholka and Velyka Uholka in Ukraine, and WILDIslands like Vilm in Germany cope with rising temperatures caused by anthropogenic influence. Or how do the fauna of natural ecosystems adapt to these climates in the Oulanka Wilderness in Finland versus the Peneda Geres Wilderness in Portugal.

4. Showing anthropogenic impact on Wilderness

Wilderness offers the chancs to study the resilience of nature and its self-regulating natural processes that are constantly being affected by humans without human intervention management techniques to assist them. For example, how does Wilderness cope with invasive species and its population dynamics, but also other anthropogenic impacts like increased nitrogen deposition. We can observe examples of these self-rewilding processes of the forests after windfall or insect attack, like in Uholka-Shyrokyy Luh Wilderness, Ukraine or Kalkalpen Wilderness in Austria.

Discussion

A symbiosis of science and Wilderness in Europe is a unique chance to better understand how we can support natural processes in other protected areas. Wilderness and science need each other to understand and communicate the processes and values, in order to raise awareness and acknowledgement among people.

It is good to be aware that Wilderness itself does not need science for its survival, as Wilderness is self-regulated by nature. But without scientific support and committed people behind this Wilderness momentum, the process of Wilderness conservation in Europe will develop at a much slower pace. Science could be a way to provide answers to the many questions that are linked to Wilderness conservation and particularly to the restoration of wild areas in other European protected areas to eventually become Wilderness. It can show Europe's natural best practice examples on the development of Wilderness.

Conclusion

We can conclude that Wilderness needs passionate protectors, who can build upon scientific proof of the importance and value of Wilderness. This support can be provided by good and systematic science. But we must also stress that all scientific research in Wilderness must be non-extractive and non-intervention and respect the principles of the Wilderness definition. Also there must be an Wilderness Integrated Monitoring with habitat independent scientific indicators to compare Wilderness all across Europe.

The most important question at this point remains: Are the Europeans ready to accept the challenges of Wilderness and protect the European Wilderness heritage?

Figure 4: The European Wilderness Network is a network of European Wilderness areas, designated and managed for preservation in their natural condition. © European Wilderness Society

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Old-growth forests of Domogled-Valea Cernei National Park (Romania) between conservation and mismanagement

Iuliana Vijulie, Laura Tîrlă, Gabriela Manea, Elena Matei, Roxana Cuculici

Abstract

Old-growth forests are extremely vulnerable to socio-economic pressures. Some of these forests are included in protected areas, but they still face difficulties in terms of conservation management, namely specific forest works and wood harvesting activities. We analyzed the contradiction between the aim and objectives of protected areas and economic activities in the Domogled-Valea Cernei National Park. We used GIS and online media monitoring techniques. Results revealed that these forest works affected considerable woodland areas, including old-growth forests.

Keywords

old-growth forest, wood harvesting, conservation, national park, Domogled-Valea Cernei, Romania

Introduction

Old-growth forests are primeval forest ecosystems, originated and developed exclusively under the influence of natural factors, without any direct or indirect human interference (ORDINUL MINISTRULUI Nr. 3397/2012). The main reasons why they have survived in the past were their inaccessibility (e.g. their location in the narrow valleys, steep and rocky areas or at the upper limit of forests) and low economic value of timber from secular trees. Over the last millennia, the forests of Europe were dramatically reduced, initially due to grazing and agriculture, and as a result of population growth, the emergence of major urban areas and industrial zones. At the same time, the natural structure of forests has changed significantly as a result of exploitation (BIRIŞ 2014). It is known that, in Western Europe, the secular beech forests have disappeared since centuries over large areas. However, such forests still exist in the Carpathians, being spared so far by mining and other major human intervention (BIRIŞ et al. 2004; VEEN et al. 2010).

Currently, old-growth (virgin) forests are extremely vulnerable to economic and social restraints. In Romania, these forests hold about 300,000 hectares, or 5% of the national forest area. However, only 18% of them have a certain protection status so far, in that it is included in the protected areas. A smaller percentage enjoys full protection. Over 80% have no form of protection and are in danger of being legally destroyed (WWF, 2011). In this respect, a legal provision has nationally been issued in 2012, governing the status of strict protection for primary forest ecosystems (ORDINUL MINISTRULUI Nr. 3397/2012) and in 2016 to ensure the protection of these forests against human intervention, the National Catalogue of virgin forests in Romania was conducted (ORDINUL MINISTRULUI Nr. 1417/2016).

In this context, *the aim* of this study was to analyze the contradiction between the purpose of protected areas and the economic activities in the Domogled-Valea Cernei National Park (South Carpathians), according to the uncontestable best practices promoted by scientific assessments. *The study objectives* were: a) to map the deforested areas within the Domogled-Valea Cernei National Park; b) to propose solutions to reduce the impact on forests with high conservation value.

Methodology

Field survey, GIS analysis, and monitoring on-line media were the main tools used for collecting the wood harvesting data of old-growth forests in the study areas. Field work conducted during July-September 2016 concerned at identifying wood harvested areas within the virgin forests of Cerna basin.

Mapping of wood extraction works was based on data obtained from field survey and satellite imagery of the study area (Google Imagery 2017 & Deforestation Map 2017). The PIN-MATRA project (BIRIŞ & VEEN, 2005; MINISTERUL MEDIULUI, 2016) resulted in a comprehensive digital database on the spatial distribution of old-growth forests. The PIN-Matra polygons were superposed over the most recent imagery to detect wood harvesting within the old-growth forests (Fig. 1).

The results were then compared to the latest studies and investigations carried out, by monitoring the official site of the European Wilderness Society (VANCURA, 2017), online media - newspapers (evz.ro, jurnalul.ro, ziarelive.ro, etc.), national websites (agentgreen.ro, wwf.ro, romaniacurata.ro, expressdebanat.ro, greenpeace.org, etc.), television channels (ProTv, Digi24TV), social networks and discussion forums aimed at highlighting the logging phenomenon in the protected areas.

Results and discussion

Wood harvesting is present in significant areas of the Domogled-Valea Cernei NP (Fig. 1). The map shows that the forest is exploited systematically within the national park area, whose purpose is the protection and conservation of forest ecosystems. Interventions in forests classified as old-growth (BIRIŞ & VEEN, 2005), and therefore subject to strict protection, were found in the Craiova, Stârminos and Curmeziş valleys (tributaries to Cerna on the right side), and on the western slope of Mount Şarba (Cerna upper basin).

The dots representing wood harvested areas fall either into non-virgin spruce, beech and mixed forests, or, most significant, into the virgin or old-growth beech forests (20% of the total logged areas). All of them are located in the upper sector of Cerna Valley, especially on the right, south-easterly-exposed slope. Forest roads were opened within the park boundaries, including old-growth forests, to facilitate wood harvesting. Thus, the quality of virgin forest is being lost and the ecosystem gradually transforms into a forest holding.

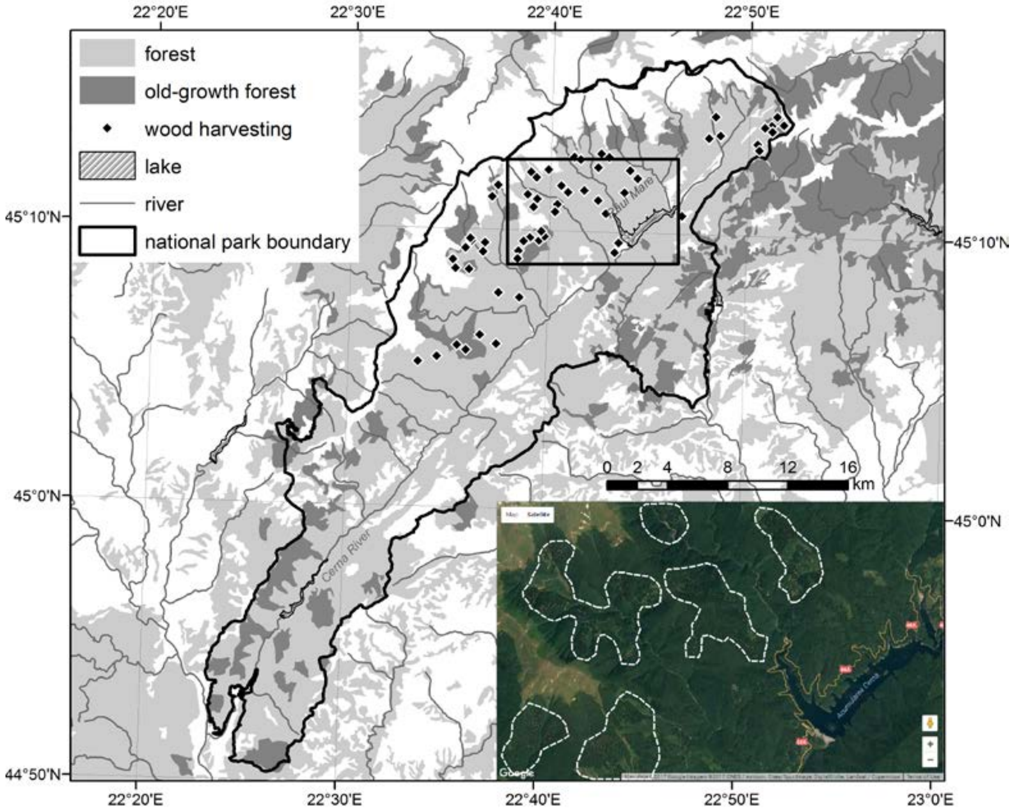

Figure 1. Present-day wood harvesting of the common and old-growth forests in the Domogled-Valea Cernei National Park. Detailed view in the inset, courtesy of Google Imagery (2017).

The spatial analysis results reflect the general views exposed by international wilderness conservation societies, national organizations and other media, regarding the sensitive status in Romania of protected forests in general, and old-growth-forests in particular.

Conclusions and recommendations

The analysis shows that some virgin forests are subject to forest works. In accordance with the worldwide recommendations of IUCN (International Union for the Conservation of Nature), the old-growth forests should not undergo any human intervention because trees should be left to die of old age, and dead wood remains in situ to feed the ecosystem and contribute to increasing the value of biodiversity. A number of proposals were made in order to limit these interventions in the old-growth forests: a) inclusion under full or even strict protection of all old-growth (virgin) forests; b) granting subsidies to forest owners in exchange for protection of virgin forests; c) rethinking internal zoning of national parks depending on the importance of forest ecosystems located within them; d) to improve national legislation in order to implement real and functional conservation measures.

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Biodiversity monitoring in the NW Italian Alps: state and expected changes

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Keywords

biodiversity monitoring, temporal changes, species distribution models

Introduction

Mountain ecosystems are considered 'biodiversity hotspot' due to the huge quantity of endemic and vulnerable species and because they have already experienced exceptional losses (GRABHERR et al. 2011). As a result, alpine ecosystems have been identified as being particularly at risk from predicted changes and are likely to show their effects earlier and more clearly than many others. This underlines the need to monitor alpine biodiversity and identify the factors that influence its distribution.

In this framework, in 2006, 3 alpine parks in NW Italy (Gran Paradiso National Park GPNP, Orsiera Rocciavrè Natural Park ORNP, Veglia Devero Natural Park VDNP) started a field project to determine the factors influencing animal biodiversity and to identify the most appropriate methods for a periodically repeatable monitoring.
Main objectives are:

- to **measure the biodiversity status,** describing animal biodiversity along altitudinal gradients in space and time. This is fundamental for creating a baseline against which to identify future changes and for planning highly focused conservation actions;
- to **forecast the biodiversity status**, for estimating the risk of biodiversity loss, also through the application of environmental change scenarios. This will allow to identify the threshold beyond which the risk of biodiversity loss will be extremely elevated and to identify potential 'vulnerability and safety'.

Methods

12 altitudinal transects (from montane to alpine belt) were chosen. Each transect was composed of 4-7 sampling units separated by an altitudinal range of 200 meters (69 plots; Fig. 1). In every station were collected data for 5 taxa (Lepidoptera Rhopalocera, Aves, Coleoptera Staphylinidae, Coleoptera Carabidae, Araneae*)*, census by standardized, repeatable and cheap methods. Each sampling station was also characterized by topographic, environmental and micro-climatic (temperature) parameters.

This research can offer a representative sample of NW Italian Alps and it is a long-term monitoring project, with two years of sampling every five years. The first sampling season occurred in 2006-2007 for GPNP and in 2007-2008 for ORNP and VDNP; the second sampling season occurred in 2012-2013 and the next one is expected to be in 2018-2019.

Results and Discussions

1. Measure the biodiversity status

In VITERBI et al. *2013*, the analysis of data coming from the first sampling season, showed that **species richness** is mainly determined by altitude and temperature (Variation Partitioning for all taxa pooled together: the relative importance of altitude is 40.9% and of temperature is 45.3%).
The species richness of all taxa pooled together presents a **hump-shaped** relationship along the altitudinal gradient ($\ln(S) = 2.841 + 0.002\,\text{Alt} - 6.420 \times 10^{-7}\,\text{Alt}^2$; $D^2_{adj}=0.425$; $p<0.0001$), with a peak around 1500 m a.s.l., corresponding to the subalpine belt (Fig. 2).

On the opposite, the proportion of **endemic and vulnerable species** significantly increases from the Montane to the Alpine belt (K-W test, N=69, d.f.=2; $H_{endemic}=30.085$, $p=0.0001$; $H_{vulnerable}=34.633$, $p=0.0001$), showing how the highest altitude of our gradient is species poor but characterised by species of conservation concern.
We carried out first comparisons between the two sampling seasons for *Lepidoptera Rhopalocera* (2006-2008 *vs* 2012-2013), analysing changes through space and time and trying to identify species or functional groups responsible of changes.

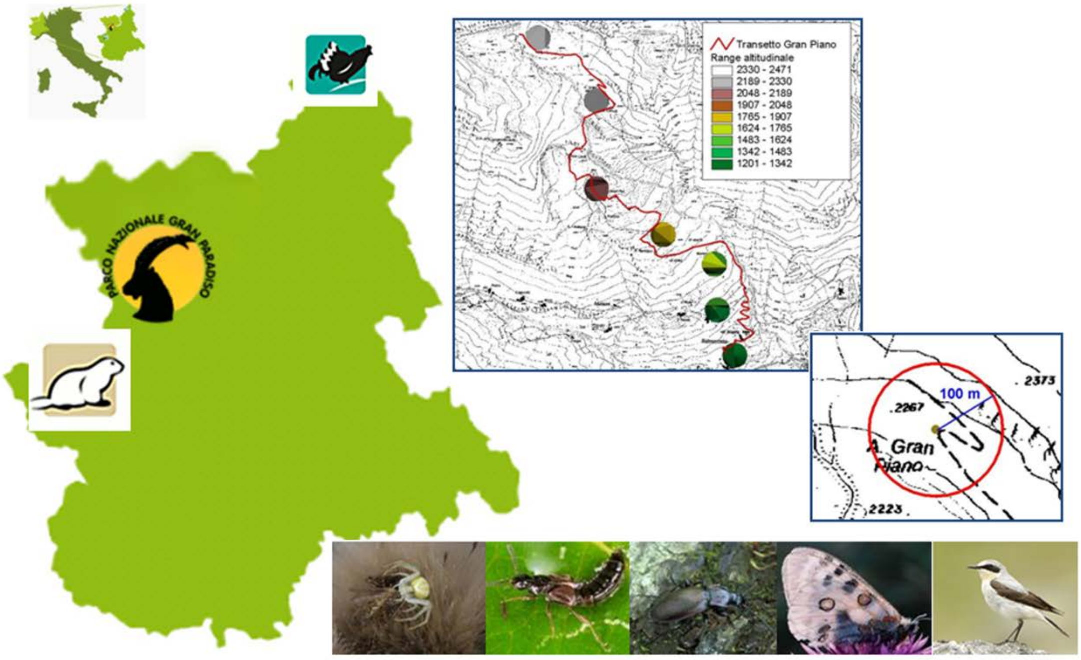

Figure 1: Study areas. 69 plots distributed along 12 altitudinal transects in 3 parks in NW Italian Alps (from S to N, ORNP, GPNP, VDNP). In each plot, 5 taxa (from the left, *Araneae*, *Coleoptera Staphylinidae*, *Coleoptera Carabidae*, *Lepidoptera Rhopalocera, Aves*) were sampled and topographic, environmental and micro-climatic parameters were recorded.

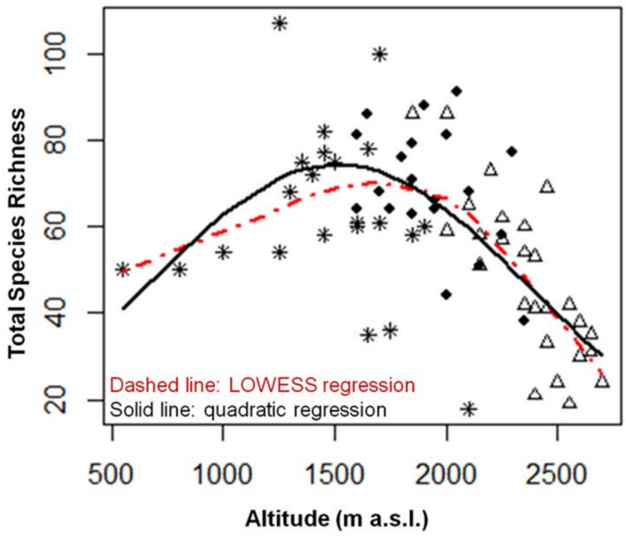

Figure 2: Scatterplot of the total Species Richness per site along the altitudinal gradient (from VITERBI et al. 2013).

140 species were shared between the 2 sampling sessions, with 146 species in the first one and 149 species in the second one. Focusing on changes, five years later only, we observed a general **increase** in mean **occupancy level** (number of plot per species; mean change=3.95±0.50, t=-7.90, p=0.001) and in **species richness** (mean change =10.32±0.86; t=-11.94, p=0.001).

Changes differed across species and occupancy didn't increase equally among ecological groups:

- concerning **feeding specialization**, specialised (monophagous) species significantly differ (mean change=-2.00±1.15, KW, χ2=8.61, p=0.035);
- regarding **altitudinal specialization**, altitudinal specialists (KW , χ2=9.17, p=0.010) and strictly alpine species (MW, W=880, p=0.014) showed a significantly lower change than compared with the other ecological groups.

Overall community composition didn't change, but we observed an increase in shared species and a tendency towards homogenisation (Analysis of Dispersion in Community Composition, F-value=13.15, p-value<0.001).
For each species, we calculated the **Species Temperature Index**, obtained combining species' distribution in N Italy (BALLETTO et al. 2007) and temperature data (METZ et al. 2014). The analysis of changes in Community Temperature Index (CTI) between sampling seasons showed that it significantly increased (t=-3.59; p=0.001) and that its changes was mainly dependent on the geographic position of the sampling plots (linear regression, model selection through AICc; $R_{squared}$=14.17, p=0.007; Protected Area, p=0.007). Indeed, in the protected area characterised by the lowest mean temperature we observed the highest increase in CTI (Fig. 3).

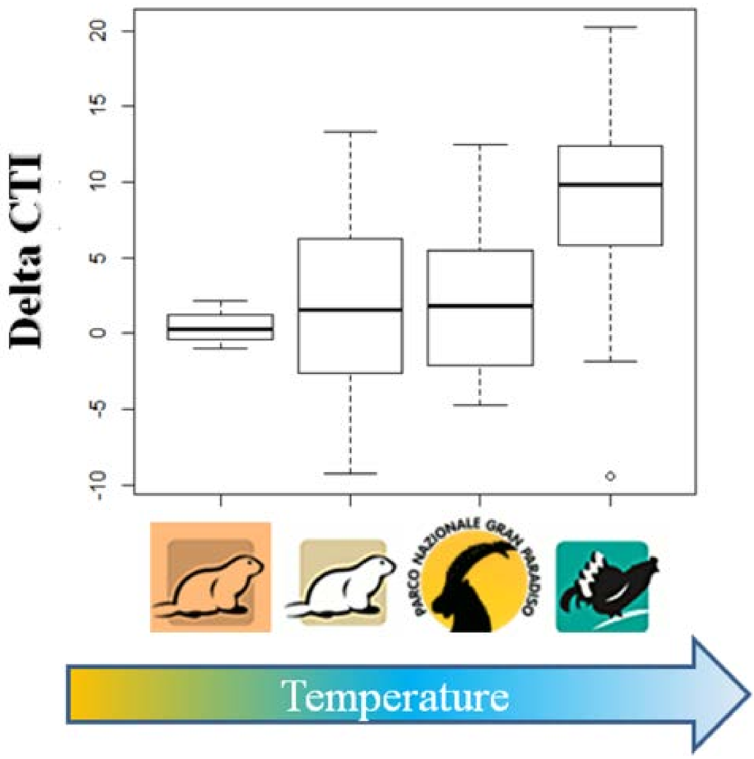

Figure 3: Variation in Community Temperature Index between sampling sessions (first sampling session *minus* second sampling session) as a function of protected areas. From left to right: Foresto xerothermic oasis (xerothermophilous area inside ORNP), ORNP, GPNP, VDNP. The protected areas are ordered from the warmest to the coldest, concerning seasonal air temperature. As can be seen, in the coldest protected area was recorded the highest increase in CTI.

2. Forecast the biodiversity status

Species Distribution Models (SDM) represent essential tools to forecast impact of temperature changes and to develop adequate conservation strategies.

In this framework, we applied presence-only distribution models (MAXENT; PHILIPS et al. 2006) to species distribution data. Purpose of our work is to evaluate the effects of a moderate increase of temperature ('*what if*' scenarios based on literature data) on multi-taxa distribution, described in term of alpha and beta diversity at plot scale.

Our results show small changes in biodiversity patterns but different responses of species, depending on the taxonomic group and the degree of specialization. In particular, we observed an increase in plot occupancy and in species richness in butterflies, whereas endemic and vulnerable species showed a pronounced decrease if compared with the all the other species.

Moreover, models agree that changes in species richness may be particularly significant in the alpine belt. Community composition changes in a coherent way and the alpine and the subalpine belts became more similar to the low altitude ones (Wilcoxon test, p<0.01; Fig. 4). Nevertheless, the gradual but clear separation among vegetation belts is still retained after temperature increase scenarios.

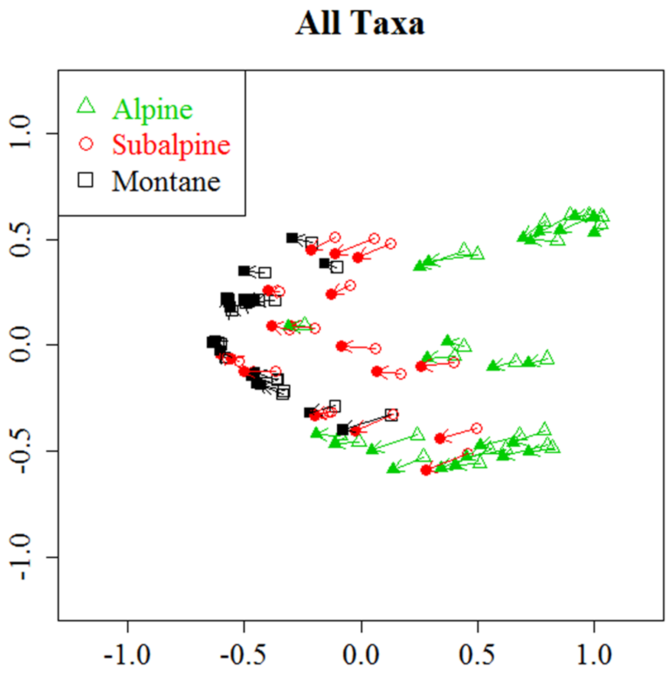

Figure 4: Correspondence Analysis for all taxa pooled together. Empty symbols indicate present situation, filled symbols the projected one. Arrows indicate shift of each plot. First axis is positively correlated with altitude and negatively with minimum temperature.

Conclusion

This study allows to assess the coherence in the distribution of different taxa along altitudinal gradients and the influence of geographical, environmental and climatic factors on biodiversity, as a baseline against which measure future changes. Our results suggest that alpine biodiversity should be deeply monitored in the long term both for early warning signs of climate change and both as empirical tests of predictions. Protected areas can be used as a litmus test of any changes. To play this role parks need to share long term monitoring programmes that allow to measure biodiversity status (species richness and distribution, community composition, functional diversity), to underline the climatic and environmental factors that influence these patterns and to model the effects of climate and land use changes on these parameters.

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The land snail fauna of the National Park Gesäuse Ecology of the alpine land snails, with a special focus on endemic species

Johannes Volkmer

Keywords

Alps, National Park Gesäuse, Gastropoda, snails, ecology, endemic, elevation

Summary

The National Park Gesäuse is located in the eastern part of the Alps in the north of Styria (Austria). With the size of about 110 square kilometers, this national park is the fourth biggest in Austria. Established in 2002, it is characterized by high limestone mountains and the Enns, a river which separates the National Park in a southern and a northern part. Because of its location, the NP is home to a high number of landsnails, featuring also several endemic species. As previous studies have been conducted in this area beforehand, the first part of this paper summarizes the literature on landsnail-fauna. Afterwards, habitat- and elevation-preferences of all alpine landsnail-species were examined by fieldwork in the summer of 2014. Thus, 54 locations (18 limestone, 18 grassland and 18 mixed) with a size of 16 square meters were investigated. Additionally, small squares (1.600 cm^2) in each location were removed, sieved and surveyed for snails. The results show that several species are restricted to a certain elevation. The total number of species decreases with increasing elevation. On the other hand, the mean number of species and mean biodiversity (Shannon Index) increases at the beginning with ascending elevation and decreases at 1900 meters. The mean number of individuals increases significantly in higher altitude, which was also shown in previous studies. In addition, several landsnail communities in Kalkschutt- / -block-habitats and Kalkrasen-habitats were described for the first time in this area.

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Ecology of springs in the Swiss National Park: first results and future plans

Stefanie von Fumetti

Abstract

In protected areas springs are usually still pristine. They are important refuges for species which elsewhere are endangered. Protected areas can be seen as flagship areas within a widely managed, anthropogenically altered landscape. For venturing future predictions and proposing possible counteractions two prerequisites are needed: We need to know the status quo in springs and we need to conduct long-term monitoring projects in order to understand future developments. I will present first results and future plans from springs and their inhabitants in the Swiss National Park.

Keywords

Macroinvertebrates, spring ecology, long-term monitoring, Swiss National Park

Introduction

Springs are ecotones between the groundwater and the surface water and provide a habitat for specialised species due to constant environmental conditions (GERECKE & FRANZ 2006). Owing to environmental changes and anthropogenic impacts springs are highly endangered. Alpine springs are especially sensitive habitats as they often exhibit a high degree of individuality (BONETTINI & CANTONATI 1996) and usually have a small spatial extent (CANTONATI et al. 2006).

The Swiss National Park (SNP) was founded in 1914 and has been subject to total nature protection since then. As research is one of the main aims of the Park, the fauna and flora is well investigated. Scientific research on springs in the SNP mostly focused on chemical and physical parameters in the past decades (e.g. NOLD & SCHMASSMANN 1955). Only NADIG (1942) intensively investigated the fauna of five springs around Il Fuorn.

Fifty-seven springs have been monitored faunistically in the SNP during the past five years. From all springs the fauna was sampled quantitatively and physico-chemical as well as structural parameters were measured. An explicit aim was to assess the function of the SNP as a refuge for endangered species and to provide a data basis for a long-term monitoring of undisturbed springs at high altitude.

Methods

The park area measures 172 m^2. The geology mainly consists of limestone (TRÜMPY et al. 1997), the isolated Macun plateau is of granite origin. The altitudinal range of the investigated springs varies from 1600 m to 2600 m a.s.l..

Of each spring at least four quantitative samples were taken with a surber-sampler (10 x 10 cm; 500 µm mesh). Additionally a qualitative sample was taken. Water temperature, pH, oxygen and electrical conductivity were measured using portable meters. The springs were mapped using the evaluation sheet of LUBINI et al. (2014).

For a long-term monitoring continuous analysis of physical and chemical parameters is inevitable. Data loggers are useful tools, which have proven to provide reliable data (e.g. KÜRY et al. 2017; VON FUMETTI et al. 2017a). Additionally ions such as K^+, Ca^{2+}, Mg^{2+}, SO_4^{2-}, F^-, HCO_3^- will be measured annually. The faunistic monitoring includes all taxa, also meiofaunal elements such as copepods and water mites. For an accurate determination the knowledge of experts and the application of genetic analyses are needed. Certain taxa such as caddisflies or water mites may be in focus of specific research questions.

Results

Substrate composition varies considerably and is mostly influenced by altitude (VON FUMETTI et al. 2017b). Water temperature in the springs varies from <4 °C to >15 °C in some springs at Macun. The pH is around 7 and the electrical conductivity is mostly between 200 and 450 µS/cm. Owing to the geology the springs at Macun have a much lower electrical conductivity (<50 µS/cm).

Over 120 species and higher taxa were identified, of which 72 taxa were determined to species level. The most diverse order were Trichoptera (33 taxa), Plecoptera (20 taxa), and Acari (20 taxa). Among the Ephemeroptera, Plecoptera and Trichoptera 21 of 48 species are listed on the Swiss Red List (LUBINI et al 2012). This is mostly due to their strong restriction to springs. *Apatania helvetica* was detected in the SNP for the first time in the springs at Punt Periv and the Clemgia valley.

Especially high diversity was found among the Drusinae: 8 different species were identified. For implementing a long-term monitoring the development of a data base is very helpful. Just recently such a data base for springs in the SNP has been developed (RUGGLI 2017). Over 700 springs were recorded in the past 100 years. From those, only about 10% were monitored faunistically. Moreover, only six springs were monitored several times and only hydrological data were measured.

Discussion

Electrical conductivity was determined as an important environmental factor differentiating springs at the Macun plateau from springs in the main part of the SNP. Owing to the harsh conditions at high altitude Macun springs are sparsely populated. Therefore Macun springs will not be selected for a long-term monitoring. The only limnocrene in the SNP has already been described by NADIG (1942). It is characterised by an extremely high electrical conductivity, mostly resulting from high sulfate concentrations, which makes it hostile for invertebrates.

Overall, eight different *Drusus* species were found. As they are often restricted to small distribution areas and are typical cold-stenothermic species, they are valuable bioindicators (WARINGER & GRAF 2011). An emphasis should be therefore placed on their monitoring in the upcoming long-term monitoring. Water mites are the most intensively investigated taxon in the SNP. The Wegerhaus spring was investigated several times by Carl Bader in the past decades. Recent results show that a species shift happened and the number of species decreased considerably (STEINER 2017).

Long-term monitoring projects of streams are scarce. The Breitenbach, a brook in the low mountain ranges of Germany, was investigated intensively over several decades (WAGNER & SCHMIDT 2004). In the Alps, over 300 springs in the Berchtesgaden National Park were monitored (GERECKE & FRANZ, 2006). In Berchtesgaden the aim was to attain a general overview of all springs in the park. In the SNP we want to identify springs which represent perennial, undisturbed springs at high altitude. We will monitor selected springs over several decades to be able to predict long-term developments of their hydrological conditions and their fauna. The selection of representative and well investigated springs – faunistically as well as hydrochemically – is a crucial aspect for obtaining reliable long-term data.

Conclusion

Compared to other alpine regions, the springs in the SNP are totally protected and suffer only minor anthropogenic impact. Considering Global Change and anthropogenic impacts the SNP provides a refuge for crenobiontic and cold-stenothermal freshwater species. This is an important prerequisite for the implementation of a long-term monitoring as it is planned in the SNP.

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Rock glaciers – prominent landforms in (protected areas of) Austria

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Abstract

About 5500 rock glaciers, permafrost-related debris accumulations in alpine environments, exist in the Austrian Alps, of which 837 are found in three National Parks. Among them, active (moving, widespread permafrost), inactive (stable, rather widespread permafrost), pseudo-relict (stable, permafrost lenses) and relict (stable, permafrost free) rock glaciers are distinguished. Permafrost existence, as a thermal phenomenon, is controlled by climatic conditions. Hence a change in climate influences its ice content und movement behavior which is also of relevance for other fields of research.

Keywords

Rock glacier; cryospheric landform; warming climate

Introduction

Rock glaciers are the most prominent permafrost-related landforms in alpine environments (e.g. BARSCH, 1996). Depending on the content of permafrost-ice, these debris accumulations can be classified as active (moving, widespread ice-bearing permafrost), inactive (stable, rather widespread ice-bearing permafrost), pseudo-relict (stable, ice-bearing permafrost lenses) and relict (stable, permafrost and ice free) ones. Permafrost is a thermal phenomenon and mainly controlled by climatic conditions. Therefore, climate change will influence ice content and activity of rock glaciers.

Research on rock glaciers, especially of relict ones, comprises their distribution (e.g., HARRISON et al. 2008; KELLERER-PIRKLBAUER et al. 2012; KRAINER & RIBIS 2012) as a base of their relevance as markers of sudden climate changes during the late glacial period (e.g., PUTNAM & PUTNAM 2009). Additional research issues are related to rock fall hazard of the destabilizing rock-ice mixture (with blocks of up to a size of several m^3) due to a warming climate and in particular the impact on the discharge pattern of springs related to rock glaciers which is of interest concerning water management in alpine catchments (e.g., KRAINER et al. 2007; PAURITSCH et al. 2017; ROGGER et al. 2017; WAGNER et al. 2016; WINKLER et al. 2016). This might be of high relevance for prognosis as the intensity of droughts as well as heavy rainfall events might increase due to climate warming.

Within an Austrian wide research project (WINKLER et al. 2017) a rock glacier inventory is currently conducted and attributed based on airborne-laser-scan data (ALS) with a resolution of 1 meter compiling and incorporating already existing inventories (KRAINER & RIBIS 2012; KELLERER-PIRKLBAUER et al. 2012; WINKLER et al., 2016). Preliminary results show a large number of these prominent landforms in the Austrian Alps: more than 5500 rock glacier-suspected landforms (WINKLER et al. 2017) are depicted (Fig. 1), of which 837 are found in three Austrian National Parks (Fig.1, green polygons). These will be the focus of the following analysis: the distribution of intact versus relict landforms is investigated.

Methods

Classification of rock glaciers regarding permafrost existence or absence in four alpine national parks of Austria (Kalkalpen, Gesäuse, Hohe Tauern and Nockberge; see Fig. 1) was carried out in ArcGIS by combining our elaborated rock glacier inventory for the federal provinces of Salzburg, Carinthia, Styria (based on LIEB et al. 2012) as well as Tyrol (based on KRAINER & RIBIS 2012) and Upper Austria (LIEB et al. 2012). In a first step all rock glaciers within the national park boundaries were selected for further analysis. In a second step these rock glaciers were combined with the regional permafrost model of BOECKLI et al. (2012) and classified into 'relict' and 'intact' rock glaciers.

Rock glaciers were considered as relict when absence of permafrost was indicated by the regional permafrost model (BARSCH 1996). Furthermore, rock glaciers were also classified as relict if only the uppermost part of the entire rock glacier surface was slightly within the modeled permafrost area. In this case the term pseudo-relict can be used because visually such rock glaciers look relict but permafrost in the uppermost part of the rock glacier is very likely (cf. KELLERER-PIRKLBAUER 2016). A clear distinction between relict and pseudo-relict is only feasible in case of subsurface permafrost data (e.g. ground temperature or geophysics).

In contrast, rock glaciers were classified as intact if the entire rock glacier body is entirely within modeled permafrost or if at least most of the rock glacier was in the model class 'permafrost only in very favorable conditions'. The former intact rock glacier-type might be regarded as an active rock glacier because widespread permafrost existence might cause downslope displacement. The latter intact rock glacier-type might be regarded as a climatic inactive rock glacier implying no present movement (cf. Barsch 1996). A clear distinction between active and inactive is only possible if a surface displacement analysis was carried out using multitemporal rock glacier surface data.

Preliminary Results

In total, 837 rock glacier-suspected landforms were identified within three NPs (NP Gesäuse, NP Nockberge and NP Hohe Tauern). As no ALS-data for the NP Kalkalpen was available for this analysis, the rock glacier inventory of Lieb et al. (2012) was used, but no rock glacier-suspected landforms were identified there. Only one single relict rock glacier was identified in the NP Gesäuse; 66 relict rock glaciers in the NP Nockberge. In contrast, a total of 770 rock glacier-suspected landforms were identified in the NP Hohe Tauern; 321 of them were classified as relict, 449 as intact. For the Carinthian part of the NP Hohe Tauern, 77 relict and 111 intact rock glaciers were identified. In Tyrol, a total of 311 rock glaciers, 90 relict and 221 intact, were recognized. For Salzburg, 154 relict and 117 intact rock glaciers were mapped, summing up to 271 landforms.

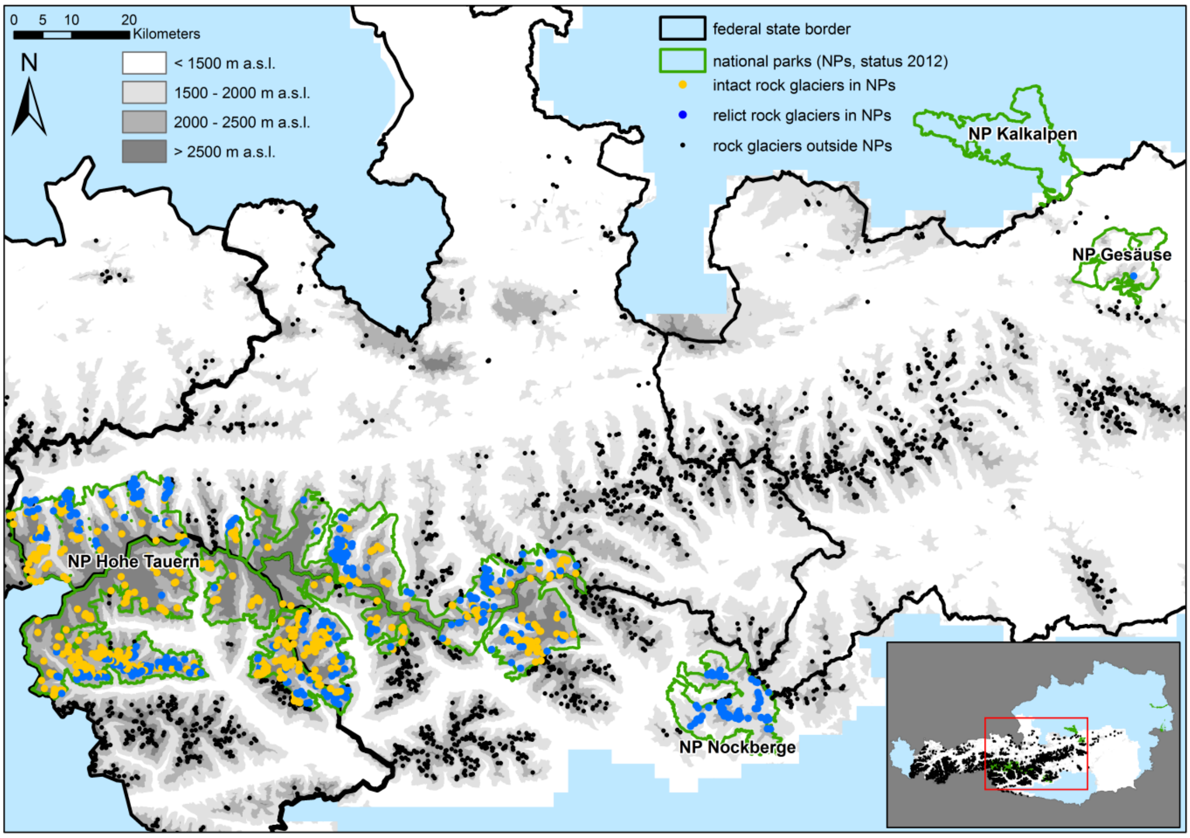

Figure 1: Distribution of rock glacier-suspected landforms in and outside of the national parks (NPs) Gesäuse, Kalkalpen, Nockberge and Hohe Tauern and their potential activity status (intact versus relict) within the NPs boundaries.

national park	rock glaciers			rock glacier data source
	relict	intact	total	
Gesäuse	1	0	1	this study
Nockberge	66	0	66	this study
Hohe Tauern	321	449	770	this study
Kalkalpen	0	0	0	Lieb et al. (2012)
total	388	449	837	this study

Table 1: number of rock glacier-suspected landforms in various national parks.

Conclusion and Outlook

The 837 rock glacier-suspected landforms within the 3 NPs represent 15% of the total number of landforms mapped so far within this project in Austria. Almost 54% of rock glaciers in NPs are intact rock glaciers, and are therefore ice-bearing landforms. Due to the expected climate warming and consequently ice-melt within intact landforms, it is expected that the discharge dynamics and storage capacities of these landforms will change accordingly. This will have an impact on the runoff of alpine catchments and will be of general water management interest as these landforms will alter the runoff pattern further downstream.

An important aspect to further quantify these ongoing changes in discharge dynamics and storage capacities is the appropriate monitoring of various intact and relict rock glaciers.

Acknowledgement

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Mobile Soil Moisture Sensing in High Elevations: Applications of the Cosmic Ray Neutron Sensor Technique in Heterogeneous Terrain

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Abstract

The use of the Cosmic Ray Neutron Sensor (CRNS) for the detection of field-scale soil moisture (~20 ha) has been the subject of a multitude research applications over the past decade. One exciting area within agriculture aims to provide soil moisture and soil property information for irrigation scheduling. The CRNS technology exists in both a stationary and mobile form. The use of a mobile CRNS opens possibilities for application in many diverse environments. This work details the use of a mobile 'backpack' CRNS device in high elevation heterogeneous terrain in the alpine mountains of western Austria. This research demonstrates the utilization of established calibration and validation techniques associated with the use of the CRNS within difficult to reach landscapes that are either inaccessible or impractical to both the stationary CRNS and other more traditional soil moisture sensing technology. Field work was conducted during the summer of 2016 and 2017 in the Rauris valley of the Austrian Alps at three field sites located at different representative elevations within the same Rauris watershed. Calibrations of the 'backpack' CRNS were performed at each site along with data validation via in-situ Time Domain Reflectometry (TDR) and gravimetric soil sampling. Validation data show that the relationship between in-situ soil moisture data determined via TDR and soil sampling and soil moisture data determined via the mobile CRNS is strong (RMSE ~ <2.5 % volumetric). The efficacy of this technique in remote alpine landscapes shows great potential for use in early warning systems for landslides and flooding, watershed hydrology, and high elevation agricultural water management.

Keywords

Mobile Cosmic Ray Neutron Sensor, Soil Water Management, High Elevation, Austria, Field Scale Soil Moisture, Hydrogeophysics, Catchment Hydrology.

Introduction

As pressure on agricultural regions increases alongside population growth and environmental change, the need for sustainable approaches to land and resource use become all the more important. Lands usually set aside as protected have become increasingly desirable as a source of arable soil. As such, determining the best practices to ensure the integrity of the land while maintaining adequate productivity is critical. The incorporation of new technologies designed to provide valuable environmental data is an important step for informed decision making. Here, the use of one such technology, the Cosmic Ray Neutron Sensor (CRNS). The CRNS is a soil moisture sensing device capable of detecting the presence of soil hydrogen over a large area (~ 20 ha). This device has a mobile 'backpack' version that can be taken to remote locations not easily accessible by its larger stationary counterpart. Here, the application, calibration, and validation of this technology in the sensing of soil moisture in high elevation heterogeneous terrain within the alpine regions of western Austria is explored. Protected ecosystems are often located within remote locations and exhibit variable terrain. Therefore, sustainable agriculture in such areas can benefit from the application of highly mobile easy to use technology to provide farmers and decision makers with the information they need.

Methods

The primary objectives of this work were to demonstrate the functionality of the mobile CRNS backpack device, calibrate the CRNS device, and validate the CRNS soil moisture data. This was carried out within the Rauris Valley of the Austrian Alps during two consecutive field campaigns in the summers of 2016 and 2017. Field sites were selected within the same Rauris watershed at three different elevations. This was done to achieve as representative a sample as possible. The highest elevation (~1700 m) was located in a high alpine meadow (alm) at the top of the valley ridge. The middle elevation (~1400 m) was located in another alm within the same watershed. The lowest elevation (~900 m) was located at the valley floor. In addition, two study sites located in central Austria were included.

The first is located near Petzenkirchen, Austria and the second near Grabenegg, Austria (both about 300 m). These two sites served as a low elevation control for the high alpine environments studied near Rauris. Each alpine study site contained one of two land uses, the first and most common being cattle grazing, and the second being the harvest of hay. Land use of the central Austrian sites consisted of mostly maize cultivation. Each location exhibited very different soil type, hydrology, topography, and vegetation density with the lower elevations having thicker darker soils with increased vegetation cover.

The mobile CRNS backpack was taken to the centre of each site where it was placed and subsequently turned on. The CRNS relies on the detection of incoming cosmic ray particles (neutrons) from outer space. These neutrons have a high affinity to be absorbed by hydrogen atoms in the atmosphere and soil. By detecting these neutrons, a relationship can be made between neutron counts and soil moisture (soil moisture being the primary source of environmental hydrogen). However, a calibration process must be performed for each new CRNS device deployed. This calibration procedure is designed to quantify sources of hydrogen within the footprint of the device other than that within soil moisture (water vapour, lattice water, soil organic compounds, etc.). To do this in-situ soil samples must be taken in a radial pattern (see Fig. 1) within the footprint and ambient humidity and temperature must be determined. These soil samples are taken at six depths ranging from 5 cm to 30 cm (30 cm being the theoretical maximum depth the CRNS can detect). The samples are sealed and later analysed for gravimetric water content and volumetric water content once bulk density is determined via standard ring sampling of undisturbed samples. Soil lattice water (water plants cannot access) and soil organic compounds (another hydrogen source) are quantified from these in-situ soil samples via a specialty laboratory located in Canada. Once soil sampling was carried out at each study site around the centre point (where the CRNS was located), the resulting information was used to calibrate the signal of the CRNS device as well as for validation purposes.

Results

Three main analyses were carried out, the first compared the volumetric soil moisture values determined from in-situ sampling (used as a 'true' soil moisture value) with the soil moisture values determined via the CRNS device (Fig. 2). The second compared the sum (in g/g) of all hydrogen (gravimetric soil moisture, lattice water, organic compounds, etc.) with calibrated counts of neutrons (counts without the signal of non-soil moisture hydrogen) to determine the fit with the CRNS calibration function curve (Fig. 3). Lastly, the penetration depth (depth the CRNS can detect) was compared to the soil moisture determined via the CRNS device (Fig. 4).

Results indicate that at each of the three study sites the CRNS is a reasonable predictor of soil moisture. Additionally, the CRNS follows the calibration function (as it should in ideal conditions) at the lower elevation control sites (Pezenkirchen and Grabenegg) but did not follow as closely at the alpine areas (Fig. 3). Lastly, the penetration depth of the CRNS is dependent on soil moisture first and foremost and varies very little between all sites studied at all elevations.

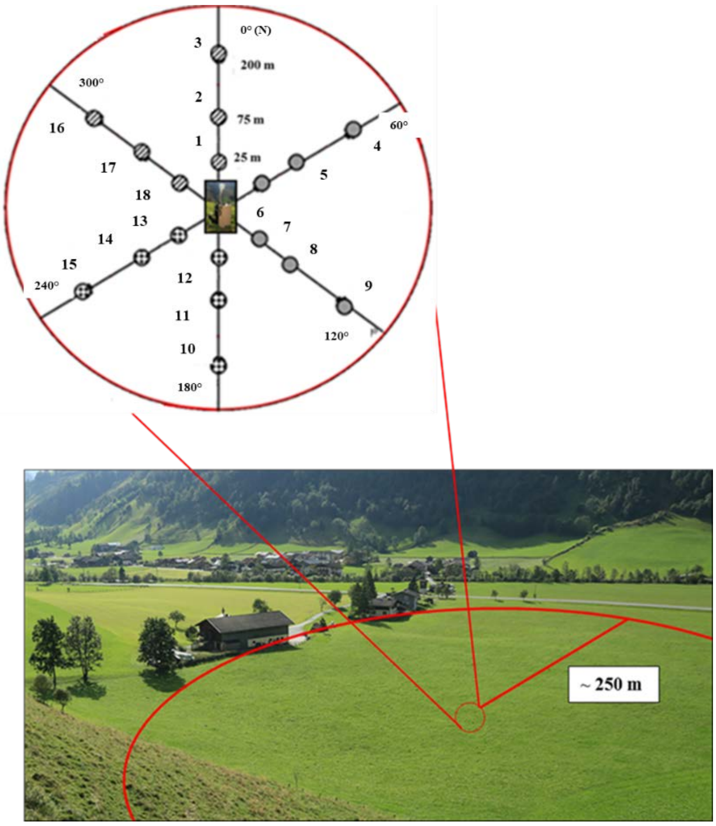

Figure 1: Illustration of the CRNS footprint and sampling pattern. Each dot represents a sampling location with the backpack CRNS at the centre.

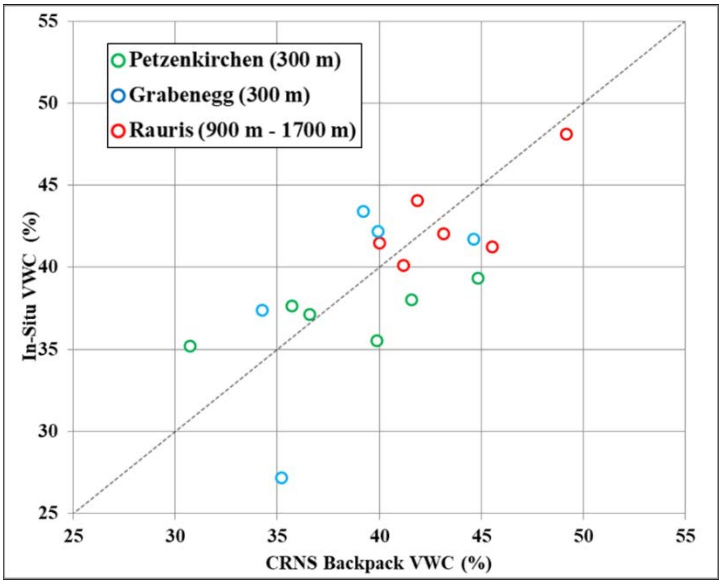

Figure 2: Graph depicting a comparison of in-situ soil moisture values (determined from traditional soil sampling) and CRNS soil moisture values.

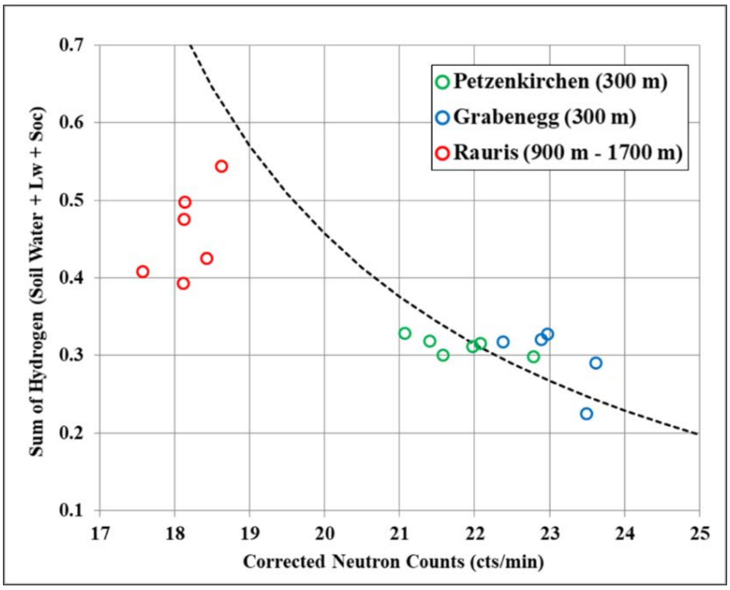

Figure 3: Graph depicting a comparison of the sum of hydrogen (soil water, lattice water, and organic carbon compounds containing hydrogen) and corrected neutron counting rates (from the CRNS device).

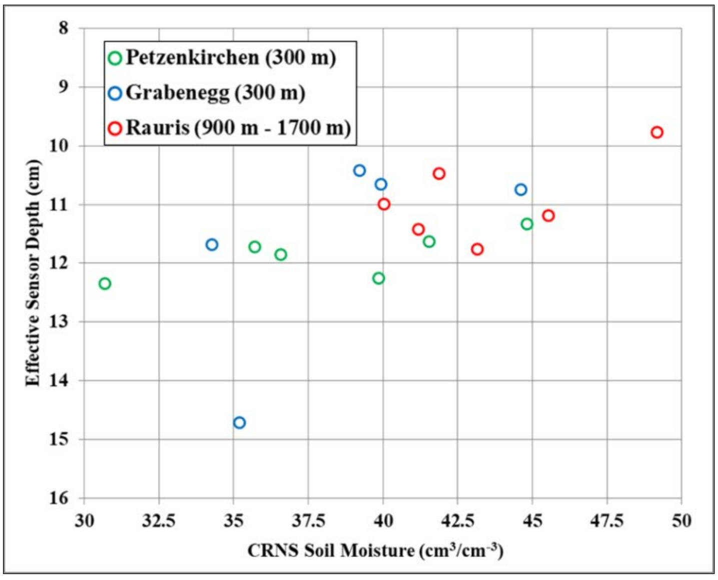

Figure 4: Graph depicting a comparison of the effective sensor depth of the CRNS device and the soil moisture values determined from the same CRNS device.

Discussion and Conclusion

The use of new technologies in sustainable agricultural practice is an important part of precision agriculture. Here, the CRNS is shown to be a reliable predictor of soil moisture when compared with in-situ soil sampling. However, further work in high elevation mountainous environments is needed (see Fig. 3). The drift of data in Fig. 3 is likely due to the fact that the soils in the high mountain sites were almost perpetually saturated with water. This is known to cause a slight bias in the CRNS calibration function. Additional work is planned to account for this error. Ensuring that agricultural productivity in protected environments remains sustainable and productive will require information on in-situ conditions such as soil moisture content. The CRNS can provide this information over large areas and entire watersheds due to its large footprint and mobile nature. The analyses shown in this work illustrate its effectiveness as a soil water sensor and its behaviour in new and variable landscapes.

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CORINE for large-scale monitoring of PAs in Europe

Ariane Walz & Oliver Korup

Abstract

CORINE Land Cover Change provides official European land cover monitoring. Here, we investigate how CORINE can be used for large-scale monitoring of Protected Areas (PAs) in Europe. Main processes observed include changes from and to 'forest and semi-natural vegetation'. Rates of change differ significantly between PAs and their direct vicinity, as well as between protection statuses of PAs. Comparison with alternative data will show that shortcomings due to the spatial and categorical resolution of CORINE might be overcome for European-wide PA monitoring.

Keywords

large-scale monitoring, protected areas, land cover, CORINE

Introduction

Protected Areas (PAs) are recognized to play a crucial role in safeguarding European biodiversity, and are therefore also directly addressed in international conservation obligations through the Convention of Biodiversity, namely the Aichi Targets. Large-scale monitoring of PAs, including not only NATURE2000 sites, but also the numerous nationally designated PAs, has not yet been well established within the EU (EEA, 2012), although a number of existing Pan-European datasets could make a start for such a monitoring.

Land cover change is among the most obvious transitions that ecosystems can go through and that often indicates the overall state of the ecosystem. CORINE land cover monitoring has been established in the late 1980s and has been iterated several times since then. It covers all Europe, including all PAs. CORINE has not specifically been designed for the monitoring across PAs, and even less so for the monitoring of single PAs. Still, it remains one of the most promising data sets for large-scale land cover monitoring of PAs across Europe over the past almost 30 years, and there is a strong potential to learn from this monitoring for future, possible more adapted monitoring of PAs based on recently more and more available remote sensing data.

In this contribution, we aim at identifying (1) large-scale patterns of land cover change in PAs based on CORINE data and (2) main drivers for land cover change in PAs across Europe.

Data and Methods

CORINE Land Cover Change data

CORINE land cover change (LCC) has been published for the four survey periods in 1990, 2000, 2006 and 2012. In addition to the well-known wall-to-wall European land cover data, also CORINE LCC focuses specifically on the monitoring of change. These data cover all 44 CORINE land cover classes, and use a Minimum Mapping Unit of 5 ha with a width of at least 100 m. The technique of mapping changes first has been applied by most countries since 2006, and for previous survey periods these data have been reconstructed. Hence, the land cover change data are available between all survey periods, i.e. for 90-00, 00-06, and 06-12.

To analyse land cover changes, the 44 CORINE land cover classes have been grouped in major land cover flows (LCF) according to Feranec et al. (2010). These LCFs include a total six flows, with LCF4 representing changes towards forest and natural ecosystems and LCF5 representing all changes with loss of forest and natural ecosystems.

Common Database on Designated Areas

The Common Database on Designated Areas (CDDA) is the official source of PA information from European countries to World Database of Protected Areas. It contains various types of nationally designated PAs and provides the IUCN category of each PA. In December 2016, CDDA contains 101,712 PAs, with 97% of them including also spatially explicit information on their extent. Data gaps still exist for Austria, Estonia, Hungary, Ireland, Montenegro, Romania and Turkey. Greenland had to be excluded because of missing CORINE land cover data. After all a total of 97,705 nationally designated PAs covering a total of 276 Mio ha, including 105 Mio ha on land, were included in the analysis.

Driving factors of land cover change

Variables tested to explain observed land cover change in PAs include data on the level of the individual PA, NUTS3, NUTS2, national and higher levels.

GIS analysis

All observed CORINE LCC were assigned to one of the six LCFs. Then all spatially explicit PAs boundaries of the CDDA were intersected by CORINE LCC. A 1km-buffer was calculated for each PA, and again intersected with the CORINE LCC. Areas of PAs, PA buffers as well as areas of each observed change within PAs were calculated. The annual fraction of change was derived by normalising observed change by PA size and the number of years between surveys. For this first analysis only land cover change was included that was completely contained within a PA, with a consequent reduction of analysed PAs by about 19 % of the PA with observed change.

Descriptive analysis and tests of observed changes

Annual fractions of change for all LCFs are plotted for each change period to identify most important processes. Using Kruskal-Wallis tests, significant differences in annual fractions of change were tested for (1) PAs, buffers around PAs and across European were tested and for (2) different IUCN categories for the last period 06-12.

Explaining land cover change

Quantile regression analysis was used to identify main drivers of CORINE LCC within European PAs. In the analysis we use drivers of different spatial resolution, namely from the level of the individual PA, NUTS3, NUTS2, NUTS1, and pan-European scale.

Results

The presented results are only preliminary and will be further analysed and confirmed until the symposium in November 2017.

Observed land cover changes in PAs

Out of the almost 95,000 PA available with their geographic boundaries, 3394 were affected by land cover change according to CORINE LCC. Changes within PAs are dominated by LCFs 4 and 5 (gain and loss of 'forest and natural vegetation') in all three CORINE LCC periods, although the identified rates of change vary considerably between the three periods (Fig. 1). Rates for LCFs 4 and 5 also dominate land cover change outside PAs and across Europe. Across all periods rates of change in close vicinity of PAs and across Europe are similar, with rates being particularly high for the period 06-12.

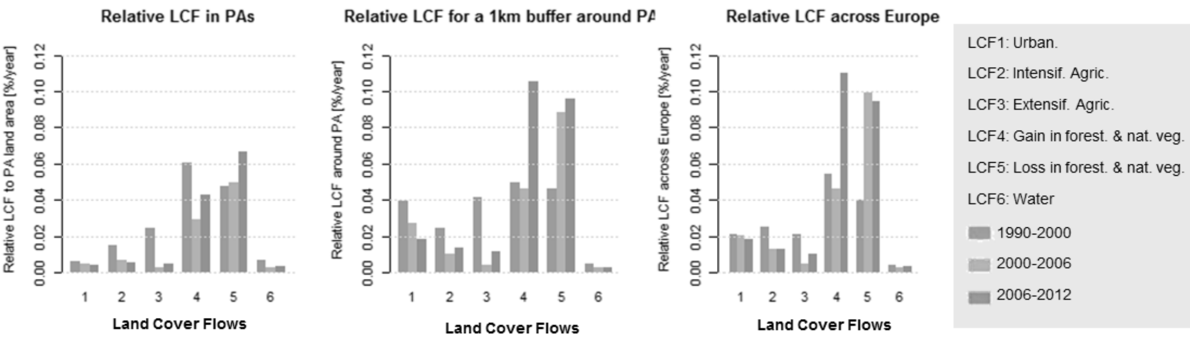

Figure 1: Mean rates of LCC for all six different LCFs within PAs, in a 1km buffer around PAs and across Europe for the periods 90-00, 00-06 and 06-12.

The two dominating LCFs vary considerably between IUCN categories (Fig. 2A) with absolute change adding up tremendously in particular for the large extent of areas protected on IUCN level V. Rates of changes normalized by the area covered by different levels of protection, however, are not exceptional for the IUCN categories V and VI, which both explicitly allow for human intervention to sustain the region and biodiversity (Fig. 2B). Gain of forest and natural vegetation is more similarly distributed between IUCN categories than loss, which is particularly low for IUCN categories Ia and Ib. Kruskal-Wallis and Dunn´s test confirm significant difference in land cover change between IUCN categories, as well as within and outside PAs.

Driving factors of land cover changes

First median regression models of potential driving factors indicate patterns to explain rates of change for LCF4 and LCF5. Significant contribution to explain both rates of land cover change include the elevation, IUCN categories, population density at NUTS 3 level, the national environmental tax as the share of GDP and latitude position of the PA. Significant explanation, thus, include factors from local, NUTS 3 and national level.

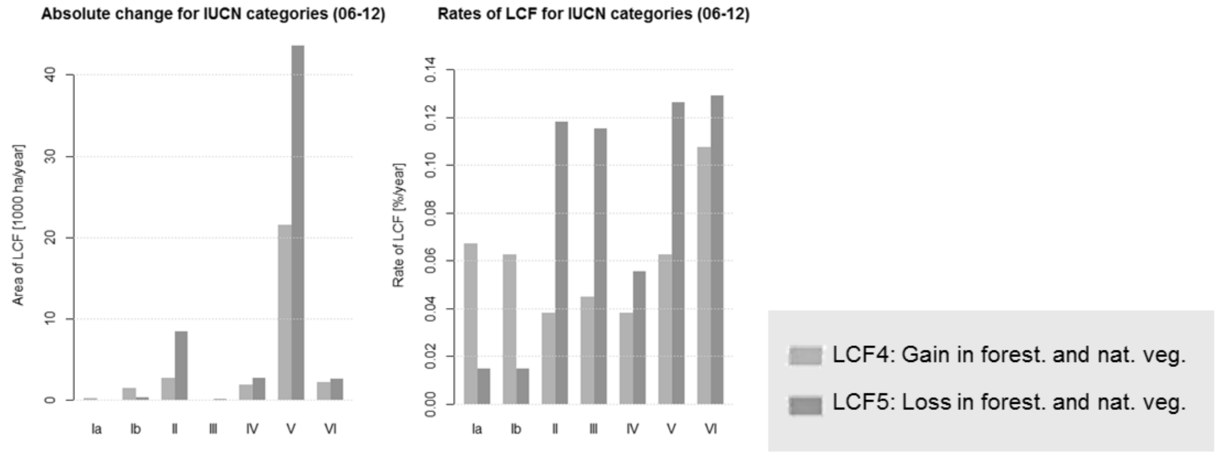

Figure 2: Rates of LCC for LCFs 4 and LCF5 (loss and gain of forest and natural vegetation) across IUCN categories for 06-12.

Scale	Variable	LCF4 Value	LCF4 Std. Error	LCF4 t value	LCF4 Pr(>|t|)	LCF5 Value	LCF5 Std. Error	LCF5 t value	LCF5 Pr(>|t|)
	(Intercept)	-0,0707	0,3245	-0,2178	0,8276	0,7042	0,3036	2,3193	**0,0204**
PA specific	Elevation (m)	-0,0004	0,0001	-4,7652	**0,0000**	-0,0003	0,0001	-5,3686	**0,0000**
	Slope (%)	0,0025	0,0018	1,4195	0,1558	0,0051	0,0019	2,6203	**0,0088**
	Marine fraction (%)	0,0146	0,0460	0,3163	0,7518	0,0037	0,0026	1,4165	0,1567
	Land area (ha)	0,0000	0,0030	-0,0161	0,9872	0,0000	0,0001	0,1923	0,8475
	Site area (ha)	0,0000	0,0030	0,0152	0,9879	0,0000	0,0001	-0,2148	0,8299
	Ann. rate of LCF4/5 (%/a)	3,0631	1,2173	2,5163	**0,0119**	1,6652	1,5762	1,0564	0,2908
	IUCNCATIb	-0,6177	0,1232	-5,0155	**0,0000**	-1,0524	0,1165	-9,0300	**0,0000**
	IUCNCATII	-0,8092	0,1007	-8,0364	**0,0000**	-0,5253	0,0913	-5,7540	**0,0000**
	IUCNCATIII	0,0201	0,1527	0,1316	0,8953	0,1984	0,1049	1,8906	0,0588
	IUCNCATIV	-0,0648	0,0649	-0,9979	0,3184	-0,2200	0,0643	-3,4185	**0,0006**
	IUCNCATUA	-0,6183	0,0873	-7,0831	**0,0000**	-0,3581	0,0869	-4,1215	**0,0000**
	IUCNCATV	-0,6959	0,0670	-10,3917	**0,0000**	-0,5242	0,0701	-7,4725	**0,0000**
	IUCNCATVI	-0,1084	0,1714	-0,6327	0,5270	-0,3496	0,1537	-2,2746	**0,0230**
NUTS 3 level	Population density	0,0001	0,0000	2,0814	**0,0375**	0,0003	0,0001	2,1169	**0,0343**
	Migration rate	0,0040	0,0052	0,7739	0,4390	0,0079	0,0033	2,3731	**0,0177**
NUTS 2 level	Population density	0,0002	0,0001	1,1163	0,2644	0,0000	0,0002	-0,0415	0,9669
	Migration rate	-0,0113	0,0066	-1,7152	0,0864	-0,0057	0,0052	-1,0907	0,2755
National level and higher	Environ.. Tax (% GDP)	-0,2761	0,0468	-5,8986	**0,0000**	-0,1578	0,0443	-3,5627	**0,0004**
	Latitude (°)	-0,0231	0,0045	-5,1237	**0,0000**	-0,0463	0,0047	-9,8619	**0,0000**
	Longitude (°)	0,0175	0,0037	4,6827	**0,0000**	0,0049	0,0026	1,8829	0,0598

Table 1: Summary of Median Regression Models for LCF5 and LCF4. Significant factors are indicated in bold for each model.

Discussion and outlook

CORINE LCC, as the one available pan-European land cover change monitoring programme, indicates dynamics in land cover within PAs that differ substantially from their direct surrounding and overall Europe. Dominating land cover changes are gains and losses of forest and natural vegetation. The observed changes are mainly from and to 'forest and natural vegetation', and confirm that development and changes in agriculture are minor within PA.

ICUN category and elevation above sea level and also regional parameter from the NUTS 3 and national level and higher are significant PA specific factors to explain rates of change,. The analysis, hence, shows that drivers for land cover change within European PAs can be identified at different scales.

Following up on these first results, we will assign land cover change to human intervention or natural processes, conduct more systematic testing of individual drivers and use hierarchical modelling for single groups of PAs.
For Pan-European land cover monitoring system of PAs, higher temporal and spatial resolution and better indication of natural disturbances and ecosystem degradation would be a powerful asset. Comparison with alternative data might give an indication about the robustness of CORINE and shortcomings due to the spatial and categorical resolution.

Acknowledgements

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Endemism below the species rank: Population genetics of the European Mudminnow (*Umbra krameri*)

Josef Wanzenböck

Keywords

mitochondrial DNA, microsatellites, Structure

Summary

Endemism is commonly handled on the level of species - an example is the theme topic of this session of the conference. However, biodiversity has an important sub-specific component, e.g. evolutionary significant units (ESUs) which are comprised of one or more populations. In fact, estimates of biodiversity loss due to population extinction are much higher compared to species loss (DICKMAN et al. 2007). Modern molecular genetic techniques shed new light on within-species diversity, starting with genetic variability of individuals, populations, ESUs and up to species (GEFFEN et al. 2007). Specifically population genetics and barcoding studies provide new information on the interplay of different levels of organization and contrast genetic with traditional, morphometric approaches (e.g. PALANDACIC et al. 2017). Here we provide an example of a population genetic study on the European mudminnow (*Umbra krameri*) analyzing the within-species genetic variability throughout the entire known rage of occurrence (MARIC et al 2017). The aim of the study was to test if the populations within the specie´s range are genetically uniform or if significant genetic structuring is present to warrant certain populations to be treated as unique and therefore endemic on a sub-specific level.

The European mudminnow (*Umbra krameri*) is a rare fish species with a relatively small total area of occurrence: It extends from Vienna in the west, through the Danube lowlands to the delta, including the Sava and Tisza River lowlands, and reaches the Dniester River in the east (WANZENBÖCK 1995). In Austria, the species occurs in only two habitats, one situated in the national park Donauauen (WANZENBÖCK & SPINDLER 1995). The species is specifically adapted to groundwater-fed waterbodies on the margins of floodplains and swamps and may serve as an indicator species of the ecological status of such critically endangered ecosystems (WANZENBÖCK 2004).

Mudminnows were sampled from 17 locations across the species natural distribution area (see Figure 1 in MARIC et al. 2017) and DNA extracted from fin clips. The mitochondrial protein-coding gene cytochrome b (1085 bp 3' -end) was PCR-amplified using GluF and ThrR primers and sequenced on an ABI Prism 3130xl machine. The genealogical relations between haplotypes were presented as a minimum spanning network (MSN) using the 95% statistical parsimony criterion in the TCS 1.2 program. Seven tetranucleotide microsatellite loci were amplified according to published protocols (WINKLER & WEISS 2009) and fragments analyzed on the ABI prism 3130xl machine. Software used to analyze the data included Gene-Mapper, Microchecker, Genetix 4.04, ADZE, SPAGeDI 1.3 and STRUCTURE (for details see MARIC et al. 2017).

The analysis of the mitochondrial cytochrome b gene revealed ten haplotypes. Their spatial distribution showed divergence of mudminnow populations according to the larger drainages: Populations in the Sava drainage showed exclusive haplotypes not found in the upper, middle or lower Danube (with one exception of the middle Danube close to the Sava mouth) or in the Tisza drainage. Similarly, populations in the Tisza drainage were composed of exclusive haplotypes not found anywhere else. The largest variety of haplotypes was found in the Danube delta (see Figure 1 in MARIC et al. 2017), however, most haplotypes dominating the populations in the upper and middle Danube were lacking in the delta.

Hierarchical STRUCTURE analysis of the microsatellite fragment length data revealed discrimination of a group consisting of populations in the upper and middle Danube, Drava, Mura and Lake Balaton from a group of populations of the lower Danube, Sava, Tisza and Dniester in a first division. Anyhow, already the second discrimination step allowed to distinguish populations of the Drava, Mura and Balaton area from populations of the middle and upper Danube, and within the latter group the population of Austria (Eckartsau) was clearly discernible from three other populations (see Figure 4 in MARIC et al. 2017). The third step of discrimination separated almost all the populations (with few exceptions).

In contrast to population genetic studies on a related species, the Olympic mudminnow (*Novumbra hubbsi*), which showed no genetic structure on the mitochondrial (mt) haplotype level, such structuring was clearly evident in the European mudminnow. Genetic structuring on the mt haplotype level coincided with the drainages of the Danube, Tisza and Sava i.e. the largest sub-drainages in the Danube system. Therefore, these three phyletic lineages could be considered potential evolutionary significant units (ESU). On the other hand, the uneven distribution of microsatellite polymorphism among the small sampled populations and high genetic structuring within each of the three phyletic lineages may not reflect a natural evolutionary process but rather random drift governed by recent habitat fragmentation as a result of human impact (e.g.damming).

Therefore, caution should be taken when delineating ESUs on the basis of microsatellites, as these markers known for their high mutation rate and neutral evolutionary history are likely to result in excessive splitting of populations and are generally inadequate for characterizing adaptive patterns. However, the Austrian population at Eckartsau, from the national park Donauauen, was found to be genetically different based on the STRUCTURE analysis very early in the hierarchical splitting procedure. This indicates that the Eckartsau population is unique on a sub-specific level and may be regarded as an endemic form or strain, warranting the status of a true biodiversity treasure in Austria.

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National parks and Natura 2000 sites in Polish Carpathians vs local people: changing attitudes within the past 10 years

Agata Warchalska-Troll

Abstract

National parks and Natura 2000 sites are very different types of PA's, however, with their very formalized status within the Polish law, they often attract conflicts with local communities. Based on several in-depth case studies (interviews, queries of official documents as well as press) I am going to compare and contrast parks and Natura 2000 sites' 'conflicting potential' in the very specific context of mountains. In these vulnerable areas, factors starting from topography, through land use and land ownership, and finally culture and personalities of local leaders, are much more visible.

Keywords

national parks, Natura 2000, Carpathians, local development

Introduction

Similarly to Western countries, also in Poland we can observe the so-called paradigm shift in nature protection (RODARY & CASTELLANET 2003; MOSE 2007), especially in case of national parks. The idea behind the establishment of first Polish nature protection sites (dating back to the 1920s and 1930s) came from Polish scientific as well as artistic environments. It is worth to be mentioned that that it was strongly rooted not only in the interest in flora and fauna of the country, but also in the fascination of local people's culture and tradition, as well as cultural landscape, especially in the mountains. Local leaders were in many cases supporters and partners for nature protection activists. This tradition of an inclusive approach and cooperation was then neglected in the communist, afterwar period, when nature protection sites were established in a totally top-down manner and with no respect for compensations. National parks entered the new, democracy era at the beginning of the 1990s with a heavy 'baggage' of local people's regrets and feelings of injustice. Since then, many effort was put by the both sides in managing conflicts and seeking compromises which in many cases resulted in starting cooperation in promotion of regions and involvement in common events and projects. However, once the weak stabilization in these complicated relationships between parks and people was achieved, a new and important circumstance appeared: the Natura 2000 network was established in Poland when the country became a EU member in 2004. Implemented quickly and often based on outdated materials, and most of all – without a proper information campaign or large-scale consultation – the network evoked many conflicts. Although problems of such kind were also reported from other countries (HIEDANPÄÄ 2002; VISSER et al. 2007; GRODZIŃSKA-JURCZAK & CENT 2011), here the previous bad experiences with national parks added to unfavourable context for the new type of protected area. At the same time, an interesting dichotomy in perception occurred in areas where both types of protection exist. Finally, the past decade of 'living with Natura 2000' brought about, among other things, the challenging process of creation, consultation and implementation of the so-called 'management action plans' (MAPs) for the bird and habitat sites. Although this process is not finished, we can try to summarize its first phase.

Aim and area of the study, research questions

The aim of this study was to define areas of conflicts connected with national parks and Natura 2000 sites and their evolution within the past decade in the Polish Carpathians. In this region, 6 national parks and 40 Natura 2000 sites with already working MAPs can be found. The following research questions have been formulated:

- what are the fears and concerns of local communities compared to real limitations that protected areas bring?
- what is the 'conflicting potential' of national parks and Natura 2000 sites in mountain conditions?
- what is the role, in this context, of economic relationships between parks and local/regional enterprises?

Methods and data sources

The research aim and questions were addressed through 6 case studies of local communities located in the vicinity of chosen national parks and Natura 2000 sites. The sites represent different historical and cultural backgrounds, as well as diverse population density and economic features. In each case, several field trips to the area, 55 in-depth interviews with local and regional stakeholders along with queries of local documentary were conducted. Moreover, the MAPs for 40 Natura 2000 sites were studied in details and analyzed in what concerns: identified pressures and threats to the subjects of protection, recommendations to local and regional legal documents as well as remarks and comments formally raised by interested parties during the public consultation process. Additionally, protocols from public consultation's meetings and local press were taken into consideration. Another important source of information about the impact of Natura 2000 on local development was the database of administrative decisions made by the Regional Directorates for Environmental Protection (RDEPs) in three Carpathian voivodeships (provinces) of Poland (Silesia, Malopolska and Podkarpacie), for the period 2009-2016 (RDEPs were established at the end of 2008). As for the data sources concerning national parks, a query of their protection plans (or plans' projects, respectively), annual reports and chronicles, and finally, the documentary of public consultation process were investigated.

The main part of the research was conducted between 2014 and 2017, though thematically covering all the period of Natura 2000 presence in Poland.

Main findings and results

When Natura 2000 was introduced in Poland, it was perceived as new threat to development of tourism and recreation and the return to management of land without consulting its inhabitants, as it was performed in the communist period and also in case of national parks right after their establishment. Some people even spoke about the violation of right to private property, as Natura 2000 also largely included private lands (KAMAL et al. 2013). Local and regional media eagerly pumped up the growing conflicts, as in case of communes like Zawoja or Szczawnica. Another fear that was broadly expressed, concerned possible obstacles for developing built-up areas. With such mixed feelings, the communities entered the hard process of negotiations and consultations within the framework of MAPs preparation. The analysis of their documentary shows that after several years of living with Natura 2000, to focus of stakeholder's concerns changed. Issues like tourism and development of built-up areas were represented only in case of 15% and 7% of the plans, respectively, while issues like possible limitation of forestry and obstacles concerning streams' regulation were expressed in 1/3 of plans. This picture is to high extent concise with the results of identification of possible pressures and threats to the subjects of protection that was a part of the part of the procedure of preparation of MAPs (Fig. 1). While the pollution and trashing were mentioned as an existing threat in most of the plans, forestry occupied the second place and the category of hydrotechnical investments was also among the important ones. When it comes to main recommendations that MAPs imposed on local and regional policies, they seem relatively low impactful and generally formulated, as most of all they required: 1) the maintenance of ecological corridors (that is, the maintenance of current land use in particular places), 2) implementing the general information about the existence of Natura 2000 site on the territory of the commune/region and 3) the necessity of agreement with a RDEP in case of certain types of investments, possibly dangerous for the nature. The analysis of administrative decisions made by RDEPs also rests in contrast to the initially expressed fears about 'not being able to build up a house on one's own parcel', as such decisions were limited to very specific cases. For instance, in Małopolskie voivodeship (province) only 1% of such cases ended up with rejection (no agreement for realization of an investment), while 75% of them were accepted even without any additional procedures.

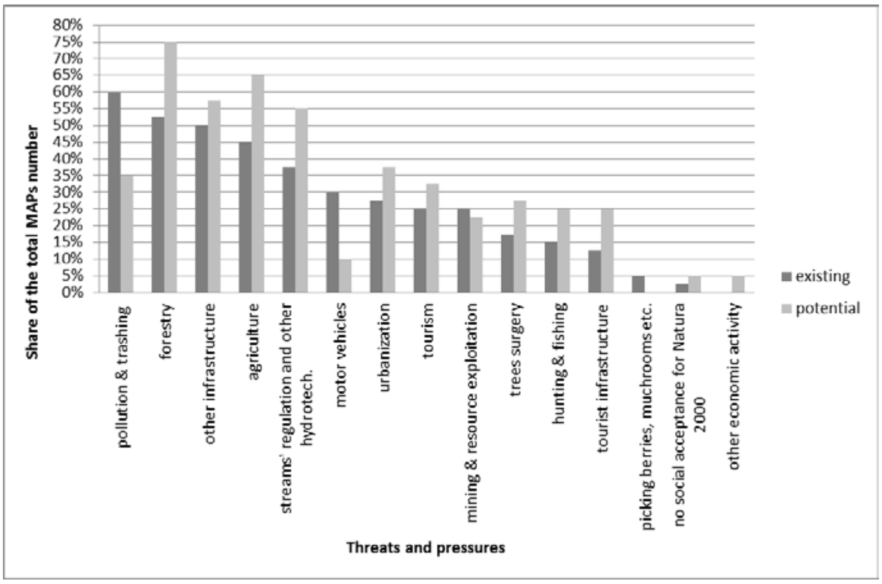

Figure 1: Pressures and threats to the subjects of protection identified in management action plans (MAPs) for 40 Natura 2000 in the Polish Carpathians, expressed as share of MAPs where a given category was present; Source: own elaboration based on MAPs

As for the national parks, especially after the implementation of Natura 2000 network, their image in local communities improved. Although some conflicts still exist (e.g. concerning urbanization pressure in particularly landscape-attractive places), the parks' involvement in promotion and social activities on the ground are generally appreciated. The interviews show that this positive 'added value' is especially visible in communities with strong identity, trying to build their brand on local traditions and natural resources such as landscape, arts and crafts or ecological agriculture. Last but not least, parks as institutions operating directly in place, are in many cases also important business partners and employers on the local and regional scale (Fig. 2, MIKA ET AL. 2015)

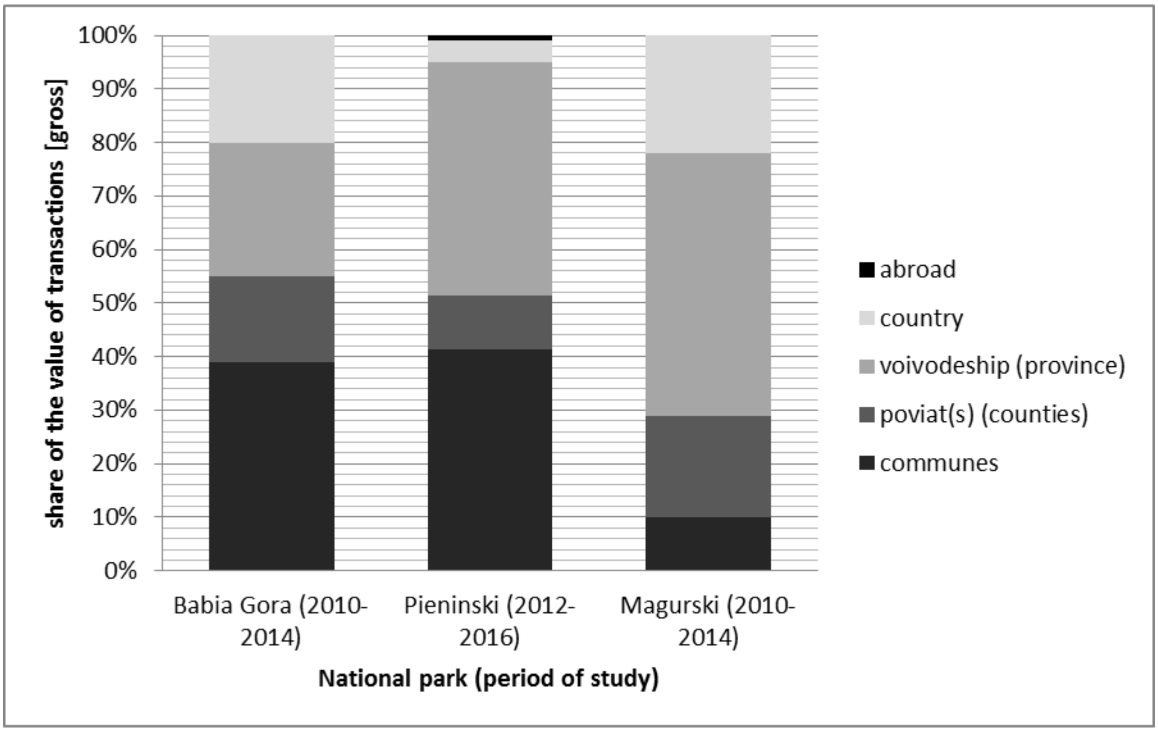

Figure 2: Share of the gross transactions value in case of purchases made by selected national parks in the Polish Carpathians, according to administrative levels; Note: commune level = commune(s) where a chosen NP is located, poviat (county) level = the poviat where a chosen NP is located, excluding 'park commune(s)'. Source: own elaboration based on data provided by the NPs (Pieninski, Magurski) and in case of Babia Gora NP Mika et al. (2015).

Conclusion

In conclusion, we have to point out that the main initial fears towards Natura 2000 network expressed by mountain communities in the Polish Carpathians did turn into reality. This obviously does not mean that the fields of conflict do not exist, but they concern usually rather forestry and streams' regulation than tourism and urbanization. Although local communities slowly learn how to deal with this type of protected areas, it seems rather unlikely that they will occupy a place similar to national parks in local environments in terms of social, cultural and economic coexistence and development.

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Population density and habitat preferences of the Collared Flycatcher (*Ficedula albicollis* Temminck, 1815) in floodplain forests – A case study from the Donau-Auen National Park, Lower Austria

Barbara M. Waringer, Karl Reiter, Christian H. Schulze

Abstract

The Collared Flycatcher (*Ficedula albicollis*) is one of a few insectivorous long distance migrants with a slightly positive population trend. In spring 2015 we examined habitat preferences of a population in the Donau-Auen National Park. Singing males were counted at randomly chosen points in six survey rounds. Additionally, possible breeding competitors and/or cavity providers, woodpecker holes, standing dead wood, flying insects, vegetation parameters (forest surface roughness, forest type, forest age) and landscape variables (distance to water bodies and open land) were recorded. A model selection approach was used to identify important factors for territory presence. 57% of the points contained territories resulting in a population density of 7.28 territories/10 ha in the sampling area. The Distance Sampling -Method estimated similar or even higher densities. Forest surface roughness was the best predictor for territories; also, presence of Great Spotted Woodpecker, cavity availability and dead wood stems had an impact. Territories with higher surface roughness showed a tendency to early establishment. As forestry measures were stopped just 20 years ago and canopy roughness increases with stand age, the habitat quality of the remaining Danube floodplain forests east of Vienna for Collared Flycatchers will likely remain similar or even increase in the mid to long term.

Keywords

cavity breeder, forest structure, playback, territory establishment, canopy surface roughness, deadwood

Introduction

In terms of disturbance, edge-richness and productivity, floodplain forests offer diverse opportunities for birds (Brawn et al. 2001; Iwata et al. 2003) and are important habitats for woodpeckers and secondary cave-breeders (Remm et al. 2006) like the Collared Flycatcher (*Ficedula albicollis*, Temminck 1815, Muscicapidae). This small, insectivorous, long-distance migrating, facultatively polygynous passerine has a mainly Eastern European distribution (Bauer et al. 2012; BirdLife International 2004). It returns from its wintering grounds in tropical Africa earliest by end of March; most of the individuals arrive at their breeding areas by mid-April up to May and leave earliest by June. Cavities are occupied and defended by the earlier-arriving males and are shown to the later arriving females. The conservation status is NT on the Austrian red list of endangered species; on the EU's Birds Directive, the species is listed on Appendix 1, Spec E (Bauer et al. 2012; Sachslehner 1995; Lundberg & Alatalo 1992; Löhrl 1951). Natural-cavity breeding populations are regarded to be threatened on a long-term scale due to land use (e.g. Sachslehner 1995).

This study was conducted in the the Donau-Auen National Park southeast of Vienna. It covers one of the last free-flowing sections of the Danube river and its surrounding floodplain forests hold a substantial proportion of Austria's Collared Flycatcher population. We addressed the following questions, assuming that in high quality habitats territories will be established earlier than in less suitable habitats: (1) In what order are the territories established? (2) What are the most important features of a high-quality habitat? (3) Is there a relationship between early territory establishment and habitat variables such as distance to water and insect density?

Methods

From April 3-May 24, 2015 multiple 5 min counts were done at 147 randomly chosen points. Each point was visited six times to document the order of territory occupation by Collared Flycatchers. Tits, European Nuthatches and woodpeckers were additionally counted to consider their potential role as breeding competitors and/or cavity suppliers.

At the points, we measured standing dead wood, counted woodpecker holes and estimated the density of flying insects. Forest type (soft wood vs. hard wood forest) and forest age were obtained from data provided by Österreichische Bundesforste AG and the governmental unit MA 49 of the province Vienna. Distance to water bodies and to open land was calculated using ArcGis 10.2. Forest surface roughness (standard deviation of mean vegetation height in a radius of 50 m) was obtained from data from a LiDAR surveying flight (available for 111 points). We used a model selection to detect important factors for territory establishment (generalized linear models with territory incidence as response variable).

Results

Collared Flycatchers are very abundant in the survey area and could be observed at least once at the majority (87.8 %) of points. The first individual was observed on April 4, the main arrival started in mid-April. At 57 % of our census points, we found a total of 84 territories within a 50 m radius resulting in a population density of 7.28 territories per 10 ha. Estimates based on the Distance-Sampling method (e.g. LLOYD et al. 1998) support even higher densities. Forest surface roughness was the best predictor for the occurrence of territories (Fig. 1); a higher surface roughness increased the probability for territories. Other important factors were the presence of Great Spotted Woodpeckers (negative effect), cavity availability (positive effect) and standing dead wood (negative effect).

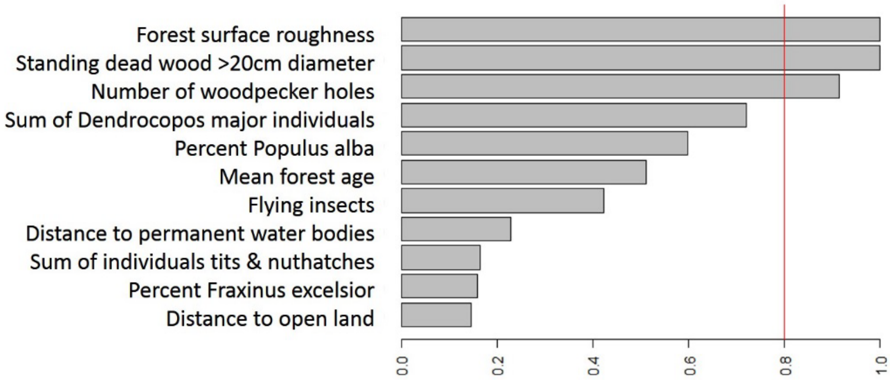

Figure 1: Model averaged importance of terms for predicting the occurrence of Collared Flycatcher territories.

There was a tendency of earlier territory establishment at points with higher surface roughness compared to those with a more homogenous tree layer (Fig. 2).

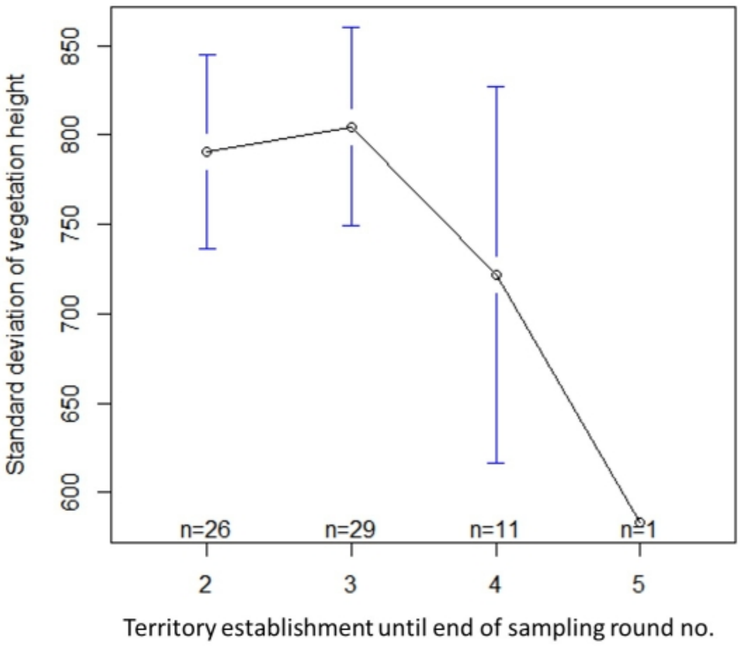

Figure 2: Mean surface roughness at territories with different establishment-time.

Discussion

The observed density of 7.28 territories per 10 ha in the riverine forests southeast of Vienna is surely exceeding the Central European average. Since the 1980ies, the population seems to be stable in the lower Austrian Donau-Auen (1983: 1.8-7.3 territories/10 ha, WINDIG & STEINER 1988).

A clear relationship between food supply, distance to water bodies and habitat quality, as documented for other flycatcher species (IWATA et al, 2003), could not be found in this study. Canopy surface roughness as best predictor for Collared Flycatcher occurrence could be an indicator for the primevalness of forest stands and is mirroring the management history, respectively. The higher light influx at forest sites with higher surface roughness could offer better foraging opportunities for Collared Flycatchers. Potential breeding competition with tits and European Nuthatches (*Sitta europaea*) had little effect, at least at the spatial scale of our study. However, as known from long term-studies from Poland, competition plays a minor role in near-natural systems (e.g. WESOŁOWSKI 2003).

Conclusion

Our study shows not only the great importance of riverine forests for Collared Flycatchers but offers hints on the high potential of remote sensing data for habitat analysis of forest bird species. In the Donau-Auen floodplain forests, which are protected since 1996, the population of Collared Flycatchers could even increase in the following years as more suitable habitats may develop due to the implemented process-orientated conservation approach. Canopy roughness – a factor most likely related to forest age and floodplain dynamics – was identified as the most important factor for predicting the presence of territories. Hence, the Collared Flycatcher could be a reliable indicator for monitoring the conditions of floodplain forest ecosystems.

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Interactive web services for landslide and habitat monitoring

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Abstract

In this study we introduce a prototype of an interactive web service for semi-automatic landslide analysis using Earth Observation (EO) data. The web service consists of four subservices for (1) landslide mapping, (2) monitoring, (3) validation, and (4) infrastructure analysis to identify landslide-affected infrastructure. In addition, we adapt the concept of the existing solution for habitat mapping and monitoring. The presented examples show that the interactive web service has the potential to support the efficient management of the environment in protected areas.

Keywords

Landslides, Habitats, Monitoring, Interactive Web Services, Semi-automated Object Delineation, Earth Observation (EO)

Introduction

The currently ongoing biodiversity crisis is primary caused by the destruction, deterioration and fragmentation of habitats (GROOM et al. 2006). Therefore, monitoring and reporting on the state of nature gained increasing importance in the European Union, for example with the implementation of the Habitats Directive and the Natura 2000 network (VANDEN BORRE et al. 2011). An interactive web service for semi-automatic habitat mapping based on Earth Observation (EO) data could ease the process of habitat delineation and monitoring.

The prototype of such a web service with functionality for semi-automated object delineation and classification, web-processing and service provision of geo-information has been developed in the FFG ASAP project Land@Slide (2015-2017; http://landslide.sbg.ac.at; HÖLBLING et al. 2016a) which focuses on mapping and monitoring of landslides. One goal of the service is to effectively manage geographically distributed landslide datasets and to promote the interaction between various users and stakeholders. There exist several local/national databases and platforms which provide and publish data of different types of landslides as well as web-based risk maps and decision support systems. Also, the European Commission implemented the Copernicus Emergency Management Service (EMS; http://emergency.copernicus.eu) in 2015 that publishes information about natural and man-made disasters and risks. The Land@Slide project goes beyond the provision of information products and developed a web service for landslides that considers user needs and requirements (cf. ALBRECHT et al. 2016; WEINKE et al. 2016) and that enables the user to semi-automatically map and monitor landslides based on EO data.

The question is if the existing functions of the interactive landslide web service also allow the delineation and monitoring process of habitats. The presented research deals with adapting the concept of the existing landslide web service solution for habitat mapping and monitoring with the aim to support the efficient management of the environment in protected areas.

Methods

An incremental and iterative approach was used for the design and development of the WebGIS platform and the interactive landslide web service (see WEINKE et al. 2016). The requirements on the system and the service were derived from the project goals and the concrete user needs (see ALBRECHT et al. 2016). Four central main modules were designed and developed for the landslide service:

1. a mapping module (including image segmentation, classification and editing approaches),
2. a monitoring module to monitor changes over time,
3. a validation module to analyze landslide delineations from different sources and
4. an infrastructure module to identify landslide-affected infrastructure.

The two modules mapping and monitoring are tested for applicability for habitats. In the current version of the prototype, the multiresolution image segmentation approach available within the eCognition software (Trimble Geospatial) is used for creating image objects. For the classification of the segmentation-derived image objects selected statistical classification algorithms (e.g. Random Forest) from the Waikato Environment for Knowledge Analysis (Weka) machine learning software are included, whereby user-selected training samples serve as input. The monitoring and validation process is based on an area comparison approach between two or more mapping results.

Results

Fig. 1 shows the overview map of the first version of the web-based Land@Slide platform. Selected mapping examples are used to demonstrate the functionality of the service within four scopes: EO Data Selection, Classification, Validation and Infrastructure Analysis. For the test sites, optical satellite images from different sensors (e.g. Landsat, Sentinel-2, SPOT-5, WorldView-3), including time series, are currently integrated. Fig. 1 shows the semi-automated landslide mapping result of the test site Fürwag/Haunsberg (Salzburg, Austria) for the year 2002, which shows a good coincidence with the manual mapping result that is used as reference for validation. The semi-automated delineation is based on a Landsat 7 scene (30m spatial resolution), a digital elevation model (DEM; 10m) and the derived slope. For more details about the landsite delineation and validation see HÖLBLING et al. (2016b) and HÖLBLING et al. (2017).

Figure 1: Land@Slide service overview map – test site Fürwag/Haunsberg (Salzburg, Austria). Landslides are semi-automatically delineated using a Landsat 7 scene from June 2002 and compared to manual mapping results.

In Fig. 2 the scope New Analysis of the web platform is shown. This scope allows users to conduct their own analysis and contains the following main functions: Mapping (including segmentation, classification, editing landslides), Monitoring, Validation and Infrastructure Analysis. Fig. 2 shows a sample of a coniferous forest habitat on satellite images from 2005 and 2015. The habitat is situated in the Berchtesgaden National Park (Germany) and represents a mountainous area, characterized by high habitat diversity. The semi-automated habitat delineation for the year 2005 is based on a pan-sharpened QuickBird scene (spatial resolution: 0.61m panchromatic band; 2.4m multispectral band) acquired in August 2005 (see PREINER et al. 2006; WEINKE et al. 2006; WEINKE et al. 2008). For the semi-automated delineation for 2015, a Sentinel-2 scene (10m spatial resolution) was used.

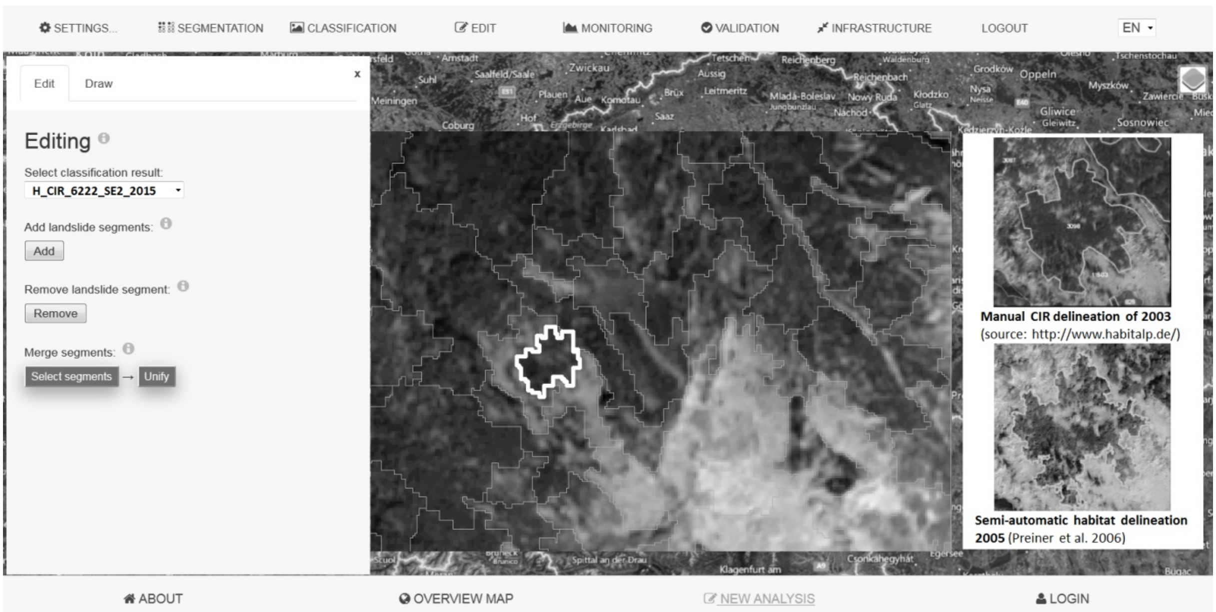

Figure 2: Land@Slide service New Analysis scope – delineation of a coniferous forest habitat on satellite images from 2005 and 2015 including a manual CIR (color-infrared) aerial photograph delineation of 2003 in the test site Berchtesgaden National Park (Germany).

Discussion and Conclusion

The examples presented above show that the tools of the interactive web service, which were developed for landslide mapping, are also able to support the delineation and monitoring process of habitats. This included the delineation of different habitats, their classification and the comparison to other datasets such as reference maps. The quality of the mapping results substantially depends on the spatial resolution of the used EO data. However, this is a general issue; the web service itself is capable to integrate EO datasets of various resolutions and from different sensors.

In a next step, experts (from national parks, etc.) could be included in a process to validate the service for specific scenarios of habitat mapping and monitoring. The feedback could be used to develop a customized interface for habitat analysis.

The Land@Slide platform is developed mainly based on a range of free and open source technologies and widely used open standards (e.g. from the Open Geospatial Consortium). Only for image segmentation the commercial software eCognition is used. It is planned that the service will be entirely developed using open source technologies to ensure interoperability among and between components and to reduce costs.

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The Social Construction of Nature, an explorative investigation of the constructed meaning of Nature within four national park exhibitions in Austria and Germany

Sarah Wendl

Abstract

Inspired by the theoretical framework on the social construction of reality by BERGER AND LUCKMANN (1991), this master thesis investigates the concept of nature constructed in four National Park exhibitions in Germany and Austria. Based on the sociology of knowledge approach towards discourses, introduced by KELLER (2011), this thesis illustrates how four different discourses structure the meaning of nature displayed in the exhibitions: nature is portrayed from a scientific, in a sustainable and in historical perspective and as something that can be experienced. Since the discourses have been created through social practices that influence and at the same time are influenced by the social order, the thesis also illuminates the complex dialectic relationship between social norms and social practices. Common beliefs are reinforced, but at the same time also questioned by the exhibition practice. By drawing attention to the variety of manners for presenting nature, experts in this field can become more aware of the range of possibilities.

Keywords

Social Construction of Reality, Concept of Nature, National Parks, Exhibitions

Introduction

What is nature? For centuries, people have been arguing and discussing about our understanding of nature, about its value and the way mankind should treat or manage it. Today, facing global warming and other environmental problems, a deeper discussion about our understanding of the concept of nature seems more necessary than ever. Instead of arguing for a specific understanding of nature, this thesis focuses on a different approach. It follows the social constructivist idea, that our understanding of nature is not a given thing, an unchangeable fact, but rather a socially constructed concept. Our idea of nature changes with our social practices and thus goes hand in hand with our social interaction. In order to be able to grasp our current understanding of nature, one has to take a closer look into current practices. National Parks, as natural heritage sites, have always been an important influence on the idea of nature and therefore provide an excellent research field. Their practice and especially their communication with the public are of particular interest while investigating the social construction of nature.

Consequently, the research aim of this thesis is to explore the current meaning of nature constructed by four National Park exhibitions. Furthermore, it also wants to illuminate the manner in which certain understandings of nature get created and socially established at the first place. For this reason, the explorative research design is based on the theoretical framework of BERGER AND LUCKMANN (1991) and the sociology of knowledge approach towards discourses introduced by KELLER (2011).

Theoretical Framework

One of the most influential works within the field of social constructivism is ‘The social construction of reality’ written by BERGER AND LUCKMANN (1991). The emphasis is set on the shared common knowledge within our society. Instead of taking this knowledge for granted, Berger and Luckmann depict the manner in which it gets created and reproduced via social interaction. Through the fact that it is shared with others and applied in our daily lives, this knowledge gains its validity. In our upbringing, we internalize this shared knowledge by participating in society. It consequently shapes our lives on a daily basis: it guides the way we think, behave and interact with each other and the environment (BERGER & LUCKMANN 1991). In short, the knowledge we experience shapes our perception of reality and structures our worldview.

At the same time, the knowledge is reproduced continuously through our social interaction and is thus subject for constant change. Experts and big institutions have due to their stand in society a certain power to shape the social practices. Nevertheless, they are also bound by the social norms in order to ensure their legitimation.

Method and Research Design

The research design is based on 'The sociology of knowledge approach to discourses', introduced by REINER KELLER (2011, 2013). This method combines social constructivism in respect to Berger and Luckmann with the method of discourse analysis, mainly based on Foucault (KELLER, 2013). The term discourse is thereby defined as communicative pattern, including all types of media that structure our knowledge (KELLER 2011, 46). The database consists of the National Parks exhibitions of the two Parks, National Park Berchtesgaden (2016) and National Park Hamburg's Wadden Sea (2016) in Germany as well as the exhibition of Parks National Park Gesäuse (2016), National Park Hohe Tauern (2016) in Austria. All parks have been visited, observational and textual analyzed with the help of an open coding system.

Results

The four case studies illustrate different ways to present nature. Each of them illustrates a unique setting and storyline, but all of them depict nature in various ways, if you look closely on their details. Nature is portrayed as something we use, transform, master, experience, protect and admire. Other examples show that humans also depend on nature, are threatened by it or encounter it as a bigger system of which humans are only a small part. This illustrates the complexity of the current construction of nature, as the different parts within the same exhibition convey different understanding of nature, which sometimes even contradict each other.

Despite the differences, there are still some common features, which can help to develop a better understanding about the involved and socially rooted discourses. The following four discourses have been identified in the analysis:

- Scientific Understanding of Nature
- Sustainability Approach towards Nature
- Historical Development
- Nature as Experience

Discussion

The similarities within the exhibitions also indicate the way social norms influence the current practice. Linking back to the theoretical framework, the discussion illuminates how the institutional setting shapes the content of the exhibition.

Berger and Luckmann stress that every institution is also a product of its history (BERGER & LUCKMANN, 1991). For this reason, the tradition of representing nature in museums, the IUCN guidelines as well as the fact, that the National Park concept has emerged in the US, structures the way nature is presented. The reason for this is that those institutional settings have created a certain guide of conduct.

At the same time, the investigation highlights the dialectic process between the objectivated social order and its constant ongoing human production. The reproducing of social order can be seen as stabilizer, but also as a driving force for social change due to their dialectic relationship. The examples show how new ideas about nature and nature conservation get integrated in social practice. Social institutions may change in order to make them more legitimate by adapting to upcoming new ideas or changing circumstances. Special attention is thereby drawn to the expert involved in the creation of exhibitions. With the choice of content and the general arrangement, the National Park administration can decide what knowledge is presented and how it is displayed. Consequently, they can influence to a certain degree the way nature is constructed within their work. Although this is a powerful position, it is important to keep in mind, that the production of reality is always a social process.

Conclusion

The thesis illustrates how the discovered common beliefs are reinforced in some parts of the exhibition, but also questioned in other parts of the exhibition. This demonstrates the possibility to portray and understand nature in various ways. With the different discourses of nature in mind, experts can become more aware of their possibilities to influence the way knowledge about nature is produced and transmitted. At the same time, it is important to keep in mind that the concept of nature is an abstract, changeable, but socially defined concept. In order to establish a new understanding of nature, a broader discussion about the social norms limiting the practice is also necessary.

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<u>Exhibitions</u>

Nationalpark Berchtesgaden, visited March 18, 2016
Nationalpark Zentrum Haus der Berge
Exhibition: Nationalpark-Ausstellung, Vertikale Wildnis, Mensch & Berg
Hanielstraße 7
83471 Berchtesgaden, Germany

Nationalpark Gesäuse, visited April 14, 2016
Naturhistorischen Museum des Stift Admont
Exhibition: Leidenschaft für Natur
In the Benediktinerstift Admont
Bibliothek & Museum
8911 Admont, Austria

Nationalpark Hamburgisches Wattenmeer, visited March 9, 2016
Nationalpark-Haus Neuwerk
Exhibition: Nationalpark-Ausstellung
27499 Insel Neuwerk, Germany
www.nationalpark-wattenmeer.de

Nationalpark Hohe Tauern, visited April 21, 2016
Nationalparkzentrum
Exhibition: Nationalparkwelten
Gerlosstr. 18
5730 Mittersill, Austria

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Bat activity above 3000 m in the Austrian Alps (Hoher Sonnblick, 3106 m)

Karin Widerin & Guido Reiter

Keywords

Chiroptera, National Park Hohe Tauern, high altitudes, phenology, bat migration

Summary

During the last few years (2013 to 2015) we investigated the migratory behaviour of bats throughout the Alpine Arch. A rather surprising result was that a large number of bats crosses the Alps at an altitude of up to 2500 m. Subsequently, we wanted to know up to which altitude bats can be detected in the Central Alps.

Thus, we investigated bat activity on top of Mt. Sonnblick at an altitude of 3106 m.a.s.l. during the years of 2014 and 2015. This mountain top is located in the South of the province of Salzburg and it is part of the main Alpine Arch. Extreme weather conditions, glaciers and rocks with very rare fragments of vegetation characterize the investigated site and hence, this habitat seemed totally unsuitable for bats.

Bat activity was monitored by automated recording of bat calls (batcorder, ecoObs, Nuremberg) during September and October 2014 and permanently from March to November 2015.

Contrary to our expectations we found bat activity from mid-April to mid-September. There was a little peak of activity in spring, however, the main activity was detectable during August and September. Among the recorded species were all long-distance migrants of Europe, namely *Nyctalus leisleri*, *Nyctalus noctula*, *Pipistrellus nathusii* and *Vespertilio murinus*, but also sedentary species like *Eptesicus nilssonii* and species with more or less unknown migratory behaviour like *Pipistrellus pygmaeus* were found.

Bat activity was strongly linked to milder weather conditions, but activity was still found at relatively high wind speeds up to 11,4 m/s and temperatures as low as –2,5°C.

Based on our findings, we strongly emphasize, that bats and their conservation are considered if wind farms are planned at high altitudes and furthermore, that measurements applied at lowlands have to be reconsidered at high altitudes.

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'Unterer Eisbodensee' - a good example for the future evolution of glacial lakes in Austria?

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Abstract

Lake Unterer Eisbodensee, located in Stubach Valley, Hohe Tauern National Park, Austria, is a good example for one of the most visible consequences of climate change in high alpine areas, i.e. the formation of glacial lakes. The visual appearance of its 1.66 km^2 catchment has, due to glacier retreat, dramatically changed since the lake first appeared at the terminus of Stubacher Sonnblickkees in 1987.

Repeated terrestrial laser-scanning and bathymetry using dGPS and echo-sounders mounted on an inflatable boat, showed that the lake doubled its surface area to 6,6 ha between 2010 and 2016 and the lake's calculated maximum extension, based on subglacial DEMs interpolated from GPR data and bathymetry in 2011, has now almost been reached.

During the same time span, the volume almost multiplied fourfold whilst the maximum depth increased from 20.4 m to 27.1 m. The volume of the lake will gradually be reduced by sediment input in the next decades, but due to the gneiss bedrock and the morphology of the catchment, not as fast as other newly-emerged glacial lakes e.g. Obersulzbach See, which first appeared in 1989.

Time series from the automatic gauging stations have shown a slight change in discharge and temperature patterns since the beginning of observations in 2002. This is mainly due to a reduced proportion of the glaciated catchment area. In order to investigate alterations in the pristine freshwater system, repeated hydro-biological probing will be carried out in the future.

Keywords

Glacier retreat, glacial lake, climate change, hydrology, discharge, sediment, Hohe Tauern

Introduction and aim

Monitoring and analysing the water cycle of glaciers and lakes in high alpine regions is, amongst others, one of the main tasks of the Hydrological Service, especially as lakes and headwaters are faced with severe environmental changes at present e.g. rising water temperatures and possible discharge regime changes.

New proglacial lakes, like Unterer Eisbodensee, can also have a great influence on the downstream geomorphological system, due to discharge modifications, decoupling effects, sediment trapping and long-term sediment storage.

They also represent the development of new pristine freshwater ecosystems and therefore, hydro-biological probing and monitoring was also of interest in the multidisciplinary monitoring programme.

Study site

Unterer Eisbodensee, located in the Hohe Tauern Range (Eastern Alps) in the south of the Province of Salzburg, lies within the boundaries of Hohe Tauern National Park. Stubacher Sonnblickkees, a small east-facing slope glacier with an actual size (2016) of 0.93 km^2 compared to 1.7 km^2 in the 8Os, has an important influence on the lake's hydrology.

The first signs of this new proglacial lake appeared in 1987 and in 1990 it was surveyed and outlined on the map 'Granatspitze' scale 1: 5000 (SLUPETZKY 1997).

In 2009 around 70 percent of the lake's total catchment area of 1. 66 km^2 was covered by glaciers (WIESENEGGER & SLUPETZKY 2009).

Methods

Several interdisciplinary methods were used to monitor and analyse the various ongoing processes at Unterer Eisboden See:

– Geodetic survey to determine lake surface area (1994)
– Repeated terrestrial laser-scanning (since 2003)
– Repeated GPS surveys of the terminus of Stubacher Sonnblickkees and the shoreline of Unterer Eisboden See (since 2003)
– Simple bathymetry by means of a perpendicular (1998)
– Bathymetry using dGPS and echo-sounders mounted on an inflatable boat (2010; 2016)
– Subglacial DEMs based on ground penetrating radar (GPR) measurements of SSK (2010)
– Water temperature, conductivity, water level and discharge registration at automatic gauging stations (since 2002)
– Hydrobiological sampling to assess biocenosis and ecosystem development (2010)

Results

Due to glacial retreat of Stubacher Sonnblickkees, the proglacial lake has continuously increased its size (Fig. 1) and volume since it first appeared in 1987 (Tab. 1).

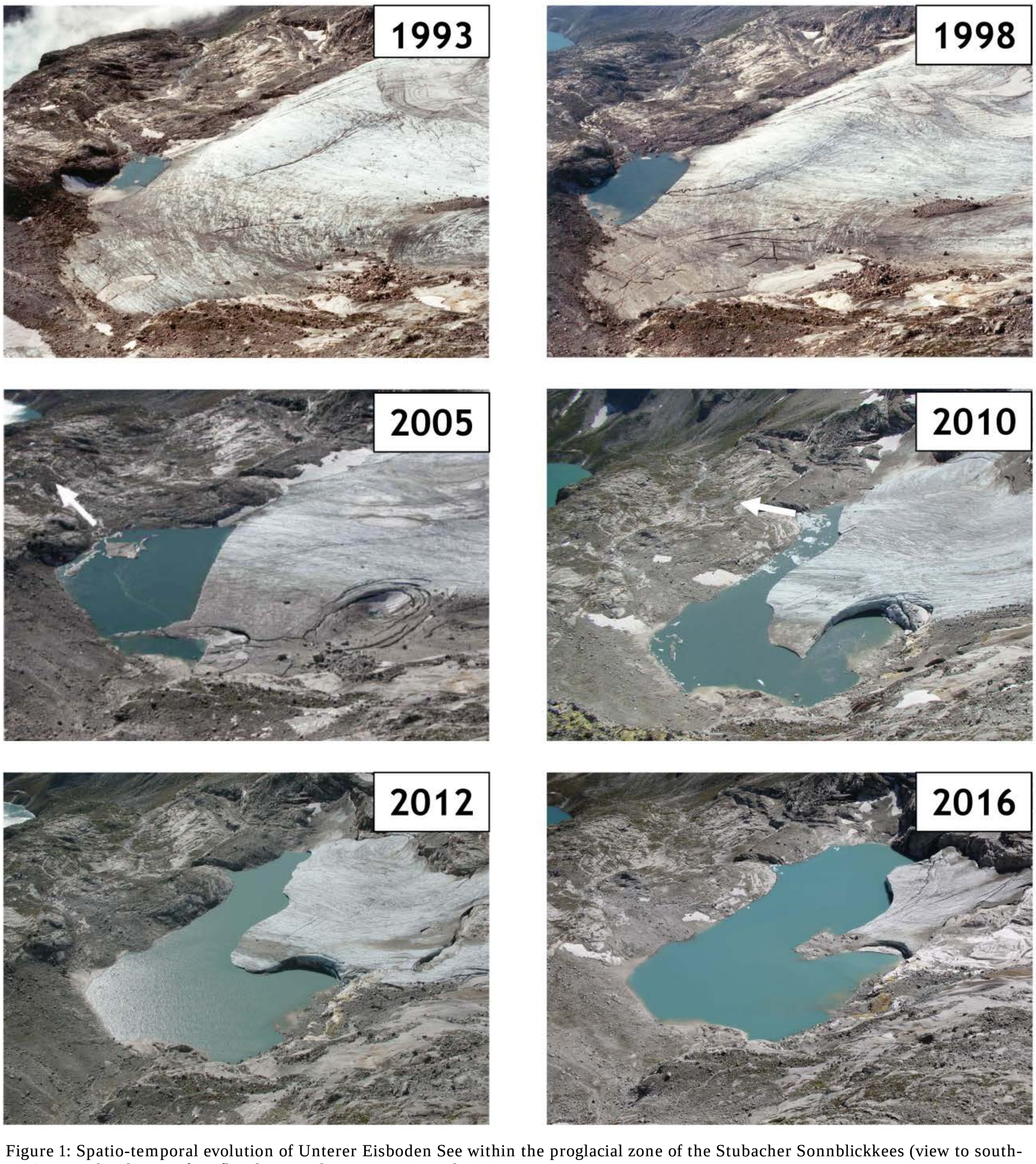

Figure 1: Spatio-temporal evolution of Unterer Eisboden See within the proglacial zone of the Stubacher Sonnblickkees (view to south-east). Note the change of outflow location between 2005 and 2010

	1994	1998	2005	2010	2016
max. length [m]	80	132	200	370	436
max. width [m]	30	62	125	206	210
area [ha]	0.470	0.627	1.90	3.10	6.6
max. depth [m]		7.8		20.3	27.1
volume [m³]		12,340		138,550	551,500

Table 1: Temporal development of characteristic figures of Unterer Eisboden See

The original hydrological system of Unterer Eisbodensee was rather complex, with two outlets (Eislbach, Keesbach) at different levels. In July 2006 a glacier outburst flood (GLOF) lowered the lake's surface by approx. 6 m and shifted the outlet to its present and steady position (WIESENEGGER & SLUPETZKY 2009).

Results of the 2016 bathymetry (KUM 2016) show, that the calculated maximum extension of Unterer Eisbodensee, based on subglacial DEMs interpolated from GPR data and bathymetry (GEILHAUSEN 2011) has almost been reached (Fig. 2).

Parameter	2010	Bedrock model	Sediment model	2016
max. shoreline [m]	1,362	1,480 (+111/-45)	1,495 (+7/-5)	1420
max area [m²]	31,050	74,790 (+644/-991)	71,730 (+802/-824)	66,100
max. depth [m]	20.3	22.3 (+-/0.4)	22.3 (+-/0.4)	27.1
max volume [m³]	**138,550**	**533,900** (+3920/-7735)	**497,130** (+5510/-5760)	**551,500**

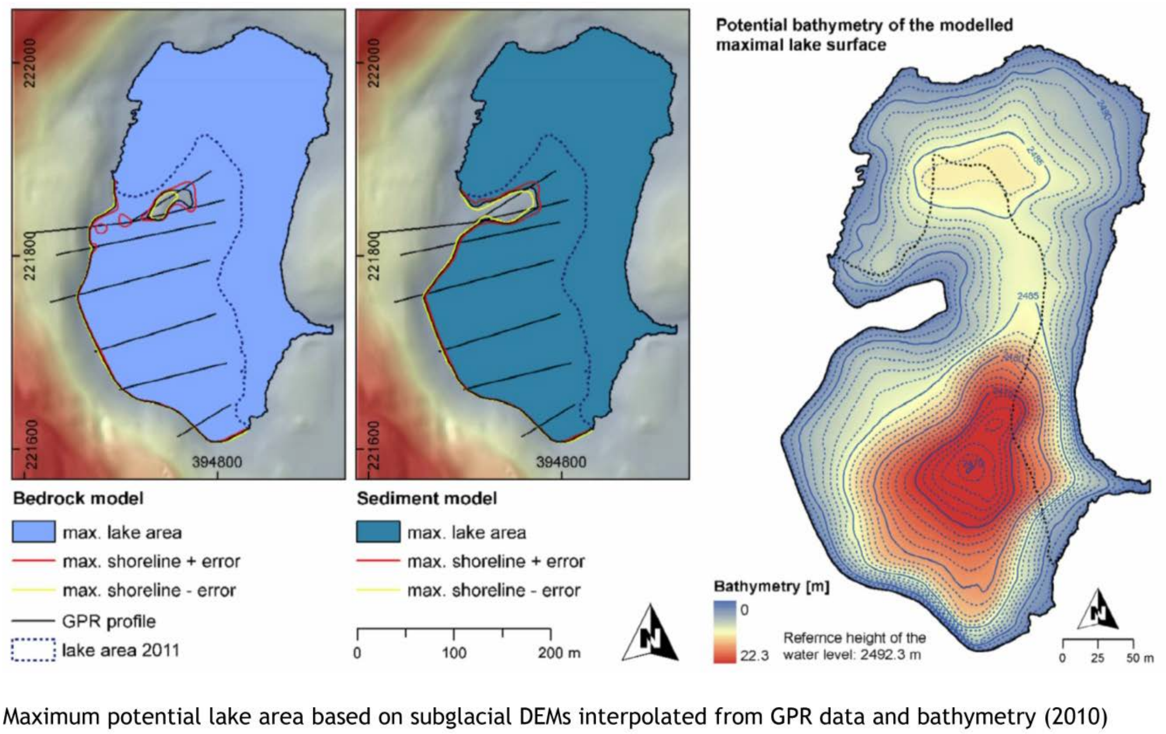

Figure 2: Unterer Eisbodensee potential development calculated 2010 compared to present situation

Between 2010 and 2016, the lake doubled its surface area, its volume almost multiplied fourfold and the maximum depth increased from 20.4 m to 27.1 m (Fig. 3).

Hydrological observations, which started in 2002, at 3 automatic gauging stations, show a slight change in discharge and temperature patterns, due to a reduced proportion (approx. 56 % in 2016 compared to approx. 70 % in 2009) of the glaciated catchment area.

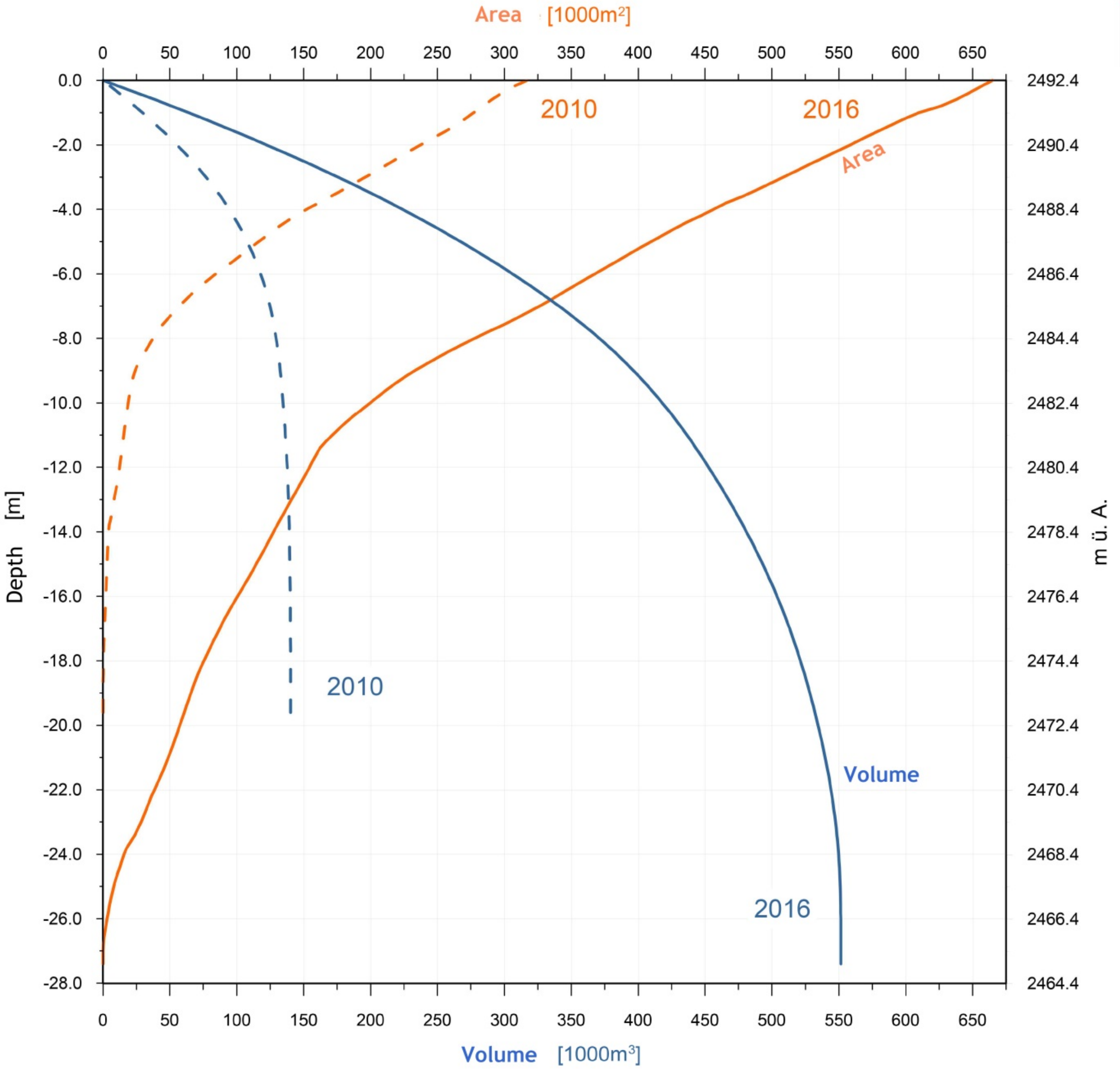

Figure 3: Unterer Eisbodensee – comparison of characteristic figures: max. depth, surface and volume

Conclusions and perspectives

In its genesis up to the present state, Unterer Eisboden See has shown interesting hydrological behaviour and it took some time to understand the ongoing processes (subglacial drainage, shift of outlets, glacier outburst flood, rhythmical water level changes etc.). The lake has now almost reached its potential maximum size and volume with its permanent outlet water level situated at 2,493 m.a.s.l.

The volume of the lake will gradually be reduced by sediment input in the next decades, but due to the gneiss bedrock and the morphology of the catchment, not as fast as other newly emerged glacial lakes e.g. Obersulzbach See, which first appeared in 1989. The results of the 2016 measurement campaign, showing no essential sedimentation, underline this assumption and repeated bathymetry surveys in the future (every 5 years) are planned to check this process.

The hydrological monitoring, in order to analyse changes in the lake's behaviour, will be prolonged and hydrobiological monitoring and sampling will be repeated every 5 years.

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Spatio-temporal patterns of dragonfly occurrence on meadows in the Donau-Auen National Park, Lower Austria

Natascha Wild

Abstract

Dispersal is a characteristic trait in Odonata. While dispersal behavior of dragonflies and damselflies between waterbodies has generally received a great deal of attention, dispersal processes subjected to terrestrial habitats and hence, Odonate's use in the context of foraging activities, have previously only attracted limited interest. This study aimed to investigate the dispersal of dragonflies and damselflies to floodplain meadows used for foraging or as refuge. The primary focus was on assessing species-specific dispersal characteristics influencing the spatial distribution of species, species richness and community structure on meadows. Therefore, dragonflies and damselflies were sampled between May and September 2016 at 16 meadow and eight waterbody sites in the Donau–Auen National Park (DANP), Eastern Austria near Orth an der Donau. In total, 1.427 dragonflies were recorded, including 667 observed on meadows. Anisopterans were more likely to disperse long distances from waterbodies than zygopterans, and females showed proportionally higher abundances on meadows than at waterbodies. Species composition, species richness and occurrence of dragonflies were highly influenced by the distance meadows were situated away from waterbodies. Moreover, the results from this study demonstrated that occurrence of Odonata, species richness and the structure of species assemblages are associated with structural characteristics of forest margins adjacent to meadows. For most Odonata species, a positive relationship between heterogeneity in forest margin vegetation structure and occurrence could be found. This study provides important insight into odonate's utilization of meadows embedded in floodplain systems and provides some basis for potential conservation management considerations with the aim to protect terrestrial habitats of rare dragonflies.

Keywords

Odonata, Anisoptera, Zygoptera, Eastern Austria, Danube floodplain, dispersal

Introduction

So far, several ecological studies have focused on the dispersal of Odonata, as a response to seasonal changes or movements between neighboring waterbodies (Conrad, et al., 1999). However, spatial movements to non-aquatic foraging habitats situated in larger distances to the larval habitats have received little attention. Only few studies have addressed dispersal of dragonflies to distanced meadows in floodplains for the purpose of foraging, mate-seeking, pairing or seeking of refuge (Conrad, et al., 1999; Hykel, et al., 2016). In this study, we assessed the importance of meadows, embedded in a river-floodplain system, as foraging habitats for adult Odonata. In particular, we addressed the following questions:

1. **Are species composition, species richness and abundance influenced by the distance meadows are situated away from waterbodies?**
   Abundance of Anisoptera is expected to be high at meadows located at larger distances to waterbodies, while abundance of Zygoptera is expected to be greater at meadows more closely situated to waterbodies due to the varying flight ability of species (Corbet, 1999). Moreover, we expect a shift in species composition at meadows with increasing distance to waterbodies. We also expect that meadows located at great distance from waterbodies are more likely to be visited by habitat generalists since the chance of finding a suitable aquatic habitat is greater for such species (Corbet, 1999). Furthermore, we also assume a female-biased sex-ratio on meadows since females are reported to spend most of their adult life away from aquatic habitats as a result of harassment by males (Corbet, 1999; Suhonen, et al., 2008).

2. **Are species composition and species richness of Odonata species influenced by the structural quality of forest margins on floodplain meadows?**
   Densely branched trees, shrubs and meadows covered with tall grass provide perching opportunities for odonates between foraging flights and provide shelter between periods of high wind, rain or dense cloud cover (Corbet, 1999). Therefore, we expect that species composition and species richness are influenced by structural characteristics of meadows. Since structural demands on habitats vary between Odonate species, it is assumed that species richness is higher at meadows characterized by structurally diverse forest margins. Moreover, species composition is expected to differ between structurally diverse and structurally uniform vegetation.

Methods

This study was conducted in the Eastern part of the DANP north of the Danube river in the area of Orth an der Donau (48° 9′ N, 16° 42′ E). A levee (Marchfeldschutzdamm) divides the study area into a northern part, an area that is protected against flooding events during periods of high water levels and the southern part, an area that is regularly flooded due to summer inundations. A total of 16 meadows were sampled from the beginning of May until September 2016. Six study sites were situated in the northern part of the area, seven sites were situated south of the Marchfeld levee and three study sites were located directly on the Marchfeld levee. Eight waterbody sites alongside Danube River's side arms and one lentic waterbody in the northern part of the study area were selected as reference sites.

Sampling of dragonflies

On each meadow, adult Odonata were sampled by slowly walking along 100 m transects placed close to the forest margins. All dragonflies and damselflies encountered within a 10m radius of walking direction were counted. Reference data was collected at waterbodies by sampling stretches of 50 m along river banks. All adults observed on the bank and over the waterbody were recorded. Field collections were performed between 10:00–16:00 CEST (SCHINDLER, et al., 2003) when dragonflies are most active. Surveys lasted between 30 and 40 minutes at each site. Sampling was performed on sunny days with low or no wind. To cover all phenological groups of Odonata, each sampling site was visited 7 times, spread over the flight season from May to September (SCHMIDT, 1985). Influence of daytime on sampling results was avoided by systematically changing the daytime a site was visited (CHOVANEC, 1999). Dragonfly and damselfly specimens were observed with binoculars (10 x 40) or caught with a sweep net and identified by sight or photographs (SCHINDLER, et al., 2003) using identification keys of BELLMANN (2013) and DIJKSTRA (2014). Caught dragonflies and damselflies were released immediately after identification.

Habitat parameters on meadows

In order to determine dispersal distances of Odonata to surrounding terrestrial habitats, meadows were located at varying distances from waterbodies. Distances ranged from 95 to 1205 meters. Structural diversity of meadows was categorized based on the availability (presence or absence) of 'big trees', 'small trees' and 'shrubs'. Sites were then assigned to three categories (category 3 represented sites were all three variables were present), resulting in a categorical structural diversity index ranging from 3 (diverse) to 1 (uniform), hereinafter referred to as 'SDIa'. Additionally, we quantified structural complexity of forest margins. Therefore, the length of the forest margin of each site was measured along the 100 m transects using a measuring tool implemented in the programme GoogleEarth version 7.1.8.3036. Values of the calculated lengths of forest margins were then divided by the length of the 100 m transects. Resulting index values ranged from 1-1.15, hereinafter referred to as 'SDIb'.

Results

In the course of this study, a total of 1.427 dragonflies and damselflies were recorded (Zygoptera: 11 species; Anisoptera: 18 species). At meadow sites, 667 individuals, representing 20 Odonata species, were counted. The most frequent Odonata species at surveyed meadow sites was *Platycnemis pennipes* (35% of counted total at meadow sites), followed by *Aeshna isoceles* (19%), *Aeshna mixta* (10%) and *Orthetrum cancellatum* (6%). Anisoptera species (62% of all individuals recorded at meadow sites) were more abundant on meadows than Zygoptera (38% of individuals). At waterbody sites, zygopterans were more abundant than anisopterans.

Species richness

Fig. 1 shows species accumulation curves, calculated for meadow sites and waterbody sites. Recorded species richness was higher at waterbodies than on meadows. However, the extrapolated part of the curve for the Odonata assemblage on meadows indicates similar species richness of both habitat types.

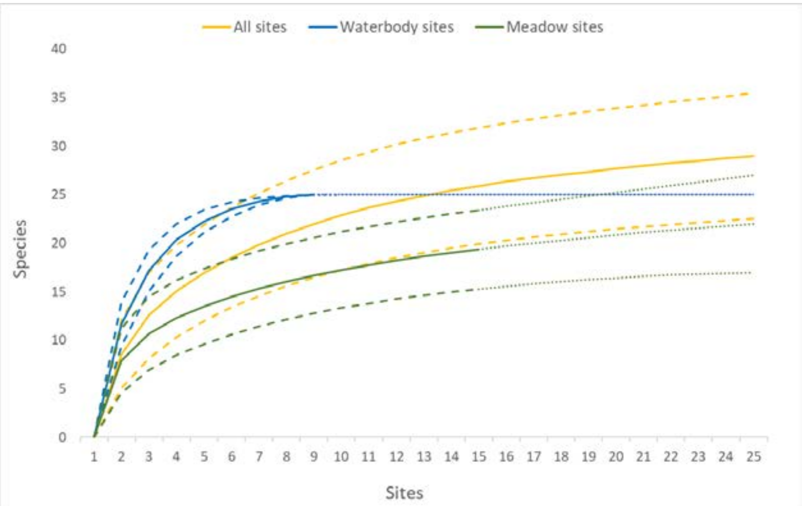

Figure 1: Species-accumulation curves (± 95% CI) calculated for all sites, waterbody sites and meadow sites. Dotted lines represent extrapolated values.

With respect to the relationship between species richness and distance, Zygoptera species richness declined significantly with increasing distance to waterbodies (r = -0.56, p = 0.02). In contrast, no significant relationship was found between Anisoptera species richness and distance to waterbodies (r = -0.19, p = 0.46). Pearson's product-moment correlation shows that overall species richness is significantly associated with SDIb (r = 0.61, p = 0.01). If taxonomical groups are considered individually, species richness of Anisoptera showed a strong positive correlation with SDIb (r = 0.69, p = 0.002), species richness of Zygoptera on the other hand was not significantly influenced by SDIb (r = 0.26, p = 0.31).

<u>Abundance</u>

While no significant correlation between the total number of recorded individuals and the distance to the closest waterbody could be observed (r = 1.14, p = 0.62), models that test Anisoptera and Zygoptera separately, yielded highly significant results. Anisoptera counts increased significantly with increasing distance to waterbody (r = 0.50, p = 0.05), by contrast, counted individuals of the suborder Zygoptera showed a highly significant negative correlation with increasing distance from a waterbody (r = -0.65, p = 0.006; Fig. 2).

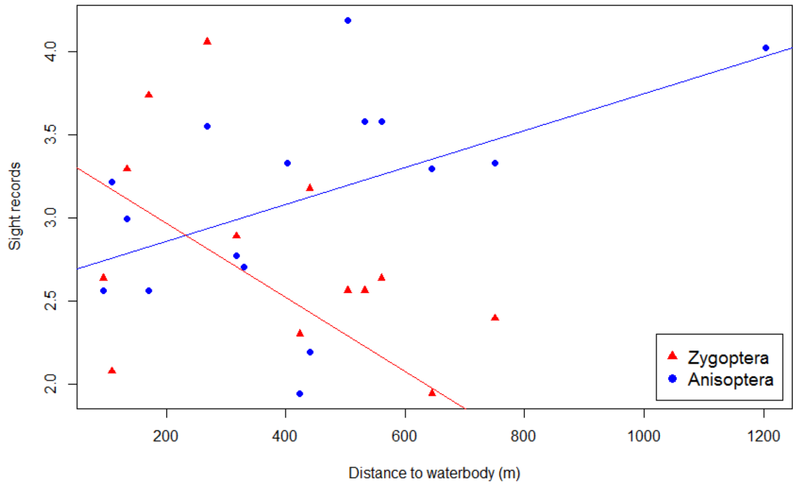

Figure 2: Relationship between recorded number of individuals (log-transformed) and distance to closest waterbody.

A comparison of relative abundances of Zygoptera and Anisoptera specimens recorded at meadow and waterbody sites illustrates that Anisoptera species were more abundant on meadows than Zygoptera. In comparison, Zygoptera were more dominant at waterbodies. Notably, *Platycnemis pennipes* was equally distributed on meadows and waterbodies. Effects of several habitat variables on the abundance of dragonflies were tested. A Kruskal-Wallis rank sum test shows that the number of individuals (H = 6.41, p = 0.04) can be significantly associated with structural diversity of the forest margin (SDIa). A post-hoc Kruskal-Nemenyi test shows that the mean number of dragonfly records at habitats with intermediate and highest structural diversity differ significantly (H = 3.40, p = 0.04). Testing for effects of structural diversity (SDIa) on the occurrence of zygopterans and anisopterans separately, showed that occurrence of Anisoptera species was significantly influenced by the structural diversity of the forest margin (H = 6.22, p = 0.04), however no significant results could be found for Zygoptera species (H = 0.54, p = 0.75).

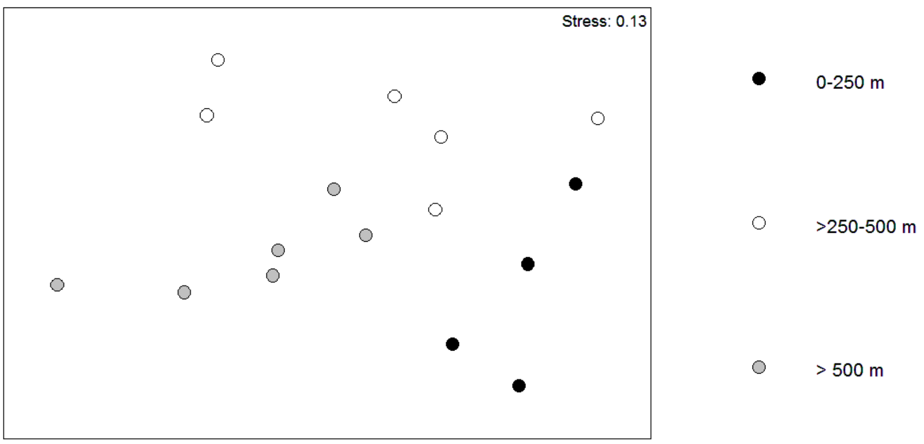

Figure 3: NMDS ordination of meadow sites based on Bray-Curtis similarities. Black points represent sites with a distance to the closest waterbody between 0-250 m, white dots represent waterbody distance of >250-500 and grey dots represent sites with waterbody distance of >500 m. Stress: 0.13.

Species composition

The NMDS ordination based on Bray-Curtis similarities (Fig. 3) shows that species composition of sites can be grouped according to their distance from a waterbody. Sites located at greatest distance from a waterbody (indicated by grey-colored dots) show a similar pattern in species composition and form a distinct group. Communities of sites with intermediate distance from a waterbody (indicated by white dots) are slightly interspersed with sites of lowest distance to waterbody (indicated by black dots).

Dimension 1 values of the NMDS ordination visualizing similarity relationships of species assemblages on meadows were significantly related the distance to waterbodies (r = -0.71, p = 0.002). A one-way ANOSIM showed that species composition differs significantly between categories of distances to waterbodies (0-250 m, > 250-500 m, >500 m) (r_{global} = 0.49, p = 0.001). Pairwise comparisons illustrate a highly significant difference between all distance groups. It was tested whether structural diversity of habitats (SDIa) influences species composition. A one-way ANOSIM showed that species composition differs significantly between categories of structural diversity (r_{global} = 0.27, p = 0.009). While pairwise comparisons revealed that sites showing high diversity and intermediate diversity each differ significantly from structurally less diverse sites, a pairwise test between diversity classes SDIa 2 and SDIa 3 did not yield a significant result.

Sex-specific differences in spatial distribution

Only a subset of species allowed identification of the sex in the field. A list of species that were included in the following calculations can be found in the appendix A5. Male dragonflies (75%) were generally more dominant in the study area than females (25%). A comparison of relative abundances of males and females shows that male Odonata were generally more dominant on meadows than females. With respect to waterbody sites, 88% of recorded Odonata were males and 11% females, resulting in a male-biased sex ratio at both types of sampling sites. The recorded sex ratio at meadows was 2.3:1, the sex ratio at waterbodies was 10:1.

Discussion

Odonata species observed in this study represent 88% of the dragonfly and damselfly fauna recorded for the study area at Orth an der Donau (RAAB, 2000) and 38% of Austria's Odonata fauna (RAAB, 2006).

Species richness

Species richness was slightly higher at waterbodies than on meadows. Only three Zygoptera species (*Ischnura elegans, Platycnemis pennipes and Sympecma fusca)* observed at waterbodies could be found on meadows. Also, the rheophilic species *Calopterix splendens* and *Gomphus vulgatissimus* (DIJKSTRA, 2014) were present at sampled waterbodies but could not be recorded on meadows. Zygoptera species richness declined with increasing distance from waterbodies. Given the assumption that zygopterans generally display poorer flight ability than anisopterans (CORBET, 1999), it is not surprising that fewer dragonfly species of the suborder Zygoptera were found on meadows. Moreover, also intraguild predation risk may come into place, preventing zygopterans from foraging in habitats where anisopterans are abundant (CORBET, 1999).

Other than expected, no relationship between structural diversity of forest margins and species richness could be found, however the significant correlation detected between heterogeneity of forest margin structure reflected in SDIb and species richness suggests that increased species richness can be expected if structural diversity of forest margins is high. This assumption is applicable for anisopterans, albeit, no such relationship could be found for zygopterans.

Sex-specific dispersal patterns

It is generally assumed that males and females differ in their tendency to disperse. Various authors describe that sex ratios at reproductive sites are mostly male-biased, once sexual maturity has been reached. Males spend most of their time at breeding sites awaiting females, females on the other hand visit reproductive sites predominantly to mate and oviposit, suggesting that they spend a great deal of time away from waterbodies and are more likely to disperse (SUHONEN, et al., 2008). Our study found that male-biased sex ratios exist at both, waterbody sites and meadow sites, however, the sex ratio at waterbodies was substantially more biased towards males than on meadows. Patterns in sex ratio at waterbodies can be the result of intraspecific faunal interactions. At breeding sites with high male density, females were reported to move away from waterbodies in an attempt to avoid excessive matings or harassment of males (SUHONEN, et al., 2008). In territorial dragonflies with male density at reproductive sites assumed rather low, females may benefit in that harassment during copulation or oviposition is reduced. Also, predation risk may be reduced in high-quality territories, hence areas were territorial males are present (SUHONEN, et al., 2008). Higher abundances of females in such territories are a logical consequence.

Abundance

Our results suggest that dispersal is strongly associated with Odonata suborder. Anisoptera records increased significantly with increasing distance from a waterbody. The opposite could be confirmed for zygopterans, which were present in great abundance, if meadows were located in close vicinity to a waterbody and decreased steeply with increasing distance from waterbodies. If distances moved by single species are considered, only few zygopterans moved long distances from meadows. With the exception of *Platycnemis pennipes* (recorded on meadows in distances of up to 750 meters from waterbodies) and *Sympecma fusca* (up to 645 meters from waterbodies), none of the Zygoptera species dispersed more than 350 meters. Anisoptera species on the other hand were recorded on meadows up to 1205 meters away from waterbodies. Quality of vegetation, such as structure or density are generally assumed to influence abundance of dragonflies (HYKEL, et al., 2016). Our results suggest that heterogeneity of vegetation structure in terrestrial habitats is of major importance for dragonflies and damselflies. High structural diversity of forest margins was significantly associated with occurrence of dragonflies. Differences in dragonfly abundance was most significant between habitats with intermediate and highest structural diversity. High abundances of *Orthetrum cancellatum* were found on the Marchfeld levee. Sampling sites on the levee were all classified uniform in terms of forest margin diversity because big trees characterize the landscape. *Orthetrum cancellatum* is not as dependent of perching or refuge opportunities in shrubs as other species and uses stony trails for resting between flights (DIJKSTRA, 2014). While it was hypothesized, that dragonflies would be more abundant if the mean height of herb layer was high, no such relationship could be observed within this study. Cover of tall vegetation. instead of height thereof and vegetation cover in general may more likely have an effect on overall dragonfly occurrence (HYKEL, et al., 2016), thus presence of fairly tall vegetation seems more relevant than height.

Species composition

Species composition on meadows was strongly affected by the distance to waterbodies. Meadow sites with similar distance characteristics were similar in species assemblage composition. These results do not only reflect differences in dispersal behavior between zygopterans and anisopterans, but also exhibit species-specific dispersal properties within suborder and family. Community structure may be shaped by faunal interactions such as interspecific competition. Interspecific aggression may force individuals of subdominant species to move to other, less preferred habitats (TYNKKYNEN, et al., 2008) or even lead to the exclusion of some species from certain waterbodies (MOORE, 1964). Whereas such aggressive interactions have mainly been described at reproductive sites (MOORE, 1964; Suhonen, et al., 2008), interspecific competition is also assumed to play a prominent role in terrestrial habitats (CORBET, 1999). Structural characteristics of forest margins also seem to shape community structure on meadows. Composition of dragonfly assemblages on meadows with intermediate and high heterogeneity differed from meadows with uniform forest margin structure, potentially reflecting species with varying demands on vegetation structure at terrestrial habitats. Whereas habitat generalists and specialists have been described in terms of reproductive habitat requirements (RAAB, 2006), knowledge on the demands of Odonata on vegetation structure at terrestrial habitats is limited. Other than expected, species composition north and south of the levee did not differ significantly.

Conclusion

The high conservation value of the DANP floodplain meadows is confirmed by the large number of species utilizing floodplain meadows for foraging or as refuge, as demonstrated in this study. A number of specimens observed during the study are classified 'vulnerable' according to the Austrian's Red List of dragonflies (RAAB, 2007), *Sympecma fusca, Coenagrion hastulatum, Gomphus vulgatissimus, Aeshna affinis, Aeshna isoceles,* and *Brachytron pretense* among them.

Effective management of threatened dragonflies takes into account ecological requirements of dragonflies at all stages of their life cycle (CORBET, 1999), and do not only concentrate on aquatic habitats but also surrounding terrestrial habitats (HYKEL, et al., 2016). As demonstrated in this study, dragonflies spend considerable time away from waterbodies (CORBET, 1999) and respond positively to rich vegetation structure on meadows. In order to maintain plant diversity and to avoid encroachment of shrubs, meadows in the DANP are mown twice annually (NATIONALPARK DONAU-AUEN, 2009). It is widely assumed that mowing affects dragonfly abundance. Lack of suitable areas for roosting during night-time or shelter during inclement weather can be the result of lower abundances of dragonflies (ROUQUETTE & THOMPSON, 2007). Recently mown habitats are largely avoided by dragonflies (DOLNÝ, et al., 2014). Mowing can increase mortality considerably, especially if mowing is done when odonates are inactive during cloudy or cold weather or periods of rain or high wind (DOLNÝ, et al., 2014). Management measures of threatened dragonflies must therefore take into account species' period of emergence; mowing regime on meadows located in close vicinity to habitats where the focal dragonfly species is present must be adapted so that first mowing is done before the emergence of adults. Second mowing should be done after the majority of Odonata completed oviposition (HYKEL, et al., 2016). Since the flying season of dragonflies observed in the study area varies significantly between species, fulfilling such requirements seems hardly possible and is possibly highly unpractical. Alternatively, a probably more economical management measure is to maintain mosaic-like mowing regimes (HYKEL, et al., 2016).

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Governing peri-urban forestry: filling the regulation gap with Swiss 'Nature-discovery-parks'?

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Abstract

Urban areas increasingly rely on goods and services provided by surrounding forests (MANN & ABSHER, 2008). However, there is often a misfit between regulations and current uses, as the laws and ordinances have often been developed historically and not adequately adapted with actors' changing behavior. E.g. in Switzerland forests are regulated by institutions dedicated to rural areas rather than by laws designed for the specific use and protection issues of peri-urban contexts. Potential ways to steer the use of urban forest areas is establishing new regulations tailored toward regulating flora and fauna in densely populated areas. In Switzerland one such potential means is the Nature-discovery-park, which is geared toward addressing the populations' needs and the potential to foster sustainable resource use in peri-urban areas. However, while other Swiss park categories (e.g. Regional-nature-parks) have grown rapidly, the Nature-discovery-parks seem to be lagging. We pose the question whether and to what extent Nature-discovery-parks may serve as a viable vehicle for regulating peri-urban forests. To conceptually address our questions we employ the Social-Ecological System (SES) framework, developed by OSTROM (2009) to analyze the sustainability of complex social-ecological systems. We aim to: (1) assess what the forest-city interdependencies and the peri-urban forestry specificities (including goods and services provided by forests) are and how they are regulated, and (2) evaluate the pros and cons of Nature-discovery-parks for regulating forest-city interdependencies in contrast to other options. To achieve these aims we study the agglomerations of Aargau, Zurich, Vaud and Berne. To analyze the viability of Nature-discovery-parks we draw on the SES framework to develop multiple assessment criteria, with such indicators as effectiveness, political legitimacy and public acceptance, which we apply in the four agglomerations. The research draws on several empirical sources including analysis of legal documents at the national and regional level, as well as semi-structured expert interviews, a survey of the population in the regions and focus groups with local stakeholders (MORGAN, 1998; MAY, 2001). We conclude that by identifying the elements of the SES it is possible to explain the misfit between regulations and uses. So far, current research has identified the features characterizing parks governance regimes in Switzerland (WILLI et al., 2016). However, other governance characteristics such as interdependencies are not considered. Thus, we fill the gap by investigating the forest-city interdependencies, the peri-urban forestry specificities and regulations. Finally, we provide recommendations for new regulatory means for peri-urban forests and improve the development and management of existing and new Nature-discovery-parks.

Keywords

Park governance, regulation, misfit, Switzerland

Introduction

Forests in Europe are expected to provide several ecosystem services. Urban areas increasingly rely on goods and services provided by surrounding forests (MANN & ABSHER, 2008). Exploratory interviews show, that there is often a misfit between regulations and current uses, as the laws and ordinances have often been developed historically and not adequately adapted with actors' changing behavior. In Switzerland forests are regulated by institutions dedicated to rural areas rather than by laws designed for the specific use and protection issues of peri-urban contexts. Potential ways to steer the use of urban forest areas is establishing new regulations tailored toward regulating flora and fauna in densely populated areas. In Switzerland one such potential means is the Nature-discovery-park, which is geared toward addressing the populations' needs and the potential to foster sustainable resource use in peri-urban areas. However, while other Swiss park categories (e.g. Regional-nature-parks) have grown rapidly, the Nature-discovery-parks seem to be lagging. One reason could be that urban forests are regulated by institutions dedicated to rural areas rather than by laws designed for the specific use and protection issues of peri-urban contexts. Subsequently, a misfit between regulations and uses can be seen. With this working paper, we aim to (1) assess what the forest-city interdependencies and the peri-urban forestry specificities are, (2) identify how forest-city interdependencies and the peri-urban forestry specificities are regulated, and (3) evaluate the pros and cons of Nature-discovery-parks for regulating forest-city interdependencies. By doing so we want to explain why Nature-discovery-parks have been lagging in their implementation and pose the question **whether and to what extent Nature-discovery-parks may serve as a viable vehicle for regulating peri-urban forests**. Our findings are of interest for planning and management of protected areas in Europe facing similar developments and challenges.

Material and Methods

For the analysis, mainly qualitative data were collected based on official documents at the national and case study level and peer-reviewed papers. Additionally, a comparative case study analysis based on exploratory semi-structured expert interviews is used (MAY, 2001). The peri-urban areas of the cantons of Aargau, Zurich, Vaud and Bern are used as the unit of analysis. The Social-Ecological System (SES) is used as the conceptual framework (OSTROM, 2009). Finally, a multi-criteria framework is used, with such indicators as effectiveness and political legitimacy, to assess the viability of differing regulations.

Results

The findings suggest that the resources and their users interplay with each other. Subsequently, the interplay between resource users constrains the development of further nature-discovery parks and leads to a misfit between regulation and uses. Finally, the misfit can vary depending on the case study, the resource (e.g. forest) of analysis and the governance system considered.

Conclusion

Current research has identified the features characterizing parks governance regimes in Switzerland. However, other governance characteristics such as interdependencies are not considered. Subsequently, with our research we address other governance characteristics by investigating the forest-city interdependencies and the (peri-) urban forestry specificities as well as regulation. We conclude that by identifying the forest-city interdependencies and the (peri-) urban forestry specificities as well as regulation it is possible to support the sustainable management of urban forest and to address the regulation misfit.

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The impact of rock glaciers on the runoff of alpine catchments in protected areas of Austria

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Abstract

Due to the coarse blocky surface debris layers, surface flow is usually absent on rock glaciers. Water infiltrates into these landforms from their respective catchment and is released at springs in a more dampened/modified way due to storage capacities of rock glaciers. Research of the recent years has indicated that the storage capacities of especially relict rock glaciers can have important impacts on the downstream sections of an alpine headwater and the fragile ecosystem therein. Here we report on these findings with a focus on the alpine environments protected by the National Parks of Austria.

Keywords

Rock glacier; storage capacity; runoff; alpine catchment; protected areas

Introduction

More than 5500 rock glacier related landforms were identified in the Austrian Alps and their related hydrological catchments cover a total area of more than 1200 km² (Winkler et al. 2017). Based on the content of permafrost-ice, rock glaciers are divided into intact (active and inactive that means moving, widespread ice-bearing permafrost and stable, rather widespread ice-bearing permafrost, respectively), and relict (stable, permafrost and ice free) ones including all crossovers between these types. All the water of their respective catchments infiltrates into these landforms and is released with some delay at springs at the rock glaciers front. Springs with considerable discharge are consequently relevant for water resources management issues in (non-karstified) alpine regions composed of metamorphic rocks and are mainly related to landforms such as rock glaciers.

Research of the last two decades showed the complexity of the runoff of rock glaciers and identified e.g. three different flow components (snow melt/rain, melting of permafrost-ice and longer stored groundwater below the rock glaciers) for active rock glaciers (e.g. Krainer & Mostler 2002; Krainer et al. 2007). Relict rock glaciers are heterogeneous, complex aquifers (Pauritsch et al. 2015, 2017; Winkler et al. 2016) and, as shown by Wagner et al. (2016), have potential storage/buffer capacities that might be of interest as the intensity of droughts as well as heavy rainfall events might increase due to climate warming (e.g. Gobiet et al. 2014). Moreover, Rogger et al. (2017) investigated the impact of the reduction of permafrost ice in a permafrost-dominated part of the Kaunertal (Ötztal Alps, North Tyrol). They showed that melting of permafrost-ice will potentially increase the storage capacities and therefore cause a more dampened discharge pattern. In addition to the quantitative hydrological issues the process-based understanding of mobilization and transport of dissolved solids in and downstream of these landforms is another important aspect. Recent research in Southern Tyrol (ca. 2700 rock glacier-suspected landforms mapped by Bollmann et al. (2012)) indicates some potential heavy metal pollution related to permafrost ice (Krainer et al. 2015). An Austrian-wide project currently investigates the hydrochemical background of rock glacier related spring waters (Winkler et al. 2017).

These recent findings indicate that rock glaciers are likely to be important debris accumulations that are going to influence in various ways the runoff of alpine catchments and are of high water management relevance in particular for drinking water supply and small power plants. Moreover, a better understanding of the related discharge dynamics will allow a better predictability of changes in alpine headwaters.

Methods

The classification of rock glaciers has been described in this conference volume by Wagner et al. (2017). The related catchments were computed using standard ArcGIS hydrology tools. All grid cells (using ALS data with 1m of horizontal resolution) flowing towards the rock glacier-suspected landforms were considered as contributing to the catchment area. This is an approach that assumes that the orographic catchment area coincides with the actual one; although this is a simplification, it is a suitable first approach for crystalline areas. Moreover, the catchment delineation has been manually checked for outliers (e.g. forest roads may create artificial flow paths). The following analysis is focused on rock glaciers and their related catchments within the boundaries of the National ParksGesäuse, Nockberge and Hohe Tauern.

Preliminary Results

Rock glaciers within protected areas of Austria were the focus of this work. Fig. 1 shows a representative part of the National Park (NP) Hohe Tauern, the rock glacier-suspected landforms mapped in that area and their related catchment areas.

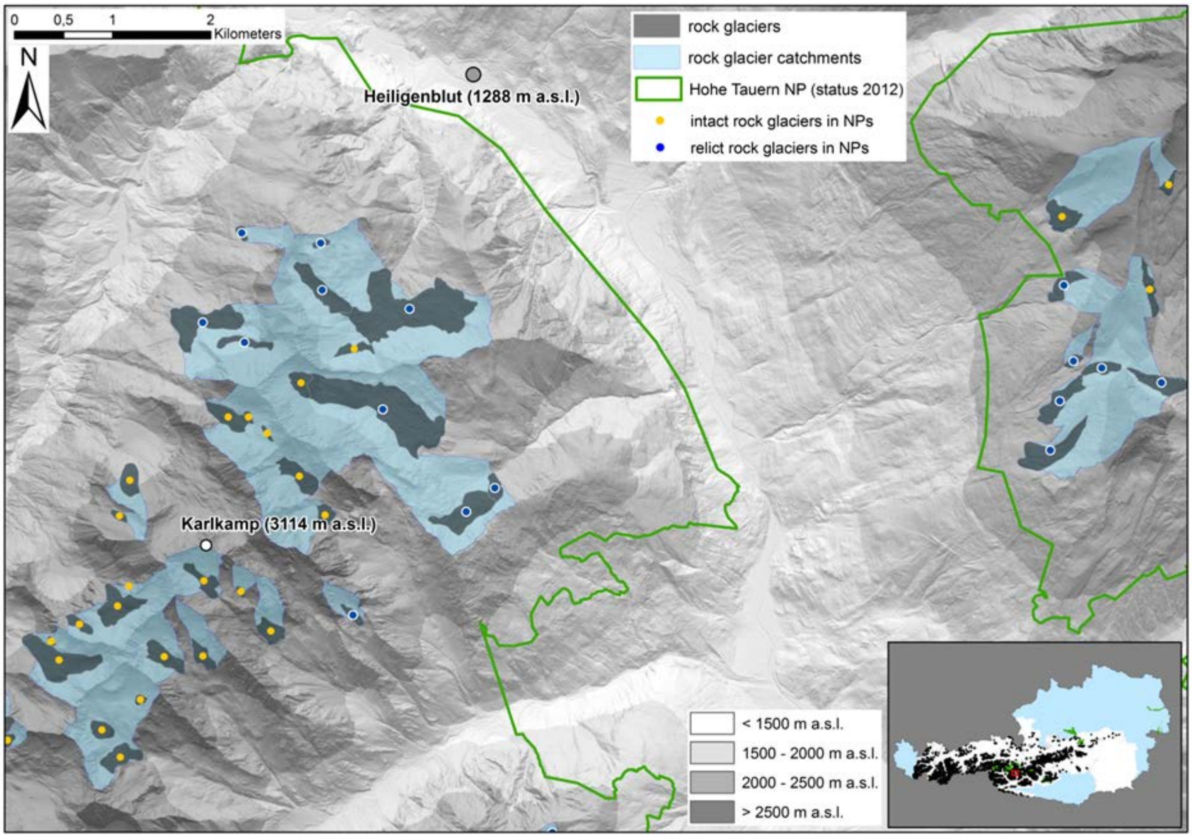

Figure 1: Rock glacier-suspected landforms (RGs) and their related catchments of a representative region of the National Park Hohe Tauern: parts of the Schober and the Goldberg Mountain Ranges south of Heiligenblut (1288 m. a.s.l.).

Tab. 1 shows the areal contribution of rock glaciers and their hydrological catchments referred to the total area of the National Parks (NPs) and to elevations above 1500 m, 2000 m and 2500 m a.s.l.. In total, only 2% of the NP areas are covered by rock glaciers, however this number increases to 7,4% if the catchment areas of the rock glaciers are considered. For elevations above 1500 m a.s.l., this value increases only slightly (8%), rises to 9,7% for elevations above 2000 m a.s.l. and further to 11,7% for elevations above 2500 m a.s.l. The Gesäuse NP contributes only very little to this analysis (a single relict rock glacier); in the Nockberge NP, 66 relict rock glaciers have been mapped. Compared to the total area of this NP (184,5 km²), the area influenced by rock glaciers (water that is drained through relict rock glaciers) is only 10,8 km², which is about 5,9%. For the Hohe Tauern NP these numbers are higher, as rock glaciers are more abundant there (770 out of 837 in total). Nevertheless, compared to the Seckauer Tauern Range (22% of areal share above 1500 m a.s.l. and 51% above 2000 m a.s.l.; WAGNER et al. 2016), these values are not exceptionally high. The highest areal share within the NPs is found in the NP Nockberge for elevations above 2000 m a.s.l. with almost 17% draining through relict rock glaciers. For the Hohe Tauern NP, a value of 9,7% is calculated, however there is a large number of intact rock glaciers that might change their discharge pattern as climate warming proceeds.

national park (NPs)	NP area [km²]	rock glaciers (RGs)			RG area	RG catchment area	RG catchment area ≥ 1500 m a.s.l.	RG catchment area ≥ 2000 m a.s.l.	RG catchment area ≥ 2500 m a.s.l.
		relict	intact	total	[km² / % of total area]	[km² / % of total area]	[km² / % of total area]	[km² / % of total area]	[km² / % of total area]
Gesäuse	110,3	1	0	1	0.1 / 0.1	0.7 / 0.6	0.7 / 2.1	0.1 / 2.1	0 / -
Nockberge	184,5	66	0	66	2.4 / 1.3	10.8 / 5.9	10.8 / 6.9	7.3 / 16.9	0 / -
Hohe Tauern	1857,1	321	449	770	39.7 /2.1	148.4 / 8.0	148.2 / 8.3	144.1 / 9.7	83.7 / 11.7
total	2151,8	388	449	837	42.1 / 2.0	160.0 / 7.4	159.7 / 8.1	151.5 / 9.9	83.7 / 11.7

Table 1: statistics of rock glacier-suspected landforms (RGs) and their respective catchments in various national parks (for details on the RGs see Wagner et al. (2017), in this conference volume).

Conclusion

Research of recent years has shown that the storage capacities and discharge pattern of rock glaciers have an impact on the runoff of alpine catchments and will be of general interest for water management as these landforms will alter the runoff behavior further downstream. Rock glaciers provide groundwater as an important resource for water management issues in alpine catchments such as drinking water supply and/or small hydropower plants. This might be of high relevance for the supply of huts with drinking water and/or electricity in alpine headwaters. However, a better understanding of the hydro(geo)logical properties of these landforms (as they might degrade from an intact state to a relict one by melting of permafrost ice and a change in storage capabilities) is crucial for the prognosis of the hydrological evolution of alpine catchments due to climate warming. Thus, the appropriate monitoring at various intact and relict rock glaciers is essential to quantify the ongoing changes in discharge dynamics and storage capacities.

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Natural forest dynamics following bark beetle outbreaks in the Berchtesgaden National Park – Forest structure and biodiversity during disturbance and succession

Maria-Barbara Winter, Roland Baier, Jörg Müller, Christian Ammer

Keywords

Natural disturbances, Natural regeneration, Alpha diversity, Beta diversity, Vascular plants, Arthropods, Wood-inhabiting fungi, Northern Limestone Alps

Summary

Disturbances are an integral part of forest ecosystems. Irrespective of scale, i. e. from single-tree dynamics to large-scale disturbances such as windthrows, fire or insect calamities, disturbances influence natural species composition and regeneration processes of forests. High shares of pure secondary coniferous stands and changing climatic conditions have increased the impact of large-scale disturbances over the last century and it is likely that they will further increase in the future due to the ongoing climate change. Knowledge about the impact of these disturbances on species composition and natural forest succession is essential for a sustainable forest management aiming to mimic natural processes for ecological and economic reasons. Due to steady interventions namely salvage-logging, planting and thinning activities, natural dynamics can hardly be studied in managed forests. However, large strictly protected areas enable such investigations of forest stand dynamics.

Therefore, natural forest succession following bark beetle-induced spruce dieback and the related changes in stand structure and biodiversity were studied in the Berchtesgaden National Park (Germany) in the Northern Limestone Alps. Centuries of intensive timber extraction, mainly due to salt mining, and intentionally high ungulate populations had heavily altered the structures and species composition of the forests in the Berchtesgaden National Park. Stands had shifted from structured natural mixed mountain forests dominated by European beech (*Fagus sylvatica* L.), silver fir (*Abies alba* Mill.) and Norway spruce (*Picea abies* (L.) H. Karst) towards homogenous stands consisting purely or predominantly of Norway spruce. Following the establishment of the national park in 1978, severe bark beetle infestations occurred especially after the winter storms 'Vivian/Wiebcke' in 1990 and 'Kyrill' in 2007. Evaluations of aerial photographs revealed a scattered and rather small-scale development of the bark beetle infestations. Mean gap sizes comprised 0.07 ha (1990-1997) and 0.29 ha (2007-2012) and total infestation areas covered 30 ha (1990-1997) and 260 ha (2007-2012). Applying a chronosequence of 96 study plots of undisturbed secondary spruce stands (**mature stage**), stands affected by bark beetles within the last five years (**initial early-seral stage**) and stands infested in the 1990s (**advanced early-seral stage**) forest succession was surveyed in montane to subalpine altitudinal zones, on south- and north-facing slopes.

The bark beetle-induced dieback of the mature spruce stands significantly reduced stand volumes and crown cover, and led to a strong increase in the amount of standing deadwood. Large shares of standing deadwood broke down due to decomposition during the first two decades of succession. Humus degradation and significant changes in mesoclimatic conditions were not found. The significantly increased shares of radiation at the forest floor induced by the spruce dieback, increased cover and height of the ground vegetation.

Even though tree seedlings had to compete with the vital ground vegetation, the gaps got regenerated rather fast. Around 5.000 seedlings and saplings (> 50 cm height) could be found on average per hectare in the montane zone two decades after the bark beetle infestation. This development was slightly protracted in high montane zones. There the importance of deadwood as substrate for seedlings establishment increased with altitude and decay stage. Natural regeneration was dominated by Norway spruce, sycamore maple (*Acer pseudoplatanus* L.) and rowan (*Sorbus aucuparia* L.). European beech and silver fir which would naturally dominate the mixed mountain forests, were found in very little shares. As a result of only few seed trees due to historical forest management seedlings of these species were rare in this study. The changes in forest structure due to disturbance and the scattered patterns of the post-disturbance regeneration initiated an increase of structural heterogeneity on stand and landscape level. The importance of advance regeneration for the regeneration success was almost negligible. Contrary to the expectations, more than 90 % of the seedlings did germinate after the disturbance events. This indicates a high resilience of the mountain forests after medium-scale disturbance, if ungulate densities enable the survival of the natural regeneration.

Epigaic species showed either no changes (Coleoptera, Arachnida, Mollusca) or decreasing species densities (Collembola) due to missing litter supply after the disturbance. Contrary, the light, nutrient and dead wood dependent species (vascular plants, Heteroptera, Aculeata, pollinating Coleoptera) did profit from the temporary gap conditions and revealed a significant increase in species densities during succession. The findings suggest that in unmanaged forests after bark beetle attack, a structurally complex phase prior to tree canopy closure can last several decades. Moreover, the still increasing species densities in the advanced early-seral stage indicate that some stand structures, driving the species diversity only fully develop given this extended time period. The mosaic of the different small-scale successional stages revealed a high gamma diversity, especially for wood-inhabiting fungi and saproxylic beetles. The species compositions of vascular plants did not vary significantly among the successional stages on landscape scale. Instead, differences among the stages were found in shifts in species dominance.

Management approaches aiming at sustaining biodiversity of mountain forest, should tolerate extended early-seral stages to support the full range of organisms and functions associated with canopy-opening disturbances. Under comparable post-disturbance conditions, the high resilience of the mountain forests is expected to lead to fair natural regeneration densities, if ungulates are managed accordingly.

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Long-term changes in summit plant diversity in the Swiss National Park

Sonja Wipf & Christian Rixen

Abstract

Botanical resurveys of mountain summits, based on historical species lists, demonstrate that species richness on summits in the Swiss National Park has strongly increased since the early 20th century. More detailed, but shorter-term monitoring of mountains summits according to the GLORIA show that species from lower altitudes are colonizing these summits. High colonization rates on the climatically favoured southern sides of summits are strongly correlated with high local extinction rates, which might indicate an increase in competition for space between plant species.

Keywords

alpine plant species, biodiversity, climate change, GLORIA, Swiss National Park, upwards shifts

Introduction

The Swiss National Park (SNP) was founded in 1914 as the first National Park in Central Europe. Since then, the protected perimeter served as a laboratory to investigate natural processes unaffected by current direct influence by humans. Thus, long-term monitoring of flora and fauna as well as of various ecosystem processes has a long tradition (HALLER et al. 2013).

Methods

To establish a baseline for the monitoring of alpine plant distribution in the European Alps and specifically in the SNP, Josias Braun-Blanquet surveyed the plant species composition and altitudinal distribution of 14 summits in and around the SNP (BRAUN 1913, BRAUN-BLANQUET 1957, 1958). Moreover, two target sites (eight summits) according to the GLORIA monitoring scheme (PAULI et al. 2015) were installed in 2002/2003 (Tab. 1). Recent resurveys of species composition on these summits allow for quantification of floristic changes over the long term and the short term, whereas detailed repeat relevés in permanent plots on the GLORIA summits give insight into the processes leading to these changes.

SN1 – calcareous bedrock	m a.s.l.	SN2 – siliceous bedrock	m a.s.l.
MBU – Munt Buffalora	2438	MCS – Munt sper Chamonna Sesvenna	2424
MCH – Munt Chavagl	2542	MIN - Minschuns	2519
PMU – Piz Murter	2836	MDG – Mot dal Gajer	2797
PFO – Piz Foraz	3092	PPL – Piz Plazér	3104

Table 1: GLORIA summits of the two target sites in the SNP region

Results and Discussion

The comparison of historical and recent surveys on 14 summits showed a clear increase in species maximum altitudes, an influx of species typical for lower altitudes, and an increase of species numbers (WIPF et al. 2013): on average, the highest occurrence of species that were present both historically and recently moved uphill by 92 m. Additionally, 38 species (out of a total of 139 species) were new to these 14 summits. Although the summits were all located clearly above treeline at altitudes between 2797 and 3412 m asl., 20% of the newly appeared species have their main distribution below treeline (according to LANDOLT et al. 2010). Due to this influx of new species, the average species number on a summit (10 altitude m below top) increased by 44% since the early 20th century, from 15.1 to 21.8 species per summit (Fig. 1).

The limiting effect of cold temperatures on the occurrence of many plant species is clearly visible from a steep decrease in species richness with increasing altitude (Fig. 1), as well as from the generally larger number of species being able to grow at the warm, southern aspect than at the colder, northern side of summits (Fig. 2). Thus, when this limiting effect is diminishing due to climate warming as seen over past decades, alpine plant composition will obviously respond strongly. The trends in the long-term development of the SNP summit floras clearly correspond to those found in most mountain regions over Europe where such historical data is available (see RIXEN & WIPF 2017 for a recent review).

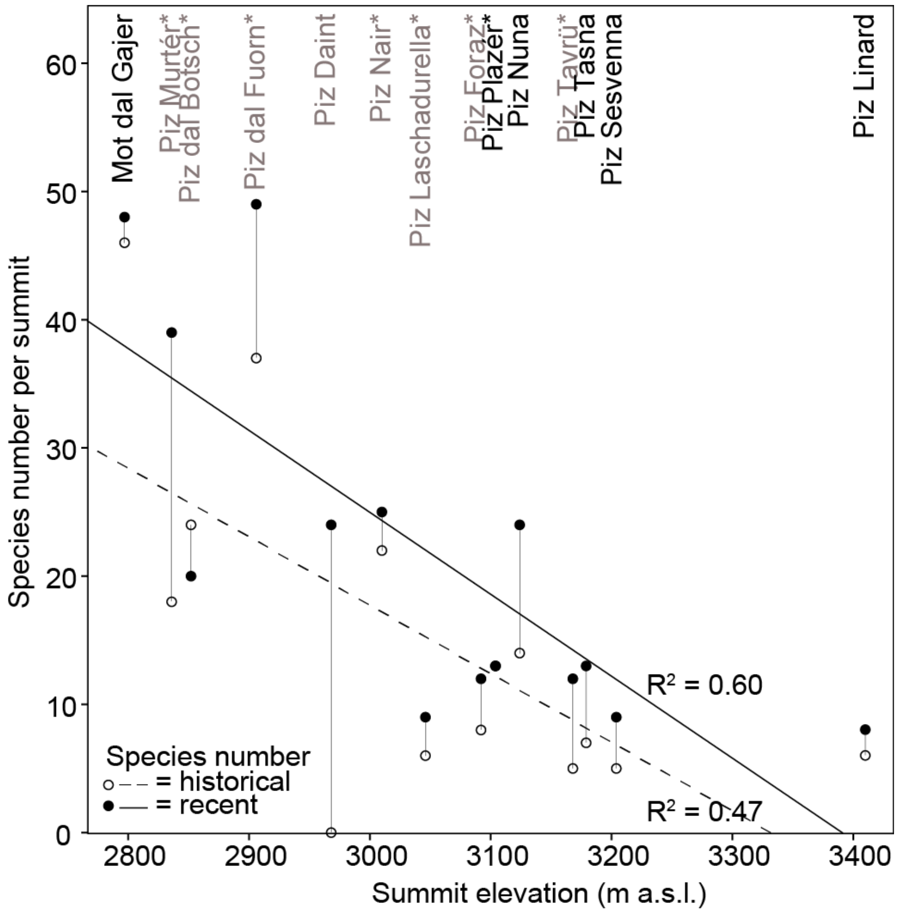

Figure 1: Species numbers increased over the 20th century on each of 14 summits in the region of the Swiss National Park. Names in grey denote summits on calcareous bedrock, asterisks mark summits that have very low visitor frequencies (as estimated from summit books, or because access is limited by park rules).

The shorter-term, but more detailed relevés on the eight GLORIA summits in the SNP region give insight into the processes taking place at a smaller spatial scale. Plot-level data indicate that the increase in species numbers mainly stems from an influx and increase of species with higher heat requirements than the previously present ones (WILD 2016). These incoming species from lower altitudes have their main distribution in montane and subalpine belts, where vegetation is generally more productive and thus competition within communities more severe than at higher altitudes. Thus, this influx of species is likely to result in higher competition pressure on cold-adapted species, especially at climatically favourable sites.

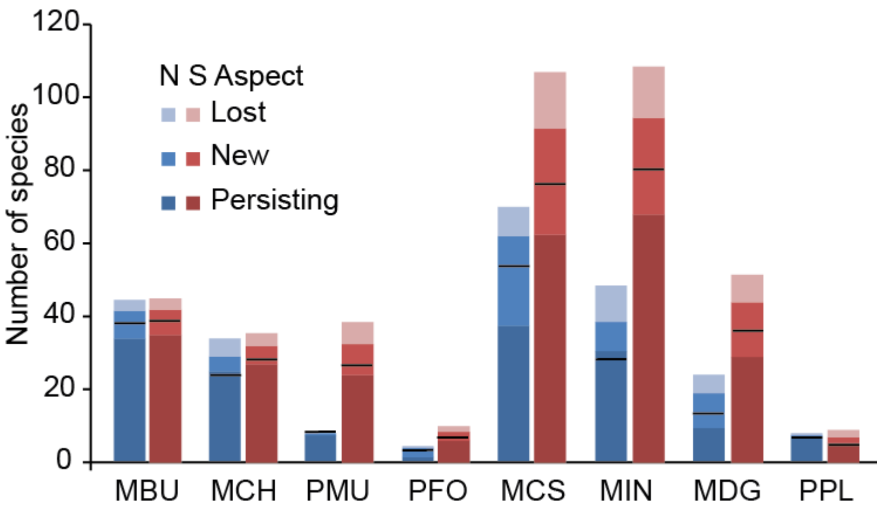

Figure 2: Number of species that persisted (dark), appeared newly (medium), or disappeared (light shade) between 2002/03 and 2015 on North (blue, left) and South (red, right) aspects of the SNP GLORIA summits. Species richness in 2015 indicated as black bars. Numbers are means of the two summit sections per aspect (0-5 and 5-10 m, see PAULI et al. 2015 for methods). Species richness is generally higher on S aspect than on N aspect, and has mostly increased over the monitoring period.

Our findings that the number of newly appearing and lost species since 2002/03 were higher in the warmer, south exposed than the colder, northern aspect (based on summit area sections, all paired t-test p<0.05; Fig. 2), could be an indication of this increased competition pressure. Also, there was a strong and significant correlation between the number of new and lost species, and this correlation was much steeper on the southern than on the northern aspect, suggesting an indirect or direct adverse effect of new colonizers on previously present species on the warm side of the summit. However, the number of newly appearing and lost species strongly correlated with species number (Fig. 3), i.e. the higher loss could simply be a random process with constant rates (and thus, higher losses in richer communities). Moreover, until now we found no indication that the lost species were especially cold adapted, as there was significant difference of temperature indicator values of lost vs. new or persisting species, results not shown).

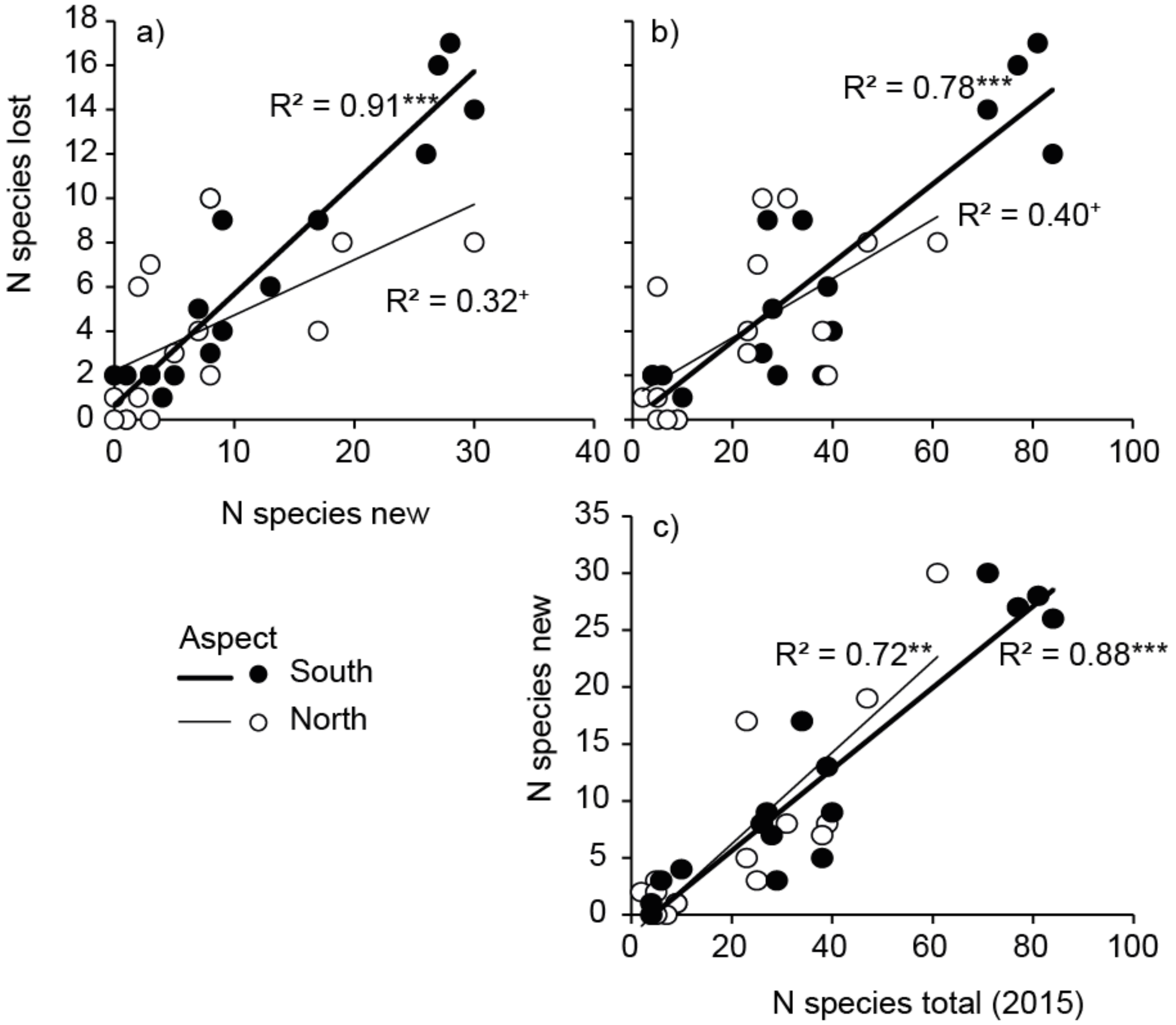

Figure 3: Correlations between lost and new (a), lost and total (b), and new and total species numbers per summit area section in the North and South aspects of 8 GLORIA summits. Significance of the correlations were calculated based on a per-aspect level (i.e. N=8; + p<0.1, * p<0.05, ** p<0.01, *** p<0.001).

Small scale mapping of abiotic conditions and species distributions in alpine habitats indicate that the diversity of thermal microhabitats and soil types is very high (SCHERRER & KÖRNER 2011, KULONEN et al. in press), and that occurrences of plant species' microhabitats differentiate along such gradients. Whether, where, and which cold-adapted species will be able to escape the newly arriving competitors with higher heat requirements, might ultimately depend on the presence and long-term persistence of such microhabitat refugia.

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Ecological Connectivity and its Contribution to a Green Economy

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Abstract

Policies to enhance ecological connectivity generally affect the quality of biodiversity and ecosystem services (ES), and may thus also have an impact on society and the regional economy. The question is, however, whether these policies support a green economy using natural resources efficiently, pollution is reduced, biodiversity loss is prevented, the economy is socially inclusive, and at the same time contribute to (regional) economic development. Economic impacts of ecological policies are often hardly quantifiable but impact chains emphasizing use and non-use values of ES help to establish links between ecological policies and the regional economy. The results show that connectivity policies may have a potential to positively affect regional economy and, in addition, to support the concept of green economy. Their actual contribution depends on the ecological, economic and social contexts, and on the way of implementation.

Keywords

Ecological connectivity, ecosystem services, regional economy, green economy, impact chain

Introduction

Measures for ecological connectivity gain in importance because of the increasing awareness that (on-site) protected areas alone are not able to protect biodiversity in the long term (KOHLER & HEINRICHS 2011: 5). In the last ten to fifteen years nature conservation activities focused, consequently, also on connectivity policies. The focus changed from on-site nature conservation in separated protected areas to policies connecting protected areas. One may even talk of a paradigm shift in nature conservation. The Alpine Network of Protected Areas (ALPARC) carried out several projects based on this paradigm change (e.g. ECONNECT, greenAlps). These projects resulted, amongst others, in the definition of eight pilot regions for ecological connectivity (PLASSMANN et al. 2016).

In the pilot regions several activities to improve connectivity have been carried out during the last years. Connectivity measures already implemented show positive effects not only for the ecological system but also for the local and regional economy. The appreciation of connectivity policies, however, is still rather loose in local politics and the local population. The aim of this study is to support the mainstreaming of ecological connectivity by visualising the economic impacts of connectivity measures. Therefore, connectivity measures are connected to several sustainable development notions including the recent 'green economy' concept.

The 'green economy' concept denotes an economy in which the natural systems set the limits for economic activities (LOISEAU et al. 2016: 364). The proposed structural changes in society and economy, which take care of nature's limits, lead to a more small-scaled and decentralized economy. Consequently, the use of natural resources is reduced to sustainable limits and is pursued efficiently, pollution is reduced, biodiversity loss is prevented, the economy is socially inclusive, and at the same time contribute to (regional) economic development (LOISEAU et al. 2016: 362). Economic growth (resilient, green) can only take place within the sustainable limits.

Connectivity policies can be defined as nature-based solutions within the concept of a green economy and, thus, may positively contribute to the local and regional economy. The question is, however, how and to which extent such measures correspond to the concept of green economy and contribute to the regional economy. As empirical analyses and data is not readily available for studying these effects, conceptual impact chains can be used to analyse and visualise the economic contribution of connectivity measures. Their contributions, thereby, are described by the amount of conserved, changed or newly provided ecosystem services (ES).

Methods and analysis

The aim of this study is not to quantify or even monetize the economic value of conserved, changed or newly provided ESs because investments in connectivity measures often are small in comparison with other investments such as infrastructure spending. Hence, it is hard to trace the economic impacts of such connectivity policies. The aim of this paper therefore is to describe the economic impact as tangible as possible. Therefore, a logic model, namely the instrument of impact chains, is used.

For creating an impact chain, it is necessary to build up broad knowledge about the objectives and the realisation of the connectivity measure. Especially, information is needed about which goods or services are provided by the connectivity measure in question and which impacts result from these goods and services for different groups of people. In the end, impact chains should describe under a theoretical framework how connectivity measures are implemented to fulfil its targeted objectives (cf. RAUSCHER et. al 2012: 5). One of the advantages of this description is that ecological impacts can be assigned directly to the relevant connectivity measure and also dependencies and links between connectivity measures and local and regional economic developments can be drawn. In addition, impact chains take not only direct or indirect use values but also non-use values of ESs into account in their evaluation process.

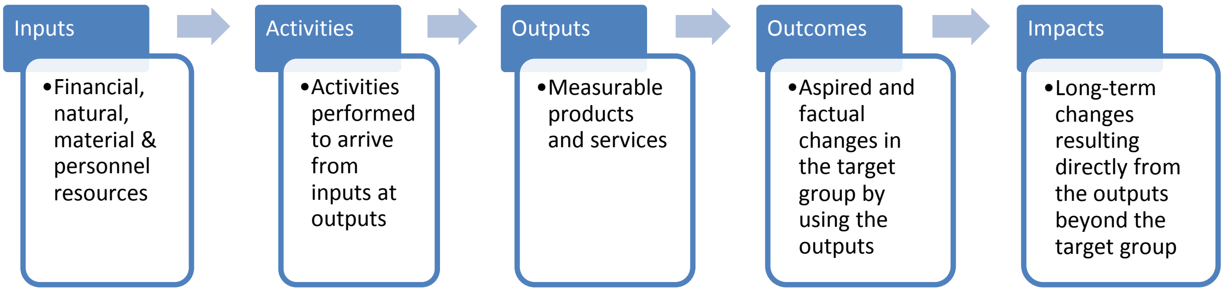

Figure 1: Elements of an Impact Chain
Source: Own representation based on RAUSCHER et. al 2012, CLARK et al. 2004, and ENERGYPEDIA.INFO 2015.

In general, impact chains consist of four to five elements (see Fig 1.). In the beginning of an impact chain **Inputs** are required. These inputs can be in form of financial, natural, material or personnel resources. Based on this input **Activities** produce **Outputs**. Consequently, outputs are the measurable products and services resulting from the activities. If the outputs are known already, the activities are often not considered in the impact chain. The use of these 'new' products and services by the target group should lead to the aspired changes, which are summarised as **Outcomes** in the impact chain. Different to the outcome the **Impacts** represent '... the portion of the total outcome that happened as a result of the activity of the venture, above and beyond what would have happened anyway' (CLARK et al. 2004: 7).

The analysis of ecological connectivity measures follows a twofold approach. On the one hand, twelve connectivity measures from the catalogue of possible measures to improve ecological connectivity in the Alps (KOHLER & HEINRICHS 2011) are selected. Data and information about objectives and probable consequences (outcomes, impacts) for ecosystems and their services to fill in the impact chain are extracted directly from the catalogue.

On the other hand, three already realized connectivity measures are analysed from the pilot regions 'Northern Limestone Alps', 'The Rhaetian Triangle' and 'The French Department Isère'. The impact chain is filled with real data, in contrast to the connectivity measures from the catalogue. The data was collected with the help of stakeholders from the pilot regions. Based on a predetermined structure ecological managers developed a profile for their respective connectivity measures. The information from this profile, in the end, is used to produce an impact chain for the relating connectivity measure.

Results

All connectivity measures have in common that financial resources are needed as an initial input for the implementation of the measure (see for details WITHALM & GETZNER, 2017). Thus, local or regional economic impacts are indisputable, but the size and extent of the impacts, of course, depends on the amount of financial recourses. As the financial inputs mostly not exceed 10,000 to 100,000 EUR for the realisation of one measure, the economic impacts are also hardly recognizable. There are exceptions, like the control of invasive species or the revitalisation of flowing waters, which entail costs of up to 1 Mio. EUR. Nevertheless, investments in connectivity measures can have initiating impacts independent from the amount of financial input for further local or regional economic development and will have social and ecological impacts for residents.

The analysis shows, moreover, that connectivity measures can substantially support the concept of a green economy. The reason is on the one hand, that connectivity measures are mostly based on local and regional strengths. The concentration on these strengths may make the region more resilient. In rare cases even new economic pillars may develop from the implementation of connectivity measures (e.g. new products or niches for new companies). Landscape conservation with sheep grazing, for example, includes economic impacts by products from sheep farming like wool, meat and dairy products. The implementation of the 'Network Natural Forest' in the pilot region 'Northern Limestone Alps' even stimulated the development of a new tourism agency in the region. Economic impacts concentrate, however, on the tourism and agricultural sectors. On the other hand, a strong concentration on natural capital and a protection of biodiversity is visible as life cycle maintenance and habitat and gene pool protection play in almost all measures an important role.

Discussion

It seems that connectivity measures bring about positive economic effects for a region in most cases. The impact is, however, dependent on where the measure is implemented, who implements the measure and how it is implemented. Consequently, it is not granted that connectivity measures have positive economic impacts for a region. Nevertheless, measures for ecological connectivity may be a good starting point to support regional development, because of their concentration on local and regional strengths.

Several connectivity measures emphasize, however, on environmental education and awareness-raising of ecological connectivity. The aim is to educate the local population as well as visitors concerning nature and biodiversity. These measures entail only indirect and insecure economic impacts. These impacts are, thus, not even to some extent predictable. Furthermore, it may take a long time until real economic impacts are noticeable.

Although connectivity measures carry a potential to entail positive economic impacts, one has always to consider the actual circumstances. Consequently, a general statement about the regional economic impact of connectivity measures is not possible.

Conclusion

Increasing ecological connectivity is a complement to PAs; its main contribution is the protection and conservation of biodiversity. As the implementation of connectivity policies requires financial resources, the regional economy is always affected. These impacts are very limited, because investments are often very small. The big profiteers are, however, the tourism and the agricultural sectors. Furthermore, connectivity measures are mainly small-scaled projects and, thus, affect only the local or regional economy; most measures do not lead to negative impacts owing to the reduction of available natural resources (e.g., land for development, extractive uses). The strengthening of local potentials may therefore contribute to the green economy concept.

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Record and description of the sediments of the flood in June 2013 in the area of the Donau-Auen National Park

Nationalparks Austria Science Award 2017

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Keywords

Donau-Auen National Park, Danube, flood, sediment, grain size, spatial distribution, overbank deposit, levee, inundation area, floodplain

Introduction

Floods appear with varying characteristics as natural phenomena of the hydrological cycle. By means of erosion, transport and sedimentation of eroded material they form the fluvial topography. A number of studies deal with the development of inundation areas in connection with overbank deposits due to floods. For instance WOLMAN AND LEOPOLD (1957) identified the main development processes as laminar deposits, development of lateral deposits in form of sand and gravel banks, as well as lateral erosion together with relocation of the riverbed. Along regulated rivers like the Danube, side erosion is prevented to a large extent and deposited material is hardly remobilized. So far, the progressive increase in elevation of the inundation area for the Donau-Auen National Park was examined by comparison of landscape models based on laser scans with historical records (KLASZ et al. 2014) or data from core drilling of different analyses (e.g. FIEBIG & PREUSSER 2007) was used.

The aim of the present paper is to assess the influence of the deposited sediment load due to bigger floods on the development of the elevation of the inundation area Donau-Auen in the context of the extreme flood event in June 2013.

Methods

This paper investigates the national park Donau-Auen. Due to the size of more than 9,300 ha (DONAU-AUEN 2014) the area was limited to the floodplain next to Orth an der Donau, approximately between river kilometre 1902 and 1907. This region serves as an inflow area with high sedimentation rates during floods (KLASZ et al. 2014). In the area of investigation two former branches of the Danube (RECKENDORFER 2006) are situated, the 'Kleine Binn' and the 'Große Binn'.

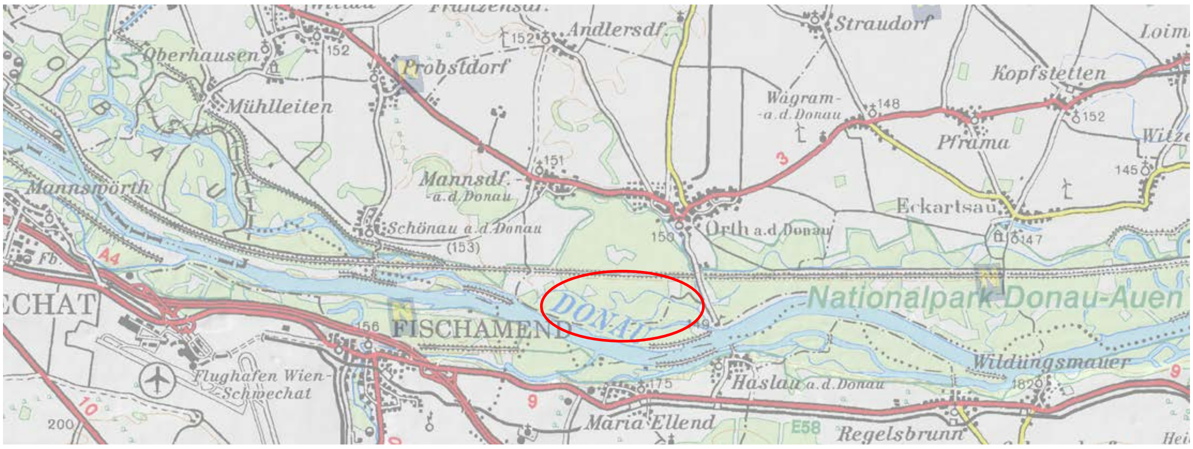

Figure 1: Layout plan of the investigation area next to Orth an der Donau (NÖ-ATLAS, 2014).

The basic approach of the analysis was the determination of the layer thickness of the deposits of the 200-year flood in June 2013 in the Danube area with the help of the overlain vegetation horizon before the extreme flood event. In the scope of the fieldwork soil profiles were used to find the former vegetation layer and to assess the newly added sediments. The different layers, their thickness, colour and grain size categories were identified.
All profiles were recorded with their coordinates (WGS84) and processed by means of an ArcGIS elevation model based on laser scans of VIA DONAU (2010), orthophotos from Google Earth and maps and orthophotos from NÖ-Atlas. The analysis and presentation of the investigated layer thicknesses as elevation model was carried out with OriginPro 9.1.

Results

In general, sand and fine sand was found next to the bank. With increasing distance to the water the fraction of silt and clay rose, whereas the amount of sand and the layer thickness declined. Next to the Danube sedimentation varied between 50 and 60 cm with a maximum of up to 1 m. In the area of the dam still 3 mm of fine sediments were found.

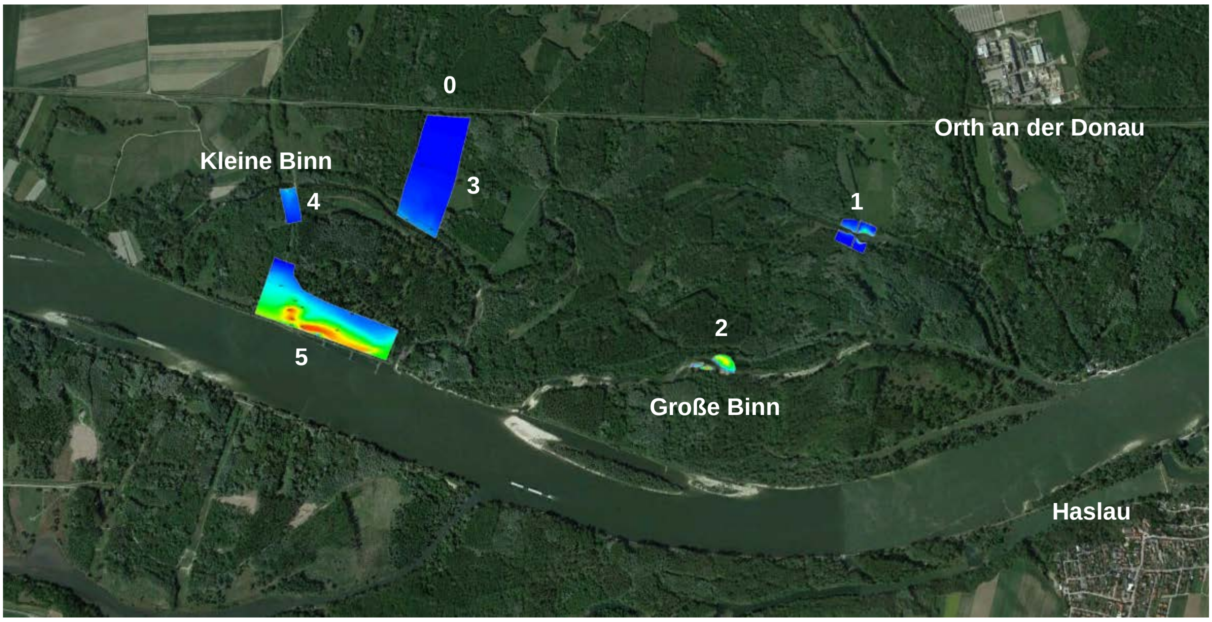

Figure 2: Areas of layer thickness investigation (GOOGLE EARTH, 2014).

Particularly in the first 100 m distance to the Danube as well as in the area of the anabranch 'Große Binn' material with highly varying layer thickness was deposited due to diverse conditions. In areas farther away from the water and in the area of the anabranch 'Kleine Binn' more homogenous layer thicknesses were found.

In addition to the spatial illustration also the change of sedimentation rates was identified as a function of distance to the water. Depending on the fact that sedimentation only starts when the bankfull discharge is exceeded (approx. 4,800-5,000m³/s; KLASZ et al. 2012; LIEDERMANN et al. 2012) and the inundation area is flooded, the bank edge was used for distance measurement.

In general, the sedimentation of the 200-year flood can be well described with an exponential function. In the context of the distance to the water this means an exponential decrease of sedimentation rates with rising distance. This correlation can for instance be identified in the diagram of the deposits at the anabranch 'Kleine Binn' in Fig. 3. The description of sedimentation by means of an exponential function is suitable for bigger observation areas with a high number of soil profiles. Especially for areas farther away from water, the fast decline of layer thickness is estimated accurately. If only bankside areas like area 4 are to be taken into consideration, for instance a power function provides a better description (Fig. 4).

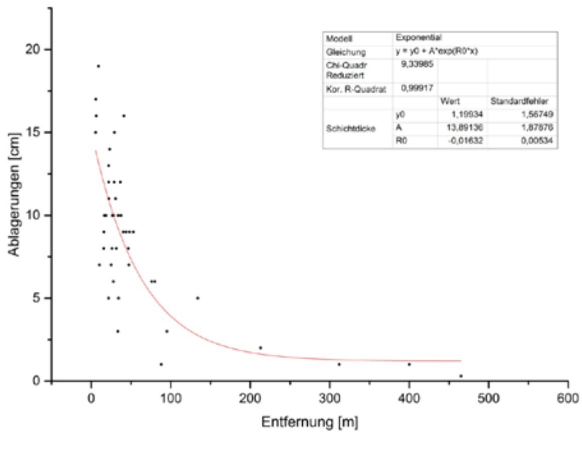

Figure 3: Description of deposited material as an exponential function of the distance to the water, area 3.

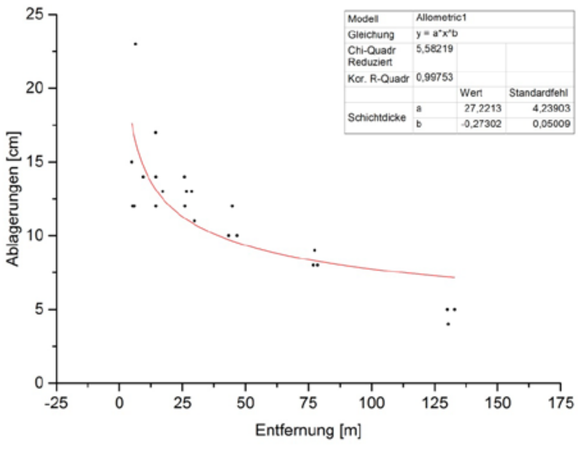

Figure 4: Description of deposited material as a power function of the distance to the water, area 4.

Discussion

KLASZ et al. (2014) estimate the average sedimentation rates of the last 120 years (since the regulation of the Danube in the national park area) to approx. 11 mm p.a. for areas next to the Danube and approx. 0.3 mm p.a. for zones in the floodplain farther away. Thus, the deposited material of the 200-year flood event significantly exceeds the estimated yearly sedimentation rates.

According to the author the investigation area is situated in a zone of increased inflow. Flood events flow into the widening inundation area and due to a reduction of flow speed more sediment load is deposited there than in other areas. Zones where the flood leaves the inundation area show lower sedimentation rates and less ground level elevation in the ArcGis model. Therefore, the observed sediment layer thicknesses of the flood event in 2013 are probably only valid for similar inflow areas and cannot be generalized for the whole national park.

WALLING AND SIMM (1998) describe in their observations that the highest sedimentation rates can be found next to the river, with high variation within individual values. This also applies to the investigation area of the Danube: the biggest variability was observed in the bankside areas of region 5. Furthermore, the authors emphasize the direct relationship between distance to the river and sediment thickness: the greater the distance, the lesser the sediment deposits. Also the exponential connection, described by a number of authors (e.g. WALLING & SIMM 1998; WALLING & HE 1998) largely applies to the area under investigation. The actual sedimentation of bankside areas can be better described by power functions, similar results were found by FILGUEIRA-RIVERA et al. (2007).

Coarser material is sedimented in bankside areas, whereupon especially the sand fraction declines relatively rapidly and fine material as silt and clay are transported far into the inundation area according to TÖRNQVIST & BRIDGE (2002). This leads to a progressive increase in elevation of the banks of the Danube due to levee formation.

Conclusion

Sand and fine sand was found in bankside areas, next to the Danube sedimentation varied between 50 and 60 cm. With increasing distance the fraction of silt and clay rose, whereas the amount of sand and layer thickness declined (3 mm in dam area). This implies that the deposited material of the 200-year flood event significantly exceeds the estimated yearly average sedimentation rates of other studies.

The highest sedimentation rates and the coarsest material could be found next to the river, this leads to a progressive increase in elevation of the banks of the Danube due to levee formation.

The Analysis showed that for bigger observation areas farther away from water, an exponential function estimates the fast decline of layer thickness with rising distance accurately. For bankside areas power functions are more suitable.

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Speleology in the Berchtesgaden National Park
Eiskapelle: 26 years of surveying

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Abstract

The Eiskapelle, one of the lowest-lying permanent snowfields in the Alps, is fed by mighty avalanches that slide down from the east face of the Watzmann and accumulate in the angle of the rock face. The thickness and expansion of the ice is related to the quantity of snowfall and the temperature during the year. Every year since 1989, speleologists have surveyed the ice cave under the snowfield. In cooperation with the Technical University of Munich and Munich University of Applied Science the surface has also been monitored. From 1970 to 2014, a loss of more than 1,000,000 m^3 of ice has been determined.

Keywords

firn, ice, cave, snowfield, climate change

Introduction

The scientific study of caves and other karst features, their composition, structure, physical properties, history, life forms, and the processes by which they form and change over time started in the Berchtesgaden National Park in the early 1970s. Speleology is an interdisciplinary field that combines the knowledge of geology, biology, climatology, paleontology, archaeology, meteorology and cartography to develop portraits of caves as complex, evolving systems. The area around Berchtesgaden is famous in Germany for its numerous deep and large cave systems. Six of the twenty-five longest caves and twenty-four of the twenty-five deepest caves are located inside or near the national park. Caving clubs from all over Germany have been working together to explore these difficult systems. In 1984 the Speleo Club of Munich VHM started to survey the Eiskapelle ice cave, a small snowfield at the bottom of the eastern face of the Watzmann. The Eiskapelle is the most low-lying perennial accumulation of firn and ice in the German Alps.

Figure 1: Eiskapelle in 1994, photo: Werner Vogel

Eiskapelle

The Eiskapelle's surface and its cave system are subject to great annual fluctuations. The firn and ice fields are fed by avalanche snow from the slopes of the Watzmann. The cave is consequently filled with masses of snow through the gap at the rock face and entrance areas. During the winter, the snow is deposited on the surface of the ice. In the early summer, the rock wall heats up in the contact zone, melting the ice and feeding countless streams. These are reinforced by productive springs located at the foot of the wall. The ice cave is characterised by a main corridor which undercuts the glacier from west to east. Up to two side corridors have been documented on the northern side and one on the southern side. These are not visible or accessible every year. The middle section of the main corridor is characterised by scallops formed by water and wind. Iit can reach a width of 30 metres. The corridor floors are created by moraine scree which also serves as the bed for the cave stream. Although the body of ice appears to be solid, the cave does experience spalling, especially in the summer. Ice flows regularly fall into the entrance area, which is why the survey activities are conducted during the cooler weather in autumn.

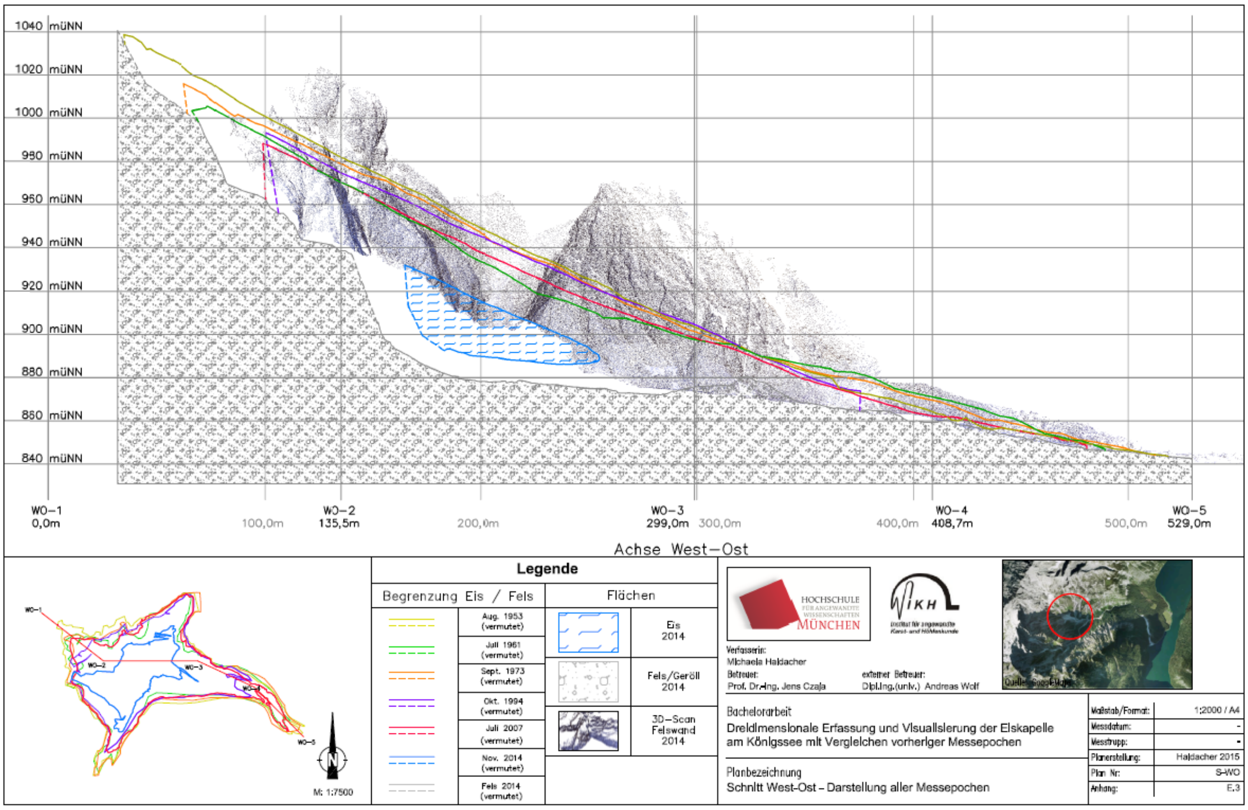

Table 1: Eiskapelle cross section, loss of ice between 1953 and 2014

Survey of the Eiskapelle

The speleological surveys and documentation underground in the ice and firn field have been conducted by members of Southern Bavaria's organised speleology.

Since 1953, the surface of the Eiskapelle has been surveyed at irregular time intervals through geodetical measurement campaigns by the following institutions:

- 1953 Technical University of Munich photogrammetric evaluation of aerial photographs
- 1961 Technical University of Munich: photogrammetric evaluation of aerial photographs
- 1973 Technical University of Munich: photogrammetric evaluation of aerial photographs
- 1994 Technical University of Munich: terrestrial field survey
- 1997 Technical University of Munich: photogrammetric evaluation of aerial photographs
- 2007 Technical University of Munich: terrestrial laser scan
- 2014 Munich University of Applied Science in cooperation with the German Institute for Karst and Cave Science: terrestrial laser scan
- 2017 Munich University of Applied Science in cooperation with the German Institute for Karst and Cave Science: terrestrial laser scan

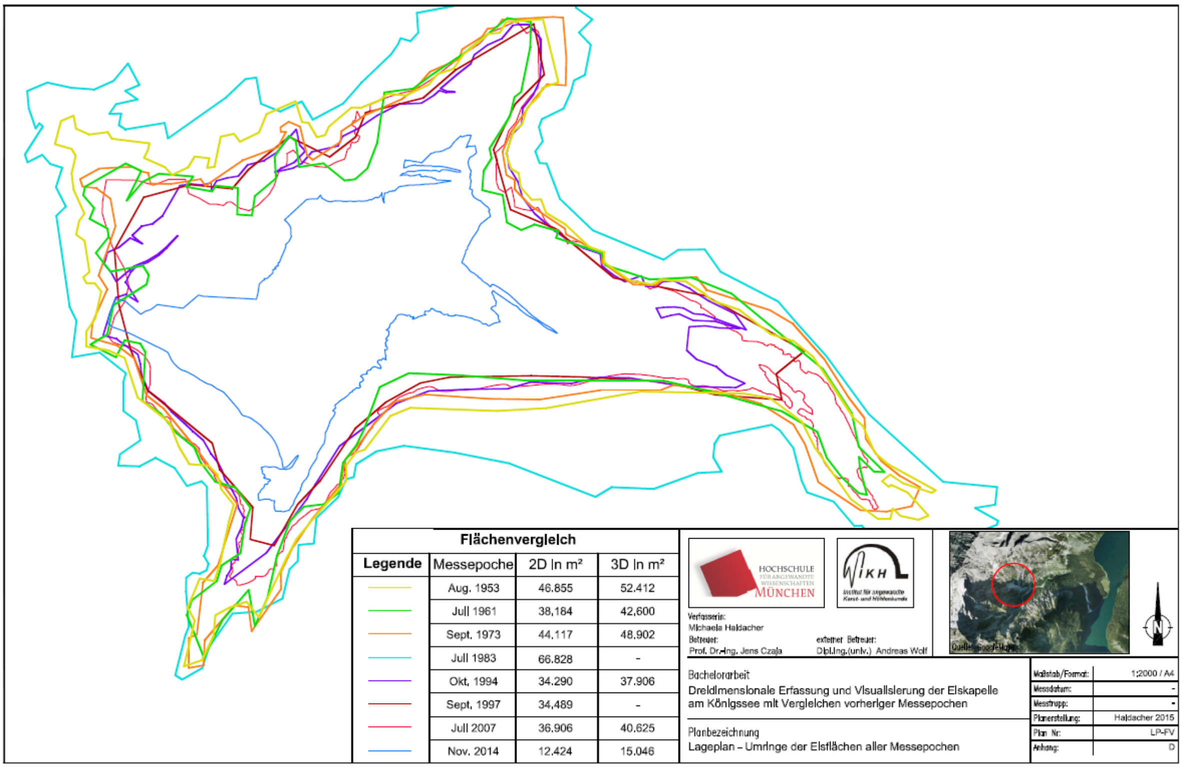

Table 2: Eiskapelle ground plan: loss of surface between 1953 and 2014

Results

Based on the long-term speleological monitoring together with the research conducted by the Technical University of Munich und Munich University of Applied Science, the following results can be presented:

- The cave system, with passages of up to 650 m in length is subject to dramatic changes.
- The surface has been reduced from 46,855 m² in 1953 to 12,424 m² in 2014.
- In the period from 1973 to 2014, a loss of up to 1,000,000 m³ of the ice mass has been observed.

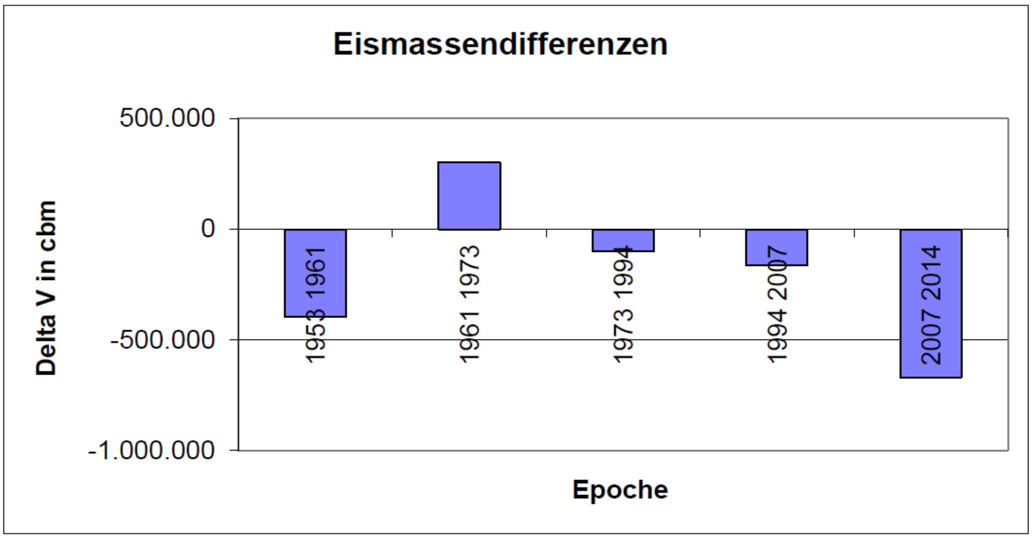

Table 3: loss of ice mass in m³

Conclusion

Despite climate change, the Eiskapelle will continue to exist due to its prominent position at the foot of the eastern wall of the Watzmann, although it will do so in reduced form. Research above and below ground will be continued.

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Further links

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Comparative population genetic analysis of brown trout (*Salmo trutta*) from Kalkalpen National Park

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Keywords

Salmo trutta, population genetics, mtDNA, microsatellites

Summary

Central Europe is known to be a contact zone between the so-called Atlantic and Danubian lineage of brown trout (*Salmo trutta*) with the Atlantic lineage being native to river systems draining into the Atlantic Ocean and the Danubian lineage being the autochthonous lineage in the catchment area of the Danube (BERNATCHEZ 2001). Natural contact as well as the anthropogenic introduction of hatchery reared fish from the Atlantic lineage through extensive stocking activities throughout Europe have led to admixture of the Atlantic and Danubian lineage (SCHENEKAR 2015). The screening of about 200 brown trout populations throughout Austria revealed that most populations show admixture between these two lineages and only 10 (~ 5%) appear to be of a purely native Danubian origin. All other populations showed medium to high levels of genetic introgression with Atlantic basin fish – most presumably of hatchery origin (LERCETEAU-KÖHLER et al. 2013).

The aim of this study was to genetically characterize brown trout populations in the Kalkalpen National Park in Austria to gain a detailed overview of the current genetic make-up of populations within this national park as well as to identify potential source populations for future reintroduction and managing efforts. Emphasis was placed upon the genetic structure within and among these populations, particularly in relation to the presence of Danubian and Atlantic lineages. The analysis and interpretation was based on three different kinds of molecular markers – sequences of the control region of the mitochondrial DNA (mtDNA), a diagnostic site in the LDH-C1* gene, and allele size variance across a set of ten microsatellites.

The screening of eight small streams in the Kalkalpen National park led to the surprising result that six of these populations appear to be of purely Danubian origin, representing the most dense collection of such populations that has thus been discovered in Austria. In total, 19 different Danubian mtDNA haplotypes were resolved in the national park, illustrating the great diversity within the Danubian lineage. The analyses showed that populations belonging to the different sub-drainages were clearly distinguishable from each other. Autochthonous populations from the Krumme Steyrling drainage (Krumme Steyrling, Rumpelmayrbach & Schafgrabenbach) are genetically clearly differentiated from populations from the Großer Bach drainage (Saigerinbach & Stöffalmgraben) and Niklbach (Paltenbach drainage) with the latter stemming most likely from a different colonization event than the other populations.

These three sub-drainages drain an area at the northernmost edge of the last glaciation and a region that was covered by small mountain glaciers about 20.000 years ago. We speculate that these populations represent glacial relicts that were already isolated from downstream areas of the Enns catchment before the Würm glaciation. Fortunately, little to know stocking of foreign stocks of fish has been carried out in these streams, and it seems that the fish have survived the last 10,000 years without influence from foreign gene flow. Thus, these fish are a very valuable genetic resource for the Kalkalpen National Park. The data presented in this study can be of use for future management and potential renaturation plans elsewhere in the national park or neighbouring regions where native Danubian fish – clearly adapted to the unique characteristics of the region – are needed. Additional genome-wide scanning using state-of-the-art technology that is currently in progress may provide a deeper insight into the population structure of the brown trout populations in the Kalkalpen National Park and will help to further identify the relationship of these fish with other autochthonous populations in Austria and Bavaria.

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Sedimentological downstream effects of dam failure and the role of sediment connectivity: a case study from the Bohemian Massif, Austria

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Keywords

Connectivity, sedimentology, freeze-core, dam failure, downstream effects, hyporheic zone

Introduction and Objectives

Sediment connectivity describes the potential for sediment transport through catchment systems, further defining locality and characteristics of sedimentation. (Bracken et al., 2015) Dams generally decrease sediment connectivity and act as temporary sediment sinks. (Pöppl et al., 2012) When dams are removed these sediments are being reworked and released downstream. In December 2015 a dam failure led to the entrainment of several tons of fine-grained reservoir sediments entering and depositing in the downstream channel reaches of the Kajabach, Nationalpark Thayatal. After excavation-works, the National Park Authority decided to initiate a flushing event in April 2016, aiming to remove the remnant deposits.

The aim of this study was to investigate the effects of dam failure-induced fine sediment release and reservoir flushing on downstream bed sediment characteristics, further discussing the role of in channel sediment connectivity.

Study Area

The Thayatal National Park is located in the Bohemian Massif, Lower Austria. The Kaja River is a mixed-load single-thread perennial wadable tributary of the Thaya River. The climate in this region is temperate, with an average temperature around 8°C and 500 – 600 mm average annual precipitation. In the upper reaches of the Kaja the landscape is characterized by wide open valleys draining a sedimentary arable environment, while in the lower reaches steep forested valleys in crystalline rocks are predominant.

Data and Methods

Geomorphological Mapping was done along the river course, recording all fine sediment bars, its size and volume as well as log jams. These features were GPS-tagged and further processed in ESRI ArcMap to retrace the movement of sediment within the channel.

For granulometry analysis, two freeze cores were taken at three spots in March an October respectively and subdivided in 10 cm layers. The first sampling point (K1) was near the broken dam, right before the inflow of a small tributary, the Merkersdorfer Bach. K2 was next to the estuary of the Kaja. The third sampling point (M) was taken in Merkersdorfer Bach as a reference point. All in all, 12 cores were taken. The analysis of the 10 cm sections was done following ÖNORM with a focus on the grain sizes sand (2 mm – 63 µm), silt (63 µm – 2 µm) and clay (< 2 µm) to determine the distribution of all grain sizes within the core.

Results

The results of Geomorphological Mapping illustrate the overall decrease of fine sediment regarding deposition area as well as volume: in March, shortly after the dam failure event, a total of 17.95 m3 of fine-grained sediments had accumulated as in-channel sediment bars, while in October, 6.85 m3 were left, forming a tenuous layer within the channel. The results further indicate a downstream migration of the fine sediment deposits (Fig. 1). Both in March and October fine sediment bars as well as fine sediment blankets were primarily formed in zones of low flow velocity and decreased longitudinal connectivity (i.e. in backwater areas of woody debris jams, or at slip-off bank locations).

Sedimentological analysis of the freeze core samples exhibited that most bed sediment layers show a significant increase of clay and/ or silt particles from October to March (Fig. 1), indicating a clogging of the hyporheic zone.

In river systems, the hyporheic interstitial vertically controls the exchange of matter, energy and oxygen between the groundwater body and the overland flow. Additionally, it is an important habitat for fishes and macroinvertebrates and helps buffering the effects of floods or pollutants. While small amounts of jetted fine grained sediment can easily be reworked, entrained clay, silt and sand particles are clogging up the channel bed (i.e. colmation), thereby decreasing vertical connectivity.

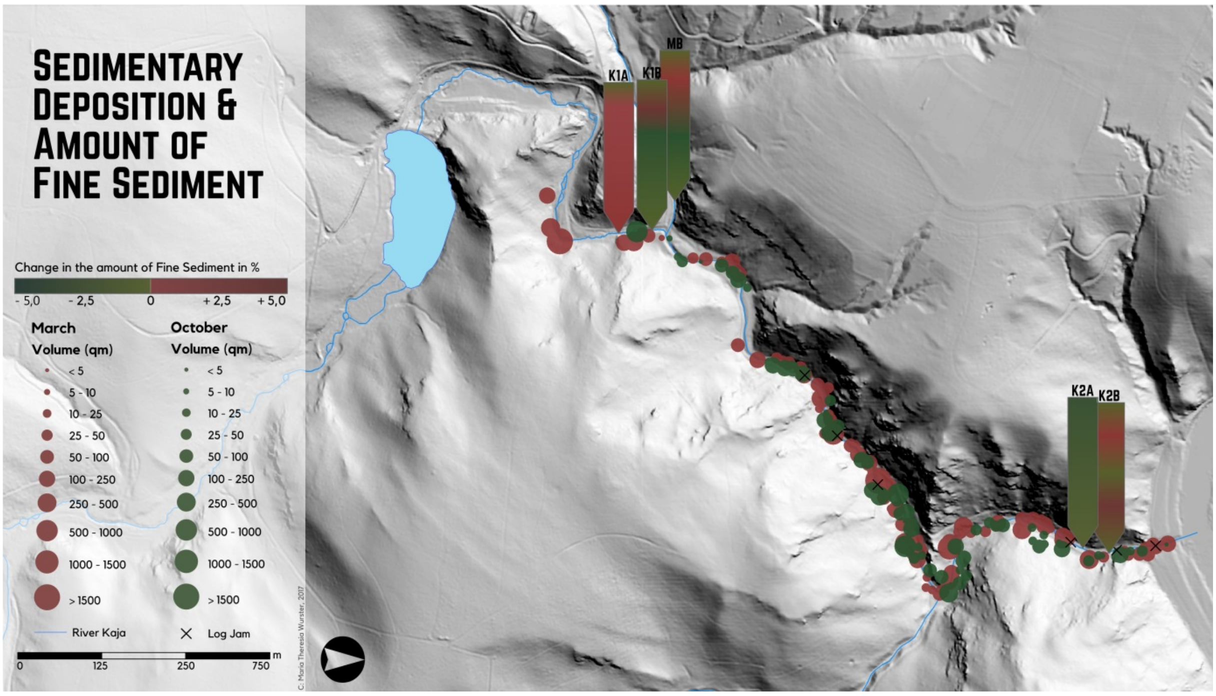

Figure 1

Conclusion and Outlook

Investigations of the consequences of dam failure-induced fine sediment release have shown that the flushing event had an improving effect, removing nearly 60% of the material. The remaining material infiltrated into lower soil horizons and, affected by geomorphological setting (narrow valley reaches) or log jams, formed tenuous layers in-channel. These layers of clay and silt decrease vertical connectivity and oxygen availability, further inducing oxidation of the upper bed sediment layers and putting strain on the overall functionality of the hyporheic interstitial. Additionally, effects on chemical conditions and invertebrate community have been observed. These observations also indicate a significant influence of vertical connectivity conditions on in-channel fine sediment storage. Overall, the effects of dam failure-induced fine sediment release and reservoir flushing on downstream bed sediment characteristics were differentiated. I could clearly be seen, that geomorphological setting was most important for sediment depostition and strongly influenced in-channel sediment connectivity.

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The mass balance series of Stubacher Sonnblickkees 1946–2016 and the semi-direct calculation of the mass balance of glaciers. A contribution to LTER Austria

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Abstract

This poster presents the results of the semi-direct calculation of the annual mass balances of Stubacher Sonnblick Glacier in the heart of NP Hohe Tauern for the periods 1946–1963 and 1981–2016. They are based on annual measurements of the mass balance by the direct glaciological method carried out between 1964 and 1980. Together they make up a mass balance series of 70 years. The small east-facing glacier is situated north of and close to the main crest of the Hohe Tauern range (Eastern Alps). In 2016 it covered an area of 1 km² and terminated at an elevation of 2,650 m. The results and observations of the 17-year series allow the inference of several systematic relations between glaciological parameters and the annual mass balance.

Keywords

glacier monitoring; long term ecological research (LTER); mass balance; semi-direct calculation, NP Hohe Tauern; climate change

Introduction

The LTER Master Site Oberes Stubachtal | Sonnblickkees is a long term research site with a main focus on measurement of glacier parameters, going along with hydrological budget estimations within the catchment area of the lake Weißsee. Stubacher Sonnblickkees (SSK) is located in the Hohe Tauern Range (Eastern Alps) in the south of Salzburg Province. From 1964 to 1981, the yearly mass balance was calculated by direct measurements. Based on these records of 17 years, a semi-direct method was used since then. From the beginning in 1964 until 2016 Heinz Slupetzky, University of Salzburg, carried out the mass balance and related glaciologycal measurements as the principal investigator and as a senior adviser since then. The usual and necessary link to the climate and climate change is given by the weather station at the Rudolfshütte (ZAMG and HDS).

The glacier type of SSK can be classified as a slope glacier, i.e. the relief is covered by a relatively thin ice sheet and there is no regular glacier tongue. The rough subglacial topography makes for a complex shape in the surface topography, with various concave and convex patterns.

The main reason for selecting this glacier for mass balance observations (as early as 1963) was to verify on a complex glacier how the mass balance methods and the conclusions - derived during the more or less pioneer phase of glaciological investigations in the 1950s and 1960s - could be applied to the SSK glacier. In terms of regional climatic differences between the Central Alps in Tyrol and those of the Hohe Tauern, the latter experienced significantly higher precipitation, so one could expect new insights in the different response of the two glaciers SSK and Hintereisferner (Ötztal Alps) - where a mass balance series went back to 1952 (FISCHER et al. 2014).

The usual and necessary link to climate and climate change was given by a newly founded weather station (by Heinz and Werner Slupetzky) at the Rudolfshütte in 1961, which ran until 1967. Along with an extension and enlargement to the so-called Alpine Center Rudolfshütte of the OeAV, a climate observatory has been operating without interruption since 1980 under the responsibility of ZAMG and the Hydrological Service of Salzburg, providing long-term met observations.

Methods

Direct yearly mass balance measurements were started in 1963, first for 3 years as part of a thesis project. In 1965 the project was incorporated into the Austrian glacier measurement sites within the International Hydrological Decade (IHD) 1965 - 1974 and was afterwards extended via the International Hydrological Program (IHP) 1975 - 1981. During both periods the main financial support came from the Hydrological Survey of Austria. After 1981 funds were provided by the Hydrological Service of the Federal Government of Salzburg. The research was conducted from 1965 onwards by Heinz Slupetzky from the (former) Department of Geography of the University of Salzburg.

These activities received better recognition when the High Alpine Research Station of the University of Salzburg was founded in 1982 and brought in additional funding from the University. With recent changes concerning Rudolfshütte, however, it became unfeasible to keep the research station going. Fortunately, at least the ZAMG weather station at Rudolfshütte is still operating.

In the pioneer years of the mass balance recordings at SSK, the main goal was to understand the influence of the complicated topography on the ablation and accumulation processes. With frequent strong southerly winds on the one hand, and precipitation coming in with storms from the north to northwest, the snow drift is an important factor on the undulating glacier surface. This results in less snow cover in convex zones and in more or a maximum accumulation in concave or flat areas. As a consequence of the accentuated topography, certain characteristic ablation and accumulation patterns can be observed during the summer season every year, which have been regularly observed for many decades. The process of snow depletion runs through a series of stages (described by the AAR) every year. The sequence of stages until the end of the ablation season depends on the weather conditions in a balance year. One needs a strong negative mass balance year at the beginning of glacier measurements to find out the regularities; 1965, the second year of observation resulted in a very positive mass balance with very little ablation but heavy accumulation. To date it is the year with the absolute maximum positive balance in the entire mass balance series since 1959, probably since 1950.

The highly complex ablation patterns required a high number of ablation stakes at the beginning of the research and it took several years to develop a clearer idea of the necessary density of measurement points to ensure high accuracy. A great number of snow pits and probing profiles (and additional measurements at crevasses) were necessary to map the accumulation area/patterns. Mapping the snow depletion, especially at the end of the ablation season, which coincides with the equilibrium line, is one of the main basic data for drawing contour lines of mass balance and to calculate the total mass balance (on a regular-shaped valley glacier there might be an equilibrium line following a contour line of elevation separating the accumulation area and the ablation area, but not at SSK). - An example: in 1969/70, 54 ablation stakes and 22 snow pits were used on the 1.77 km^2 glacier surface. In the course of the study the consistency of the accumulation and ablation patterns could be used to reduce the number of measurement points. - At the SSK the stratigraphic system, i.e. the natural balance year, is used instead the usual hydrological year.

From 1964 to 1981, the yearly mass balance was calculated by direct measurements. Based on these records of 17 years, a regression analysis between the specific net mass balance and the ratio of ablation area to total area (AAR) has been used since then (SLUPETZKY 2014). The basic requirement was mapping the maximum snow depletion at the end of each balance year. Verifications took place as often as possible by means of independent geodetic methods, i.e. monoplotting, aerial and terrestrial photogrammetry, more recently also the application of PHOTOMODELLER and laser scans. The semi-direct mass balance determinations used at SSK were tentatively compared with data from periods of mass/volume change, resulting in promising first results on the reliability of the method. In recent years re-analyses of the mass balance series have been conducted by the World Glacier Monitoring Service and will be done at SSK too. The methods developed at SSK also add to another objective, much discussed in the 1960s within the community, namely to achieve time- and labour-saving methods to ensure continuation of long-term mass balance series.

The regression relations were used to extrapolate the mass balance series back to 1959, the maximum depletion could be reconstructed by means of photographs for those years. R. GÜNTHER (1982) calculated the mass balance series of SSK back to 1950 by analysing the correlation between meteorological data and the mass balance; he found a high statistical relation between measured and determined mass balance figures for SSK.

Results

In spite of the complex glacier topography, interesting empirical experiences were gained from the mass balance data sets, giving a better understanding of the characteristics of the glacier type, mass balance and mass exchange. It turned out that there are distinct relations between the specific net balance, net accumulation (defined as Bc/S) and net ablation (Ba/S) to the AAR, resulting in characteristic so-called 'turnover curves'. The diagram of SSK represents the type of a glacier without a glacier tongue. Between 1964 and 1966, a basic method was developed, starting from the idea that instead of measuring years to cover the range between extreme positive and extreme negative yearly balances one could record the AAR/snow depletion during one or two summers. The new method was applied on Cathedral Massif Glacier, a cirque glacier with the same area as the Stubacher Sonnblickkees, in British Columbia, Canada. During the summers of 1977 and 1978. It returned exactly the expected relations, e.g. mass turnover curves, as found on SSK.

Between 1965 and 1981, there was a mass gain of 10 million cubic metres. With a time lag of 10 years, this resulted in an advance until the mid-1980s. Since 1982 there has been a distinct mass loss of 35 million cubic metres by 2013. In recent years, the glacier has disintegrated faster, forced by the formation of a periglacial lake at the glacier terminus and also by the outcrops of rocks (typical for the slope glacier type), which have accelerated the meltdown. The formation of this lake is well documented. The glacier has retreated by some 600 m since 1981. - Since August 2002, a runoff gauge installed by the Hydrographical Service of Salzburg has recorded the discharge of the main part of SSK at the outlet of the new Unterer Eisboden See.

Discussion

The annual reports - submitted from 1982 on as a contractual obligation to the Hydrological Service of Salzburg - document the ongoing processes on the one hand, and emphasize the mass balance of SSK and outline the climatological reasons, mainly based on the met-data of the observatory Rudolfshütte, on the other. There is an additional focus on estimating the annual water balance in the catchment area of the lake. There are certain preconditions for the water balance equation in the area. Runoff is recorded by the ÖBB power stations, the mass balance of the now approx. 20% glaciated area (mainly the Sonnblickkees) is measured and the change of the snow and firn patches/the water content is estimated as well as possible. (Nowadays laserscanning and ground radar are available to measure the snow pack). There is a net of three precipitation gauges plus the recordings at Rudolfshütte. The evaporation is of minor importance. The long-term annual mean runoff depth in the catchment area is around 3.000 mm/year.

The precipitation gauges have measured deficits between 10% and 35%, on average probably 25% to 30%. That means that the real precipitation in the catchment area Weißsee (at elevations between 2,250 and 3,000 m) is in an order of 3,200 to 3,400 mm a year. The mass balance record of SSK was the first one established in the Hohe Tauern region (and now since the Hohe Tauern National Park was founded in 1983 in Salzburg) and is one of the longest measurement series worldwide. Great efforts are under way to continue the series, to safeguard against interruption and to guarantee a long-term monitoring of the mass balance and volume change of SSK (until the glacier is completely gone, which seems to be realistic in the near future as a result of the ongoing global warming).

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Disturbance and recovery of Biological Soil Crusts (BSCs) in the high alpine region of the Hochtor (Grossglockner, Austria)

Lingjuan Zheng & Thomas Peer

Abstract

Based on preliminary results of BSCs recovery in the SCIN project, we assessed the succession of recovery by recording cyanobacteria, seedlings, lichens, bryophytes and vascular plants within the treatment plots from 2013 to 2017 on the Hochtor. The results indicate a very fast re-colonisation of cyanobacteria, a high seedlings emergence in summer, and a first attempt of colonisation by vascular plants. However, cryptogams (lichens, bryophytes) hardly contribute to the recovery of BSCs so far. Soil nutrients also did not show significant increase over the study period. The strong soil erosion and the extreme climate conditions are the two main factors which hamper the regeneration process.

Keywords

Recovery, cyanobacteria, seedlings, vascular plants, soil nutrients

Introduction

Long-term observation programmes are of high importance for protected areas by giving insight into the complex ecological interactions over a long time, providing knowledge about long-term effects like climate change or soil disturbance. Biological Soil Crusts (BSCs) have been recognized to contribute to erosion control and nutrient cycling, and to be very important in arid and semi-arid areas as well as in alpine environments (Belnap & Lange 2003). To estimate the ecological functions of alpine BSCs, first analyses on the Hochtor were performed (Huber et al. 2007; Peer et al. 2010; Zheng et al. 2014). Actually, with the start of the SCIN-project (Soil Crust Inter National) in 2012, which was integrated in the network of Biodiversa (www.biodiversa.org), the alpine BSCs on the Hochtor have been examined in a broader geographical context (Büdel et al. 2014; Williams 2017). In this study we confined our presentation on recovery traits: (i) the building of a 'new crust', (ii) the presence of new established seedlings, (iii) the presence of new-established higher vascular plants and lichens, and (iv) the change in physic-chemical properties of soil.

Methods

The study area was located in the central part of Hohe Tauern, near the Grossglockner High Alpine Route. It belongs to the north facing 'Plattenkar', in the east of the Hochtor at an altitude of 2.576 m a.s.l. (47,0456N; 12,5052E), and is a part of the National Park Hohe Tauern. The bedrock consists of calcareous Rauwacke, belonging to the Seidlwinkl Triassic. Ten control plots and ten treatment plots were established in 2012 and investigated until 2014 on soil properties, and until 2017 in respect of seedlings, vascular plants, and lichens. Seedlings were always recorded at the end of July, except of 2015 (September). For this procedure, we used a frequency frame at 1m x 1m, which was further sub-divided into quadrats at 10cm x 10cm. The other methods and first results are described in Büdel et al. (2014), Maier et al. (2014), and Williams et al. (2017). The 'new crust' was also illustrated by vertical sections embedded in resin (Körapox 439).

Results

Compared to the control plots, the treatment plots on the Hochtor were not significantly different in cyanobacteria abundance and composition, but showed a very fast re-colonisation in the first year (Maier et al. 2014; Williams et al. 2017). Bryophytes were largely missing in treatments, and also in controls. They had only a cover degree of less than 10%. A few small thalli of lichens could be detected in treatments in 2014 (e. g. *Buellia elegans* and *Bilimbia lobulata*), not any in 2016, and again, some few small thalli of *Psora decipiens* in 2017. In controls, lichens often dominate, developing coverage up to 50%. In treatments, the number of seedling ranged from 141 to 312 after one year and this number doubled after 2 years, as well as in 2016 and 2017. Most of them were distributed compacted inside of gritty cracks and in layers adjacent to edge of controls. In autumn 2015 the number of seedlings had drastically reduced, and most seedlings did not survive the harsh winter time. The number of re-established higher plant species ranged from 14 to 51 (2016) and from 18 to 48 (2017). The cover degree was generally below 1%. However, the species composition was quite similar in both years. *Braya alpina*, *Minuartia gerardii*, *Persicaria vivipara*, *Silene acaulis*, and *Salix herbacea* were among the most common species. Some individuals of *Braya alpina* and *Minuartia gerardii* had already flowered in 2017.

As shown in the vertical sections from control plots, hyphae of lichens formed a dense web that tightly bound soil particles (Fig. 1A). In addition, a dark layer of cyanobacterial filaments covered the surface of BSC (Fig. 1B). In treatment plots, a dark but fragmentary layer of cyanobacterial filaments has been developed after 2 years (Fig. 1C, Fig. 1D).

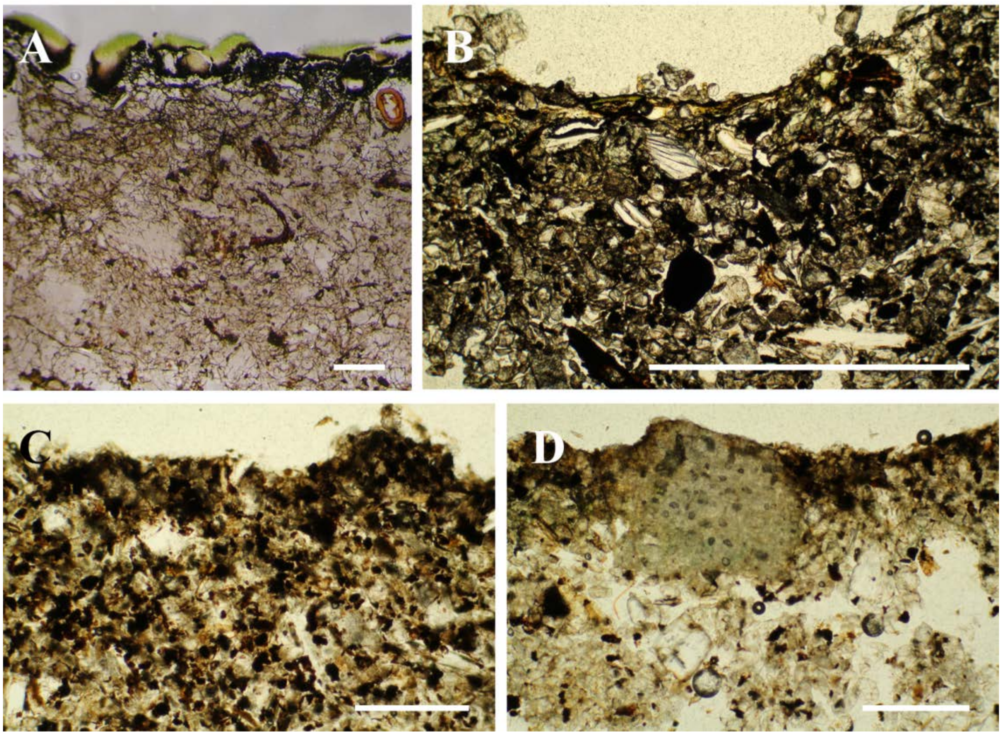

Figure 1: Vertical sections on Hochtor samples, collected in 2014. A: Control plot with lichen; B: Control plot with cyanobacteria layer; C, D: Treatment plot with fragmentary cyanobacteria layer. Bar: 0,5mm.

Total organic carbon content (TOC) and total nitrogen content (TN) in BSCs were generally low, the controls contained distinct more TOC and TN than the treatments (Fig. 2). This also applied to the availability of phosphorus (P) and potassium (K). The content of the other elements hardly changed from 2012 to 2014, with the exception of TN. Higher values were achieved in Ca und Mg, without great differences between controls and treatments, and also over time. All elements varied markedly within and between plots, a distinct recovery was therefore not shown. The particle size distribution was not significantly different between controls and treatments, and over time. pH and EC showed a temporal change by increasing in treatments and decreasing in controls.

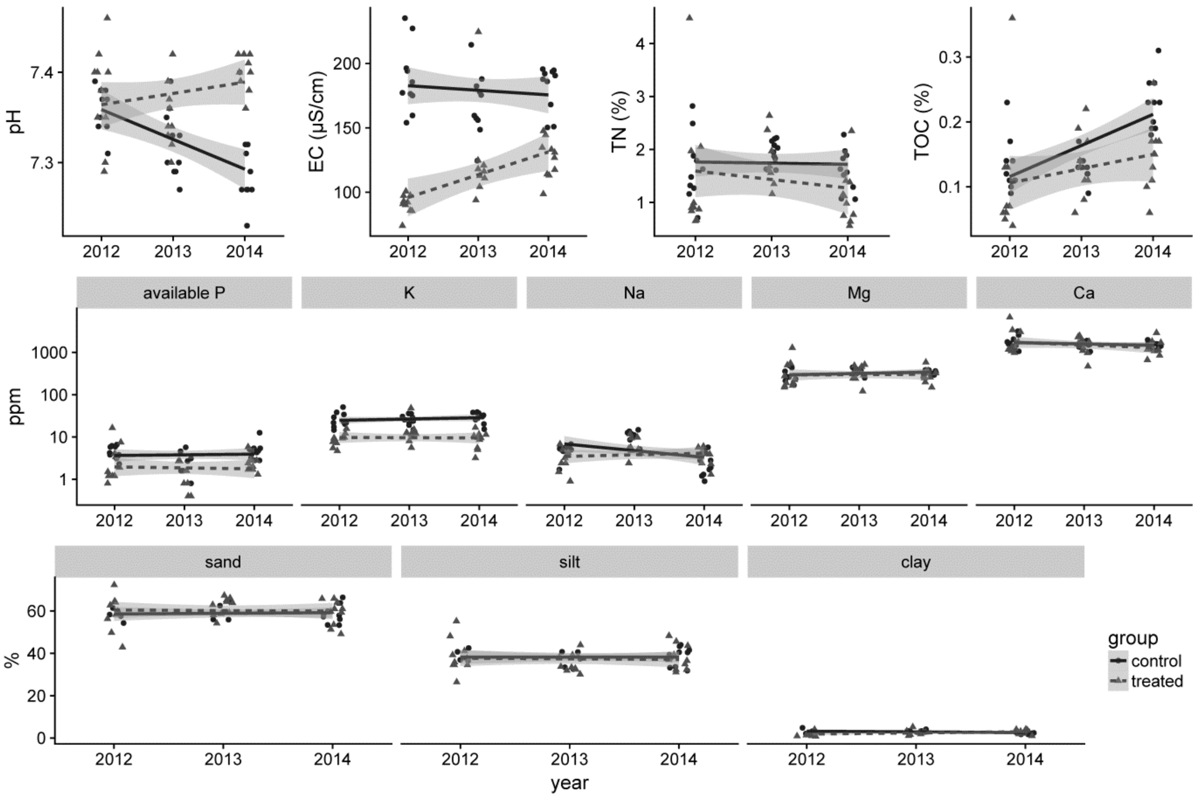

Figure 2: Physical and chemical parameters in control and treatment plots from 2012 to 2014.

Discussion

Cyanobacteria are often the first and fastest colonizers in disturbed areas (BELNAP & ELDRIDGE 2003; WEBER et al. 2016). Even on the high alpine Hochtor, the harsh climate, with 7 months snow cover, coldness, and heavy rainfall at all times, seems not to be a barrier for cyanobacteria growth (ZHENG et al. 2014 and references therein). On the other hand, high soil erosion in all open treatment plots obviously hampers the establishment of bryophytes, lichens and vascular plants. Nevertheless, an initial settlement of vascular plants, which have invaded from the surrounding BSC communities or have arisen from casually deposited fragments, can already be seen. Some seedlings may also be able to grow further. The resettled plants tent to be cushion-forming (e. g. *Silene acaulis, Minuartia gerardii*) or produce runners (*Salix herbacea, Saxifraga oppositifolia, Persicaria vivipara*), and are thus able to better withstand erosion. The reproduction of *Persicaria vivipara* is often by the bulbils, which are numerously dispersed on the open surface. The high surface inhomogeneity of the gravely scarped treatment plots has resulted in an extremely high standard deviation of the single soil measurements. The presented data do therefore not give a clear picture about the recovery process during the short observation time. Only electrical conductivity and nitrogen may indicate to a slight improvement in treatment plots. We suppose that if microorganisms and cryptogams have stabilized the bare surface over a longer period (10 years and more), and have thereby increased the availability of nutrients, cryptogams and vascular plants will become more widespread (BELNAP & ELDRIDGE 2003; LANGHANS et al. 2010; WEBER et al. 2016).

Conclusions

Our results provided interesting insights into the dramatic consequences of BSC destruction in a high alpine environment, and the subsequently protracted recovery process. For further investigations on recovery process, the National Park Authority should ensure that the treatment plots would be further monitored and new programmes could be started. Active soil inoculation with biocrust microorganisms and cryptogams can significantly accelerate biocrust recovery, including increasing lichen and moss cover, and cyanobacteria colonization. The mosaic-like placement of small mats of vascular plants may also facilitate the rehabilitation process of disturbed areas (e.g. BOWKER 2007; CHIQUOINE et al. 2016; WEBER et al. 2016). It is also important to ensure that hiking outside the marked trail is not allowed. A reduction in trampling on the soil surface will result in the re-establishment of BSCs and their associated organisms, and ultimately lead to lower levels of water and wind erosion.

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ArcGIS-generated map of FFH-habitat types for Natura-2000 site Ennstaler Alpen/Gesäuse (Styria, Austria)

T. Zimmermann & D. Kreiner

Abstract

Presented is a map of FFH-habitat types of Natura 2000-area 'Ennstaler Alpen/Gesäuse' set up by National Park Gesäuse. It combines terrestrial mappings and ArcGIS-modelled areas based on aerial photo analysis and forest stand types. The 26 evidenced FFH-habitat types cover 75% of the Natura 2000-area. Due to the alpine character, limestone rocks (8210, 8240), calcareous screes (8120, 8160), mountain pine bushes (4070), calcareous grasslands (6170) and natural spruce forests (9410), which surpass the deciduous forests (91E0, 9130, 9140, 9150, 9180) altogether, are the predominant habitat types.

Keywords

National Park Gesäuse, Natura 2000 site Ennstaler Alpen/Gesäuse, FFH habitat types, GIS modelling, HABITALP aerial photo interpretation, field mapping, forest stand types

Introduction

From the beginning, the first accurate map of FFH-habitat types of the Natura-2000 site Ennstaler Alpen/Gesäuse (HÖBINGER 2012) posed an interim result only, due to missing 'real' data blending and partly insufficient terrestrial data (especially concerning beech forests, Tilio-Acerion forests and bogs). More recent terrestrial mappings plus a validation of the implemented aerial photo interpretation (HAUENSTEIN & HALLER 2013) initiated a revision.

Figure 1:© T. Zimmermann

Methods

Instead of vegetation mosaics, the new map version depicts the predominant type only. Although this is less precise in terms of surface area in comparison to using complex units, it is quite advantageous when it comes to map readability. While some small-scale, interspersed FFH-habitat types such as 6110 (Alysso-Sedion albi) are certainly underrepresented, in the case of more common types that frequently occur in combination with others, like calcareous grasslands (6170) on calcareous rocky slopes with chasmophytic vegetation (8210), we assume that assigning a type to one or the other category is somehow balanced in the end.

Habitats without FFH-status were put in meaningful units such as tall natural grasslands, nutrient-rich alpine pastures, waters, pioneer forests, scots pine forests or artificial spruce forests.

Data blending of several terrestrial mappings presupposed a careful investigation of the various mapping units and their transformation into FFH-habitat types (ZIMMERMANN 2013). To reduce conflicts that arise from differing vegetation identification, special mappings were favoured over more general mappings because of their stronger focus, which means that a data hierarchy was induced. On the other hand, very differentiated mappings had to be partly simplified in order to reach consistent FFH-habitat type definitions over the whole map (this is especially true for biotope mapping).

The majority of woods and shrubs, which represent about 60% of total land coverage, are not mapped but modelled based on local forest stands (CARLI 2008) and aerial photo interpretation (see ZIMMERMANN & KREINER 2012). Due to the very accurate elevation model, it was possible to calculate with raster cells of 2x2 metres, which is a resolution fine enough not to lose narrow linear structures such as forest roads or creeks. On the other hand, whenever relief data is incorporated into the modeling, the small cell size will cause a very patchy appearance, which does not provide a correct picture of the situation, since a forest type is only making sense if a certain minimum size is reached. It was therefore necessary to smoothen (that is: coarsen) the calculated repectively imported terrestrial mapping data via multiple filter rounds, in order to eliminate micro areas. Also, very elaborately mapped regions proved to be better integrated into the rest of the map afterwards.

Conducting a 'real' data blending offers the possibility to analyze the FFH-habitat types with respect to their location preferences, i.e. their abundance in relation to parameters such as geological underground, altitude, exposition, slope, radiation energy and so on. Furthermore, the map is going to be the spatial foundation for the projected modeling of the corresponding conservation statuses.

Results

In the following, the resulting numbers for the Natura-2000 site are presented.

Absolute and relative shares of vegetation formations	**14.524,6 ha**	**100,0 %**
woods	6.657,7 ha	45,8 %
shrubs	2.192,1 ha	15,1 %
tall grasslands, clearings, pastures, calcareous grasslands	2.243,9 ha	15,5 %
rocks and screes	2.834,4 ha	19,5 %
waters	108,6 ha	0,7 %
non-natural areas and/or vegetation-free	487,9 ha	3,4 %

Table 1 shows the overall distribution of the occurring vegetation formations.

The 145 km^2 Natura-2000 site is composed of 61 % woods and shrubs, 20 % rocks and screes, 15 % tall grasslands, clearings, pastures and calcareous grasslands, 3 % non-natural resp. vegetation-free areas and 1 % waters.

Absolute and relative shares of FFH-habitat types	**14.524,6 ha**	**100,0 %**
FFH-habitat types – woods and shrubs	6.464,5 ha	44,5 %
FFH-habitat types – open land	4.560,3 ha	31,4 %
no FFH-habitat types	3.499,8 ha	24,1 %

Table 2 shows the overall amount of area occupied by FFH-habitat types.

About 76 % of the map area represent FFH-habitat types, while only 24 % do not have a FFH status (which does not mean that they aren't in part ecologically valuable, as are the thermophilic Scots pine forests or the species-rich *Calamagrostis varia*-grasslands in avalanche corridors). The FFH-types consist of 60 % wood and 40 % open land habitat types.

FFH	Description	ha	%
-	Non-natural and/or vegetation-free	487,9	3,36
-	Artificial spruce forests	1.969,9	13,56
-	Scots pine forests	344,7	2,37
-	Pioneer woods	71,1	0,49
-	Tall natural grasslands	329,0	2,26
-	Waters without FFH-status	107,2	0,74
-	Cultivated grasslands without FFH status	190,1	1,31
3220	Herbaceous vegetation along the banks of alpine rivers	1,4	0,01
3240	Ligneous vegetation with *Salix eleagnos* along alpine rivers	3,2	0,02
4060	Alpine and boreal heaths	2,2	0,01
4070	Bushes with *Pinus mugo* and *Rhododendron hirsutum*	2.188,8	15,07
6110	Rupicolous calcareous or basophilic grasslands of the Alysso-Sedion albi	uncertain	uncertain
6150	Siliceous alpine and boreal grasslands	2,2	0,01
6170	Alpine and subalpine calcareous grasslands	1.593,4	10,97
6230	Species-rich *Nardus*-grasslands on silicious substrates in mountain areas	1.593,4	10,97
6430	Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels	84,6	0,58
6510	Extensively managed hay meadows of the planar to submontane zones (Arrhenatherion)	6,6	0,05
7110	Active raised bogs	0,2	0,001
7140	Transition mires and quaking bogs	0,2	0,001
7220	Petrifying springs with tufa formation	uncertain	uncertain
7230	Alkaline fens	1,5	0,01
8120	Calcareous screes of the montane to alpine levels	314,3	2,16
8160	Medio-European calcareous scree of hill and montane levels	303,9	2,09
8210	Calcareous rocky slopes with chasmophytic vegetation	2.206,8	15,19
8240	Limestone pavements	9,4	0,06
8310	Caves not open to the public	uncertain	uncertain
91E0	Alluvial forests (Alnion incanae, Salicion albae)	34,0	0,23
9130	Asperulo-Fagetum beech forests	882,6	6,08
9140	Medio-European subalpine beechwoods with *Acer* and *Rumex arifolius*	366,5	2,52
9150	Medio-European limestone beechforests of the Cephalanthero-Fagion	414,8	2,86
9180	Tilio-Acerion forests of slopes, screes and ravines	43,8	0,30
9410	Acidophilous Picea forests of the montane to alpine levels	2.077,0	14,30
9420	Alpine Larix decidua and/or Pinus cembra forests	453,3	3,12
	Total area in ha	**14.524,6**	**100**

Table 3 shows the shares of all depicted vegetation types in particular.

The overall distribution of the types reflects the alpine character of the Gesäuse area: Screes and rocks with sparse vegetation (8120, 8160, 8210, 8240) represent 1/5 of the total area, and *Pinus mugo*-shrubs and calcareous grasslands (4070, 6170) together account for 1/4. Another 1/5 is made up of natural coniferous forests (9410, 9420); their main area of distribution lies in the subalpine zone, but due to the rugged relief and vegetation dynamics along debris flows they can descend to the lower montane zone (in that case they often form Scots pine forests without FFH status).

In comparison, only a small area of 1/8 is composed of deciduous forests (9130, 9140, 9150, 9180, 91E0, pioneer forests); taking into account that a further 1/8 of the area are potential deciduous forest stands currently occupied by artificial spruce forests with no FFH status, the share of deciduous forests would rise to 1/4 in a near-natural situation, though.

So far, 26 FFH-habitat types have been recorded in the area. One is underground (8310) and cannot be incorporated in the area summary (according to HERRMANN 2016, 463 caves have been recorded so far). Another two (6110, 7220) only occur in sizes of a few square meters, which is why the map just indicates their existence (point-signature) instead of their actual size; but it is safe to assume that both belong to the rarest types in share of area.

The most common habitat types by far are represented by 8210, 4070, 9410 and 6170, which contribute 11-15% of the map area each. So these four together already account for 73 % of the overall FFH area.

The next most common FFH-habitat type is 9130, which contributes about 6 %. Followed by a number of FFH-habitat types, which share 2-3 % each: 9420, 9150, 9140, 8120 and 8160. Summarizing the 10 FFH-types mentioned so far, over 98% of the total FFH area are reached.

That means that the remaining 15 types account for only 2% of the total FFH-area. In decreasing order these rare types are: 6430, 9180, 6230, 91E0, 8240, 6510, 3240, 4060, 6150, 7230, 3220, 7110 and 7140, plus 6110 and 7220, which were not calculated.

The reasons for the relative scarcity of those FFH-habitat types are manifold: Mainly, it's regional specifics such as the scarcity of truly acidic soils (6230, 4060, 6150, 7140), the general lack of water on limestone (6430, 7230, 7110, 7140), unfavourable relief and altitude (7110, 7140), a lack of gravel bars suitable for vegetation (3240, 3220) as well as the absence of rural settlements (6510). In part, forest conversion of former stands is responsible (9180, 91E0). Finally, some habitat types are small-sized by nature (6110, 7220).

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Benefits of mosquito surveillance programs in protected areas: two case reports from Eastern Austria

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Abstract

Mosquitoes (Diptera: Culicidae) are important vectors of pathogens, which raises conflicts between human interests and species conservation in protected areas. We will present two studies partly focusing on wetland areas in Eastern Austria (including e.g. the Nationalpark Donau-Auen) that demonstrate the comparatively little importance of protected wetland areas as vector sources for the spread of emerging human pathogens like West-Nile Virus and how protected areas can benefit from carefully designed mosquito monitoring to inform visitors, stakeholders and the local populace.

Keywords

Culicidae, non-native species, autecology, *Culex pipiens* complex, pathogens

Introduction

Mosquitoes (Culicidae: Diptera) are hematophagous insects of significant importance in human and veterinary medicine due to their ability to transmit several pathogens such as *Plasmodium* spp., Dengue and West Nile viruses, all of which can have a severe impact on human health. Despite their epidemiological importance, comparatively little is known about the extant mosquito species inventory, occurrence, distribution and dispersal in Austria. Furthermore, mosquito species and vector-borne diseases continuously spread outside their native range into new countries and continents as a consequence of climate change, global trade, and transcontinental movement. Moreover, recent human activities substantially changed the environment, and facilitated the displacement of mosquito species by creating new habitats. As mosquito species differ in their vector capacity and competence they also differ in their medical importance. Therefore, a better knowledge of the seasonal and spatial distribution of the Austrian mosquito species is essential to assess vector-pathogen dynamics (ZITTRA et al. 2017a). Particularly, mosquito monitoring in combination with pathogen screening allows estimating potential health risks for humans, their pets, and stock-rearing.

Nature reserves, especially wetlands, are frequently confronted with accusations to be sources of enormous amounts of mosquitoes. As frequently, there are insinuations that protected areas lead to increased health risks for the human population. Here we present results from a mosquito diversity assessment and screening for mosquito-borne pathogens conducted in Eastern Austria, including protected areas, especially the National Park Donau-Auen.

Methods

Female mosquitoes were sampled twice a month for a 24-h time period from April to October 2014 and 2015 at 35 permanent and 23 non-permanent trapping sites using carbon dioxide-baited traps. Collected mosquitoes were stored at -80 °C and morphologically identified using the key of BECKER et al. (2010).

We assessed mosquito community responses to environmental parameters based on 14-day-average values that possibly affect mosquito ontogenesis. Furthermore we used canonical correspondence analysis to relate mosquito community fluctuation patterns based on abundance responses of single species to environmental parameters. Land use type as available in the CORINE Land Cover (CLC) database was included as a predictor variable. Furthermore, the analysis included scaled weather data (raw data provided by the Austrian official weather service, ZAMG), and Danube water levels (raw data provided by the viadonau GmbH). We used ontogenetically relevant 14-day-mean values prior to each single sampling date to assess effects of meteorological data (relative air humidity, sunshine duration, the amount of precipitation, air temperature and atmospheric pressure) as well as Danube water levels on mosquito communities (ZITTRA et al 2016; ZITTRA et al. 2017a).

Morphologically identified mosquitoes were pooled by species, collection site and date. Genomic DNA and RNA were extracted from single pools. Pools were then screened for flaviviruses, filarioid helminths, *Plasmodium* spp. (avian malaria), *Trypanosoma* spp. and *Francisella tularensis* using molecular methods. We used standardized protocols to amplify and sequence gene loci. If PCR gave positive results for pathogens, PCR products were sequenced; obtained sequences were matched to available reference databases (BLAST against GenBank and MalAvi) for molecular identification of pathogens.

Results

Altogether 29,734 female mosquitoes were collected. Although four species were firstly collected in Austria (*Culiseta longiareolata*, *Orthopodomyia pulcripalpis*, *Anopheles hyrcanus* and *Ochlerotatus japonicus japonicus*, the Asian Bush mosquito), no invasive behaviour was observed during the three year sampling period (ZITTRA et a. 2017a, ZITTRA et al. 2017b, LEBL et al. 2013). Statistical analyses revealed significant differences in mosquito abundance between sampling years and provinces. Incidence and abundance patterns were found to be linked to 14-day mean sunshine duration, humidity, water–level maxima and the amount of precipitation. However, land cover classes were found to be the most important factor, effectively assigning both indigenous and non-native mosquito species to various communities. Taxa of the *Culex pipiens* complex, competent vectors of the West Nile virus, were strongly associated with urban areas, especially continuous and discontinuous urban fabric land cover types, instead of natural wetland areas as the National Park Donau-Auen (ZITTRA et al. 2016, ZITTRA et al. 2017a). Pathogen screening recorded no pathogens of human medical importance in any of the pools tested.

Discussion

The assessment of mosquito diversity and abundance patterns in Eastern Austria indicates a low relevance of protected areas as sources for mosquitoes of medical interest. However, our results suggest an increased potential of West Nile Virus (WNV) transmission in urbanized areas due to the distribution patterns of the Northern house mosquitoes, which are the main vectors of WNV. Potentially invasive species like the Asian Bush mosquito and the Asian tiger mosquito primarily use artificial breeding habitats in Central Europe. Moreover, these species are mostly dispersed through global trade and transcontinental movement (BECKER et al. 2010). The other three species firstly recorded in Austria must be considered as remnants of immigrations during the Holocene Climatic Optimum or later (recent) immigrations during warmer periods. Also, *Cs. longiareolata* and *Or. pulcripalpis* seem to have limited distribution areas and low population densities in Austria (ZITTRA et al. 2014, ZITTRA et al. 2017a, ZITTRA et al. 2017b) and are of no medical interest due to non-mammal hosts. In contrast, *An. hyrcanus* can occur locally in high abundances despite their present limited distribution areas and more investigations are needed to fully access the status of this species in Austria.

Despite the presence of a quite diverse mosquito fauna, no mosquito-borne pathogens potentially affecting humans were detected. However, our results suggest an increased risk of West Nile Virus transmission in urbanized areas compared to natural areas due to the distribution patterns of the *Cx. pipiens* complex, the most important WNV vector.

Conclusion

Our results demonstrate that protected areas, while providing a wide range of potential breeding habitats or containing a wide range of different mosquito species do not consequently represent hotspots for mosquito-borne pathogens. Also, nature reserves benefit from information created by carefully designed mosquito monitoring programs: the identification of seasonal and spatial distribution patterns of mosquito species and screening for mosquito-borne pathogens can support decision-making concerning public-health related mosquito management.

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Best practice Science_Link^{nockberge} – Benefits and challenges of five years of co-operation between biosphere reserve and university

Daniel Zollner, Julia Falkner, Heike Egner & Michael Jungmeier

Abstract

Biosphere reserves as recognised model regions for sustainable development are supposed to maintain permanent access to scientific findings, innovation, new technologies and scholarly discussions. Science_Link^{nockberge} is an institutionalised cooperation between the biosphere reserve Kärntner Nockberge and Alpen-Adria-Universität Klagenfurt. In their contribution, the authors provide an overview on the cooperation, reflect their experiences and argue that such a cooperation is mutually beneficial for all sides: the management of the biosphere reserve, the university as well as the region to which the biosphere reserve belongs.

Key words

biosphere reserve, learning sites, social innovation, transdisciplinary, intervention, ESD (education for sustainable development)

Introduction

The biosphere reserve 'Salzburger Lungau und Kärntner Nockberge' is situated in the Austrian federal states of Salzburg and Carinthia. On the Carinthian side a national park had been established in 1984, the establishment of a biosphere reserve was the final result of a debate about the future of the region which started in 2002. Interestingly, two parallel processes in both federal states resulted in the application for a joint biosphere reserve, which was recognised by UNESCO in 2012.

The shift in paradigms from research dominated biosphere reserves in the early 70s to holistic and participatory learning sites - as advocated by UNESCO´s Seville strategy (UNESCO 1996)- nowadays, calls for a new understanding of scientific processes. These tasks meet with recent political and scholarly discussions, in which biosphere reserves are considered to be learning sites or – at least – essential parts of learning regions (e.g. KUSOVA et al. 2008). Following the definition by HASSINK (2005: 521), learning regions are to be understood as 'regional development concepts in which the main actors are strongly, but flexibly connected with each other and are open both to intra-regional and inter-regional learning processes'. Explicitly, higher education institutions are considered as main actors in such regions.

Targets and Methods

The long-term cooperation Science_Link^{nockberge} between park and university is based on a contract, as agreed and signed in 2013. It aims at (1) building a bridge between excellent international research and everyday life in the region of Nockberge, (2) stimulating, triggering and scientifically supervising technical, economical, ecological and social innovations in the region, (3) giving access to international developments and trends and the scientific community as well and (4) to raise public awareness for the importance and potentials of the biosphere reserve. The biosphere reserve contributes with technical, logistical and financial support to the research activities, the university contributes with network and scientific expertise. Technically, the cooperation is based on a yearly work plan and a yearly report on activities and achievements (e.g. EGNER et al. 2015).

Science_Link^{nockberge} is characterised by a quite unique cooperation design: (1) It has a long-term institutionalised character (contract between equal partners, persons in charge of the coordination, annual work plan, activity reports). (2) A set of tools forms the technical backbone for the cooperation (a virtual library - the 'Nockothek', the research forum - a catalogue of research questions from different disciplines, standardised student´s work agreement). (3) Joint outreach activities support the dissemination of results. (4) Sience_Link^{nockberge} is closely connected to the management plan of the biosphere reserve (ZOLLNER et al. 2015).

Results – activities, benefits, challenges

Manifold activities breathe life into the cooperation: Primarily, different educational offers at the university (such as seminars or lectures) and students works (such as bachelor or diploma thesis) connect to the biosphere reserve. Seminars of the Institute of Geography focussing on regional issues allowed for presenting students´ works in small regional events. Students are challenged by presenting for a 'real life audience' aside of university´s seminar facilities and by answering unexpected 'real life questions'. Besides new information, guests and stakeholder from the region gain personal insights into university and the scholarly world.
Such events have turned out to be interesting, surprising and sometimes irritating for either side and, thus, can be considered as an intervention to both 'worlds' to gain personal competencies related to the UNESCO´s Decade of Education for Sustainable Development (NAGEL & AFFOLTER 2004, RAUCH et al. 2016, VARE & SCOTT 2007). Additionally, some students have addressed their bachelor or master thesis (so far in the fields of human geography and landscape planning, but after some time also in social science and other fields) to the biosphere reserve. The journal of the biosphere reserve, Meine Biosphäre, has a column dedicated to the cooperation, communicating its activities and outcomes, such as the students works, to the region on a regular basis.

By conducting GEO-Days of Biodiversity, also elements of citizen science (FINKE 2014) are integrated into the cooperation. The first GEO-Day in the Nockberge region in June 2016 attracted notable zoologists and botanists who explored the flora and fauna of a territory around St. Oswald. Interested laypeople, stakeholder from the region and school children attended scientists at their expeditions and supported research work.

Technically, the cooperation is based on two features, (1), the 'Research forum', containing a catalogue of potential research topics and (2) the database 'Nockothek' (www.biosphaerenparknockberge.at/bildung/science-link-nockberge), which is regularly updated, providing substantial information about the Nockberge (recently some 190 publications, documents, grey literature).

Some challenges have to be faced, however. The region of Nockberge is a peripheral region characterised by ageing of population, brain-drain and little contact with academic life. This has implications for the development of a research cooperation such as Science_Link. In comparison to other parks in Austria, research work conducted in the previous national park Nockberge never had been very intensive. At the same time, the University of Klagenfurt does not have a faculty of natural sciences, and the region had limited access to other research institutions, which leads to feelings of 'strangeness' or unfamiliarity in contact. Additionally, the establishment of the biosphere reserve in 2013 has called for working on social, cultural and economic research questions.
To sum it up, the cooperation had to be developed against a long-term perspective and needs to overcome 'cultural' and institutional barriers.

Discussion/Conclusion

The cooperation Science_Link^{nockberge} has not yet been subject to a systematic review nor evaluation. However, after some five years Science_Link^{nockberge} appears to be a relevant institutional arrangement that is mutually beneficial to both partners. Bringing together two distinct institutions with different focuses on research and education, definitely provides new opportunities and generates new networks for knowledge-based activities (JUNGMEIER et al., in print). However, the concepts and practices of a park management are very distinct to the concepts and practices at a university and vice versa. Both follow a distinct 'logic' in terms of priorities, time scales, decision making procedures and planning processes. Both, furthermore, address different issues and stakeholders. Thus, besides opportunities and new networks, the cooperation between park management and university created inter-institutional challenges, which were not expected. The practical and theoretical implications of the cooperation need to be understood and will be investigated more in depth including new and a holistic set of criteria (e.g. HELMING et al. 2016).

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What is biodiversity, how can it be quantified and prioritised and what does that mean for Austrian national parks?

Klaus Peter Zulka, Georg Bieringer, Erich Weigand

Keywords

Conservation prioritisation, LCA, responsibility, environmental impact assessment; National Park Kalkalpen, National Park Gesäuse

Summary

The term 'biodiversity' has become ubiquitous in conservation science – finding a project report or proposal within the field not using it will be next to impossible. However, like many terms in conservation ecology, 'biodiversity' has developed into an all-encompassing buzzword. Without a universally agreed definition and delineation, quantification, comparison and prioritisation of biodiversity interventions is difficult or impossible.

For quantitative assessments, biodiversity is sometimes reduced to species numbers, sometimes circumscribed with various biodiversity indicators, i.e. environmental variables that are more or less related to some biodiversity aspects. Neither way has led to a unified quantity that can be used to compare and to rank interventions.
Important components of such an operationalisation of biodiversity are Red Lists of Threatened Species. Red Lists are indispensable in identifying biodiversity elements with a high risk of being lost and thus are essential building blocks in the quantification of biodiversity changes and biodiversity prioritisation.

Based on a method originally developed by Bieringer and Wanninger for the province of Lower Austria, we illustrate with an example from Kalkalpen National Park how species of national importance can be identified and conservation priorities can be derived (ZULKA et al. 2017). The method uses Red List categories (quantified as extinction probabilities per unit time) and regional responsibility (quantified as percentage of species range in the target area) and combines them into a conservation priority score. Species or habitat types can then be ranked according to these scores.

Among Austrian endemic animal species living in National Park Kalkalpen, we obtained highest conservation priority scores for the groundwater snail *Bythiospeum nocki*, the cave beetle *Arctaphaenops muellneri*, the leaf beetle *Oreina plagiata commutata*, die ground beetles *Leistus austriacus* and *Pterostichus lineatopunctatus* and the caddisfly *Rhyacophila producta*.

However, the method is not restricted to assess conservation priorities. Using the responsibility score, we found that an enlargement of National Park Kalkalpen by integrating Haller Mauern, Warscheneck and Totes Gebirge would triple its average responsibility for Austrian endemic species (4.0%). In this respect, an enlarged National Park Kalkalpen would even overtake National Park Gesäuse (2.3%), one of the endemic species hot spots in Austria.

In a similar attempt to make biodiversity impacts accessible to life cycle assessment (LCA) of products and processes, the potential effect of any intervention impinging on biodiversity can be quantified. Basically, three components need to be assessed:
1. the probability that a population is affected by the intervention,
2. the gravity of the effect, judged by the Red List category of the species and
3. the direction and impact on a single population.

Summed across all species in the intervention region, a characterization factor (CF) for the intervention can be obtained.

This quantification method can be adjusted to account for other practical problems, e. g. in environmental impact assessment or monitoring. In particular, it can be applied for conservation problems in Austrian national parks. We provide an example of biodiversity quantification for assessing the success of habitat restoration measures in the National Park Gesäuse (ZULKA 2013).

Quantification of biodiversity has been sometimes met with scepticism owing to its tendencies towards reductionism and over-reliance on simple numbers for complex problems. We discuss data requirements, the chances and opportunities, but also the risks and pitfalls of such quantification approaches.

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