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Coordinator Prof. Marco Vighi

Development of methodologies and indicators to assess sustainability in tourism and agriculture

Tutor: Prof. Demetrio Pitea
Dr. Serenella Sala

Dr. Valentina Castellani
Department of Environmental Science and Technology

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1. Introduction

My PhD research project is about methodologies and indicators to evaluate sustainability with specific reference to tourism and agricultural activities. Object of the research is to analyze the relationship between the mankind (i.e. its presence and its activities) and the natural environment from the sustainability point of view. The project is developed within the field of research of **Sustainability Science,** which can be defined as

"a newly emerging academic field that seeks to understand the linkages among global, social, and human systems, and concomitant risks to human well-being and security. It is a problem-oriented discipline methods and visions for repairing these systems and linkages" (Integrated Research System for Sustainability Science research network of the University of Tokyo)

The concept of a "science of sustainability" has been mentioned since the Proceedings of the Congress of the International Society for Ecological Economics, edited by the ecologist Robert Costanza in 1991, and then in many other documents published by widely recognized researchers working in different fields, such as the report of the US National Research Council "Our common Journey" (1999) and the article published on "Science" by Robert Kates and others (2001). To fully understand the importance of this science and of the new scientific theory which constitutes its basis, it is necessary to consider the most well-known definitions of sustainable development (Bruntland, 1987; IUCN/UNEP/WWF, 1991). Development has to be considered sustainable only when economic, environmental, social and institutional sustainability are taken into account. A new paradigm of development has to be defined, able to optimize resource use, respecting the carrying capacity of the ecosystems and ensuring a fair distribution of the resources among the populations and the generations, and good welfare conditions from the economic and the environmental point of view (UNCED, 2002). This approach is strongly interdisciplinary and involves economics, social science and environmental science, highlighting the need to find new way to evaluate the complex interrelations existing among human, economic and environmental systems.
As outlined by the Sustainability Science Program at Harvard University's Center for International Development, sustainability science seeks:

"to advance basic understanding of the dynamics of human-environment systems; to facilitate the design, implementation, and evaluation of practical interventions that promote sustainability in particular places and contexts; and to improve linkages between relevant research and innovation communities on the one hand, and relevant policy and management communities on the other" (Harvard University)

As highlighted by several researchers, to fulfil this aim, a new research paradigm is needed that reflects the complexity and the multidimensional character of sustainable development. The new paradigm

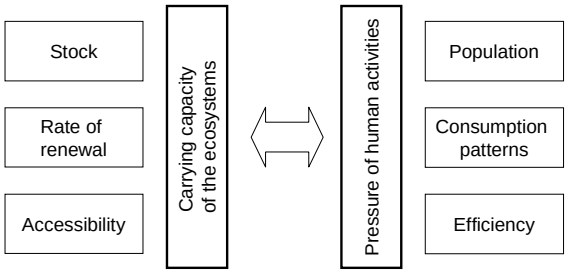
"must encompass different magnitudes of scales (of time, space, and function), multiple balances (dynamics), multiple actors (interests) and multiple failures (systemic faults)." (Reitan, 2005).

Sustainability science represents an attempt to define this new paradigm and to integrate different disciplines to encompass the complexity and the multidimensional features of sustainable development. It is based on the consciousness that social and economic systems rely on natural resources that are limited and that determine the impossibility of an infinite growth of our activities and, moreover, of our consumptions and emissions.

The existence of limits to the growth has been pointed out firstly by report "Limits to growth", commissioned by the Club of Rome and written by Donella Meadows and other colleagues from the MIT in 1972; the book has been updated afterwards in 1992 with the title "Beyond the limits" and in 2004 as "Limits to growth: the 30-year update".

The issues that can determine sustainability or in-sustainability of human activities in the long term are the **population**, the **pattern of consumption** and the **efficiency** (intended as the efficiency of consumption and the technological efficiency). These aspects have to be considered in an integrated manner, even if in some cases some of them can have a predominant role upon others (e.g. the rate of population growth is a worrying aspect at the global level, while in OECD countries the pattern of consumption plays a major role and in emerging countries the technological efficiency has to be promoted in order to prevent environmental damages caused by their rapid industrial expansion).

The carrying capacity of natural ecosystems in relation of economic and social systems consists in their ability to support human life and human activities without altering their characteristics and compromising their ability to survive in the long term. Carrying capacity depends on several factors, such as the existing **stock** of available resources, their **rate of renewal** through time and their **accessibility** (not all the resources are effectively available due to economic constraints – e.g. high cost of mining – or operational constraints – e.g. difficulties related to harvesting and transportation in the case of forest biomass use). The following scheme illustrates the conceptual model that summarizes the issues discussed before and that was considered as a basis for the PhD research.



Referring to this framework, the evaluation of sustainability needs to combine the information coming from a wide range of disciplines and to analyze the complex interaction existing between these different issues. Final aim of this field of research should be to support the analysis of the current state and to give to decision makers useful and reliable instruments to define strategic lines of actions for future sustainable development.

Therefore sustainability evaluation is a complex task, that has to face some challenges coming from its own aim and its own features. The most important issues to consider in defining a methodology for sustainability assessment are:

- the need to translate the knowledge about a wide range of aspects, which are often interrelated and measured through different models and different units, into a unique information (or a simple set of information) able to support operational activities to improve sustainability;
- the clear definition of the system boundaries considered for the evaluation: if the boundaries are not clearly explicit, the results of evaluation can be misleading (e.g. a single country can reduce its emissions of GHGs thank to the delocalization of production, but this doesn't reduce the emissions at the global level);
- the results of an assessment made through indicators need to be evaluated against some reference values in order to provide effective information about the state and the level of sustainability of the area or the actions under evaluation. However, the definition of sustainability thresholds or the selection of values that identify a "sustainable condition" is a challenging task, so standards that are widely accepted by the scientific community are not yet available for the sustainability field and the selection of reference values entails a certain degree of subjectivity by the researchers;
- the definition of methodologies and indicators to evaluate sustainability has to balance the need to ensure a certain degree of specificity (necessary to ensure that the assessment is useful at the local level and in the specific area under investigation) and the repeatability of the assessment also in other areas and other conditions (necessary to ensure comparability of the results across different area and different level of investigation);
- the aggregation of data into indices implies a higher level of uncertainty, so the methodologies for the evaluation have to be validated in order to produce reliable and comparable results;
- environmental and sustainability problems act at a global level, but need to be addressed through actions that have to be performed at a local level in order to be effective ("think global, act local"). In this perspective, there are two main issues about the interaction between science and policy:
    - local stakeholders (local administrators, local business, the local community) can play a relevant role in the definition of strategies for local development (e.g. through participatory planning processes and community based evaluation);
    - effective communication of research results is a key aspect in supporting decision making (for policy or business) and advancing the awareness and the involvement of the local community;
- technology can have a role in improving efficiency of consumption and reducing impacts, but it is not possible to assume that technological improvements can solve any problem about sustainability. Substitution of some ecological and social function of natural resources by

technological and economic improvements it is not always possible, so the weak sustainability perspective seems to be not applicable.

Considering these key issues, my PhD research tries to answer the following research questions about sustainability evaluation (modified from Kates et al., 2001):

1. How can the dynamic interactions between nature and society be better incorporated in emerging models and conceptualizations that integrate the Earth system, human development, and sustainability?
2. How are long-term trends in environment and development, including consumption and population, reshaping nature-society interactions in ways relevant to sustainability?
3. Can scientifically meaningful "limits" or "boundaries" be defined that would provide effective warning of conditions beyond which the nature-society systems incur a significantly increased risk of serious degradation?
4. How can today's operational systems for monitoring and reporting on environmental and social conditions be integrated or extended to provide more useful guidance for efforts to navigate a transition toward sustainability?
5. How can today's relatively independent activities of research planning, monitoring, assessment, and decision support be better integrated into systems for adaptive management and societal learning?
6. How can local policies (and policy makers) contribute to improve sustainability at the global level?
7. How can scientific research support the definition of more sustainable policies, businesses and consumption patterns?

The research of responses to these answers should be a first step towards the answer to a more complex question, raised by Kates, about "what determines the vulnerability or resilience of the nature-society system in particular kinds of places and for particular types of ecosystems and human livelihoods? And how can this resilience be taken into account in order to define carrying capacity and to assess sustainability of human activities in that context".

The research has been developed trying to answer to these questions and evaluating these issues through several methodologies and tools, applied to two economic sectors that have a strong relationship with natural resources (for the production of goods and services): tourism and agriculture, with specific reference to forestry. Moreover, the research has been focused on sustainable development at local scale, taking into account the possibility for local systems to be self-sustained and evaluating the economic and social benefits coming from the considered activities.

The research is focused on:

- the **development and implementation of indices and indicators set able to evaluate sustainability at the local scale**, in order to address policy and support decision making , with specific attention to the two economic sectors considered;

- the **possibility to integrate different methodologies and instruments** in the evaluation of sustainability (e.g. Life Cycle Assessment and Ecological Footprint with reference to the tourism sector and Life Cycle Assessment and Lean Manufacturing with reference to forestry);
- the **role of scientific research in political processes** and in their interaction with local actors (through the study of a participatory planning process, namely the European Charter for Sustainable Tourism in Protected Areas, ECST);
- the **communication of research results to policy makers, businesses and citizens** through the development of decision support systems, initiatives for communication of science, environmental education, transfer of research results to decision makers.

More in detail, the methodologies developed for sustainability assessment through indicators and indices are:

- **Tourism Carrying Capacity:** development of a methodology for the evaluation of carrying capacity of tourist destination, integrating environmental aspects and management issues, in order to evaluate the vulnerability of the natural environmental and the structural limits of tourist infrastructures (e.g. wastewater treatment capacity) that can influence the sustainability of the tourist system.
- **Ecological Footprint of tourism**: adaptation of the methodology developed by Wackernagel and Rees in order to perform the evaluation of the Ecological Footprint and the Biocapacity at the local scale for tourism systems, with a specific reference to the impacts of accommodation. The aim is to use ecological footprint as a tool for making tourists, hotel managers and policy makers aware of the impacts coming from tourist activities and to give information about the more sustainable choices that can be made.
- **Sustainable Performance Index**: development of an aggregated index, integrating objective, subjective and strategic analysis of the local context made within a participatory planning process for sustainable tourism development. The methodology is developed with reference to ex-ante and ex-post evaluation of sustainable policies, with a twofold aim: to support the definition of policies for sustainable development at local scale and to measure the impacts of these policies.
- **Decision Support System for Technology Sustainability Assessment:** development of a set of indicators that consider technological, environmental, economic and social aspects for the evaluation of different technological options for energy production using forest biomass. The object is the sustainability evaluation of a technology considering not only its specific characteristics but also the feasibility of implementation in a specific context (e.g. the availability of a sufficient amount of local biomass to ensure the operability of the plant).
- In addition, through the **organization of educational and information activities**, part of the work has been dedicated to the transfer of knowledge from science to policy, business and citizens, trying to identify the most suitable way to translate information into a usable format for different kind of users and to understand which could be the relationship among these actors.

This PhD research report starts with a section about sustainability indicators, that illustrates the state of the art in this field of research and highlights the most important topics and research questions considered during my work; the following sections refer to the main areas object of the research (tourism, forestry and biomass use, science and policy interface and communication of science) illustrating the methodologies developed and the results obtained. The sections include: text published in scientific journals, text published as chapter of books, text published in the proceedings of conferences and text to be published in the future (this aspect is mentioned at the beginning of every single part).

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2. Sustainability indicators

The Organization for Economic co-Operation and Development (OECD) defines an indicator as "*a parameter, or a value derived from parameters, which points to, provides information about, describes the state of a phenomenon/environment/area, with a significance extending beyond that directly associated with a parameter value*" (OECD, 2003).

The main role of indicators is to **quantify** information so its significance is more readily apparent and at the same time to **simplify** information about complex phenomena to improve communication. This means that the definition of indicators entails a certain degree of balance between complexity (to ensure that all the relevant aspects have been taken into account) and simplicity (to ensure that the information is easily understood by the public to which they are oriented, e.g. researchers, policy makers or citizens).

"Indicators arise from values (we measure what we care about), and they create values (we care about what we measure)" (Meadows, 1998). The main feature of indicators is their ability to summarise, focus and condense the enormous complexity of our dynamic environment to a manageable amount of meaningful information (Godfrey and Todd, 2001). By visualizing phenomena and highlighting trends, indicators simplify, quantify, analyse and communicate otherwise complex and complicated information (Warhurst, 2002).

Indicators provide information to help to prevent or solve problems and they can be useful as proxies or substitutes for measuring conditions that are so complex that there is no direct measurement. They are based on the analysis of primary data derived from monitoring, that can be further aggregated to form composite indicators or indices; a composite indicator is formed when individual indicators are compiled into a single index on the basis of an underlying model. It is supposed to measure multidimensional concepts which cannot be captured by a single indicator, as it is for sustainability. The World Resources Institute defined this process of progressive aggregation as an information pyramid, illustrated in the following figure.

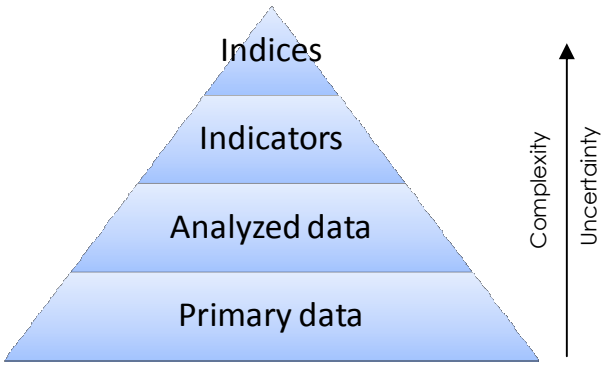

Figure 1 – The Information Pyramid (modified from Hammond et al, 1995)

Indicators for sustainable development can have different roles:

- assess sustainability conditions and trends;
    - support the definition of the sustainable development policy agenda (identifying issues that need to be considered and problems that need to be addressed);
    - monitor progress towards sustainable development;
- evaluate sustainability policy impacts and results;
- communicate relevant information to policy makers and to citizens.

Indicators represent an empirical model of reality, not reality itself; nevertheless they must be analytically sound and have a fixed methodology of measurement. Moreover, they imply a metric against which some aspects of public policy issues, such as policy performance, can be measured. This implies that they need to be developed with reference to a conceptual framework which help to identify a model or set of assumptions that relates the indicator to more complex phenomena, identifying the boundaries of the system under evaluation and the aspects that has to be considered. What it is important to ensure that the indicator is not misleading is that all the underlying theoretical assumptions composing the reference framework and the limits of the methodology are widely explained to users, in order to allow them for a proper use and to avoid wrong use or interpretation of results (i.e. misleading information for decision makers) (Mayer, 2008).

The most common conceptual models that have been developed and applied for sustainability assessment are:

- the Wuppertal Institute Sustainable Development Indicator Framework, based on the four dimensions of sustainable development, as defined by the United Nations CSD.

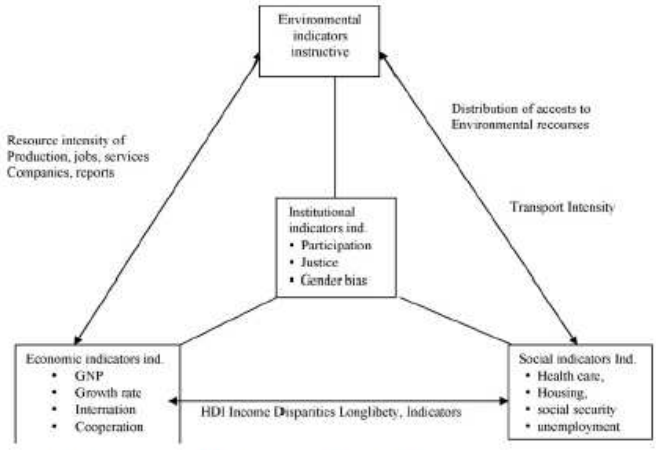

Figure 5 – The Wuppertal Sustainable Development Indicator framework (source: Singh et al, 2009)

- the Pressure State Response (PSR) framework, which is based on the following concept of causality: human activities exert 'pressures' on the environment and change its quality and the quantity of natural resources (the 'state'). Society responds to these changes through

environmental, general economic and sectored policies (the 'response'). (OECD, 1998)

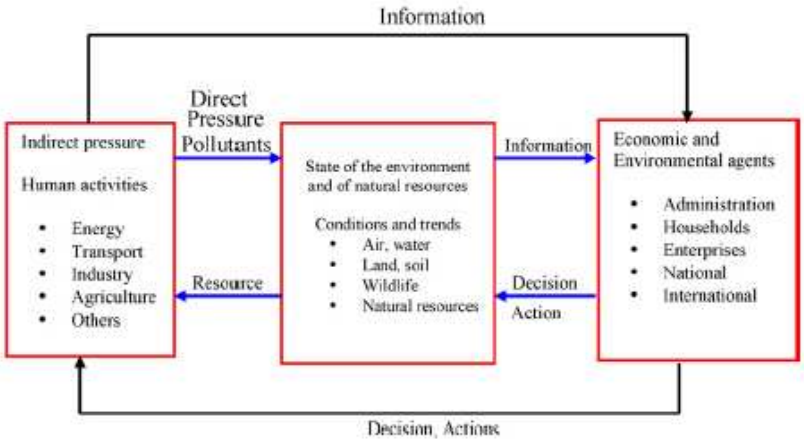

Figure 2 – The pressure-state-response framework (source: OECD, 1998)

- the Driving Force Pressure State Impact Response (DPSIR), which is an extension of the PSR framework (including also Drivers and Impacts) and has been adopted by the European Environmental Agency (EEA) and the European Statistical Office since 1997.

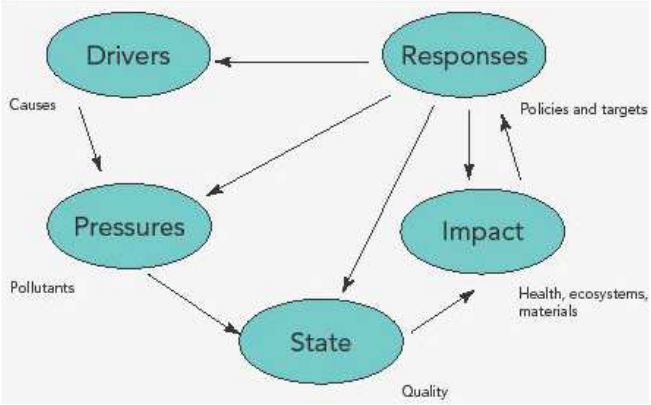

Figure 3 – The DPSIR framework (source: Smeets and Weterings, 1999)

- the eco-efficiency framework of the WBCSD, designed to measure progress towards economic and environmental sustainability using indicators that are relevant and meaningful for business (WBCSD, 1999)

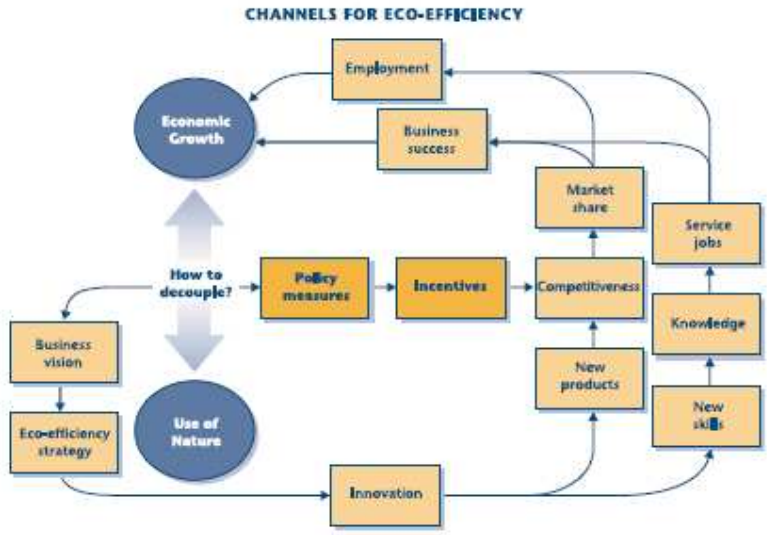

Figure 4 – The Eco-efficiency framework of the WBCSD (source: WBCSD, 1999)

A high number of sustainability indicators has been developed since the 1970s; the characteristics of each existing indicator or set of indicators depend on the system boundaries chosen for the evaluation and on the conceptual framework upon which the indicator is based, so different definitions of sustainable development lead to different methodologies for measurement. The main differences in sustainability evaluation are determined, for instance, whether the assumptions refer to weak sustainability (as it is for instance for indicators that express all the measures in economic values) or strong sustainability (as it is for indicators that measure sustainability focusing on physical conditions). (Sutton, 2003; Pillarisetti, 2005; Clarke and Islam, 2006; Zhou et al., 2006; Lawn, 2007; Ness et al., 2007).

In the report "Sustainable Development Indicators – Proposals for a way forward" prepared for the UN-DSD expert meeting on sustainable development indicators (New York, December 2005), the International Institute for Sustainable Development (IISD) identifies the existence of these differences as one of the main reasons that determine the difficulty to define sustainable development and sustainable development indicators:

Defining SD in general, and SDI in particular, continues to be challenging at least for the following reasons:

- *absence of general scientific consensus on many of its specific components and the required quantities and qualities of these components;*
- *dependence on often context-specific conditions;*
- *dependence on what is being valued, and to what extent, by human society today and human societies in the future.*

Furthermore, on the existence of different frameworks arising from a diversity in core values about sustainable development, and the challenges related to the definition of a global framework for sustainable development indicators (which is one of the objectives of the United Nation Commission for Sustainable Development, UNCSD, work about sustainable development indicators), the IISD highlights the following issues:

The diversity of core values, theories on SD and the proliferation of SDI processes typically result in the development and application of many different conceptual frameworks.

Conceptual frameworks for SDIs help focus and clarify what to measure, what to expect from measurement and what kind of indicators to use. A framework serves as a high-level, direct reference to the basic concepts of SD. Underlying an SDI framework is usually a conceptual model that helps identify and organize the issues that will define what should be measured. The main differences among frameworks are the way in which they conceptualize the main dimensions of SD, the inter-linkages between these dimensions, the way they group the issues to be measured, and the concepts by which they justify the selection and eventually the aggregation of indicators.

The variety of frameworks, however, appears to signal that there is conceptual uncertainty or at least ambiguity with regard to the specific elements of sustainability, the inter-linkages among these elements, and their connections with indicators and indices. It also signals that different frameworks appear to resonate with different regions, organizations, cultures and political purposes. Even when a common conceptual framework is used, as it was attempted in the country pilots based on the CSD's indicator menu, countries might choose to develop customized indicator sets that suit their needs and conditions in order to maximize policy relevance. (IISD, 2005).

The need to develop customized indicator sets arises from the fact that, in order to be effective and useful, the assessment have to be set considering the local features and, possibly, involving the stakeholders to identify their priorities and needs, especially if the aim of the assessment is to support sustainable development planning. Thus, one of the big challenges in defining sustainable indicators is represented by the need to balance a certain degree of **specificity** (necessary to ensure that the assessment is useful at the local level and in the specific area under investigation) and the repeatability of the assessment also in other areas and other conditions (necessary to ensure **comparability** of the results across different area and different level of investigation).

For this reason, it is important that a strong conceptual framework for the development of the indicators is established and made clear by researchers and that the methodology is designed taking into account commonly shared methods, that can be easily adjusted to the local context. One important feature that ensures repeatability of the assessment, and so helps comparability of results, is the transparency of the process adopted for the development and the evaluation of the indicators: the production of methodology sheets for each indicator developed, clearly stating the aim of the evaluation, the boundaries of the system considered, information about the assumptions made and the methods used for data processing and

aggregation and, finally, the source of raw data, is a useful way to ensure transparency of the whole method. Moreover, if the methodology is designed to use data coming from official national and international statistics data systems (such as Eurostat), this will ensure data availability (at present and in the future, also in different areas), i.e. comparability of the results.

Another important aspect to be considered in the definition of indicators is that, in order to be really effective for policy making and for giving information about the sustainability state of a given area, is the necessity to have reference values against which evaluate the results of the assessment. According to Lancker and Nijikamp (2000) "a given indicator does not say anything about sustainability, unless a **reference value** such as thresholds is given to it". The identification of reference standards allows researchers and decision makers to evaluate the results of the indicator in comparison with a threshold (i.e. to verify if the value measured is below or beyond a determined thresholds of sustainability) or in comparison with a previous state (i.e. monitoring the situation through time and eventually assess progress or retreats) or with reference to a target (i.e. the value measured enable to verify if a define target has been reached totally or partially, or if it is not been reached; this is particularly helpful when evaluating the results and impacts of development policies).

Recognising that, even if the definition of thresholds is necessarily a choice that implies a certain level of subjectivity, the evaluation of indicators becomes meaningless in absence of reference targets and standards, the methodologies and indicators developed in my PhD research represent an attempt to focus on limits and targets in the evaluation of sustainability through single and aggregated indicators and set of indicators. In particular, the thresholds identified for the indicators developed refer to **limits** determined by the availability of resources and the management requirements and feasibility of the activities under evaluation and to **policy targets** set by policy makers.

The definition of reference value is a challenging task, especially in the sustainability field, where, as explained before, a certain degree of uncertainty and of subjectivity about what to sustain and to what extent (Bartelmus, 2003) and the absence of widely accepted standards make this operation dependent on a certain degree of subjectivity by the researcher. Some authors highlighted the necessity to link indicators to policy standards and targets to strengthen their role in supporting decision makers (see, for instance, Hammond et al, 1995; IISD, 2005). However, standards derived from professional norms or regulations are frequently non-existent for some topics, so there is the need to find alternative solutions (as stated, among others, also by PAP/RAC in1997 about reference for tourism carrying capacity assessment), such as expert judgement made through Delphi surveys.

2.1 Criteria for defining and selecting indicators

As indicators are used for various purposes, it is necessary to define general criteria for selecting indicators and validating their choice.

The main criteria identified by OECD are: **policy relevance and utility for users**, **analytical soundness**, and **measurability;** these criteria can be

rarely completely met in practice, so they define the ideal conditions for sustainability indicators development.

POLICY RELEVANCE AND UTILITY FOR USERS
A sustainability indicator should:
- provide a representative picture of environmental conditions, pressures on the environment or society's responses;
- be simple, easy to interpret and able to show trends over time;
- be responsive to changes in the environment and related human activities;
- provide a basis for international comparisons;
- be either national in scope or applicable to regional environmental issues of national significance;
- have a threshold or reference value against which to compare it, so that users can assess the significance of the values associated with it.

ANALYTICAL SOUNDNESS
A sustainability indicator should:
- be theoretically well founded in technical and scientific terms;
- be based on international standards and international consensus about its validity;
- lend itself to being linked to economic models, forecasting and information systems.

MEASURABILITY
The data required to support the indicator should be:
- readily available or made available at a reasonable cost/benefit ratio;
- adequately documented and of known quality;
- updated at regular intervals in accordance with reliable procedures.

(Extract from "Environmental indicators for environmental performance reviews", OECD, 1993).

In addition, another criteria that international resolutions and guidelines consider important to ensure that indicators are linked with the local context and consider the priorities of local stakeholders is good **governance**: the debate about the relation between science and policy in the selection of indicators suitable to measure the sustainability of development policies, especially at the local level (McCool et al., 2004; Reed et al., 2006) highlights the necessity to have sustainability indicators based both on scientific criteria and on the results of participatory processes of policy planning. The selection of sustainability indicators is therefore both a technical and political decision and has to be focused on the identification of issues that are relevant and valid for the evaluation of social, economic and environmental local systems (Redman, 2004; Munda, 2005; Deconchat et al., 2007; Ohl et al., 2007). This implies that the development of indicators result from a dynamic iterative process and dialogue among non-expert citizen participants, government bureaucrats and technical experts, in order to allow participants to define locally-relevant aspects of sustainability from their unique perspectives, anchored by their own values.

The following table, coming from a review about Sustainable Development Indicators made by The Macaulay Institute in 2005, summarizes the most important phases of sustainability indicators development, and the relative criteria that have to be taken into account. What is important to note about this process is that it has to be intended as a **dynamic process,** where

indicators are continuously reviewed, updated and improved according to the feedbacks coming from the system and the changes in the situation under evaluation.

Developing Indicators of Sustainability: Process Criteria	
1. Identification of community sustainability goals	Wide consultation and community participation (e.g. surveys, focus groups, meetings) to establish broad-based stakeholder defined sustainability goals
2. Scoping	Determine target audience; Consider spatial and temporal bounds; Include institutional partners; Establish relevant number of indicators
3. Choose indicator framework	Select a framework that maximises ability of indicators to assess progress towards sustainability.
4. Define selection criteria	Indicator selection criteria should be based on community values and sustainability goals determined through stakeholder involvement.
5. Identify potential indicators	Use existing indicators lists as a guide and stakeholder input to refine listings to what is potentially viable.
6. Select final indicators	Apply framework and selection criteria to select final set.
7. Collect necessary information	Collect data on each indicator- this may involve both quantitative and qualitative techniques.
8. Analyse indicator results	Compare indicator values and trends to specific target levels based on community sustainability goals.
9. Report indicator results	Report indicators to target audience e.g. through the use of amoeba diagram and solicit feedback
10. Assess indicator performance	Identify progress towards established sustainability goals.
11. Review indicators	Over time indicators may need to be adapted to any system change, abandoned altogether and new ones adopted.

Figure 6 – Process criteria for developing indicators of sustainable development (adapted from Waldron and Williams, 2002) (source: White et al, 2005)

2.2. Indices and set of indicators

The multi-dimensional features of sustainability (involving environmental, economic, social and institutional aspects) implies that its measurement is made through a wide range of methodologies (specifically developed for each subject), using different measurement scales and units (Hanley et al., 1999; Rees, 2002b; Mayer et al., 2004; Esty et al., 2005;Wilson et al., 2007). Thus, to ensure that all the aspects of sustainability are taken into account and that every aspect is evaluated with the appropriate methodology, the sustainability of a system is often evaluated trough a **set of indicators**, that can be eventually aggregated to form a composite indicator, or **index**.

Sets of sustainability indicators, and aggregation of these indicators into indices, are increasingly used to make policy decisions (Oras, 2005; Hezri and Dovers, 2006), e.g. as policy tools useful for identifying issues that deserve greater attention within national environmental programmes and as benchmark tools to compare sustainability performance of different

countries, to identify trends and to assess progress at the international level, if regularly measured (the most common sustainability indices and dashboards are presented in Table 2).

Sets of indicators differ from indices in that they do not involve any quantitative aggregation of data, but rather provide qualitative ways of presenting large numbers of indicators (Olalla-Tárraga, 2006). They have an advantage over indices because the values of all of the indicators are easily observed and there is no loss of information (Anand and Sen, 1994) and because the risk of conveying misleading information due to aggregation bias and compensation between indicators is avoided. A few indicators with very negative values may not be obvious from the value of an index which aggregates hundreds of indicators into one number. However, it can be difficult to observe trends over time and to compare the comprehensive performance of different countries using sets, because the comparison can be more qualitative than quantitative (Mayer, 2008).

In its "Handbook on Constructing Composite Indicators", the OECD identifies the main positive and negative features of indices, illustrated in Table 1.

Pros	**Cons**
- Can summarise complex, multi-dimensional realities with a view to supporting decision makers. - Are easier to interpret than a battery of many separate indicators. - Can assess progress of countries over time. - Reduce the visible size of a set of indicators without dropping the underlying information base - Thus make it possible to include more information within the existing size limit. - Place issues of country performance and progress at the centre of the policy arena. - Facilitate communication with general public (*i.e.* citizens, media, *etc.*) and promote accountability. - Help to construct/underpin narratives for lay and literate audiences. - Enable users to compare complex dimensions effectively.	- May send misleading policy messages if poorly constructed or misinterpreted. - May invite simplistic policy conclusions. - May be misused, e.g. to support a desired policy, if the construction process is not transparent and/or lacks sound statistical or conceptual principles. - The selection of indicators and weights could be the subject of political dispute. - May disguise serious failings in some dimensions and increase the difficulty of identifying proper remedial action, if the construction process is not transparent. - May lead to inappropriate policies if dimensions of performance that are difficult to measure are ignored.

Table 1 – Pros and cons of composite indicators (Source: Handbook on Constructing Composite Indicators, OECD and JRC, 2008).

The present PhD research report includes sustainability indicators, sets of indicators and indices, that has been developed considering two main activity fields where the relationship between natural resources and human activities is particularly relevant: tourism and agriculture. Within the research, focused on the sustainability assessment at local scale, different

type of indicators has been developed referring to the same field of activity and mainly to the same geographical area, to have the possibility to compare different results and to integrate different perspective of analysis, as suggested also by Mayer (2008).

The comparison of results obtained for each issue with the assessment performed by different methodologies enables researchers and decision makers to analyze the situation from different perspectives, underlying which are the most important problems to be addressed and suggesting responses that could be implemented by stakeholders involved (local administrators, businesses and the local community).

Furthermore, the assessment of specific aspects included in one or two of the selected methodological schemes, enable to deepen the analysis about some issues that are more relevant for that kind of perspective.

Moreover, the use of complementary indicators evaluation methods allows to combine different perspectives of analysis and to integrate the characteristics of each methodology applied. With respect to tourism activities, for instance, the assessment made through Tourist Carrying Capacity, Ecological Footprint and the Sustainable Performance Index enables to consider the analysis of assets availability from an ecological point of view, the analysis of the sustainability of current consume patterns and the analysis of actual and potential effects of institutional policies in a tourist destination.

2.3 Overview about the existing sustainability indicators and indices

There is an impressive number of sustainability indicator and indices that has been developed by researchers working in different fields. The range of sustainability issues and the possible recipients considered by these indices is very large.

According to the review made by Singh et al in 2009, the main areas covered by existing sustainability indices are: Innovation Indices, Knowledge and Technology Indices; Development Indices; Market and Economy-based Indices; Eco-system based Indices; Composite Sustainability Indices for Industries; Investment, Ratings and Asset Management Indices; Product-based sustainability Indices; Sustainability Indices for Cities; Environmental Indices for Policies, Nations and Regions; Environmental Indices for Industries; Energy-based Indices and Social and Quality of Life-based Indices.

The degree to which these indices differ in their results is due not only to the focus of their evaluation but also to their methodological disparities, coming from different goals of the evaluation, boundaries of the system considered, data availability, spatial and temporal scale, etc. Thus, different classification of the existing indices can be made according to their scope, the method used to aggregate indicators, their interpretation of sustainability (e.g. weak or strong sustainability), etc.

Figure 7 gives an overview of some of the most common Sustainability Assessment Tools, as they have been classified in the review by Ness and colleagues (2007), according to temporal focus and object focus of the tools, while Table 2 represent a summary of the main sustainability indices (made by Singh et al in their review, 2009) where for every index the main

characteristics (number of indicators, scaling, method used for weighting and method of aggregation) are illustrated.

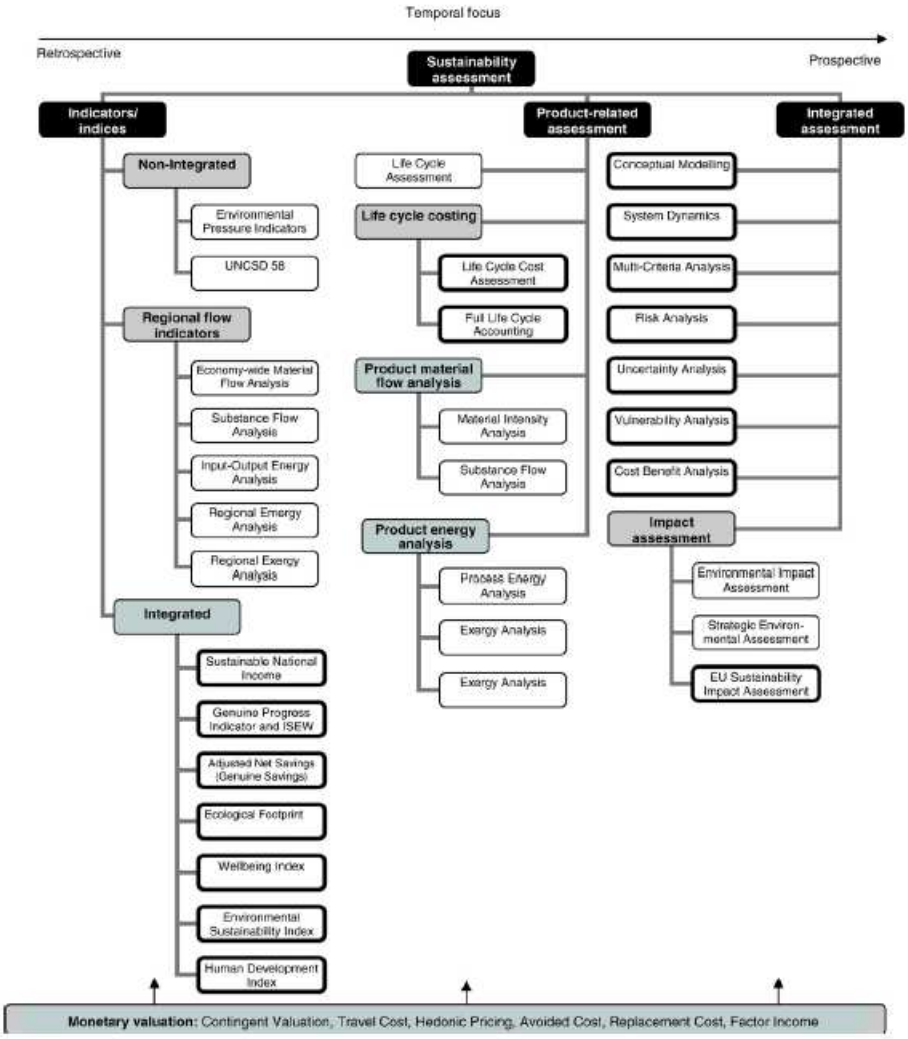

Figure 7 – Classification of sustainability assessment tools (Source: Ness et al 2007)

	Name	Number of sub-indicators	Scaling/normalisation	Weighting	Aggregation
1	Summary innovation, index	17	[+10 −10] mean subtraction	Equal weights	Number of indicators that are more than 20% above the European average minus the number of indicators which are more than 20% below and division by the total number of available indicators for each country
2	Internal Market Index	19	Percentage annual differences	PCA	Synthesis of variables using PCA
3	Business climate indicator	5	−100 to 100	PCA and FA	PCA applied to define weights. One principal component adopted as the composite indicator
4	Investment in the knowledge-based economy	7	Mean subtraction and division by the standard deviation	Choice of weights is up to the user	Weighted average
5	Performance in the knowledge-based economy	7	Mean subtraction and division by the standard deviation	Choice of weights is up to the user	Weighted average
6	Relative intensity of regional problems in the community	3	Mean subtraction and division by the standard deviation	Empirical weights are determined considering the degree of correlation between two sub-indicators	Neutralising the effect of correlation
7	Economic sentiment indicator	4	Dividing the month-to-month changes with the average month-to-month change	Equal weights	Summation
8	Composite leading indicators	Number varies across Member States	Mean subtraction and division by the mean of the absolute differences from the mean	Smoothing via "Months for cyclical dominance moving average"	Arithmetic average of the normalised indicators
9	Information and communication technologies	5	Country rankings for each indicator		Sum of rankings
10	Environmental sustainability index	68	Mean subtraction and division by the standard deviation	Equal weights	Arithmetic average of the normalised indicators
11	Human development index	3	[0, 1], using minimum and maximum value for each indicator as goal post	Equal	Arithmetic average of the scaled indicators
12	Technology achievement index	8 (grouped in 4 sub-indices)	[0, 1] using minimum and maximum value for each indicator as goal post	Equal	Arithmetic average of the 4 sub-indices
13	Overall health system attainment	5	[0, 100]	Weights based on survey of preferences of informed individuals	Summation
14	Two "Synthetic environmental indices"	22	Indicators are combined into 2 synthetic indices a structural and a functional one	Equal	Arithmetic average of the indicators
15	National innovation capacity	8	The logarithmic values of the sub-indicators are considered	Multiple regression model	Regression analysis employed
16	General Indicator of Science and Technology	13	FA/PCA was applied to define weights	PCA	PCA (primary principal component of each set)
17	Success of software process improvement	14	Subjective scale	PCA	–

Table 2 – Overview of sustainability Indices (Source: Singh et al, 2009)

18	European labour market performance	3	[0, 100] efficiency frontier (objective method)	Weight based on value judgement	–
19	Eco-indicator 99	3	Division by a reference value for each indicator	Weighting scheme is selected by a panel of experts	–
20	Concern about environmental problems	11	Dividing the value in each year by the value for the year for which each indicator is first available	Weights derived from public opinion polls	Sum of normalised weights multiplied by the corresponding normalised indicators
21	National Health Care systems performance	6	No standardisation	'Budget allocation' survey of 1000 people across the UK defined the weights for the indicators	Weighted average
22	Index of sustainable and economic welfare	20	Sub-indicators are expressed in monetary terms.	Equal. Allow the user to change the weightings and assumptions used in the index	Arithmetic average of the indicators
23	Index of environmental friendliness	11	Normalisation of problem indices by dividing the sectoral problem index by the value of the national problem index.	Subjective weights for the normalised problem indices are determined from experts by means of the Analytic Hierarchy Process.	Weighted sum
24	Environmental policy performance indicator	6 theme indicators (composed of several simple indicators)	Division by the corresponding (a) sustainability levels, and (b) policy targets	Equal	Sum of the six theme indicators
25	Living planet index	2000 populations of more than 11,000 species	Ratio to current and previous year	Equal weights	Geometric mean
26	Ecological footprint	6	Area	Equal	Summation
27	City development index	5	Distance from mean	PCA/experts	Weighted average
28	Environment performance index	Six policy categories	[0, 100]	PCA/experts	Weighted average
29	Environment vulnerability index	50	Aim = 1, worst = 7	Equal	Average
30	Well being index	87	[0, 100]	Subjective	Weighted average
31	Composite sustainability performance index	Five categories; 59 indicators	Distance from mean divided by standard deviation	AHP	Weighted average
32	Composite sustainable development index	Three categories; 38 indicators	Distance from maximum and minimum	AHP	Weighted average
33	Ford of Europe's product sustainability index	8	Life Cycle Impact assessment	–	–
34	Genuine savings index	3 capitals	Monetized	Equal	Summation
35	Sustainability performance index	5	Area	Equal	Total area per unit product divided by area per capita
36	Compass index of sustainability	Four categories of indicators	[0, 100] normative judgement	Equal	Average
37	ITT Flygt sustainability index	40	[+10, −100]	Company opinion	Summation
38	Environment quality index	Based on multi-attribute utility theory	[0, 10], linear utility function	AHP	Weighted sum
39	Life cycle index	4 categories; 21 indicators	Linear and non linear functions	AHP	Geometric mean
40	G score	5 categories	Subjective	Equal	Summation
41	Index of sustainable society	5 categories; 22 indicators	Mathematical formula for each indicator	Equal	Summation

Table 2 – Overview of sustainability Indices (Source: Singh et al, 2009)

2.4 The UN Commission for Sustainable Development (UN-CSD) indicator process

Agenda 21, the action program adopted by the 1992 Rio Summit, calls in Chapter 40 for countries, international organizations and non-governmental organizations to develop and use SDIs, as part of an integrated approach to accounting.

"Commonly used indicators such as the gross national product (GNP) and measurements of individual resource or pollution flows do not provide adequate indications of sustainability. Methods for assessing interactions between different sectoral environmental, demographic, social and developmental parameters are not sufficiently developed or applied. Indicators of sustainable development need to be developed to provide solid bases for decision-making at all levels and to contribute to a self-regulating sustainability of integrated environment and development systems." (Agenda 21, Paragraph 40.4)

The UNDSD's work program on indicators was adopted in 1995 in response to this call with the following elements:

a) enhanced information exchange among all interested actors;

b) development of methodology sheets, to be made available to governments;

c) training and capacity-building at regional and national levels;

d) testing of the menu of indicators and monitoring of experiences in three to four countries;

e) evaluation of the menu and adjustment, as necessary (UNDSD 1995).

The program, coordinated by the UN Department for Policy Coordination and Sustainable Development (UN-DPCSD) involved a participatory, iterative exercise to develop a SDI set. The SDIs were intended to help measure progress on the wide range of sustainability concerns of UN member states, and the aim was to have an agreed set of SDIs that all countries could accept by 2001.

The process consisted of the following phases:

1. Selection of the priority topics to be tested according to the key national problem areas of SD. Issues on the UNCSD list which are not priorities for each pilot country were neglected and issues which are of prime national importance but are not on the list were added.
2. Selection of individual indicators for all priority issues: the indicators suggested in the UNCSD working list were reviewed and amended.
3. Review of the data basis: the focus lay on issues about data availability (including the identification of data gaps) and data quality for the selected indicators.
4. Evaluation of indicators to be tested: the question as to whether the chosen indicators convey effective information for monitoring progress towards SD?
5. Further methodological development of the UNCSD indicators.

While this approach provided indicators that were more relevant at the national level, it did not lead to a truly common and comparable set of measures across the board, given the difference between what SD issues and indicators various countries would consider applicable and important. Partial comparability of SDIs was achieved related to issues and indicators that matter everywhere or among peer groups of countries with similar concerns and conditions.

Although the first set of SDIs did not lead to a common set of indicators, testing helped identify some that were selected everywhere. This information, along with the consideration of other criteria helped whittle down the SDI set from 134 to 58. Even this shorter list contains some obvious irrelevancies for some countries—for example, none of the indicators related to coastal and marine issues are directly relevant for landlocked countries —while it may miss critical issues that are not universally important, but critical for some. For instance, while infection by AIDS didn't make the list and it may not seriously affect some countries, for others, like many countries in Sub-Saharan Africa, it is now an essential measure of both social and economic sustainability. Given national differences, some lack of relevance is probably unavoidable even at this level of 58 measures.

Recognizing the need for flexibility, the CSD took a pragmatic approach and in the guidelines for developing a national program of SDIs it calls for the use of even the shorter list as a menu, even though it refers to the indicators as a 'core set' (UN 2001). This approach is more realistic than the expectation that countries would buy into a comprehensive, global set of measures that may or may not reflect their concerns, without a link to a strong policy agenda and in the absence of incentives, such as participation in well funded capacity building or tying the indicators to economic assistance. Such a link was strongly resisted, and it is unlikely that through this mechanism alone a further reduced core set would simply 'emerge.'

Beyond specific indicators, the CSD's approach brought political attention to indicators, which probably mattered particularly in developing countries, and provided some other tools such as methodology sheets that could increase the rigor and credibility of national processes.

(Source: "Sustainable Development Indicators – Proposals for a way forward", prepared for the United Nations Division for Sustainable Development (UN-DSD), December 2005)

2.5 Beyond GDP – alternative measures of welfare and development

One of the most debated fields in sustainability indicators research is related to the role of Gross Domestic Product (GDP) in measuring welfare and development. GDP is the best known measure of macro-economic activity. GDP was developed in the 1930s and has become a standard benchmark used by policy-makers throughout the world and is widely used in public debates. GDP has also come to be regarded as a proxy indicator for overall societal development and progress in general. However, since the 1970s, certain economists have highlighted the shortcomings of GDP as instruments for measuring the development and level of welfare of a State or a local community (Daly et al., 1989; Daly, 1996; World Bank, 1997; Lawn, 2003). Since that time, alternative methods of measure have been defined - for example satellite accounts integrated with national accounting and

specific indexes of sustainable development such as the Environmental Sustainability Index (ESI) (Esty et al, 2005) and the Environmental Performance Index (EPI) (Esty et al, 2008), the Index of Sustainable Economic Welfare (ISEW) (Cobb et al., 1994; Castaneda, 1999) and the Genuine Progress Indicator (GPI) (Anielski et al., 1999).

Moreover, the need to improve data and indicators to complement GDP has been increasingly recognised and is the focus of a number of international initiatives: the UNDP has developed a Human Development Index (HDI) to benchmark countries based on combined measurement of GDP, health and education. In November 2007, the European Commission (together with the European Parliament, the Club of Rome, the WWF and the OECD) organized the Beyond GDP conference. The conference revealed strong support from policymakers, economic, social and environmental experts and civil society for developing indicators that complement GDP and aim to provide more comprehensive information to support policy decisions.

In the Communication "GDP and beyond - Measuring progress in a changing world" (COM (2009) 433 final) the Commission identifies five actions that can be taken in the short to medium term to accomplish this objective:

1. Complementing GDP with environmental and social indicators

   Indicators that summarise important issues with a single figure are essential communication tools. GDP and the unemployment and inflation rates are prominent examples of such summary indicators. But they are not meant to reflect where we stand on issues such as the environment or social inequalities. To fill this gap, the Commission services intend to develop a comprehensive environmental index and improve quality-of-life indicators.

2. Near real-time information for decision-making

   Factors including globalization and climate change are bringing ever faster changes to the economy, society and the environment. Policy-making requires equivalent information on all those aspects – even if this goes at the expenses of accuracy – as it has to react quickly to new developments. The Commission will therefore aim to increase the timeliness of environmental and social data to better inform policy-makers all across the EU.

3. More accurate reporting on distribution and inequalities

   Social and economic cohesion are overarching objectives of the Community. The aim is to reduce disparities between regions and social groups. To foster exchange of experience between Member States, the Commission reports on a set of indicators agreed with Member States, to inform policy-makers about income disparities and particularly about the situation at the lower end of the income scale. In the future, these analyses will be regularly updated and their results published.

4. Developing a European Sustainable Development Scoreboard

   The EU Sustainable Development Indicators (SDIs) have been developed together with Member States to monitor progress on the multitude of objectives of the EU Sustainable Development Strategy (SDS). However, to stimulate the exchange of experience between Member States and among stakeholders on policy responses, there

is the need a more concise and up-to-date set of data. The Commission therefore explores the possibilities to develop, together with Member States, a Sustainable Development Scoreboard. The SD Scoreboard, based on the EU SDI set, could also include other quantitative and qualitative publicly available information, for instance on business and policy measures.

5. Extending National Accounts to environmental and social issues

   The European System of Accounts is the main tool behind EU economic statistics as well as many economic indicators (including GDP). In the intention of the UE Commission, the national accounts will be further complemented with integrated environmental economic accounting that provides data that are fully consistent. Then, as methods are agreed and the data becomes available this will be complemented, in the longer term, with additional accounts on social aspects.

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3. Tourism

3.1 Sustainable tourism: from policy to action

The United Nation World Tourism Organization (UNWTO) in 1996 defined sustainable tourism as "tourism which leads to management of all resources in such a way that economic, social and aesthetic needs can be fulfilled while maintaining cultural integrity, essential ecological processes, biological diversity and life support systems"; in addition, referring to the definition of sustainable development, UNWTO stated that that it should be intended as "a process which meets the needs of present tourists and host communities whilst protecting and enhancing needs in the future".

Sustainable tourism development guidelines and management practices shouldn't be considered only as regarding special categories of tourism activities (e.g. eco-tourism, green travel, responsible tourism, etc.) but they have to be considered as the referential framework for driving all forms of tourism in all types of destinations, including mass tourism and the various niche tourism segments, towards more sustainable patterns. Sustainability principles refer to the environmental, economic and socio-cultural aspects of tourism development, and a suitable balance must be established between these three dimensions to guarantee its long-term sustainability.

Thus, sustainable tourism should:

1) Make optimal use of environmental resources that constitute a key element in tourism development, maintaining essential ecological processes and helping to conserve natural heritage and biodiversity.
2) Respect the socio-cultural authenticity of host communities, conserve their built and living cultural heritage and traditional values, and contribute to inter-cultural understanding and tolerance.
3) Ensure viable, long-term economic operations, providing socio-economic benefits to all stakeholders that are fairly distributed, including stable employment and income-earning opportunities and social services to host communities, and contributing to poverty alleviation.

The commitment to sustainable tourism development from governments and tourist business starts from the consciousness that tourism represents nowadays a growing economic sector, based on resources that are limited and often need particular protection, such as natural beauties, artistic and cultural heritage. These two aspects, a growing condition and the necessity of preservation of the resources, suggest to define two major tasks:

- to find the best strategies to sustain the development of tourism in the next years;
- to direct the actions of supply and demand towards conservation and valorisation of local resources (nature, culture, local identities, etc).

Therefore the success of tourism development in the long-term is founded on the ability of tourism sector to manage economic, social and environmental aspects holistically, ensuring the respect of the three dimension of sustainability:

- ecologic perspective: environmental quality of natural resources of a destination represents one of the most important and fragile elements of attractiveness for tourists, so every activity that compromise these resources, depleting their attractiveness, determines, in the medium or long-term, the decrease of tourists arrivals and of the economic success of the destination.
- socio-cultural perspective: social and cultural heritage of the area can play a relevant role for tourism, especially in destinations of high artistic and cultural value or in places where traditional and local values and activities play a relevant role for tourism (e.g. African countries). In general, the most important threat is represented by the fact that tourism can become the dominant activity and the prevailing source of income and jobs, determining the decline in traditional activities and, in some case, the dependence from foreign enterprises and tourism operators.
- economic perspective: non sustainable tourist development can generate social and environmental costs that, in a long-term perspective, can be greater than the economic benefits. When these externalities are not taken into account for the evaluation of the economic success of tourism, this results in an altered vision of the real situation, which is misleading for planning decisions.

Thence, tourism sustainability depends on the ability to create economic benefits which are widespread among local operators and assuring, at the same time, the valorisation and conservation of the local social, cultural and environmental heritage. This means that tourism activities have to be developed respecting the ecologic carrying capacity of the area where they take place, producing an increase in "strategic values" related to social and economic perspective .

Sustainable development concept was firstly defined during the United Nations Conference on Environment and Development (UNCED) in 1992, through specific policy indications to enrich sustainability concept, defining common objectives. Two different levels of sustainability may be considered: weak and strong sustainability. Weak sustainability is the idea that natural capital can be used up as long as it is converted into manufactured capital of equal value. Otherwise, strong sustainability is the idea that there are certain functions that the environment performs that cannot be duplicated by humans: as a minimum necessary condition, "strong sustainability" requires that the total stock of natural capital remains constant over time, as illustrated by Costanza in "The ecological economics of sustainability" contained in the book "Environmentally Sustainable Economic Development: Building on Brundtland", published by UNESCO in 1991). Considering tourism sector, weak sustainability seems to be not applicable, due to the strong dependence of business from the availability and quality of natural capital and to the fact that natural capital can be hardly substituted with other forms of capital. Nevertheless, in some cases, strong sustainability seems to be hardly applicable, especially where tourism activities represent the main source of income for the local community. The challenge for local administrators is, thence, to find a balance between different needs, defining strategies for local development that ensure sustainability and economic growth in the long term and that are commonly shared by all the stakeholders involved.

The challenge for local administrators and tourism operators is the mainstreaming of sustainability into planning and policy for competitiveness, employment and social cohesion, as stated in recent European guidelines (e.g. the renewed Lisbon Strategy).

The Renewed EU Tourism Policy (COM (2006) 134 final, "Towards a stronger partnership for European tourism") underlines the role of tourism for job creation and economic growth, recognizing its role in the challenge to reach the goals of the renewed Lisbon Strategy (COM (2005) 24). Moreover, the Commission declares that "Tourism plays an important role in the development of the vast majority of European regions: at the pan-European level, the travel and tourism industry contributes to about 4% of total employment and about 11% of GDP (data from WTTC, year 2006). Infrastructure created for tourism purposes contributes to local development, and jobs are created or maintained even in areas in industrial or rural decline, or undergoing urban regeneration. The need to improve the attractiveness of the regions acts as an incentive to an increasing number of destinations and stakeholders to turn towards more sustainable and environmentally friendly practices and policies. Sustainable tourism plays a major role in the preservation and enhancement of the cultural and natural heritage in an ever expanding number of areas, ranging from arts to local gastronomy, crafts or the preservation of biodiversity" (the European Sustainable Development Strategy 2005 – 2010). Thence, the role of sustainable tourism for assuring long-term development of tourism destination and for facing the challenges of tourism sector (e.g. ageing of the population, change in public demand and growing of new needs from tourists, necessity to preserve attractiveness of the destinations) seems to be crucial: economic, social and environmental sustainability are key factors for the competitiveness of destinations and the welfare of their populations, as well as for the creation of employment and for the preservation and enhancement of the natural and cultural attractions.

Subsequently, the Renewed European Tourism Policy has the aim "to improve the competitiveness of the European tourism industry and create more and better jobs through the sustainable growth of tourism in Europe and globally", making the best use of available resources and taking advantage of all possible synergies.

The main areas on which the policy focuses are:

1. Mainstreaming measures affecting tourism (through better regulation, policy-coordination, improved use of available European financial instruments).
2. Promoting tourism sustainability (developing a European Agenda 21 for tourism and implementing specific supporting actions for the sustainability of European tourism).
3. Enhancing the understanding and the visibility of tourism (improving the understanding of European tourism through more detailed statistics, made available in a timely manner; supporting the promotion of European destinations).

In this context, the role of the European Commission concerns activities such as coordinating actors to produce and share knowledge (i.e. research and sharing of best practices), providing economic support through EU

financial instruments (in particular the Cohesion Policy funds) and mainstreaming sustainability and competitiveness in Commission policies.

The Agenda for a sustainable and competitive European tourism (Com (2007) 621 def) recognises that finding the right balance between an autonomous development of the destinations and the protection of their environment on the one side and the development of a competitive economic activity on the other side may be challenging but, nevertheless, in the long-term, competitiveness of tourism destinations depends on sustainability. To achieve the goal of a competitive and sustainable tourism the Commission, through the Agenda, invites all actors to respect the following principles:

Take a holistic and integrated approach - All the various impacts of tourism should be taken into account in its planning and development. Furthermore, tourism should be well balanced and integrated with a whole range of activities that affect society and the environment.

Plan for the long term - Sustainable development is about taking care of the needs of future generations as well as our own. Long term planning requires the ability to sustain actions over time.

Achieve an appropriate pace and rhythm of development - The level, pace and shape of development should reflect and respect the character, resources and needs of host communities and destinations.

Involve all stakeholders - A sustainable approach requires widespread and committed participation in decision making and practical implementation by all those implicated in the outcome.

Use best available knowledge - Policies and actions should be informed by the latest and best knowledge available. Information on tourism trends and impacts, and skills and experience, should be shared across Europe.

Minimise and manage risk (the precautionary principle) - Where there is uncertainty about outcomes, there should be full evaluation and preventative action should be taken to avoid damage to the environment or society.

Reflect impacts in costs (user and polluter pays) - Prices should reflect the real costs to society of consumption and production activities. This has implications not simply for pollution but for charging for the use of facilities that have significant management costs attached to them.

Set and respect limits, where appropriate - The carrying capacity of individual sites and wider areas should be recognised, with a readiness and ability to limit, where and when appropriate, the amount of tourism development and volume of tourist flows.

Undertake continuous monitoring - Sustainability is all about understanding impacts and being alert to them all the time, so that the necessary changes and improvements can be made.

(COM (2007) 621 def).

The Agenda is based on the Report of the Tourism Sustainability Group (TSG) of the European Commission ("Action for more sustainable European Tourism", 2007), which analyzes the situation of sustainable tourism in Europe so far, starting from the 12 Aims for Sustainable Tourism identified by UNWTO and UNEP, that are intended as a referential framework for policy makers:

1. **Economic viability**. To ensure the viability and competitiveness of tourism destinations and enterprises, so that they are able to continue to prosper and deliver benefits in the long term.
2. **Local prosperity**. To maximize the contribution of tourism to the prosperity of the host destination, including the proportion of visitor spending that is retained locally.
3. **Employment quality**. To strengthen the number and quality of local jobs created and supported by tourism, including the level of pay, conditions of service and availability to all without discrimination by gender, race, disability or in other ways.
4. **Social equity**. To seek a widespread distribution of economic and social benefits from tourism throughout the recipient community, including improving opportunities, income and services available to the poor.
5. **Visitor fulfilment**. To provide a safe, satisfying and fulfilling experience for visitors, available to all without discrimination by gender, race, disability or in other ways.
6. **Local control**. To engage and empower local communities in planning and decision making about the management and future development of tourism in their area, in consultation with other stakeholders.
7. **Community wellbeing**. To maintain and strengthen the quality of life in local communities, including social structures and access to resources, amenities and life support systems, avoiding any form of social degradation or exploitation.
8. **Cultural richness**. To respect and enhance the historic heritage, authentic culture, traditions and distinctiveness of host communities.
9. **Physical integrity**. To maintain and enhance the quality of landscapes, both urban and rural, and avoid the physical and visual degradation of the environment
10. **Biological diversity**. To support the conservation of natural areas, habitats and wildlife, and minimize damage to them.
11. **Resource efficiency**. To minimize the use of scarce and non-renewable resources in the development and operation of tourism facilities and services.
12. **Environmental purity**. To minimize the pollution of air, water and land and the generation of waste by tourism enterprises and visitors.

(Making Tourism More Sustainable, A guide for policy makers UNWTO/UNEP, 2005)

3.1.1. From referential framework to challenges and solution

The analysis carried out by the TSG about the current situation of sustainable tourism in Europe led to the identification of the main challenges that European tourism faces in meeting these aims; for every key challenge, examples of possible actions are presented in this book.

The case studies and the theoretical researches presented in the papers of the congress testify that the topics identified by the report as priorities find confirmation in the analysis of real situations and in the strategies implemented by local actors. The key challenges, which are strictly related

also to the seven key challenges identified in the renewed EU Sustainable Development Strategy, are the following:

- Challenge 1: Reducing the seasonality of demand. Possible actions include: addressing non-seasonal markets (e.g. business tourism, school tourism); develop of new tourist products and events for the off-season; price differential and incentives; cooperation between service suppliers and operators to extend opening times.
- Challenge 2: Addressing the impact of tourism transport. Possible actions include: promotion of more environmentally friendly forms of transport, both to and within the tourist destination, through taxation and pricing mechanisms, assuring a good public transport system, improving integration between different types of transport service, carefully locate new tourism structures with respect to accessibility.
- Challenge 3: Improving the quality of tourism jobs. Possible actions include: assure good working conditions in tourism sector to reduce the problem of staff turnover and improve qualification of staff; strengthening the application of common standards in tourism training across Europe and mutual recognition of qualifications; application of life-learning initiatives; exchange of good practice in tourism training across Europe.
- Challenge 4: Maintaining and enhancing community prosperity and quality of life, in the face of change. Possible actions include: assure a careful planning, taking into consideration the character of existing settlement and maximising the level of use of existing properties; give priority to type of accommodation and facilities that reflect the special character of the destination, minimise environmental impact and deliver value to the community (economic and employment); strengthen local supply chains and promote use of local products, shops and other services by visitors.
- Challenge 5: Minimising resource use and production of waste. Possible actions include: actions for strengthening environmental management in tourism enterprises and influence tourists behaviour, with the aim of minimising energy consumption and promoting reduction, reuse and recycling of materials; assuring air and water quality and an appropriate management of sewerage and grey water.
- Challenge 6: Conserving and giving value to natural and cultural heritage. Possible actions include: promoting and completing the Natura 2000 network of protected areas; strengthening the relationship between protected areas and local tourism interests, within the context of a sustainable tourism strategy and action plan (e.g. following the model of the European Charter for Sustainable Tourism in Protected Areas promoted by Europarc); adopting visitor management plans to ensure that tourism does not damage natural and cultural resources; developing monitoring programmes to measure trends and impacts and facilitate adaptive management.
- Challenge 7: Making holidays available to all. Possible actions include: encouraging policies and action to promote social tourism; designing and adapting tourism facilities and sites to meet requirements for physical disability; improving information availability for disabled people and under-privileged groups.

- Challenge 8: Using tourism as a tool in global sustainable development. Possible actions include: encourage programmes to support appropriate tourism development as a tool for sustainable development and poverty alleviation; encourage European tour operators and investors in tourism services abroad to abide sustainability principles and seek to benefit the environment and local communities in which they operate.

Actions to enhance sustainable tourism and to address these main challenges, can be promoted at different levels and involve different actors.

The wider level, apart from international and national regulation and programmes, is sustainable destination management, with different stakeholders working together for the definition of a strategy for sustainable tourism and an action plan to be implemented in the destination. Regional and local authorities play a relevant role at this level, even if all the interest of local stakeholders (e.g. tourism businesses, environmental and cultural heritage bodies, the transport sector, local recreation/consumer groups, trade unions, local education and training bodies) have to be taken into account in the process of planning. The whole action has to be intended as a developing process, in which the results of the implementation need to be monitored over time and the strategy has to be periodically reviewed.

The second level regards the private sector and the promotion of sustainable tourist business in the destination. The key challenge for this sector is to take a long term view and to deliver wider economic, social and environmental benefits, while ensuring viability and competitiveness. Actions for this scope can be developed in the field of promoting corporate social responsibility, awareness raising among business and tourists, financial incentives and assistance and the development and use of performance criteria, with the possibility of identification and reward of the best performers. Business associations can play a relevant role in this field, influencing the actions of their members and promoting training, networking and best practice sharing about sustainable tourism actions.

The third level, strictly related to the others, is the one of responsible tourists. Tourists themselves are a key factor as a market driver, through their behaviour (e.g. resource consumption and production of waste) and their choice (e.g. selection of operators and enterprises that are adopting good practices). Tourists can be influenced stimulating awareness of impacts and through the provision of information useful to facilitate appropriate choices and actions; in addition, also differential pricing related to the sustainability performances of goods and services (e.g. road tolls, incentives for alternative transports, etc) can help destination managers to influence tourists' behaviour.

Finally, it is important to mention the role of monitoring systems to assure the long-term success of the strategies and actions implemented; the identification of indicators associated with sustainability objectives, and a process of regular monitoring against them, is a critical component of destination management to assure sustainability. The EU has been working on the establishment of an indicator set for tourism sustainability (e.g. EUROSTAT working group on tourism statistics) and other work in this field has also been looked at by the TSG. The result is a proposed indicator set for destinations (available as an Annex in the TSG report), that identifies a number of core indicators which are seen as both fundamental to

sustainability and relatively straightforward to collect, and additional indicators which destinations are encouraged to consider.

The indicators given in the report relate to sustainability issues common to most destinations; however, the relevance of indicators can vary between destinations and the final selection of indicators should be determined, in consultation with all stakeholders, according to the type of destination (beach, mountain, urban etc.) and the particular circumstances found there. Then, after the selection of the appropriate set of indicators for the destination, indicators need to be reviewed and updated on a regular basis to ensure that targets are progressive and encourage continuous improvement. Furthermore, it is important to define targets and limits as a reference for the evaluation of the indicators' results (e.g. targets to be reached by sustainable tourism development policies or limits of acceptable change in natural conditions due to the impacts of tourism activities).

3.1.2 Regulations, Declarations, Charters and Codes about sustainable tourism

1995. Lanzarote Charter for Sustainable Tourism. The Charter for Sustainable Tourism was developed at the World Conference on Sustainable Tourism, in Lanzarote, Canary Islands, Spain on 27-28 April 1995. The Charter for Sustainable Tourism' identified 18 Principles which defined how tourism should be developed. This charter has been the basis for much subsequent work on how tourism should be developed.

1995. The European Charter for Sustainable Tourism in Protected Areas. The origins of the Charter are in a project started by the Europarc Federation in 1991. This project resulted in a report titled 'Loving Them to Death' which highlighted the threat that inappropriate tourism development poses to the integrity of protected areas. The charter was developed by representatives of European protected areas, the tourism industry and their partners and follows the 18 principles of the World Charter for Sustainable Tourism as well as being supported by the Tourism and Protected Areas and Tourism Task Force of the World Conservation Union (IUCN).

1997. The Berlin Declaration on biological diversity and sustainable tourism. Signed during the International Conference of Environment Ministers on Biodiversity and Tourism 6-8 March, 1997, Berlin. The Declaration notes that tourism increasingly turns to areas where nature is relatively undisturbed so that a substantial number of the world's remaining natural areas are being developed for tourism activities. The Declaration also expresses concern that tourism may contribute significantly to socio-economic development but can degrade the natural environment, social structure and cultural heritage, and expresses the conviction that sustainable forms of tourism have the potential to contribute to the conservation of biological diversity outside and inside protected areas.

1999. Global Codes of Ethics for Tourism. Document adopted by resolution A/RES/406(XIII) at the thirteenth World Tourism Organization General Assembly (Santiago, Chile, 27 September - 1 October 1999).

1999. **Documents edited by the UN Commission on Sustainable Development**, Seventh Session (April 1999):

- The Global Importance of Tourism
- Workers and Trade Unions in the Web of Tourism
- Sustainable Tourism: A Local Authority Perspective
- Sustainable Tourism: An NGO Perspective

2001. APEC/PATA Code for Sustainable Tourism. The Code for Sustainable Tourism has been adopted by both PATA (the Pacific Asia Travel Association) and APEC (Asia Pacific Economic Co-operation) as a reflection of their strong commitment to tourism growth across the Asia and Pacific region that is viable and sustainable over a long-term future.

2002. Agenda 21 and Sustainable Tourism. In 2002, the World Summit on Sustainable Development in Johannesburg addressed sustainable tourism in Chapter IV ("Protecting and managing the natural resource base of economic and social development"), paragraph 43 of the Johannesburg Plan of Implementation.

2002. The Cape Town Declaration, about Responsible Tourism in Destinations. Signers committed themselves to work with others to take responsibility for achieving the economic, social and environmental components of responsible and sustainable tourism.

2002. Final report of the World Ecotourism summit and Québec Declaration on Ecotourism. In the framework of the UN International Year of Ecotourism, 2002, under the aegis of the United Nations Environment Programme (UNEP) and the World Tourism Organization (WTO), over one thousand participants coming from 132 countries, from the public, private and non-governmental sectors met at the World Ecotourism Summit, hosted in Québec City, Canada, by Tourisme Québec and the Canadian Tourism Commission, between 19 and 22 May 2002. The Declaration is the result of a multi-stakeholder dialogue, although it is not a negotiated document. Its main purpose is the setting of a preliminary agenda and a set of recommendations for the development of ecotourism activities in the context of sustainable development.

2005. Making Tourism More Sustainable, A guide for policy makers by UNWTO/UNEP**.**

2006. The Renewed EU Tourism Policy. COM (2006) 134 final, "Towards a stronger partnership for European tourism".

2007. Climate Change and Tourism Responding to Global Challenges, Davos Declaration. The international community is taking concerted action against climate change around a commonly agreed framework led by the United Nations. This UN framework seeks to establish a long term post-Kyoto roadmap with rapid deployment and targeted milestones. The tourism sector has an important place in that framework, given its global economic and social value, its role in sustainable development and its strong relationships with climate.

2007. Agenda for a sustainable and competitive European tourism. (COM (2007) 621 def)

2007. Action for more sustainable European Tourism. Report of the Tourism Sustainability Group of the European Commission.

2008. Global Partnership for Sustainable Tourism Criteria. A Partnership including Rainforest Alliance, the United Nations Environment Programme (UNEP), the United Nations Foundation, and the United Nations World Tourism Organization (UNWTO), launched the Sustainable Tourism Criteria at the World Conservation Congress in October 2008. These criteria will be the minimum standard that any tourism business should aspire to reach in order to protect and sustain the world's natural and cultural resources while ensuring tourism meets its potential as a tool for poverty alleviation.

3.2 Sustainability indicators for tourism

(Published in the book "Sustainable tourism as a factor of local development", edited by V. Castellani and S. Sala, Tangram Edizioni Scientifiche, Trento, ISBN 978-88-6458-001-2, in press)

Valentina CASTELLANI – Serenella SALA

Abstract: Spatial planning processes need to be supported by instruments able to evaluate current situation and to measure long term effects of the policies for development that are implemented. The use of indicators for measuring sustainability of tourism addresses some important needs: (1) quantitative evaluation of current state of environmental, social and economic conditions in the destination; (2) the definition of measurable targets; (3) the possibility of comparing results through space (comparison with other destinations) and time (measure of evolution through time of local situation – measure of achieved results); (4) communication of results to relevant actors (political decision makers, local stakeholders). The present paper aims to analyze opportunities and limits connected to the implementation of some sustainability indicators (e.g. Carrying Capacity, Ecological Footprint, Genuine Progress Indicator) to the tourism sector, with a specific reference to the possibility to address the criteria for the selection of indicators identified by OECD (policy relevance, analytical soundness, measurability, coherence with the priorities identified for spatial planning, involvement of stakeholders). Specific attention will be paid to the analysis of possibilities of implementation at local scale (e.g. in relation with the availability of local data and effective meaning of results). Final aim of this study is to identify a way for understanding and communicating the results of the evaluation, to provide information that is effectively supporting for decision making processes at different scales (local administrators, tourism operators, tourists and visitors).

Keywords: *Sustainability indicators, sustainable tourism, Tourist Carrying Capacity, Ecological Footprint, Genuine Progress Indicator*

Introduction

Spatial planning processes in tourist destinations need to be supported by instruments able to evaluate current situation and to measure long term effects of the policies for development that are implemented. It is important that tourism planning made by local decision makers is intended to assure a good level of conservation of natural resources and to mitigate the impacts that tourism necessarily involves. If managed in a responsible and sustainable way, tourism can be a motivating force to the conservation of local heritage; on the other hand, if the strategy adopted for tourism development has only the aim to get huge and immediate economic results through the uncontrolled growth of tourist flow, this will bring to a rapid exploitation of the destination, which, after a short period, will become spoilt and no more attractive. The impact which is more evident is the one on natural environment, but there are also some possible effects on social and economic dynamics of local community that have to be considered in a sustainable vision.

Indeed, effective policy planning for sustainable tourism development has to be based on an analysis of actual and potential environmental, social and economic conditions and on the needs of local communities and enterprises (Hezri, 2004). Furthermore, the results of local policies for development have to be monitored through time to assess impacts on the local environment and, where appropriate, to redefine policy and plan future steps to be taken in order to continuously improve the environmental and sustainability performance of the area (Ko, 2001). It is therefore essential to identify indicators suitable to measure and evaluate the temporal evolution of development policies (Oras, 2005; Hezri et al., 2006) and to assess the possibility of sustainable socio-economic development facilitated by the promotion of sustainable tourism products.

The use of indicators for measuring sustainability of tourism addresses some important needs: (1) quantitative evaluation of current state of environmental, social and economic conditions in the destination; (2) the definition of measurable targets; (3) the possibility of comparing results through space (comparison with other destinations) and time (measure of evolution through time of local situation – measure of achieved results); (4) communication of results to relevant actors (political decision makers, local stakeholders). The present paper aims to analyze opportunities and limits connected to the implementation of some sustainability indicators (e.g. Carrying Capacity, Ecological Footprint, Genuine Progress Indicator) to the tourism sector, with a specific reference to the results of an analysis performed from three different perspectives – the analysis of assets availability from an ecological point of view, the analysis of the sustainability of current consume patterns, the analysis of actual and potential effects of institutional policies – in a tourist destination.

Materials and methods

The methodology is based on an evaluative procedure inspired to DPSIR model, useful to underline which are the drivers of impacts and which is the most useful dataset to describe current and future scenarios.

Table 1. *Analysis of tourism sector according to DPSIR model*

Drivers	Construction and management of hospitality structures and facilities, presence of tourists, urban traffic.
Pressures	Emissions of air pollutants, use of groundwater resources, emission of pollutants in stream waters, production of solid urban waste, land use and soil erosion, energy consumption, presence of tourists in protected areas.
State	Concentration of pollutant in air and water, groundwater availability, quantity of solid urban waste, level of urbanization, level of crowding in natural sites.
Impacts	Loss of biodiversity, disturb of wild species, adverse effects on human health.
Responses	Promotion of sustainable tourism: reduction of water and energy consumption, reduction of waste production and increasing of separated waste collection, promotion of public transports, use of renewable energy, promotion of ecotourism activities.

The analysis of sustainability of the tourist destination was performed from three different perspectives, as highlighted in the previous sections; to address the aim of an integrated evaluation of tourism sector in the area, three methodological models were developed:

- Tourism Carrying Capacity (TCC)
- Ecological Footprint of tourism (EFT)
- Sustainable Performance Index (SPI).

For carrying capacity assessment, all environmental aspects are separately took into account and main environmental issues related to daily life of residents and to tourism activities (air quality, water quality and disposability, waste management, soil use) are considered. The methodology aims to integrate physical carrying capacity assessment with the evaluation of managing capacity of environmental and public services (Castellani et al., 2007), to give a quantitative evaluation of the carrying capacity of tourist system. Final aim is the assessment of current situation and the definition of targets useful to identify main pressures and threats that may affect the area in case of an increasing in the number of tourists and tourist structures. This approach is based on the consciousness that two major types of impact can be identified in a tourist destination: those which are associated with tourism structures (hotels, roads and other facilities) and those resulting from the tourists themselves (crowding of natural sites, air and water pollution)

Ecological Footprint is an aggregated index that correlates the life-style of a population with the amount of natural resources needed to support it (the "life-supporting natural capital") (Wackernagel et al, 1998). Assessing EF of tourism enable to evaluate the overall impacts of an holiday, involving not only the impacts due to the stay in an hospitality structure, but also, for instance, the impacts due to the trip from home to the destination and back. The research about methodology lead to the development of a model to assess EF of tourists according to the kind of accommodation they choose for their holiday.

Finally, the results of every single evaluation of EF of tourist in every hospitality structure is summed up to assess the total EF of tourism in the destination considered and, then, this last result was added to the value of EF of residents to be compared with local biocapacity. (Castellani et al., 2008)

With the aim of measuring local levels of development and quality of life, overcoming the evaluation of mere economic indicators such as GDP, a new integrated index of sustainable development was developed, starting from the conceptual model of indicators as the Index of Sustainable Economic Welfare (ISEW) (Cobb et al., 1994; Castaneda, 1999) and the Genuine Progress Indicator (GPI) (Anielski et al., 1999). The Sustainable Performance Index (SPI) is an integrated index composed of 20 indicators concerned with: 1) demographic dynamics, 2) economic and social conditions of local communities, 3) environmental factors and 4) tourism characteristics of the region under investigation. This approach enables one to make an assessment based on available local data, reducing the need to use proxy data and creating an evaluation of effective possibilities of development in the analysed area. Every indicator can assume a value from 0 to 10, which

represents the level of sustainable development assessed for that issue (10 indicates the higher level of development). Finally, the results of the evaluation of each indicator are combined to obtain a composite evaluation of the Sustainable Performance of every municipality: the mean SPI value for the municipalities involved represents the value of SPI for the entire area considered.

Results and discussion

Area of study

The destination object of the implementation of the three methodologies is Alpi Lepontine Mountain Community1, which represents an interesting situation because it has undertaken the process of European Charter for Sustainable Tourism in Protected Areas developed by Europarc (European Federation of Parks), to promote sustainable tourism. In this context, the evaluation of the sustainability of tourism in the area represents an attempt to provide a valuable tool for policy makers to set targets for sustainable policies of development and to verify the ecological implications of policy choices.

Results

The integrated methodological approach adopted for the evaluation of tourism sector in Alpi Lepontine focused on several issues, which are considered in a different way by each indicator implemented. Table 2 compares the issues evaluated by the sustainability indicators assessed.

	TCC	**EFT**	**SPI**
Environmental conditions	X		X
Energy consumption	X	X	X
Waste	X	X	X
Biodiversity	X		X
Land use	X	X	X
Mobility	X	X	X
Number of tourists/visitors	X	X	X
Food consumption		X	
Goods consumption		X	
Social conditions			X
Economic conditions			X
Economic efficiency of tourism	X		

[1] Italian Mountain Communities are administrative cluster of municipalities in mountain areas

The issues considered by the all three indicators of sustainability chosen for the evaluation are Energy consumption, Waste production, Land use, Mobility, Number of tourists/visitors of the area. The comparison of results obtained for each issue with the assessment performed by different methodologies enable to analyze the situation from different perspectives, underlying which are the most important problems to be addressed and suggesting responses that could be implemented by stakeholders involved (local administrators, tourism operators, local community and tourists). Furthermore, the assessment of specific aspects included in one or two of the selected methodological schemes, enable to deepen the analysis about some issues that are more relevant for that kind of perspective (e.g. food and goods consumption, for the analysis of sustainability of consumption patterns chosen by tourists or hospitality structures managers).

As for the coherence of results with the criteria defined by OECD, the use of a composed set of indicators allows to combine different perspectives of analysis and to integrate the characteristics of each methodology applied. Tourist Carrying Capacity, for instance, assure the measurability of results and the possibility of comparing results for different destination (because the model is designed to use national statistical data sets available at local scales); Ecological Footprint considers data of consumption which are partly standardized and partly not (e.g. due to a lack of availability of structured data sets about hospitality structures consumption of food and goods), but it is a strong tool for the communication of results to all the stakeholders of the tourist system; Sustainable Performance Indicator assessment and definition method has a strong connection with the priorities identified for spatial planning and the vision arising from the involvement of stakeholders.

Conclusions

The evaluation of the sustainability of tourism sector involves 3 categories of subjects: tourists, tourism operators and local administrators. Each kind of subject indeed can act for the development of tourism in a more sustainable perspective:

- tourists can choose different aspects of their holiday: kind of accommodation, length of stay, mean of transport, local or international food, etc;
- tourism operators can act to make tourism structures more ecologically efficient, reducing impacts due to energy and water consumption, production of waste, etc.;
- public administrators are involved in the definition of land use planning and can influence the whole tourism system, promoting communication campaign to raise environmental consciousness among residents, tourism operators and tourists, and supporting the development of the destination in a sustainable perspective.

In this context, sustainability indicators and their evolution in time could represent a useful tool for highlighting the priorities of action from each perspective (ecological, consuming and institutional point of view) and enable the categories of actors listed before to define lines of intervention for promoting sustainable tourism in the area. Furthermore, the application of sustainability indicators at a local scale is a promising tool for addressing

the definition of lines of action for local development and evaluating the short and long term effects of strategies developed through the participatory processes of the European Charter for Sustainable Tourism in Protected Areas.

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3.3 A proposal for integration between Life Cycle Assessment and other instruments and indicators as a way to promote Sustainable Production and Consumption strategies

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Serenella Sala, Valentina Castellani

Introduction

The necessity of a more sustainable approach to production and consumption patterns has been widely highlighted by international resolutions and directives as a way to promote sustainable development in daily life activities (see, for instance, the EU Strategy for Sustainable Development and the Integrated Product Policy). Furthermore, spatial planning processes need support by specific tools for evaluation that are able to analyze long term effects of the defined policies. Within this context, Life Cycle Assessment represents a useful tool for the investigation of impacts and the identification of more sustainable solutions within the whole supply chain (from the choice of raw materials to the delivery services and recycle or waste processing) (Hertwich E. G., 2005, Raggi et al, 2009).

To address the goal of making people, organization and institution more aware about the importance of their choices, a more communicative tool is needed, useful to visualize the impacts and compare them with the actual availability of assets. The present work defines a comprehensive conceptual model for the integration of detailed Life Cycle analysis of a specific supply chain in the evaluation of the sustainability of consumption patterns performed with Ecological Footprint method. Final aim is to provide a tool that enables to identify scenarios of development and to define decision support systems, to improve awareness and responsibility of organizations that provide goods and services and of consumers. In this context, the Life Cycle Assessment of significant aspects of tourism (hospitality structures, tourist services, transportation) is integrated in the methodology of other sustainability indicators, enabling to identify development scenarios and to support decision-making by local administrators.

Materials and methods

The present study analyzes the possibility to integrate LCA of tourism activities and Ecological Footprint of tourism: final aim is the definition of a model that can assure a widen analysis of each aspect of tourist activities (performed by LCA method) and, in the same time, assure an easier communication of the results for rising consciousness among the stakeholders involved (that can easily visualize the impacts through the extent of Ecological Footprint of tourism in the destination).

The application of LCA methodology to tourism sector highlights a question about the definition of the system which is the object of the evaluation: in the present study, for the definition of the conceptual model, we decided to consider three relevant aspects of the whole holiday (considering the trip "from door to door"): the journey, the stay in the destination (including the fruition of several services as accommodation, catering, cultural and recreational activities, etc.) and the building of the hospitality structure (which is a fundamental aspect of a tourist destination). The selection of these aspects for Life Cycle Assessment considers also the possible connections with Ecological Footprint's methodology, which includes the impacts deriving from waste production and from 5 categories of consumption: transportation, food, goods, services, and building.

2.1 Conceptual model

The conceptual model developed consist of two sections (Figure 1): analysis of the role of LCA as a source of information to support decision makers; analysis of possible integration between LCA and Ecological Footprint of tourism (according to the component model methodology).

The first part of the model analyzes the relation between LCA of the three aspects of tourism considered (building of hospitality structures, staying in the destination, journey) and the role of stakeholders in the decision-making process: local administrators play an important role in spatial planning, selecting building areas and giving permissions for the building of hospitality structures and facilities; entrepreneurs (directly or indirectly involved in tourism activities) determine the type of tourist services available for tourists, influencing their possibility for making sustainable consumption choices; tourists make consumption choices which are limited by the effective availability of sustainable products and services and are determined by their environmental consciousness and responsibility.

Indeed, the choice of the model of development for tourism destination, (e.g. the level of urbanization, the prevailing type of hospitality structure, the infrastructures and tourist facilities existing), affect the possibility for tourists to make more sustainable choices of consumption: for instance, if the number of beds in less impacting structures (as B&B and agritourism) is limited, then the number of tourists that spend their holiday in less sustainable type of accommodation will be necessarily higher; in the same way, if public transport is not efficient, then it would be difficult to make tourist leave their private car at home.

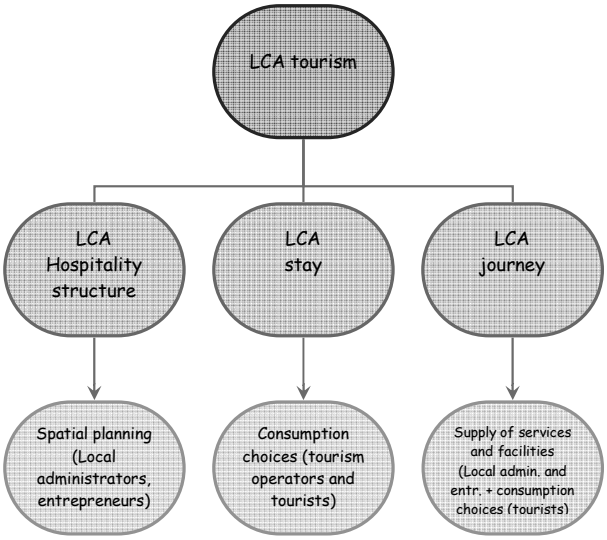

Figure 1: LCA of tourism as a support to decision making processes

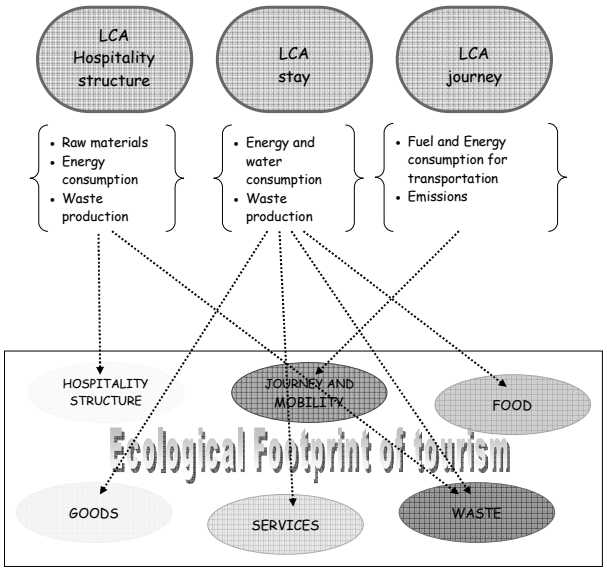

Figure 2: LCA and Ecological Footprint

The second part of the model explores the possibility of integration between LCA and Ecological Footprint of tourism. There are several implementation at local scale of the original model developed by Wackernagel and Rees (Monfreda and Wackernagel, 2004; Wackernagel and Rees, 1998), and some new models developed for the assessing of Ecological Footprint of tourism (see, for instance, Castellani and Sala, 2008, Johnson P.A., 2003); however, the development of equations able to evaluate the footprint of tourism

starting from local tourist data (considering all the possible categories of consumption) represents a challenging task, that have to include necessarily the use of proxy data. For this reason, the definition of LCA studies about the three aspects of tourism activities could be a valuable integration for the existing model, enabling to use more detailed and local data. Starting from these remarks, the second part of the conceptual model identifies the relationship between the three aspects considered for LCA and the categories of consumption included in the Ecological Footprint of tourism method.

Conclusions

Starting from the previous remarks, we highlight the importance of the implementation of LCA to tourism sector and of its integration with methodology regarding Ecological Footprint of tourism, because LCA has valuable potential for the validation of Ecological Footprint methodology and for the development of instruments able to support decision making both for individuals (tourists or tourist operators) and public administrations (e.g. for spatial planning of the destinations). Further development of the research could include widen Life Cycle Analysis of the three aspect of tourism activities (analysis of different kind of accommodation, about the management of the hospitality structures – consumption of resources and energy, waste production, etc); moreover, it would be interesting to integrate LCA and Ecological Footprint referring also to the life cycle of the destination, considering that, emerging and mature destinations can have different situations (e.g. about the level of urbanization, presence of second houses, protected areas etc)

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3.4 Assessing tourism carrying capacity integrating resources' limits and management needs of a tourist system.

(to be published)

Abstract: Tourism sector accounts nowadays for about 10% of world GDP (source: World Travel & Tourism Council – WTTC) and it is widely acknowledged that tourism activities depend highly on the quality of natural resources. Therefore, it is important that tourism planning made by local decision makers is intended to assure a good level of conservation of natural resources and to mitigate the impacts that tourism necessarily entails. The present research focus on the evaluation of sustainability in tourism sector with the aim to develop a method for assessing environmental and managing carrying capacity of tourism destinations, as a tool to analyze the sustainability of the current situation and to determine to which extent a rise in visitors number could affect the quality of the environment, the resources availability and the quality of public services. In literature can be found only few attempts to make carrying capacity concept operational, defining a framework to obtain numerical standards for the destination, as a management tool that enables decision makers to implement the results of the assessment in the planning process; the present study is an attempt to overcome this limit, through the development of a methodology for tourism carrying capacity assessment focussed on environmental and management issues, applied to two tourist areas in northern Italy, which are characterized by the presence of protected areas.

Keywords: tourism carrying capacity, sustainable tourism, tourist management plan

1. Introduction

Tourism sector accounts nowadays for about 10% of world GDP (source: World Travel & Tourism Council – WTTC) and it is widely acknowledged that tourism activities depend highly on the quality of natural resources (see, among others, Inskeep, 1991). Thus, the aim of sustainable tourism development plans, in order to reach sustainable development goals, should be the decoupling of economic growth from natural environment depletion, through the definition of more sustainable patterns of production and consumption in tourism activities, as stated also by international and European resolutions about sustainable development (see, for instance, the Reviewed Strategy for Sustainable Development, the Integrated Product Policy, the Action Plan on the Sustainable Consumption and Production and Sustainable Industrial Policy, the Renewed EU Tourism Policy).

Considering that in order to reach this goal and to set targets for improvement the basic requirement is to investigate the physical and managing limits of the system, carrying capacity evaluation seems to be a useful concept to support the definition of local management strategies and plans for sustainable tourism.

Moreover, sustainable development, and particularly the development and application of indicators able to measure sustainability of specific activities, require a multidisciplinary approach, that allows to obtain results for specific aspects (Farrell et al., 2004). As underlined also by some authors referring to the *triple bottom line* approach (Elkington, 1997; Buckley, 2003), it is necessary to develop new methodologies, able to widen and to integrate analysis in a systemic vision, through instruments that consent to evaluate different aspects in a comprehensive manner. An accurate evaluation of tourism sector, for instance, necessarily involves aspects related to productive activities (production of goods and services for tourists), the construction and management of tourist facilities (hospitality and leisure structures, management of mobility), consumption of resources (energy consumption, water consumption and wastewater treatment, waste management) and the effects of tourism activities on the quality of life of local community (availability of services, crowding, pollution).

Starting from this considerations, the present research focus on the evaluation of sustainability in tourism sector with the aim to develop a method for assessing physical and environmental carrying capacity of tourism destinations, as a tool to analyze the sustainability of the current situation and to determine to which extent a rise in visitors number could affect the quality of the environment, the resources availability and the quality of public services. Final aim of the study is to provide results supported by quantitative data, overcoming the qualitative approach which is quite common in tourism carrying capacity evaluation (Prato, 2001).

2.Tourism and sustainability

Tourism can generate both positive and negative effects on the conditions of the areas where visiting and fruition activities take place: it can be a positive element for the local economy of tourist destinations, but can also generate some externalities (positive or, more frequently, negative) that are not included in the local economic balance and that can affect the quality of visitors' experience (Mathieson, A. and Wall , 1982; Casagrandi and Rinaldi, 2002; Gössling and Hall, 2005; Saarinen, 2006). Therefore, it is important that tourism planning made by local decision makers is intended to assure a good level of conservation of natural resources and to mitigate the impacts that tourism necessarily entails.

If managed in a responsible and sustainable way, tourism can be a motivating force for the conservation of local heritage; on the other hand, if the strategy adopted for tourism development has only the aim to get huge and immediate economic results through the uncontrolled growth of tourist flow, it will lead to a rapid exploitation of the destination, which, after a short period, will become spoilt and no more attractive (Khan, 1998; Manning, 2002).

Impacts related to tourism activities can be divided into two main categories (May, 1991).

a) Impacts due to the building of hospitality structures (hotels, restaurants, camping sites) and the production of goods and services for tourists; they can be summarized in:

- loss of soil previously used for agriculture, pasture or other activities;
- necessity to build new roads to connect new tourist structures or to improve and enlarge existing roads to adequate them to an increased level of traffic. It is important to consider that this kind of impacts is persistent, because tourist structures, often scaled for the wider tourist flow of the destination, stay in the territory, even if almost empty, during the whole year;
- resource consumption and pollution (emissions, waste water and solid waste production).

b) Impacts due to the presence of tourists and, generally, to the fruition of the area.

   The presence of tourists can generate two main kind of problems: the production of solid waste and wastewaters (that imply a cost for the collection and disposal systems, which is paid by the local community and need the organisation of a service of collection scaled to the maximum volume generated during the year, i.e. in the peak of the tourist season); the possibility of conflict between residence and tourists in the use of local resources and services (use of drinkable water and wastewater treatment plants, air pollution, noise pollution, traffic, crowding, etc.). Furthermore, when natural and protected areas are involved, the presence of a high number of visitors can cause disturbance to fauna and flora, especially when visitors are not well informed about the proper conduct to assume in that context.

In addition, it is necessary to consider that the impact generated by tourism activities is strictly dependent on the type of tourism which is predominant in the destination and on tourist behaviour: each tourist visiting the destination generate a different amount of impact (waste production, energy and water consumption, land use, etc) which is dependent on numerous factors, such as the type of activities undertaken during the holiday, the length of stay, etc. Nevertheless, it has to be considered that the type of tourist services available for tourists influence their possibility for adopting sustainable behaviours: tourists make consumption choices which are limited by the effective availability of sustainable products and services and are determined by their environmental consciousness and responsibility. This implies that it is not possible to assess sustainability of a destination in an absolute manner, but it is more useful to define scenarios for the evaluation, considering possible patterns regarding the production (tourism offer) and the consumption (tourism demand) sides.

Moreover, considering that even eco-tourism activities generate, undoubtedly, some impacts on the area where they take place, to assure a sustainable development of the tourism sector it is necessary that the planning of tourism development of a destination takes into consideration the relationship between tourism activities and the local environment (from natural, economic and social points of view). Therefore, it should be based on a robust analysis of environmental, social and economic conditions of the area and on an evaluation of existing physical, economic and social limits to current and potential development of tourist activities, i.e. an assessment of the actual carrying capacity of the destination.

3. Carrying capacity of tourist systems

As illustrated in section 2, tourism, as every kind of human activity, causes changes on environmental conditions; to evaluate consequences of tourism activities impacts is necessary to know the characteristics of the environment where they insist on and especially its resilience, which is the magnitude of disturbance that a system can experience before it shifts into a different state of equilibrium (Holling, 1973). Indeed, carrying capacity concept is linked with resilience and rises from the necessity to measure which is the maximum acceptable level of impact for the environment or for one of its components and the capability of recovery of previous condition. The purpose of the evaluation of carrying capacity of a destination is the measurement of the threshold over which alteration due to human activities becomes unacceptable for the resource recovery.

World Tourism Organization has defined Tourism Carrying Capacity as "the maximum number of persons which could visit a location within a given period, such that local environmental, physical, economic, and socio-cultural characteristics are not compromised, and without reducing tourist satisfaction" (WTO, 1999).

This definition of carrying capacity of a destination led to some attempts to develop quantitative carrying capacity assessment by defining a unique number of tourists which represents the limit beyond which the degradation of the destination occurs (see, among others, Brown *et al*, 1997; Saveriades, 2000).

Nevertheless, this kind of approach highlighted some flaws linked to the concept of tourist carrying capacity intended as a mere application of ecological carrying capacity concept to tourism destinations, some of which were pointed out by McCool and Lime in 2001: 1) tourism destination are complex systems, which include objective (e.g. availability of resources) and subjective variables (e.g. tourist and local community perceptions) (Bimonte and Punzo, 2005); 2) the definition of the maximum number of tourists that can visit the destination without causing permanent damage should entail the possibility to limit to the access to the destination (but this can be true only for a few kind of places – e.g. nature reserves, historical sites –) otherwise it remains only a theoretical exercise, with no operational meaning (Hof and Lime, 1997); 3) the extent of the impacts caused by tourism activities is not uniquely dependent from the number of tourists that visit the area, but also, and maybe in more considerable ways, by their behaviour (Wagar, 1974; Ioannides and Billing, 2005) and by the characteristic of the local offer; 4) tourist destinations don't have a unique carrying capacity, but multiple carrying capacities, determined not only from the availability of natural and physical resources, but also from the characteristics of the management system, from the type of tourism that characterises the area, from stakeholders perception (e.g. perception of crowding) and other local conditions (Ioannides and Billing, 2005). Therefore, some authors (see, for instance, Lindberg *et al*, 1997; McCool and Lime, 2001) suggested a shift from the question "How many is too many" to "How much change from natural conditions are acceptable given the goals and objectives of an area" starting from the Limit of Acceptable Change (LAC) model (Stankey *et al*, 1985). This approach suggests setting the tourism carrying capacity assessment method not only as a scheme aimed to obtain a unique value,

but rather as a framework composed by a set of standards able to quantitatively define acceptable changes (Ahn *et al*, 2002).

In literature can be found only few attempts to make carrying capacity concept operational, defining a framework to obtain numerical standards for the destination, as a management tool that enables decision makers to implement the results of the assessment in the planning process (Huges, 2002; Clivaz *et al*, 2004, Trumbic, 2005). Moreover, there are several models such as Visitor Impact Management (VIM) (Graefe *et al*, 1990), Visitor Experience and Resource Protection (VERP) (US Department of the Interior, 1997) and Tourism Optimization Management Model (TOMM) (Manidis Roberts Consultants, 1997), that, even if represents an attempt to combine scientific expertise and public held knowledge to give a quantitative evaluation of the limits existing to tourism development in the destinations, are more decision-making frameworks rather than scientific theory.

Thus the challenge in tourism carrying capacity research is the definition of a conceptual model that could be applicable to all kind of tourism areas but that allows to select indicators and to define standards that are relevant for each specific destination. As highlighted by the guidelines developed by UNEP - PAP/RAC (1997), a good method for carrying capacity assessment should be able: 1) to consider the priorities of the area under investigation (e.g. involving decision makers and local experts in the definition of indicators and standards at local scale); 2) to identify local constraints to tourism development, balancing the demand of new tourist infrastructures and the necessity to protect local environment, also because it could represent an important factor of attractiveness; 3) to select a set of indicators that can be useful to all tourism sector managers and that can be easily applicable, with well defined sources (i.e. the availability and quality of data should be checked, to assure the possibility of monitoring through time); 4) to define scenarios for the development of the destination.

According to these recommendations, the present study suggests a methodology for tourism carrying capacity assessment focussed on environmental and management issues, applied to two tourist areas in northern Italy, which are characterized by the presence of protected areas.

4. Methodology

The methodology developed for this study is based on an evaluative procedure inspired to DPSIR model (Drivers, Pressures, State, Impacts, Responses), useful to underline which are the drivers of impacts and to define which is the most useful dataset to describe current and future scenarios for the area under investigation. The conceptual model DPSIR, developed by the European Environmental Agency (EEA, 1999), highlights causal links and relationships between human activities, pressures on the environment and impacts on ecosystems and human health. In order to address local policies, the model includes also the responses, i.e. promising measures to reduce the extent of drivers and pressures, improve the state of ecosystems and mitigate impacts. It is possible to identify several kind of responses, involving different actors: planning strategies defined by decision makers, technical solutions (e.g. BAT); education and communication strategies among stakeholders and, finally, the involvement of all local actors in a participatory process, with the aim of defining a commonly shared

planning strategy and of building a network of subjects working on sustainable solutions.

The analysis of tourism sector based on DPSIR model allows to identify the main issues related to tourism activities and to address the definition of a framework for tourism carrying capacity assessment (Table 1 shows an analysis of tourism sector based on DPSIR model).

Table 1: DPSIR model for tourism sector

DRIVERS	Construction and management of hospitality structures and facilities, presence of tourists, road traffic.
PRESSURES	Emissions of air pollutants, use of groundwater resources, emission of pollutants in surface waters, production of solid urban waste, land use and soil erosion, energy consumption, presence of tourists in protected areas.
STATE	Concentration of pollutant in air and water, groundwater availability, quantity of solid urban waste, level of urbanization, level of crowding in natural sites.
IMPACTS	Loss of biodiversity, disturb of wild species, adverse effects on human health.
RESPONSES	Promotion of sustainable tourism: reduction of water and energy consumption, reduction of waste production and increasing of separated waste collection, promotion of public transports, use of renewable energy, promotion of ecotourism activities.

In the conceptual framework presented in this article, main environmental and socio-economic aspects of the area are separately took into account to evaluate tourism carrying capacity of the destination: environmental and managing issues related to daily life of residents and to tourism activities (air quality, water quality and disposability, waste management, land use) are considered and included in the evaluation.

One of the main aim in developing this methodology is the attempt to define thresholds for each indicator composing the framework: indeed, even if the definition of thresholds is necessarily a choice that implies a certain level of subjectivity, the evaluation of indicators becomes meaningless in absence of reference targets and standards. Some authors highlighted the necessity to link indicators to policy standards and targets to strengthen their role in supporting decision makers (see, for instance, Hammond et al, 1995; Pinter et al, 2005); nevertheless, standards derived from professional norms or regulations are frequently non-existent for some topics, so there is the need to find alternative solutions (PAP/RAC, 1997). The methodology presented in this study considers some alternatives for defining reference values when law limits standards are not available: policy targets (e.g. target for recycling of solid urban waste production in European countries), objective physical limits (adopting the precautionary principle, the current structure of the tourism system is taken as a baseline, to ensure that no additional impact is generated through the construction of new tourism infrastructures; thus, there are some physical limits that cannot be overcome, e.g. the number of

beds available in the system, the capacity of wastewater treatment plants, etc.); benchmark values coming from data at national or regional level and values derived from literature (e.g. hospitality density); in addition, when it is not possible to find reference values following the previous methods (e.g. for biodiversity issue, which is quite controversial), the evaluation is made by expert judgement, involving local experts (e.g. park managers), to ensure that indicators (i.e. issues) are not excluded for the evaluation due to methodological problems.

The methodology consists of a preliminary analysis of the area to identify existing data sets and to define the typology of the tourist destination; final aim of this phase is the identification of issues that are more relevant for the development of the tourist destination. Then, for each issue identified, the following steps are implemented:

1. analysis of the issue and characterization of the drivers related to it: identification of activities which are more relevant in local situation;
2. selection of drivers relevant for the issue referring to the tourism system, from the set of drivers identified in step 1;
3. identification of main pressures generated by the selected driver/s.
4. definition of quantitative indicators for identified pressures, to measure the state: in the selection of indicators, priority is given to indicators already existing and commonly implemented for tourism activities analysis and to the availability of data at local scale, to assure the possibility of monitoring results through space (comparison between different destinations) and time (evaluation of trends in the same area); furthermore, for each indicator included in the evaluation scheme, the source of data has to be indicated, to help the collection of updated data in the future;
5. definition of standards for the indicators considering benchmark values, minimum and maximum, for the definition of classes of carrying capacity (high, medium and low) for the result. As explained before, selection of reference values is based on:
    a. standards determined by International, European and National laws or policy targets
    b. physical limits
    c. benchmarking with Regional or National situation
    d. literature
    e. expert judgement (for which the used of standardised method is required, such as Delphi method);
6. collection and processing of local data;
7. evaluation of carrying capacity of the issue, based on benchmarking among considered variables; for the evaluation, precautionary principle is adopted: worst case is taken into account and, if one of the variables is near the limit, low carrying capacity is attributed to the entire issue;
8. responses development: processing of the results to provide descriptive information about local situation to decision makers, with the aim of enabling them to select appropriate short or long term solutions of main problems identified, which can be performed by public and private administrators and by tourists themselves, in a shared responsibility

perspective. The development of responses is part of the process but it stands for a separate stage; indeed, the development of responses is composed by two steps: the first is the identification of possible actions (from technological solutions to communication actions) based on the results of scientific assessment; the second is the policy development, based on a participatory process that should involve all stakeholders, aimed to chose adequate actions providing for each of them objectives and targets. This process encompasses both descriptive scientific assessment and policy making, using scientific results as guidelines for action, bridging the gap between science and policy.

Table 2 shows an example of a detailed scheme, developed for "air" issue in Oltrepo Mantovano area.

DPSIR	**METHODOLOGY**	**LOCAL RESULT**
1) DRIVERS	Analysis of datasets of emissions sources aimed to identify which sources / activities are most relevant in the area object of the investigation.	Analysis of data from Inemar Lombardy Region inventory of emission sources: main drivers for Oltrepo Mantovano are: electric power generation (electric power plants), non industrial combustion (heating) and urban traffic, which cause emissions of PM_{10}, CO_2, COV, NO_x, SO_2 and CO.
2) DRIVERS AND VARIABLES RELEVANT FOR TOURISM SECTOR	From the drivers set identified in step 1, selection of drivers which are most relevant for tourism sector.	The emission source most relevant for tourism sector evaluation in Oltrepo Mantovano is emissions due to road traffic, because electric power generation is an industrial activity, not strictly linked with local consumption and heating becomes not relevant during high tourist seasons (spring-summer).
3) PRESSURES	Selection of main pressures generated by identified driver/s.	Urban traffic generates emissions of $PM_{10,}$ CO, COV and NO_x. Regional Environmental Agency (ARPA) monitoring network registers periodically the values of concentration of $PM_{10,}$ CO and NO_2; data of COV concentrations are not available.
4) INDICATORS	Selection of appropriate indicators to measure state. Indicator used by European and Italian legislation to evaluate air pollution level is the number of daily overcoming of limit concentration during a year.	a) number of overcoming for PM_{10} concentration in Oltrepo Mantovano; limit value: 35 days of overcoming/year. b) number of overcoming for NO_2 concentration in Oltrepo Mantovano; limit value: 35 days of overcoming/year. A limit for CO is not fixed because this pollutant is no longer a problem in Italy.
5) STATE CLASSES	On the basis of indicators and limit identified in the previous step, classes of carrying capacity are fixed.	a) nr of overcoming for PM_{10} <10: HIGH carrying capacity nr of overcoming for PM_{10} =35: LIMIT of carrying capacity nr of overcoming for PM_{10} >35 and < 50.: LOW carrying capacity nr of overcoming for PM_{10} >50: VERY LOW carrying capacity b) nr of overcoming for NO_x <10: HIGH carrying capacity nr of overcoming for NO_x =18: LIMIT of carrying capacity nr of overcoming for NO_x >18 and < 30 LOW carrying capacity

		nr of overcoming for NO_x >30: VERY LOW carrying capacity
6) LOCAL RESULT	Analysis of local data about indicators identified.	nr of overcoming for PM_{10}: 108 nr of overcoming for NO_x: 1
7) CARRYING CAPACITY	Carrying capacity assessment, based on classes identified and data collected; carrying capacity level of the entire compartment is assigned according to precautionary principle.	a) PM_{10}: **VERY LOW** b) NO_x: **HIGH** Carrying capacity of the issue: **VERY LOW**
8) RESPONSES	Processing of the results and discussion among stakeholders to plan responses, based on scientific assessment, that can be included in the local strategy for sustainable tourism development.	To promote public transport and tourist offers for discouraging use of private car by tourists: improvement of existing bike-routes (included in Eurovelo 7 and 8) and establishment of facilities for bikers along the trails (hotel with special services for bikers, renting stations, etc.) to promote bike tourism and to encourage the use of bicycles for local connections).

Table 2: example of assessment for the issue "air" in Oltrepo Mantovano area

5.Areas of study

The methodology developed was implemented in two areas of Lombardy region: Oltrepo Mantovano and Alpi Lepontine Mountain Community (Italian Mountain Communities are administrative cluster of municipalities in mountain areas); the study was performed in order to support this two destinations in the implementation of the European Charter for Sustainable Tourism in Protected Areas (Europarc, 1993).

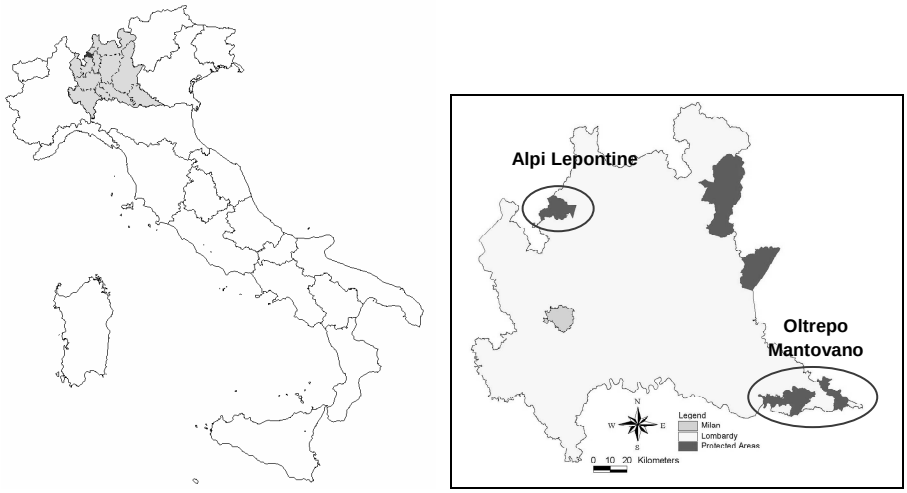
The European Charter is a process promoted by Europarc (the European Federation of Parks), with the aim of ensuring environmental conservation and promoting economic and social development through the definition of a strategy for sustainable tourism development of the area. Assessing carrying capacity in these areas is, thence, an effort to provide a useful tool to decision makers which have to define tourism development policy for future years, aiming to promote sustainable development and to prevent adverse effect on environmental, economic and social system of the destinations.

The protected areas of Alpi Lepontine and Oltrepo Mantovano applied to the European Charter in 2006 and have been awarded with the Charter certificate in 2008; they are now at the second stage of the process, which is the implementation of the strategy and action plan, and that will be followed by an evaluation by Europarc in 2012, necessary to renew the certificate for the following 5 years.

It is interesting to compare tourism carrying capacity assessment in the two areas because, even if they are now involved in the same planning process, they represent two different stages of the life cycle of destination model (Miossec, 1977; Butler, 1980; Agarwal, 1994): Oltrepo Mantovano is a newly emerging destination, not well structured yet, with few tourists arriving in the area; Alpi Lepontine is a more mature destination, even if it shows contrasting aspects (e.g. in the summer season the number of tourist is high in some municipalities near the lakes, but very low or null in mountainous ones).

The case studies show that the evaluation of tourism carrying capacity can support the planning process and provide useful information to decision makers both in case of a newly emerging destination and of a more mature destination: in the first case, it can draw the guidelines for a more conscious planning, helping to prevent overexploitation of resources and rapid decline of the destination; in the second case, carrying capacity assessment can help to evaluate the possibilities of rejuvenation policies (e.g. investments for promoting a new type of tourist for the destination), to avoid the stagnation and decline phases that can occur when the depletion of natural and physical capital of the area make the destination less attractive for new tourists (Prideaux, 2000; Farrell and Twinning-Ward, 2004; Hernandez and Leon, 2007).

Figure 1 – The two areas of study in Lombardy Region, northern Italy



6. Results and discussion

According to our methodology, the first step carried out was a comprehensive analysis of the area, to identify existing data sets and to define the typology of the tourist destination, the general characteristics of the area and its development (Castellani et al., 2007; Trentini et al, 2007). Then, starting from the results of the analysis, main environmental and physical aspects of the area were separately took into account to evaluate tourism carrying capacity of the destination, following the steps illustrated in section 4. Table 3 illustrates the indicators considered for the evaluation in the two destinations and carrying capacity classes defined for each indicator. As explained in section 4, classes of carrying capacity were defined for each indicator, in order to allow the comparison of local results with reference standards and to assess tourism carrying capacity of the destination based on quantitative evaluation. The following paragraphs illustrate more in detail the references considered for the definition of the classes.

For the following issues, classes were defined referring to law limits and policy targets:

- Quality of fresh waters – People served by wastewater treatment plants, Ecological state of fresh waters and ecological condition of lakes: 2000/60/EC, "Water framework Directive";
- Waste management – Separate waste collection: Regional Law 26/2003 (that defines the target of 40% by 2010 for separate waste collection);
- Waste management – Per capita daily production: classes defined considering the average urban solid waste production per capita in Europe (about 600 kg/d per capita in 2008) and the target of the European Campaign for Waste Reduction, which is 100 kg/d per capita.
- Air quality: 96/62/EC, "Air quality framework Directive".

Classes defined with reference to physical limits of the system includes:

- Drinking water supply and consumption – Ratio between abstraction and recharge
- Quality of fresh water – designed capacity/actual capacity used;
- Quality of fresh water – capacity of wastewater treatment plants;
- Waste management – residual capacity of waste collection system.

Benchmark values coming from data at national or regional level and values derived from literature were used to define classes for the following indicators:

- Drinking water supply and consumption – Water balance: the classes are defined considering the Water Exploitation Index (WEI) and its warning threshold of 20%, which distinguishes a non-stressed from a stressed region, while a threshold of 40% identifies a region where severe stress occurs (source: EEA, Europe's environment, fourth assessment, 2007);
- Drinking water supply and consumption – daily consumption: classes defined considering that the average domestic water consumption in Europe is around 150-200 L/d per capita, while a tourist can consume on average 300 L/day (source: Freshwater in Europe - Facts, Figures and Maps, UNEP/DEWA, 2004);
- Energy consumption: comparison with national average of energy consumption;
- Land use - Hospitality density: EEA classification in "Indicator Fact Sheet Signals 2001 – Chapter Tourism", 2001;
- Land use - Tourist buildings, a and b: classes defined on the basis of the situation existing in some of the major tourism destination in the Italy; (under 20% of second houses in low density destinations, over 80% in high density destinations such as Alpine sky areas; source: Dossier about second houses in the Alps by Legambiente (2009) and 3rd report about the state of the Alps by CIPRA (2008);
- Land use - Daily visitors: estimation based on previous studies about the impacts generated by residential tourists and visitors;
- Use of tourist structures: classes defined considering the average occupancy rate in Italy (which is around 30%; source: Eurostat, 2008);
- Mobility - ratio of tourists reaching the destination by private car: classes defined starting from European figures about car use for tourist

purposes (61% of tourist travel by road, source: EEA, Europe's environment, third assessment, 2003);

- Mobility – nr of cars in the area/residents: classes defined considering the average car ownership in Europe-15 (0,50 passenger cars/inhabitant; source: Eurostat, year 2006);
- Mobility – nr of vehicles in tourist peak season: the classes has been defined considering a monitoring study performed by the Province of Parma about the traffic in some roads which are similar to the ones in the two destination considered ("Analisi sui flussi di traffico in provincia di Parma", Province of Parma, 2001);
- Tourism intensity: the classes are defined considering that the two destination under evaluation are nature-based destinations, that cannot afford to sustain high levels of tourists intensity (high density destinations in the Alps have currently a level of tourist intensity around 8, while international mass tourism seaside resorts, such as the Balearic island, can reach a peak level of tourist intensity of 50).

Finally, expert judgement from local experts helped to evaluate carrying capacity of issues for which it was not possible to identify suitable carrying capacity classes:

- Biodiversity – loss of species, disturb caused by tourism activities
- Land use – crowding of natural sites and paths.

Table 3: Indicators selected for Tourism Carrying Capacity assessment

Indicator	**State - classes [2]**		**Indicator**	**State - classes [1]**	
Drinking water supply and consumption			**Biodiversity**		
1. water balance (WEI: consumption / availability) (L*residents^{-1}*d^{-1}) /(L*residents^{-1}*d^{-1})	H	WEI < 20%	**13. loss of species, disturb** (total nr of visitors in protected areas*year^{-1})	no classes, expert judgement	
	M	20%<WEI<40 %			
	L	WEI > 40%			
2. daily consumption (L*residents^{-1}*d^{-1})	H	< 150 L*res^{-1}	**Land use**		
	M	150-250 L*res^{-1}	**14. hospitality density** (beds*1000 residents^{-1})	H	0-100
	L	> 250 L*res^{-1}		M	10-300
3. withdrawal / recharge of ground water (m^3*d^{-1})/(m^3*d^{-1})	H	< 1		L	> 300
	M	= 1	**15a. tourist buildings** (non-hotel structures/total hospitality structures)	H	> 20%
	L	> 1		M	10%-20%
Quality of fresh water				L	< 10%
4. people served by water purifier (people served*people resident^{-1}) *100	H	100%-75%	**15b. tourist buildings** (houses not used by residents/total nr of houses)	H	< 20%
	M	74%-50%		M	20%-50%
	L	< 50%		L	> 50%
5. potential P.E./actual P.E.	H	> 1	**16. crowding of natural sites and paths**	no classes, expert judgement	
	M	= 1	**17. daily visitors** (V = nr daily visitors	H	V < 1
	L	< 1		M	1 < V < 2

2 Classes: H = high c. capacity; M = medium c. capacity; L = low c. capacity; LL = very low c. capacity.

6. ecological state of fresh water (LIM index)	H	optimal, good	/ nr resident tourists)	L	V > 2
	M	sufficient	**Economic efficiency of tourism sector**		
	L	bad, poor	**18. use of tourist structures** [(overnights*beds^{-1})*365]*100	H	< 20%
7. ecological state of lakes (correspondence to natural condition)	H	current state = natural state		M	20% - 40%
	L	current state ≠ natural state		L	> 40%
Energy consumption			**Mobility**		
8. local energy consumption/national mean energy consumption (MWh*residents^{-1}) / (MWh*residents^{-1})	H	< 1	**19. % of tourists reaching the destination by private car**	H	< 40%
	M	= 1		M	40%-70%
	L	> 1		L	> 70%
Waste management			**20. nr of cars in the area/residents**	H	0-0,3
9. per capita daily production (kg* residents^{-1}*d^{-1})	H	0,27 Kg*res^{-1}*d^{-1}		M	0,3-0,5
	M	0,28 – 1 Kg*res^{-1}*d^{-1}		L	0,5-0,8
	L	> 1Kg*res^{-1}*d^{-1}	**21. railway service** (nr of municipalities with railway station/total nr of municipalities)	H	0,8-1
10. residual capacity of waste collection system (C = volume of waste collected daily/ volume of waste collectable daily)	H	C < 0,7		M	0,4-0,7
	L	0,7<C<1		L	0-0,3
11. % Separate waste collection	H	> 45%	**22. nr of vehicles in tourist season** (nr vehicles*peak hour^{1})	H	< 100
	M	35-45%		M	100-300
	L	< 35%		L	> 300
Air quality			**Tourism intensity**		
12. nr of days exceeding law limits per year	Law limits: 35 days of exceeding/year $PM_{10,}$ 18 exceeding/year NO_2		**23. tourist intensity in high season** I = (overnights high season*d^{-1})*residents^{-1}	H	I < 0,5
				M	0,5 < I < 1
				L	I > 2

The application of the methodology to the two areas under investigation provided an overall evaluation of tourism carrying capacity of the two destinations. Table 4 compares the results for Alpi Lepontine and Oltrepo Mantovano (data refer to year 2005). The table of results contains also some issues for which local value and carrying capacity score are not mentioned: they were included in the model because emerged as relevant ones according to the DPSIR evaluation, but it was not possible to evaluate carrying capacity for them, because of the lack of available data at local level. The choice of including these issues in the results arises from the consciousness that there is the risk to "measure what is measurable rather than what is important" (highlighted also by White et al in their review about sustainable indicators for tourism, 2006), providing misleading information to decision makers. On the contrary, our aim was to make decision makers aware about the importance of these topics and the necessity to deepen the current investigation and to provide a collection of data about them.

The analysis of results enables researchers and decision makers to comprehensively evaluate the tourist carrying capacity of each area and then to compare carrying capacity of a newly emerging destination (Oltrepo Mantovano) with carrying capacity of a more mature one (Alpi Lepontine). This difference is underlined also by the ratio of employees involved in tourism activities: the comparison between the value for Alpi Lepontine (13%

in 2005, according to the Regional Statistic Office data) with the value for Oltrepo Mantovano (3% in 2005, according to the Regional Statistic Office data) shows as in the first area tourism is already an important activity for local economy, while in the second one is still a marginal activity. Also the differences about land use are representative of the different level of development of the two areas: the hospitality density in Alpi Lepontine is considerably higher than in Oltrepo Mantovano, while the difference in the ratio of houses not used by residents (considered as a proxy for the number of second houses, which are not officially recorded) is negligible. Nevertheless, the value of "tourist intensity" puts Alpi Lepontine in the high class of tourism carrying capacity; though it has to be underlined also that the indicator considers the whole area, creating a compensation between the municipalities near the lakes, which have an higher tourist intensity, and the mountainous ones, where the intensity is very low. Therefore, to have a more precise and useful information, it could be necessary to deepen the investigation at the municipality level.

The analysis of tourism carrying capacity about natural resources and infrastructures allows to evaluate the possibility of development of the destinations for the future; the evaluation is made considering the capacity of the current system of facilities and infrastructures, in the perspective of avoiding new buildings (i.e. excessive urbanization and land use). Data about water availability and consumption, even if not complete, show a problem about abstraction from groundwater sources in Oltrepo Mantovano: the situation is already unsustainable, and could be worsened by an increase in the number of tourists visiting the area; in Alpi Lepontine, instead, there is a problem about the capacity of wastewater treatment plants, which are already near their capacity limit and would not be able to assure continuity and quality of the service if the volume of water to be treated will increase (e.g. in case of an increase in the number of tourists).

Another critical issue in Alpi Lepontine is the separate waste collection system, that includes only 12,4% of the total amount of waste generated in the area: this value is lower than 35%, which was the minimum ratio that was fixed by European and national regulations as a target for 2003 and could be a serious problem, especially in summer season, when the presence of lot of visitors causes a growth in the volume of waste to be collected and processed.

Mobility is a problem for both the destinations, firstly because the number of cars owned by residents is high and, secondly, because, due to the scarcity and the inefficiency of public transport services, most of the tourists reach the areas by their private cars; this situation affect the quality of the tourist experience and the quality of life for residents, causing congestion of the streets, noise (that could disturb especially protected areas) and, in Oltrepo Mantovano, high level of air pollution.

From the methodological point of view Moreover, the most critical issues to be evaluated for tourism carrying capacity assessment seem to be water availability and energy consumption, for which there is a lack of data in Italian statistic dataset at local level, and the impacts on biodiversity. Data of local energy consumption available in Italy refers to 1997, because it is the last year of national management of energy market: from 1998 in Italy there are various energy supplier, so the collection of data is now very difficult and a detailed national dataset on consumption is no more available.

Besides, measuring impact of tourism activities on biodiversity requires specific study on the areas under investigation, because every situation has specific characteristics. The assessment of loss of biodiversity due to tourism activities requires to define a representative species for each kind of impact, considering a multiple stress condition. These information is not yet available, so periodical detailed monitoring campaign on flora and fauna of protected areas should be promoted in order to have reliable data sets at national and local level and investigation on number and characteristic of tourists should be carried out to obtain more data useful to measure the disturb caused by tourism activities and to assess carrying capacity of the areas.

Table 4: results of Tourism Carrying Capacity evaluation in Alpi Lepontine and Oltrepo Mantovano

Indicator	**Oltrepo Mantovano**		**Alpi Lepontine**		**Source of data**
	Value	**Carrying capacity**	**Value**	**Carrying capacity**	
1 water balance (consumption / availability)	n.a.	--.	n.a..	--.	
2. daily consumption	280,2	L	229,3	M.	ISTAT, National Statistic Institute (1999)
3. withdrawal / recharge of ground water	1,3	L	n.a.	--.	Lombardy Region
4. people served by water purifier	75%	H	95%	H	Local water resources plan
5. potential P.E. / actual P.E.	>1	H	1	M	Local water resources plan
6. ecological state of fresh water (LIM index)	sufficient	M	Good	H	Province authority
7. trophic state of lakes	Not applicable (there are no lakes)	--	current state ≠ natural state	L	Province authority
8. mean energy consumption in municipalities / national mean energy consumption	0,8	H	1,4	L	Terna - owner of the National high-voltage Electricity Transmission Grid (2003)
9. per capita daily production of waste	1,6	H	1,1	H	Provincial waste monitoring office
10. residual capacity of waste collection system	n.a.	--.	n.a.	--.	
11. % Separate waste collection	39,8%	M	12,4%	LL	Provincial waste monitoring office
12. nr of days exceeding law limits per year	PM_{10}: 108 NO_x: 1	LL	PM_{10}: 0 NO_x: 0	H	ARPA (Regional Agency for env. protection)
13 loss of species, disturb	4.000-5.000	H	"Area rilev. Amb": 4.000-5.000	H	Local experts
			"Riserva Lago di Piano": > 50.000	LL	Local experts

14. hospitality density	13,7	H	419,0	L	Provincial tourism office, ISTAT
15a. tourist buildings	54%	H	60%	H	ISTAT
15b. tourist buildings	8%	H	29%	M	ISTAT
16. crowding of natural sites and paths	low	H	Low	H	Local experts
17. daily visitors	>2	L	n.a.	--.	Local experts
18. use of tourist structures	30,7%	M	7,5%	L	Provincial tourism office
19. % of tourists reaching the destination by private car	>70%	L	>70%	L	Survey
20. nr of cars in the area / residents	0,6	L	0,6	L	ISTAT
21. railway service	0,6	M	0	L	Ministry of Transports
22. nr of vehicles in tourist season	n.a.	--	360	L	Estimation
23. tourist intensity in high season	$0,2*10^{-3}$	H	0,1	H	Provincial tourism office

Even if not completely exhaustive, the results of tourist carrying capacity assessment allow for a comprehensive evaluation of the situation in the destinations and are useful for underlying critical issues to be considered for the definition of policies for sustainable tourism in the areas.

Results of carrying capacity assessment were opened to feedback from the stakeholders: they were presented in a forum consultation involving decision makers, tourism operators and residents and were taken as the basis upon which some responses to the main problems identified were planned; the responses, commonly shared by local administrators, local stakeholders and experts, compose the Action Plan included in the "Strategy for sustainable tourism" presented at the end of the first phase of the implementation of European Charter for Sustainable Tourism in Protected Areas process (Tarelli et al, 2008, Trentini et al, 2008).

The identification of responses for issues, including those which have currently a good carrying capacity score was carried out in order to prevent possible damages coming from an excessive and uncontrolled tourist development and to address the planning of the entire sector towards sustainability. Clearly, actions developed to be included in a tourist management plan cannot address all the drivers that influence the state of the environment in the destination (e.g. energy generation in Oltrepo Mantovano area): the tourism carrying capacity assessment is intended to support the development of sustainable tourism activities, in order to decouple economic growth of tourism sector from its impact on natural environment in the destination.

7. Conclusions

The most critical aspect associated with carrying capacity assessment of tourism destination is the complexity of making carrying capacity concept operational and of providing quantitative results, compared to established thresholds. The present study represents an attempt to quantify the current state of every compartment involved in tourism management and to give a

quantity perspective on present and future scenarios of destination development, with the aim to address future policies for sustainable tourism.

The application of the methodology to two destinations in northern Italy highlighted some critical aspects, that should be further considered for research; the following paragraph lists some reflections about them:

- there is the need to define thresholds of sustainability to be able to evaluate the results of the indicators selected for the assessment, even if in some cases (e.g. when commonly recognized values are not available), it could entail a certain degree of subjectivity;
- in the definition of thresholds, a good solution seems to be the use of law limits, but these are not available for all issues, so further research is required, especially in the field of ecologic issues (e.g. biodiversity);
- the integration between physical carrying capacity and managing carrying capacity supports decision makers in the planning process, providing useful information about the interaction between physical limits determined by the characteristics of the natural environment and limits of the existing structure of the local tourism system (e.g. the number of beds or the capacity of local wastewater treatment plants) that can influence the feasibility of some responses;

The choice of not aggregating the indicators to compose a final index of tourism carrying capacity of the area comes from the consciousness that it is not feasible (nor useful) to set a limit to the tourists number (due also to the fact that not every tourist determines the same impact, see sections 2 and 3.) and that having a set of information about single issues, to be considered in a comprehensive manner, helps to avoid compensation between different aspects. For instance, considering the indicator “Economic efficiency of tourist structures”, it could be argued that increasing the number of beds in the destination (i.e. increasing the number of tourists that can be accommodated) could be a good solution to improve the performance of the system (because it would lead to an increase in carrying capacity in that issue) but, if we consider also the other aspects, such as “Land use” or “Waste management”, it becomes evident that increasing the number of beds would increase the pressure due other issues, i.e. reduce the carrying capacity of the system.

Moreover, to evaluate the effectiveness of the policies for development that are defined starting from the results of sustainability evaluation, it could be interesting to extend the assessment of tourism carrying capacity trough time, to have a multi-year period of evaluation. Finally, further development of the research could refer to the development of scenarios considering what the situation would be according to existing plans for development in the areas under investigation (e.g. the local structure plan).

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3.5 Ecological Footprint: a way to assess impact of tourists' choices at local scale

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V.Castellani, S. Sala

Abstract

Ecological footprint (EF) is a method developed to assess the sustainability of different consumption patterns and to address human choice in the daily life. Considering that different kind of tourism can have different impact on the environment (due, for instance, to energy consumption or to the extension of built-up land), there is the need of development of valuable tool to compare sustainability of different issues related to tourism. In this study, EF method was fitted to Italian situation and to an assessment of potential impact of tourism at local scale, underlining how tourists' choice could affect the quality of the environment in a tourist destination. The presented case study consists in the development of a framework, based on EF method, to assess the ecological costs of different kind of holiday, related also with accommodation type chosen by tourists. Through model implementation, it is possible to calculate the EF of one overnight of staying for each kind of accommodation. The model was applied to a specific destination in Italy, Alpi Lepontine, to assess EF of tourism in this area, and to evaluate sustainability of the destination, comparing EF of tourists and residents with local biocapacity. Aim of the study is to evaluate the current situation, and to identify solutions that assure the development of tourist with fewer environmental costs (e.g. network of small hospitality structures, sustainable mobility).The results of this work represent not only a supportive information for decision makers but also a useful tool to raise environmental consciousness among tourists.

Keywords: Ecological footprint, sustainable tourism, tourist impact, accommodation impact

Introduction

Tourist activities can be a positive element for the local economy of tourist destinations, but can also generate some externalities (positive or, more frequently, negative) that are not included in the economic balance. The impact which is more evident is the one on natural environment, but there are also some possible effects on social and economic dynamics of local community that have to be considered in a sustainable vision. Therefore, it is important that tourism planning made by local decision makers is intended to assure a good level of conservation of natural resources and to mitigate the impacts that tourism necessarily involves. If managed in a responsible and sustainable way, tourism can be a motivating force to the conservation of local heritage; on the other hand, if the strategy adopted for tourism development has only the aim to get huge and immediate economic results through the uncontrolled growth of tourist flow, this will bring to a rapid exploitation of the destination, which, after a short period, will become spoilt and no more attractive.

Impacts related to tourism activities can be divided into two main categories (May [4]).

a) impacts due to the building of hospitality structures and tourism facilities;

b) impacts due to the presence of tourists and, generally, to the fruition of the area.

   a) The first class consists of all impacts due to the building of hotels, restaurants, camping sites and tourist facilities, that can be summarized as: loss of soil previously used for agriculture, pasture or other activities; necessity to build new roads to connect new tourist structures or to improve and enlarge existing roads to adequate them to an increased level of traffic. It is important to consider that this kind of impacts is persistent, because tourist structures, often scaled for the wider tourist flow of the destination, stay in the territory, even if almost empty, during the whole year.

   b) The presence of tourists can generate two main kind of problems: the production of solid and liquid wastes (that imply a cost for the disposal which is paid by the local community and need the organisation of a service of collection dimensioned with reference to the maximum volume generated during the year, i.e. in the tourist season); the possibility of conflict between residence and tourists in the use of local resources and services (use of drinkable water and treatment of wastewater, air pollution, noise pollution, traffic, crowding, etc.)

Thence, to assure a sustainable development of the tourism sector, it is important that the planning of tourism offer of a destination is based on a robust analysis of environmental, social and economic conditions of the area and of current and potential impact of tourist activities, in comparison with the carrying capacity of the destination.

According to this purpose, the assessment of the EF of tourists and of the biocapacity of the area represent an attempt to provide a supporting tool to decision makers, with the aim to address tourism strategies for the future development of destination in a more sustainable way. Moreover, the aim of the present study is to analyze the impact of tourism on a destination, and to compare the sustainability of different kind of holiday (due, for instance, to energy consumption or to the extension of built-up land), to evaluate the current situation, and to identify solutions that assure the development of tourist with fewer environmental costs.

Methodology

Ecological footprint (EF) method was developed in the first '90s by the ecologist William Rees from the British Columbia University, and then deepened and applied by Mathis Wackernagel [7], from Ecological Footprint Network. EF is an aggregated index that correlates the life-style of a population with the amount of natural resources needed to support it (the "life-supporting natural capital"). It is an indicator based on a basic concept, which is highly communicative because this relationship is measured by a quite simple parameter: the extent of the natural bioproductive area (measured in hectares per capita) needed to satisfy the consumption and to

absorb the waste of a population. The assessment of EF is based on an evaluation of consumption, clustered in five components: food, housing, transportation, goods and services. Any of these component is responsible of an EF, which is measured in a specific unit of measure that is equal to one hectare of the mean productivity of the earth. The EF is the sum of six different kind of land: Cropland, Pasture, Forest, Fisheries, Energy land, Built-up land. To determine if the EF of a community is sustainable or not, it is necessary to compare local extension of bioproductive land (biocapacity) with local demand of land (EF), defining an environmental balance of the local system. Assuming that to be sustainable a system has to be self-sustaining, the amount of deficit or overshoot of natural resources emerging from the environmental balance represents an estimation of the level of sustainability of the area considered.

Ecological footprint of tourism

Assessing EF of tourism enable to evaluate the overall impacts of an holiday, involving not only the impacts due to the stay in an hospitality structure, but also, for instance, the impacts due to the trip form home to the destination and back.

There are two main accounting methods for EF assessment (Monfreda et al. [5], Wackernagel et al. [8], Lewan et al. [3]):

- the compound model ("top-down" approach): the assessment is based on the sum of EF of the consumption of an area (estimated using the aggregate national data about production and trade);
- the component model ("bottom-up" approach): the assessment is based on the sum of EF of all relevant components of a population's resource consumption and waste production.

The second one is considered a more comprehensive and robust approach because the components of consumption of the community are considered in a whole and double counting is avoided. Nevertheless, is not possible to apply this method for the assessment of EF of a tourism destination because it is a peculiar system, for which is not possible to obtain aggregate data. For this reason, in the present study the component model is applied: consumption of every single person is estimated, considering the sum of all relevant components of consumption, and then EF of the area is evaluated, multiplying this value for the overall number of person in the area (residents and tourists).

The phases of the evaluation are:

1. Assessment of EF of residents.
2. Assessment of EF of tourists.
3. Assessment of biocapacity of the area.
4. Comparison between the sum of EF of residents plus EF of tourists and local biocapacity, to evaluate sustainability of the area.

Previous assessment of EF according to the component model utilized the spreadsheet "Household Ecological Footprint Calculator", v. 3.2, 2003, developed by Redefining Progress (see, for example, Johnson [2]). In this study, the spreadsheet, developed for a Canadian assessment, was fitted to Italian situation and to an assessment of potential impact of tourism at local

scale, to highlight how tourists' choice could affect the quality of the environment in a tourist destination. Thence, some standards about local situation contained in the equations of the model were modified and new values from literature and statistical data on Italian situation were introduced (e.g. mean size and age of houses, characteristics of roads and railways, etc.), to develop a spreadsheet useful to assess EF in a local area in Italy.

Furthermore, each item of the spreadsheet was associated with an item of official Italian statistical data, to assure the complete repeatability of the evaluation. Afterwards, starting from the result of the previous phase, the spreadsheet was further modified, to be adjusted to the consumption of a tourist during his holiday (trip, stay, food, excursions, etc.): some items that were not relevant for tourism activities were removed (e.g. goods and services not directly related with tourism) and then the model was modified to allow the evaluation of different kind of holidays.

The research about methodology lead to the development of:

a. A model to assess EF of Italian residents at local scale
b. A model to assess EF of tourists according to the kind of accommodation they choose for their holiday. This model is composed by the following sections:
    - EF of trip depending on the mean of transport chosen (plane, car, motorbike, train, bus, bicycle)
    - EF of one night spent in a 1*-2* hotel
    - EF of one night spent in a 3* hotel
    - EF of one night spent in a 4* hotel
    - EF of one night spent in an camping site
    - EF of one night spent in an agritourism
    - EF of one night spent in an B&B
    - EF of one night spent in a second house of property or rented
    - Total EF of the holiday (EF of accommodation * nr of nights + EF of the trip)

Biocapacity

To evaluate the result of EF assessment of a specific area, it is necessary to compare this value, representing the human demand of nature for that area, with the amount of natural capital stock that the area can supply. In this perspective, local biocapacity represents the reference value to determine if human consumption is in a condition of deficit or overshoot in comparison with natural resources availability.

Biocapacity of the area is evaluated assigning factors of bioproductivity (equivalence factors) to every type of land. The first step in the evaluation of biocapacity at local scale is, then, the comparison between the classes of soil use available in local classification (in this case, the DUSAF database by Lombardy Region) with the six classes of land defined by the model developed by Redefining Progress. The result of this comparison is summarized in Table 1

Table 1 - Comparison between land classes in Ecological footprint model and in DUSAF database

Land in Ecological Footprint model		**DUSAF classes of land use**	**Equivalence factor**
Energy land and forest		Natural vegetation, woodland, woody plants	1,34
Pasture		Pasture and meadows	0,49
Cropland	primary	land under cultivation (arable crops, orchards, vineyards, horticultural land)	2,21
	marginal	Uncultivated land	1,79
Built up land		serviced and infrastructured land, urban decay, mining land	2,21
Fisheries		Lakes, basins, river beds e artificial watercourse	0,36
		infertile soil, sandy lands, gravelly soil, beaches, detritical deposits, rocky outcrop without plant cover	0,00

The last class in the table ("non productive land") is an integration in respect to the model developed by Redefining Progress: some classes of land use in DUSAF database have no correspondence with land classification in EF model and, moreover, they have a productivity equal to 0. For this reason, this new class was created, with an equivalence factor equal to 0. Assigning equivalence factors to the areas included in the respective DUSAF classes associated in the table, it is possible to estimate total biocapacity (expressed in global hectares or global square meters[3]) of the area considered. Comparing EF of tourists and residents with local biocapacity enables to assess the impact of tourism in this area in relation with local resources, and to evaluate the sustainability of the destination.

Finally, the results of every single evaluation of EF of tourist in every hospitality structure is summed up to assess the total EF of tourism in Alpi Lepontine and, then, this last result was added to the value of EF of residents to be compared with local biocapacity.

The EF of tourism was calculated with the following equation:

$$\sum_i (EF_i * O_i) + (EF_t * T) \qquad (1)$$

EF_i = EF of an overnight spent in the *i* type of hospitality structure

3 Every kind of land has a different bioproductivity. To have EF results expressed in a unique measure – the global hectare – the model normalizes the values of bioproductivity of the areas in different nations and of different kind of land.

O_i = number of overnights per year spent in the *i* kind of structure in the area considered

EF_t = mean EF of trip to Alpi Lepontine (forward and back) per tourist

T = total number of tourist in the destination in the considered year

Area of study

The destination object of the study is Alpi Lepontine Mountain Community4, which is an area in Lombardy Region, in Northern Italy, near Switzerland. Alpi Lepontine represents an interesting situation because it has undertaken the process of European Charter for Sustainable Tourism in Protected Areas promoted by Europarc (European Federation of Parks), to promote sustainable tourism. In this context, the evaluation of EF of tourism in the area and the assessment of the ecological deficit or overshoot of the whole area is an attempt to provide a valuable tool for policy makers to set targets for sustainable policies of development and to verify the ecological implications of policy choices.

There are also some specific characteristics of Alpi Lepontine that identify this destination as an interesting area for EF evaluation: first, the problem of soil exploitation and excessive urbanization, underlined as a crucial alarm by both residents and tourists (Castellani et al. [1], Tarelli et al. [6]), suggest the importance of an indicator that emphasizes the necessity of bioproductive land to support human consumption of goods and services; secondly, a questionnaire survey among tourists highlighted the importance of nature, and especially protected areas, as a key resource and a key factor of attraction for this destination: the presence of tourist that are more "environmentally friendly" represents a solid base for a communication campaign, based on EF results, to address tourist choices (e.g. kind of accommodation, mean of transport, etc.) towards a more sustainable behaviour.

Results and discussion

The main results of the implementation in Alpi Lepontine area are summarized in Table 2.

Table 2: Main results of EF and biocapacity assessment in Alpi Lepontine (gha/year)

Biocapacity	**EF of residents**	**EF of tourists**	**EF residents + EF tourists**
3.693	78989	18684	97673

As it is shown in Table 2, EF of Alpi Lepontine largely exceeds the biocapacity of the area, highlighting a deficit between human demand of nature and natural stock: it means that Alpi Lepontine area would not be

[4] Italian Mountain Communities are administrative cluster of municipalities in mountain areas

able to support its level of consumption without depending on external resources. Although EF of tourists is quite large, it is still smaller than the footprint of residents, therefore the action toward sustainability should involve both tourism and local activities.

Comparing the daily footprint of residents and the daily footprint of tourists, it is possible to notice that even the smallest footprint of a tourist (551 gm^2/day) is higher than the resident's one (103 gm^2/day): it depend on the fact that the impact of hospitality structures derives from the number of beds the structure can offer but the number of tourists effectively present during a single day, especially in non tourist season, is rarely equal to the maximum; on the other hand, the impact of a house of property has to be divided for the number of people living in that house, which is often proportional to the house size. In addition, hospitality structures remain on the territory for the whole year, but the presence of tourists is often condensed only in some period of the year, so the territory has a benefit from them only for a part of the year, but their footprint stays for the whole year.

Table 3 - EF of an overnight spent in different kind of accommodation (gm^2/day)

	ACCOMMODATION						
FOOTPRINT [gm2]	H. 1*-2 *	H. 3*	H. 4*	Second house	Agritourism	B&B	Camping site
FOOD	0,36	0,36	0,36	0,36	0,36	0,36	0,36
HOUSING	24,78	59,21	597,22	197,00	36,83	15,67	1248,89
LOCAL TRANSPORT.	9,98	9,98	9,98	9,98	9,98	9,98	9,98
GOODS	1,56	1,56	1,56	1,56	1,56	1,56	1,47
SERVICES	516,99	516,99	516,99	516,99	516,99	516,99	0,00
WASTE	7,15	7,15	7,15	7,15	7,15	7,15	7,15
TOTAL EF	**560,82**	**595,25**	**1133,25**	**733,04**	**572,87**	**551,70**	**1267,85**

Table 3 shows the results of the footprint assessment for a night spent in different kind of accommodation that can be chosen by Alpi Lepontine tourists: 1*-2* hotel, 3* hotel, 4* hotel, camping site, agritourism, B&B and second houses. The accommodation that assure the smallest EF is B&B, while the biggest footprint comes from a night spent in a camping site (especially because of the footprint by housing, as explained further in the paragraph) and 4* hotel (especially because of energy consumption for services).

The analysis of the single components of the footprint, highlights that housing is the most relevant component that discriminate footprint of different kind of accommodation: once more, camping site and 4*hotel are the most expensive accommodation according to this parameter. In camping sites the footprint of housing is highly related to the soil use ("built-up" land) but it has to be considered that this land, although no more bioproductive (e.g. not available for agriculture or pasture), is not entirely built-up and can still provide some ecological functions (e.g. water runoff, carbon absorption or recreational use); regarding 4* hotels, the main contribute to footprint comes from energy consumption.

Indeed, a focus on the single items of footprint in the component "housing" highlights that energy consumption rises in hotel and non hotel structures as the level of services increase (form B&B to 4* hotel); the only exception is the second house, because of the high amount of energy necessary to create building materials, and especially cement, for a structure which is often similar to the size of a 1*-2* hotel, but is used only by few people and for a shorter period. To reduce the impact of this kind of hospitality structure, it would be useful to promote the use of these houses as guest accommodation.

Table 4 - EF on energy land by housing component in different structures

HOSPITALITY STRUCTURE	HOUSING - ENERGY [gm2]
Bed&Breakfast	12,06
Agritourism	13,53
Camping site	14,91
Hotel 1 - 2 *	15,74
Hotel 3 *	32,09
Hotel 4 *	66,34
Second house	186,72

It is not possible to compare the footprint of food because, due to the non availability of specific data on food consumption (e.g. from specific questionnaires on the territory), the input values for food consumption are the same for the whole study (both for residents and tourists) and are obtained from national statistics on food consumption.

The footprint of goods is similar in all structures except from camping site, because this item depends mainly on the footprint of furniture of the bedroom, which is quite similar in all kind of hotel bedrooms (especially because Italian law gives some standard rules about the furniture in hotel rooms) and it is not present in a camping site.

As for goods, also the footprint of services is quite similar in the hotel and non-hotel structures, except for camping site. This difference is due to the fact that the model developed includes three kind of services in the footprint calculation (wastewater disposal, laundry and phone services) but data were available only for one of them, the laundry service, which is often self-organized by tourists in the camping site, and can't be considered a structured service, used by all the tourists. It is important to notice that in hotel structures (and often in agritourism) the laundry service could concern also the restaurant (not only the lining for the bedrooms), but in many cases the restaurant is not only dedicated to resident tourist, so it would be difficult to identify the footprint of this service for each resident tourist; for this reason, the footprint of laundry service is calculated only for the lining of the bedrooms.

As for food consumption, there are not available detailed data about waste production in different kind of accommodation, so in this study the amount of waste for every single night spent in an hospitality structure was considered equal to the amount of waste produced by a local resident during one day. It is of course a significant approximation, because every kind of

accommodation has different services and different management, so for future studies it would be very interesting to deepen the analysis on this topic, trying to define a specific relation between the type of accommodation chosen by tourists and the amount of waste generated per tourist.

EF of local mobility, due for instance to daily excursions, is evaluated on the basis of a local survey about tourists behaviour, and is therefore the same for every type of accommodation.

The assessment of EF of the component "transportation", which consist of the trip from home to the destination and back (the local transfer by tourists is included in the daily footprint), was developed separately from the assessment about accommodation, because this two kind of choices are independent. Considering that the EF of a trip depends on the distance of the starting point from Alpi Lepontine, which is different for every tourist, a mean value per tourist was calculated, based on a weighted distance estimated from statistic tourist data (number of tourist from every region and country) and on a percentage distribution of mean of transport use (investigated by specific questionnaires and analysis).

Conclusions

Ecological footprint methodology application could be useful to understanding the impact of several kind of human pressure and their capability to be "sustained" by a territory. The assessment of tourism impacts done through the evaluation of EF of a tourist destination involves 3 categories of subjects: tourists, tourism operators and local administrators. Each kind of subject indeed can act for the development of tourism in a more sustainable perspective:

- tourists can choose different aspects of their holiday: kind of accommodation, length of stay, mean of transport, local or international food, etc;
- tourism operators can act to make tourism structures more ecologically efficient, reducing impacts due to energy and water consumption, production of waste, etc.;
- public administrators are involved in the definition of land use planning and can influence the whole tourism system, promoting communication campaign to raise environmental consciousness among residents, tourism operators and tourists, and supporting the development of the destination in a sustainable perspective.

A further implementation of the methodology requires a better evaluation of waste production and energy consumption (included in the model but still lacking of more detailed information) and the evaluation of water consumption (not yet included in the original model).

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3.6 Sustainable Performance Index for tourism policy development

Valentina Castellani, Serenella Sala

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Abstract
Development of sustainable tourism policies could be a useful way of encouraging new forms of business, increasing employment and promoting the conservation of landscapes; in this regard, the application of the European Charter for Sustainable Tourism in Protected Areas represents a referential methodology for local development and a possibility to involve local stakeholders in the definition of sustainability policy. In many cases, integrated sustainability indicators are developed within a participatory process; the present study represents an innovative attempt to evaluate sustainability holistically, by defining specific targets through the definition of indicators suitable to measure and evaluate the temporal evolution of development policies, mainstreaming sustainability to reduce adverse effects on the environment and promoting conservation of local and traditional values. Application of sustainability indicators to measure welfare and development at local scales is strategic to evaluate the short and long term effects of strategies developed through the European Charter participatory process.

Keywords*: sustainable tourism, local development, protected areas, Sustainable Performance Index, GPI*

Introduction

Sustainable tourism and ecotourism are widely recognized as means of enhancing local development as well as protecting natural environment and traditional and cultural heritage in international resolutions (Convenzione delle Alpi, protocollo Turismo, 1991; Lanzarote Charter, 1995; Lisbon Strategy, 2000; Carta di Rimini, 2001, Quebec Declaration on Ecotourism, 2002, The renewed EU Tourism policy, 2006; Agenda for a sustainable and competitive European Tourism, 2007) and scientific studies (Wells, 1997; Godde, 2000; Milne et al., 2001; Dallari, 2002; Bimonte et al., 2003; Neto, 2003, Franch et al., 2007). Moreover, the implementation of participatory processes of environmental governance is recognized as useful to address complex sustainable development issues and for planning local strategies of development (United Nation Economic Commission for Europe (UNECE), 1998; European Commission, 2001; van der Hove, 2006; White et al., 2006), especially when it is integrated with a scientific analysis of the situation (Behringer et al., 2000; Stirling, 2006) . The consultation of local stakeholders and their involvement in the definition of strategies for development, indeed, helps to highlight new perspectives about local situation and to assure that all the priorities of different actors and their opinion about possible measures of intervention are well-known and taken into account for the evaluation of scenarios and the definition of a strategy for local development (Tosun, 2000; Stagl, 2006, Logar, 2009).

The attempt to measure sustainability has to face some conceptual challenges: 1) the concept of sustainability is not univocally defined and efforts to measure it are difficult to implement (Hardi et al., 1997, Butler, 1998, Bell et al, 1999); 2) sustainability is not a universal concept, it may be influenced by local environmental, social and economic contexts which may require more attention to be paid to specific aspects over others (Twinning-Ward et al., 2002; Bell et al., 2003; Reed et al., 2003; Ko, 2005); 3) legal compliance is not enough to define a sustainable model of development and, in many cases, is difficult to achieve. Furthermore, the challenge posed by the evaluation of a mid-long term process of local development is two-fold, seen in: 1) the need to find new methods for measuring local levels of development and quality of life, overcoming the evaluation of mere economic indicators such as GDP (Dymond, 1997; Daly et al., 2004; Common et al., 2005, Blackstock et al., 2006) and 2) the need to evaluate temporal evolution of these policies, adopting instruments that enable decision makers to investigate the effects of the strategy adopted for local development and to compare the situation before and after its implementation (Dovers, 2005; Grosskurth et al., 2005, OECD, 2009, Connell et al., 2009).

This paper describes the experience of the implementation of a participatory process of local development (i.e. the European Charter for Sustainable Tourism in Protected Areas, 1995) in a marginal area of the Lombardy Region of Northern Italy as the starting point for the definition of new methodologies and indicators of sustainability in order to evaluate the actual impact of sustainable tourism development policies in marginal areas. Firstly, the paper describes the process of implementation of European Charter, as set by Europarc; secondly, it explores some theoretical implications deriving from the need to assess sustainability of local development processes and to define tools able to support the definition of policies (integrating objective, subjective and strategic analysis of the area and of its priorities) and to monitor their impacts through time; thirdly, a new index developed by authors for the evaluation of sustainability of local development policies in tourist destination (the Sustainable Performance Index - SPI) is described; finally, a case study is presented, in order to explain more in detail the methodology of the Sustainable Performance Index.

The European Charter for Sustainable Tourism in Protected Areas

In 1995, Europarc (the European Federation of Protected Areas, that represents 500 members responsible for the management of more than 400 protected areas across the continent) took the initiative to set up the European Charter for Sustainable Tourism in Protected Areas (1995) with a project funded by the EU's LIFE programme and led by the Fédération des Parcs Naturels Régionaux de France.

The European Charter for Sustainable Tourism in Protected Areas is an innovative planning instrument aimed at enhancing sustainable tourism in protected areas, cited also by the Report of the Sustainability Group of the EU Community (2007b) as an interesting model for strengthening the relationship between protected areas and local tourism interests. Park authorities (signatories of the European Charter) are committed to

implementing local strategies for sustainable tourism, enhancing cooperation and implementing joint actions with local partners.

The European Charter process combines economic, cultural, social and environmental aspects as a basis for the definition of future scenarios of local development. The phases of the Charter include: economic, social, cultural and environmental diagnosis of the area in question, with a focus on specific characteristics, strengths and weaknesses; participatory processes engaging local stakeholders; participatory planning; definition of action strategies for sustainable tourism development and, ultimately, implementation of these strategies. The consultation process is designed to improve collaboration and capacity building between local stakeholders, both in the public and private sectors (Castellani et al., 2007a).

The process of implementation is planned to last 7 years: the first two years being assigned to the development of a strategy of action for sustainable tourism, the remaining five years for the implementation of that strategy. At the end of every phase there is an evaluation by Europarc: the first (after two years) is for the award of the Charter Certificate to the protected area and the second (at the end of the 7th year) for the evaluation of results and the renewal of Charter membership.

It is important to note that the strategy for sustainable tourism must be based on both the results of analysis of local contexts (environmental, economic and social factors in relation to the tourism sector) performed by experts, and the results of the consultation and planning process conducted with local stakeholders.

The whole process is inspired by ten principles, listed in the Charter text, which form the basis of the definition for the action strategy.

According to these principles, the aim of the process is the development of new models for tourism related to protected areas, whilst protecting the natural environment and granting benefits and a good quality of life for local residents.

Methodology

The methodology presented in this paper was specifically developed and implemented by the authors to address and support the implementation of European Charter for Sustainable Tourism in Protected Areas in marginal areas of the Lombardy region, starting from the guidelines provided by Europarc.

The process of implementation of the European Charter is a local development management system focused on sustainable tourism. The process is inspired by the Deming cycle (Deming, 1994) within a continuous quality improvement model consisting of 5 phases:

1. economic, social, cultural and environmental diagnoses, to highlight the objective strengths and weaknesses of the territory;
2. consultation of local stakeholders, to compare objective results with a subjective and common perceptions of the local situation;
3. participatory process of planning;

4. production of a strategy for sustainable tourism development, linked with an action plan based on the results of previous phases;
5. overall evaluation of the strategy and planning of improvement actions.

It is important to check the whole process and to verify that the actions planned for the development are targeted to the specific pressures identified and shared by all stakeholders. Indeed, effective policy planning for sustainable tourism development has to be based on an analysis of actual and potential environmental, social and economic conditions and on the needs of local communities and enterprises (Rydin et al., 2003; Hezri, 2004).

Furthermore, the implementation of the strategy planned has to be monitored over time to assess impacts on the local environment and, where appropriate, to redefine policy and plan future steps to be taken in order to continuously improve the environmental and sustainability performance of the area (Ko, 2001, EU Commission, 2005; EU Commission - Tourism Sustainability Group, 2007b).

It is therefore essential to identify indicators suitable to measure and evaluate the temporal evolution of development policies (Waldron et al., 2002; Oras, 2005; Hezri et al., 2006, Singh et al., 2009) and to assess the possibility of sustainable socio-economic development facilitated by the promotion of sustainable tourism activities in marginal areas.

Instruments suitable to measure welfare and development

Since the 1970s, certain economists have highlighted the shortcomings of economic indicators (e.g. GDP) as instruments for measuring the development and level of welfare of a State or a local community (Daly et al., 1989; Daly, 1996; World Bank, 1997; Lawn, 2003). Since that time, alternative methods of measure have been defined - for example satellite accounts integrated with national accounting and specific indexes of sustainable development such as the Environmental Sustainability Index (ESI) (Esty et al, 2005) and the Environmental Performance Index (EPI) (Esty et al, 2008), the Index of Sustainable Economic Welfare (ISEW) (Cobb et al., 1994; Castaneda, 1999) and the Genuine Progress Indicator (GPI) (Anielski et al., 1999).

One of the objectives of the present study is to analyse opportunities provided by this field of research with the aim of identifying a method suitable to measure actual levels of development in disadvantaged areas (classified as “areas facing structural difficulties” by the European Community: see EC Council Regulation 1260/1999) and trying to integrate classic economic evaluation with an assessment of social and environmental factors, with a particular reference to the definition of sustainable tourist strategies as a way to promote local sustainable development.

An analysis of the situation in Italy regarding dataset availability in national and regional statistics (i.e. the set of data needed to calculate GPI or ISEW) highlights the unavailability of such data at local scales (almost all data are at national or regional scales) and the unfeasibility of performing a specific investigation at the municipality level - already underlined in some studies

on GPI applications at the regional scale (e.g. Clarke et al., 2007) and in reviews on the strengths and weaknesses of sustainability indicators (e.g. OECD, 2002; Ness, 2007; Mayer, 2008).

Nevertheless, there are lot of studies performed all around the world to measure the role of sustainable tourism in promoting welfare and development at local scale through the use of sets of indicators (Inskeep, 1991; Coccossis et al., 1996; Garcia et al., 2000; Miller, 2001; Sirakaya, 2001). Indeed sustainable tourism indicators are widely recognized as a useful tool for: 1) evaluating policies and monitoring performances (Butler, 1998; Crabtree at al., 1998; Kelly et al., 2002, Gahin et al., 2003; EU Commission – Tourism Sustainability Group, 2007b); 2) defining strategies for development and setting numerical targets (Bakkes, 1997; Stoeckl et al., 2004); 3) easily communicating the current situation and future scenarios to all the stakeholders (Smeets et al., 1999; OECD, 2009; Hammond et al., 1995).

The debate about the relation between science and policy in the selection of indicators suitable to measure the sustainability of local development (McCool et al., 2004; Reed et al., 2006) highlights the necessity to have indicators of sustainability based both on scientific criteria and on the results of participatory processes of policy planning. The selection of sustainability indicators is therefore both a technical and political decision and has to be focused on the identification of issues that are relevant and valid for the evaluation of social, economic and environmental local systems (Redman, 2004; Munda, 2005; Deconchat et al., 2007; Ohl et al., 2007).

A comprehensive analysis of sustainability performance of tourist destinations at local scales assessed via a suite of indicators suitable to measure welfare and development at that scale and to evaluate both the short and long term effects of development policies, should fulfil the following requirements (Miller et al., 2005):

- integration of different aspects of sustainability;
- involvement of stakeholders in the definition of priorities of action for local development;
- consideration of the local situation, focusing on the analysis of specific factors;
- evaluation of the temporal evolution of sustainability performance, enabling decision makers to assess the effective impacts of the policies undertaken.

Sustainable Performance Index

Definition of the set of indicators

Considering that the current sets of sustainability indicators often meet only some of the requirements listed above, a new integrated index of sustainable development was developed with the aim of ensuring a comprehensive evaluation of sustainability performance, focused on local situations and measurable over time.

The Sustainable Performance Index (SPI) is an integrated index composed of 20 indicators concerned with: demographic dynamics; economic and social conditions of local communities; environmental factors; tourism

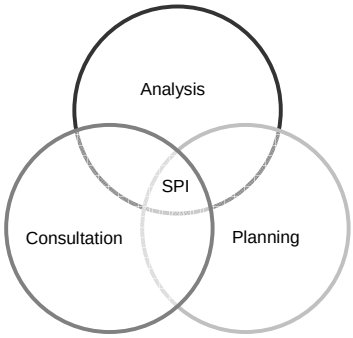
characteristics of the region under investigation. The selection of indicators composing the final index is based on the results of every aspect of the European Charter procedure as follows:

1. Objective analysis of local situation:
    - economic, social, cultural and environmental diagnosis of the area (Castellani et al., 2007b), highlighting the most critical issues for the area.
    - assessment of the Tourism Carrying Capacity of the destination (Castellani et al., 2007c), to identify natural resources that are scarce or could be scarce following a significant growth in tourists and public and environmental services that could limit accessibility for tourists or cause environmental damage.
2. Consultation of local stakeholders (subjective analysis):
    - topics emerging from the vision were developed by local stakeholders through an EASW workshop (European Commission, 1994). This part of the consultation was aimed to add subjective information about the identification of the main drivers that could lead to a sustainable or unsustainable tourism development in the area.
    - results of a thematic focus groups with local stakeholders, interviews with local actors and surveys, to integrate objective analysis of the situation with local perceptions about what constitutes the priorities of intervention to promote the development of the area as a sustainable tourism destination.
3. Planning process for sustainable tourism development in the area (strategic analysis):
    - the ten principles inspiring the European Charter (see section 2) provides directions for the identification of priorities for development.
    - the strategy for sustainable tourism arising from results of previous phases that defines the main areas of intervention and the priorities for the future - to be set by local administrators according to stakeholder consultation and the analysis of the area.
    - the diagnosis of the area and the assessment of Tourism Carrying Capacity (TCC), summarized in a SWOT analysis (see section 2 for more details), which is a first step towards the selection of topics that need to be evaluated to assess the sustainable performance of the destination.
    - the results of one-to-one interviews with relevant actors inside and outside the area, which are strategic for the planning of the destination (e.g. provincial and regional representative of environmental and tourist offices, eco-tourism tour operators).

The process of selection developed for SPI is an attempt to balance the need to have a comparable method of evaluation with the need to assess the effective needs of local situation. The process refers to the frameworks developed by some important European projects about sustainability assessment in rural and mountainous regions, such as the DIAMONT

(Schönthaler, 2008) and MARS (Schoder, 2005) projects. The aim is to identify a comprehensive set of indicators, based on objective and subjective priorities of the area, addressed to the specific trends of regional development. The conceptual model for the process of selection is illustrated in Figure 1.

Figure 1 – Conceptual model for the selection of SPI indicators



The technical analysis of the area provides objective information about the local state (from an environmental, economic and social point of view, with a focus on tourism aspects) and an evaluation of future perspectives, based on the TCC assessment. Consultation with stakeholders provides additional subjective information, enabling one to select the most important aspects and to assign different levels of priority to them; the planning phase, based on the outcomes of the previous steps and involving local communities, local administrators and scientific experts, defines the field of action for the future and is important for identifying the issues that have to be monitored to assess the success of development policies. Thus the indicators composing SPI are indicators of current sustainability arising from analysis and consultation steps, and indicators that measure the achievement of the development policies planned.

Sustainable Performance Index Assessment

Sustainable Performance Index value is the sum of the values of these 20 indicators:

$$\text{SPI} = \sum_{i=1}^{20} Ii \qquad \textbf{[1]}$$

Though composite indicators can be misleading if poorly constructed and can involve subjective evaluations (e.g. about weights), the decision to aggregate the data together to produce a performance index comes from the consciousness that composite indicators can help to measure multi-dimensional concepts (as sustainability) that cannot be capture by single indicators. Furthermore, the aggregation of results in a single score can help decision makers to understand the overall performance of the tourist destination and to compare the performance of different areas.

To enable every decision maker (e.g. local administrators) to apply the model to a specific area and to use the results to address local policy, for every indicator composing the index, a dedicated sheet is created that provides some basic information about it (e.g. name, year, source of data, extent and periodicity). The model is flexible, so it can be adjusted to the specific situation of the area under evaluation: it is possible to assign a different weight to each indicator, according to the priority of action emerging from the analysis and the consultation of local stakeholders. Even if this intervention will necessarily bring subjectivity into the selection process, it is important that the selection of indicators takes into account local priorities. The only requirement that is strongly need to ensure robustness to the final index is that the assignation of weights is done in a transparent way, justifying the choice of the weights according to objective, subjective and strategic analysis performed before the selection of indicators.

In this case study presented below the same weight is assigned to every indicator, assuming that every issue has the same relevance for the area under evaluation.

Every indicator can assume a value from 0 to 10, which represents the level of sustainable development assessed for that issue (10 indicates the higher level of development). If the relation between the value of the issue and the value of the indicator is in direct proportion (e.g. "level of education": if the level of education is high, the sustainable performance is high), then the value of that indicator is calculated by equation [2]; if the relation between the value of the issue and the value of the indicator is, on the other hand, in inverse proportion (e.g. "urbanisation": if the level of urbanisation is high, the sustainable performance is low), then the value of that indicator is calculated by equation [3]. Equations for the calculation of indicator values, starting from the value of every issue are:

$$I_i = \frac{S-s}{V_i - v_i} * x_i + S - (\frac{S-s}{V_i - v_i}) * V_i \qquad [2]$$

$$I_i = -\frac{S-s}{V_i - v_i} * x_i + S + (\frac{S-s}{V_i - v_i}) * V_i \qquad [3]$$

I = indicator

S = maximum value of the indicator scale (10 in the present study)

s = minimum value of the indicator scale (0 in the present study)

V = maximum value of the scale for the considered issue

v = minimum value of the scale for the considered issue

x = value of the issue measured

A special case is represented by the issue of "tourist overnights", in that it is difficult to assign an absolute positive or negative meaning (and so to chose between the direct or inverse proportion equations) to the amount of tourist overnights; the presence of tourists in a destination has a positive effect on local development (especially for local economy and labour market), but if the amount of tourists in the destination is too high, it can have a negative effect on the quality of the environment (e.g. air pollution, production of waste, etc.) and on the quality of life of local people (e.g. crowding, traffic, noise, etc.) (Eagles et al., 2002; Cullen et al., 2004; Manning, 2002; Moore et al., 2007). For this reason, the indicator "tourist overnights" is calculated by

equation [2] up to a specific threshold of sustainability ([nr of overnights/day]/residents *100% lower than 25%), and by equation [3] when the value of the issue is over this threshold. The threshold was defined subjectively, considering the specific characteristics of Alpi Lepontine (see below) as a tourist destination. Analysing the local situation and context, the ratio between residents and tourists shows that tourism is not the main economic sector and that the hospitality and infrastructure system is not exclusively dedicated to tourism activities. Hence in this context, the main sustainability object is to maintain a balance among several economic sectors, such as agriculture, retail and manufacturing. Reference values for establishing maximum and minimum value ranges for every issue are determined through comparison with national or regional mean values. Finally, the results of the evaluation of each indicator are added to obtain a composite evaluation of the Sustainable Performance of every municipality [1]: the mean SPI value for the municipalities involved represents the value of SPI for the entire area considered.

Area of study

The case study presented in this paper is the implementation of the European Charter for Sustainable Tourism by the Alpi Lepontine Mountain Community (Italian Mountain Communities are administrative clusters of municipalities in mountainous areas). Alpi Lepontine is an area of mid-high altitude in the Lombardy Region in northern Italy. It can be divided into two different sub-areas: the first one consists of municipalities near Lugano and Como lakes, with high tourist flows and high levels of urbanization; the second consists of other municipalities in a more marginal mountainous area, where there are only a few villages of low population density and a lower level of tourism development. There are two protected areas candidate to the European Charter, both managed by the Alpi Lepontine Mountain Community, which is a union of 13 municipalities. These protected areas applied to the European Charter in 2006 and have been awarded with the Charter certificate in 2008.

The activity started in September 2006, when the project staff held an opening meeting in the Visitor Centre of the Riserva Naturale Lago di Piano for the presentation of the process to the population and for a first analysis of local perceptions about sustainable tourism and local development. During the meeting a workshop regarding the perception of local threats and trends; according to the EASW method was performed: participants were asked to list five threats and five opportunities about tourism in the area of Alpi Lepontine in order to develop two possible scenarios - one positive and one negative - for the next ten years. The results of the workshop were then clustered to identify the main topics of tourism in the Alpi Lepontine, linked with the European Charter principles.

The vision developed in the first meeting addressed the selection of some topics for the planning process, discussed in 4 roundtables. Roundtables consisted of four categories of stakeholders (tourism business, local administrators and NGOs, school operators and farmers and trade associations), with the aim of allowing the definition of shared proposals and to create a network of subjects sharing the same goals, as asked by stakeholders in the first meeting. On the basis of this structure, the main topics of the planning process were handled by the roundtables, in relation

to the fields of action and the needs of participants. Members of the project staff also conducted one-to-one interviews on specific topics with relevant subjects of the area, such as provincial tourism and environmental authorities and representatives of local organizations. Furthermore, during the process of analysis, questionnaires were submitted to tourists, tourism operators and local people to investigate opinions about protected areas (both present and potential situations) in the Alpi Lepontine region.

Results

The main results of the diagnosis of the territory, performed within the process of the European Charter for Sustainable Tourism in Protected Areas, and further developed by the study about Tourism Carrying Capacity of Alpi Lepontine, are summarized in Table 1, which illustrates the results of a SWOT analysis of the local situation regarding natural and cultural heritage, socio-economic contexts and tourism. The main threats to the area relate to the impact of tourism on the natural environment (manifest in crowding, pollution, urbanization, etc.), whilst the main opportunities are connected to the development of 'lighter' forms of tourism: "green holidays" for school tourism, bicycle trails, mountain excursions and other nature based activities.

Table 1 - SWOT analysis of Alpi Lepontine as a tourist destination

	STRENGTHS	WEAKNESS
NATURAL AND CULTURAL HERITAGE	1. Natural value of protected areas 2. Existence of an organized system of local museums 3. Riserva Lago di Piano: protected area with organized paths and facilities for visitors	1. Difficulties in reaching some museums and the protected areas by public transport 2. Few people available for managing the services, so that some museums have to be opened only when one visit is booked 3. Urban degradation near the borders of Riserva and presence of Regina national road (that generates pollution and noise) close to the area 4. Lack of signalling, especially for Area di rilevanza ambientale
SOCIO-ECONOMIC CONTEXT	1. Rich and wide historic and cultural heritage	1. Lack of services in mountain villages 2. High level of commuting from Italy to Switzerland 3. Lack of cooperation between operators for the promotional activity
TOURISM	1. Wide tourist offer based on local heritage (nature, history, culture) 2. Connections with Como Lake and Switzerland. 3. Length of stay in the territory higher than provincial average.	1. High seasonality 2. Concentration of tourist in areas near the lakes of Piano and Lugano (some municipalities doesn't have any hospitality structure). 3. Lot of information available only in Italian 4. Hospitality structures not organized in network 5. Lack of agritourism and B&B structures 6. Low availability of connections by public transport (especially for mountain area).

	OPPORTUNITIES	THREATS
NATURAL AND CULTURAL HERITAGE	1. Special projects focused on agriculture (creation of a local brand, benefits for conservation of agricultural environment) 2. Enlarging of environmental education activities 3. Valorisation of local products of mountain pasture. 4. Development of activities about guided excursions	1. Human pressure on protected areas 2. Dropping of agricultural and forest activities that causes loss of identity of the areas 3. Lack of cooperation between public administrations about heritage management 4. Hydrogeologic accidents and fires due to the lack of maintenance in mountain and agricultural areas
SOCIO-ECONOMIC CONTEXT	1. Valorisation of agricultural production through new forms of marketing 2. Valorisation and development of environmental, historical and cultural heritage 3. Improvement of rural tourism 4. Information and communication technologies as a support for local community and enterprises.	1. Aging of population 2. Marginality of local protected areas in the national contest 3. Evolution of tourism towards mass tourism instead of tourism of quality
TOURISM	1. New markets: United States, European countries currently not present and Italians from outside Lombardy, school tourism, sport and nature-based tourism 2. Promotion in IAT of Como 3. Adhesion to national and international ecotourism networks	1. Impact of tourism on ecosystems 2. During summer months, competition between tourists and residents in using local services (especially water and waste disposal) 3. High density of tourist facilities on the territory

Table 2 lists the main topics emerging from the vision developed by local stakeholders, which provided subjective information for SPI indicators selection. The main topics highlighted by the local community in the Alpi Lepontine region are “mobility” (which suggests that traffic congestion could be a problem for the area and that sustainable mobility has to be promoted) and “valorisation of local strengths”, especially of natural, traditional and cultural heritage, which is linked with “environmental protection”.

Table 2 - Main topics emerging from the vision developed by local stakeholders

Topic	Nr of votes
Problems of mobility	25
Valorisation of local strengths	20
Environmental protection	19
Promotion of tourist information and communication about the territory	15
Quality of tourist offer	12
Urban planning	11
Valorisation of local heritage	9
Promotion of tourist path and routes	9
Tourism facilities	9
Order and neatness	7
Training for tourism operators	6
Environmental training and consciousness	5
Prices	4
Promotion of local products	2
Maintenance of drainage system	2

(Numbers of votes indicates the number of participants to EASW workshop that voted that topic as a driver for tourism development in the area)

The set of indicators identified for the Alpi Lepontine area, selected according to the method explained in section 3.2 and illustrated in Figure 1, are listed in Table 3. It consists of indicators regarding social, economic and environmental aspects that have been identified as main drivers (according to the DPSIR model of analysis) for sustainable tourism development in the Alpi Lepontine area; a more comprehensive evaluation of future perspectives of sustainability could be obtained by combining SPI evaluation with a more detailed assessment of the ecological balance of tourism activities in the area, done, for instance, using the Ecological Footprint method applied to the tourism sector and the Biocapacity assessment of the destination.

Table 3 - Set of Indicators for SPI assessment in Alpi Lepontine area

POPULATION	HOUSING	SERVICES	ECONOMY AND LABOUR	ENVIRONMENT	TOURISM
1) Net migration 2) Old-age index 3) Level of education	4) Rate of houses not owned from resident people	5) Nr of local unit in services sector 6) Voluntary work 7) Nr of daily routes of public transport	8) Employment rate 9) Nr of enterprises with ISO 14001 or EMAS certificate. 10) Rate of new enterprises survived after 18 months from birth 11) Female entrepreneurship 12) Rate of commuting population 20) Per-capita value added	13) Urbanisation 14) Production of energy from renewable sources 15) Ecological state of fresh water 16) % of separate waste collection 17) % of farming area occupied by organic farming	18) Overnights 19) Nr of b&b and agritourism/ total nr of hospitality structures

Table 4 – Results of SPI analysis in Alpi Lepontine.

B. Lario	Carlazzo	Cavargna	Corrido	Cusino	Grandola	Plesio	Porlezza	S. Bartol.	S.Nazzaro	S.Siro	Valrezzo	Valsolda	CMAL
6,67	7,51	1,75	6,49	9,02	8,09	7,61	7,34	6,36	5,42	6,37	4,96	5,81	6,41
8,95	9,14	3,38	9,52	0,91	7,72	4,45	8,79	6,96	4,03	5,19	2,98	5,69	5,98
1,37	2,66	1,97	3,67	0,82	3,96	0,26	2,94	1,04	0,75	3,94	1,44	5,36	2,32
6,95	6,43	3,81	6,34	3,63	5,81	2,09	6,40	4,41	3,67	4,99	5,38	4,00	4,91
3,87	4,97	2,54	1,10	1,53	5,21	3,23	7,53	3,04	0,48	0,48	2,76	3,01	2,89
6,20	6,20	6,20	6,20	6,20	6,20	6,20	6,20	6,20	6,20	6,20	6,20	6,20	6,20*
10,00	2,56	1,00	3,36	2,07	4,91	0,44	5,81	1,91	1,51	2,96	0,38	1,30	3,29
4,57	7,44	2,41	6,05	4,24	6,13	4,42	6,80	5,47	5,73	4,60	4,04	4,37	5,10
0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	5,26	0,00	0,00	0,00	0,40
-	-	-	-	-	-	-	-	-	-	-	-	-	n.a.
4,48	4,48	4,48	4,48	4,48	4,48	4,48	4,48	4,48	4,48	4,48	4,48	4,48	4,48*
2,08	1,28	6,70	1,67	4,39	2,18	2,79	1,77	2,56	2,41	3,86	3,50	3,53	2,98
9,09	6,71	9,63	8,52	9,52	8,51	8,86	6,78	8,68	9,37	8,13	9,52	8,92	8,63
-	-	-	-	-	-	-	-	-	-	-	-	-	n.a.
7,50	7,50	7,50	7,50	7,50	7,50	7,50	7,50	7,50	7,50	7,50	7,50	7,50	7,50*
1,62	1,50	2,51	1,53	1,33	2,17	4,01	1,13	1,67	1,68	1,43	1,52	2,37	1,88
9,57	3,56	9,52	0,13	0,01	4,56	0,00	0,13	0,00	0,00	0,00	0,76	1,85	3,34
0,00	5,56	0,00	0,00	0,00	1,58	1,03	8,54	0,00	0,00	1,63	0,00	1,58	0,79
0,00	2,50	0,00	0,00	0,00	4,29	0,00	0,00	5,00	0,00	2,50	0,00	0,00	0,83
8,47	5,57	5,57	5,57	5,57	8,47	8,47	5,57	5,57	5,57	8,47	5,57	5,57	6,46
91,39	**85,56**	**68,97**	**72,13**	**61,23**	**91,77**	**65,84**	**87,71**	**70,85**	**64,04**	**72,73**	**60,99**	**71,52**	**74,41**

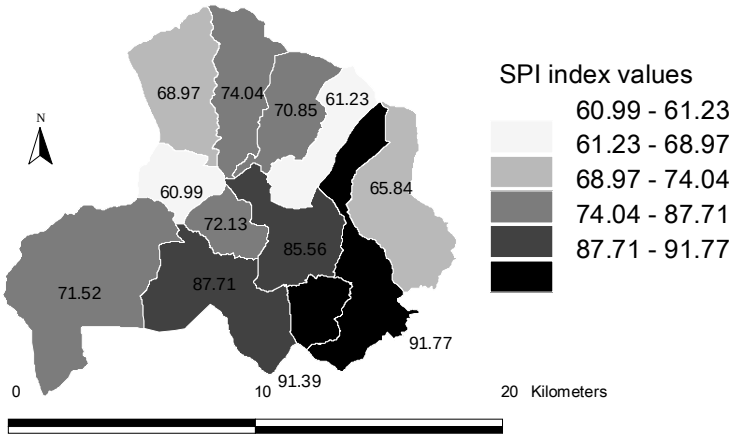
Please note that data for I_{10} and I_{14} were not available and data signed with * refers to the whole Province of Como.

Table 4 shows the results of the application of the SPI method in the Alpi Lepontine area. The mean value is 74.41: it is quite low result, considering that the highest result achievable is 180 (it should be 200, arising from the value 10 for each of the 20 indicators, but in this case for two out of the twenty indicators data were not available). The result seems to confirm the classification given by the ex-ante evaluation of the European structural fund (Regione Lombardia, 2004).

The analysis of the value for each indicator considered allows for a SWOT analysis to be performed, supported by quantitative data – thereby overcoming the limits of a simple qualitative approach. According to these results, the main strengths of the Alpi Lepontine area are urbanisation, the ecological state of fresh waters, net migration and per-capita value added, while the most useful information given by SPI analysis in support to decision making about tourist development in Alpi Lepontine is to address future tourist policy to the development of tourism in the whole area, spreading its positive influence also to small villages and preserving more developed tourist centres from overexploitation.

The SPI method can also give relevant information about each single unit composing the area considered (in this case the municipalities) allowing one to deepen the analysis and to highlight the disparities among them.

Figure 2 – Map of SPI results in Alpi Lepontine municipalities



In the present case study, the whole area has reasonably homogeneous results (see Figure 2), even if comparing the SPI analysis of a mountain village (e.g. Cavargna) to a more developed municipality (e.g. Porlezza), as shown in Figures 3 and 4, it is possible to highlight the disparities between these two different situations and to identify their strengths and weaknesses, as information to support development policies of the Alpi Lepontine Mountain Community.

Figure 3 – Example of SPI results: municipality of Cavargna

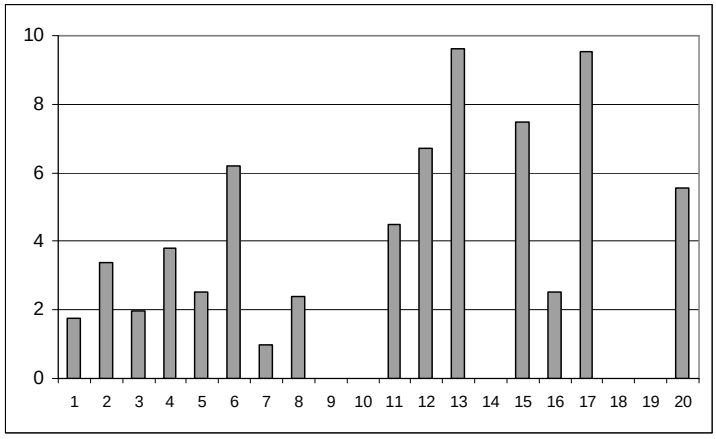


Figure 4 – Example of SPI results: municipality of Porlezza

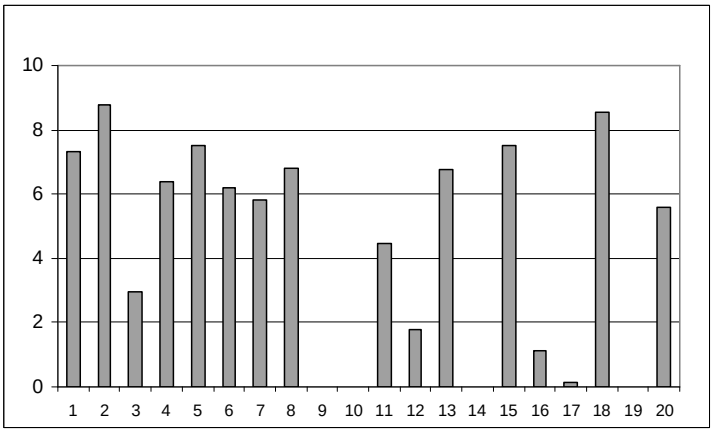


Figure 3 and 4 show two examples of SPI scores for two municipalities (Cavargna and Porlezza): numbers on x-axis represents the indicators composing SPI (as listed in Table 3); y-axis shows the score (from 0 to 10) of each indicator for the municipality.

Cavargna, as with most mountain villages, shows a lack of public services (including public transport) which leads to the ageing of the local population and to migration, especially of young people (due also to the limited job opportunities); nevertheless, it has good SPI rates connected with urbanisation, which is very low (I_{13} =9,63), and the organic farming rate, which is very high (I_{17} = 9,52). The two strengths identified could be used for the valorisation of the village through the promotion of tourism, especially agritourism, and the retail of local products: currently the village of Cavargna doesn't have any tourist structure and therefore doesn't register any overnights, but, as suggested by SPI analysis, and by scientific literature (see, among others, Frechtling et al, 1999, Baetzing, 2005) sustainable tourism could be a good instrument for the sustainable development of the

local economy and society. Porlezza, on the other hand, is quite a developed municipality, with higher rates of services, public transport and employment in respect to the whole area, but is still limited regarding the number of tourists staying in the area (especially during the summer season) and the level of urbanisation (due in part to the presence of second houses); it also shows a very low rate about organic farming. In this case, consequently, the main suggestions for decision makers, arising from SPI analysis, are: encouraging the re-use of existing buildings as tourism structures to avoid the construction of new buildings for tourist purposes, and promoting organic farming and the production of local products as an additional tourist attraction.

In conclusion, the SPI analysis of the Alpi Lepontine Mountain Community produces the following guidelines to address policies for sustainable tourism development by local decision makers. These are summarized in the action plan for sustainable tourism submitted to Europarc Federation by Alpi Lepontine Mountain Community (Tarelli et al., 2008):

- To fill the gap between mountain villages and the municipalities in the plain area, e.g. supporting the activities that can attract people in the mountain (as using abandoned mountain huts and mountain pasture structures for tourist accommodation and creating points where tourists can taste and buy food products coming from local farming); improving the quality of services in mountainous municipalities (frequency of bus service, public services for local people and tourists).
- To encourage local entrepreneurship, especially among young people, to reduce the dependence on Swiss jobs and to reduce commuting: as highlighted by SPI analysis, sustainable tourism could be a good solution for this purpose, especially in mountainous areas. Possible actions in this field could regard public funding for the start up of tourist enterprises by local young people (possibly in cooperation with the local high school for hospitality and tourism).
- To assure good quality of life for local people, e.g. improving and innovating public services and reducing the impact of tourism activities on the area (especially about environmental pollution, noise and crowding).
- To promote and improve sustainable mobility services, which could help to prevent overcrowding as well as noise and air pollution, especially in the tourist season. Considering that tourists reported that one of the main reason for visiting the area is the possibility to play sports and visit natural sites, the promotion of bicycle routes and of a bike-sharing service seems to be an interesting area of intervention for the destination under investigation.
- To support the strengths of the region, with specific attention paid to the safeguarding of local natural heritage and protected areas: e.g. by the promotion of guest accommodation, agritourism and organic farming and the improvement of separate waste collection.

Discussion and conclusions

The methodology of European Charter for Sustainable Tourism in Protected Areas presented in this paper suggests that sustainable tourism projects may help to promote local sustainable development of mountain areas and

that the Charter is a useful mechanism for involving stakeholders in the planning process. Indeed, the European Charter procedure meets the necessity of widening the concept of participation, from pure consultation to active involvement of local stakeholders, both in the planning process and in the implementation process; it can help to make an overall evaluation of environmental, social and economic contexts of the area, whilst also considering the perception of the local community. Furthermore, the methodology developed for the implementation of the European Charter in marginal areas (starting from the experience of one mountainous area in Italy), closely related to the conceptual model developed for the SPI assessment, allows to identify the objective, subjective and strategic key points during the whole process.

From this perspective, the application of sustainability indicators at a local scale, such as the Sustainable Performance Index, is a promising tool for addressing the definition of lines of action for local development and evaluating the short and long term effects of strategies developed through the participatory processes of the European Charter method. Furthermore, sustainability indicators and their evolution through time could represent a useful tool for decision makers to assess policy efficacy in defining models of sustainable tourism, particularly in marginal and transforming areas. The SPI method allows to assess current levels of sustainable development in the area under evaluation and is a valuable instrument for the assessment of the positive potential of that area. The fact that the methodology for the identification of the set of indicators is strictly related to an existing and widely implemented procedure (the European Charter guidelines and principles developed by Europarc) helps to standardize the whole process, enabling researchers and decision makers to compare results through space and time (which is one of the requirements identified by EU Commission for sustainability indicators, 2005).

The attempt to define a methodology for the definition of a sustainable tourism development indicators set that can be easily shared by practitioners working in different situations and that incorporate stakeholder participation, answers to some of the most important challenges identified for sustainable tourism indicators research (Klaric et al., 1997; Miller et al., 2005; Pinter et al., 2005; White et al., 2006).

Moreover, the final SPI value allows to comprehensively evaluate the sustainability performance of the whole area considered, while the results of the single indicators composing SPI allows to deepen the investigation at the level of municipalities and to identify possible inequalities between them. It would be therefore possible to assign a different weight to each indicator, according to the development priorities of the specific area under consideration, as identified by local decision makers, or highlighted by the process of consultation with local stakeholders. The strong relationship between the local situation (local policy for development, analysis of the perception of local community) and the process of selection of the indicators and the evaluation phase is the most useful characteristic of SPI method; although it makes the index less comparable to other international standardized methods applicable at national level (for example GPI, ISEW or EPI), it prevents the unfeasibility of application at local scales (e.g. in the case of a lack of local data) and helps to find solutions that are shared by local communities and targeted to specific priorities. In fact, the SPI

assessment meets both the necessity to ensure the connection with local policies and local features and the need to ensure repeatability in different context and comparability through space: the connection with European Charter procedure, which is applicable to protected areas all around Europe (and, potentially, all around the world) ensure repeatability and comparability, while the conceptual framework underlying the selection of indicators in the SPI method, thank to its linkage to policy targets, to objective key issues and to stakeholders priorities, is applicable for all areas under evaluation and allows to adapt the evaluation to different situations, taking into consideration local priorities and features.

Furthermore, the strategic analysis included in the conceptual framework for the selection of indicators illustrated in Figure 1, ensure the link with existing policy targets and priorities and the reference to the local institutional and political context, answering to the need of a stronger connection between indicators development and strategies development should be strengthened, pointed out by Pinter et al. (2005), recognizing that current sets of indicators often show a political weakness and finally result to be only an addition to existing environmental, economic and social statistics.

At the same time, the objective analysis, and particularly the Tourist Carrying Capacity assessment, provides an evaluation of "what to sustain" and "to what extent" (Pinter et al., 2005) to achieve sustainable development in the area under evaluation. In addition, the authors made an effort to develop indicators that have a close reference to official statistical data systems, with the aim of improve data availability (at present and in the future) and comparability through space.

Finally, the presence of a transparent framework, that involves also stakeholders, for the selection of indicators help decision makers and stakeholders to easily understand the process and to negotiate the selection of indicators when appropriate, in a perspective of adaptive monitoring and management over time. In the case of SPI evaluation, the review of indicators selection can be coupled with the periodic review of sustainable tourism strategy planned every five years according to the European Charter procedure.

Further development of methodology should be the validation of the model, with the aim of highlighting the role of each issue considered, to investigate the possibility of compensation between the scores of different issues (e.g. environmental and economic aspects) in the final comprehensive evaluation. The assessment at local scale, indeed, can be performed also analysing single aspects in detail, but, if you want to compare the scores of several areas, you have to be aware of the role of single indicators in defining the final result, to avoid giving unreliable information to decision makers (OECD, 2008).

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4. Forestry

4.1 Forest resources and biomass use

As highlighted in the introduction of this work, natural resources play a relevant role in supporting human activities, but since the 1970s, some concerns have been raised about the long-term availability of these resources, especially the ones that are non-renewable on human time-scale, and the sustainability of their use.

There are three main kinds of natural resources that can be identified (Reijnders 1999, Chapman 1983): continuous resources such as sunlight and wind, the use of which does not lead to a reduction in their size; renewable resources, such as wood and crops that can be harvested – but not faster than their rate of replenishment; and non-renewable resources such as fossil fuels and minerals. In addition, resources as clean water, fertile soils and biodiversity, given the time required for their recovery, can also be considered to be non-renewable and non replaceable (e.g. through technological improvement or economic investments). From this point of view, forest biomass can be considered a renewable resource since the harvesting is made in a way that respect the limit posed by the rate of renewal of the forest.

Forests can have

- an ecological role in carbon storage, protection of soil and water, protection against soil erosion, desertification and natural hazards;
- a social role in providing amenities and recreation in urban and rural areas and creating employment in rural areas;
- an economic role connected with the provision of biomass for bio-energy production and wood-based products industries.

Forest-based industries (industries producing pulp, paper, packaging and the woodworking industries like sawmills and wood-based panels firms) in Europe account for a production value of € 365 billion and have more than 3 million jobs in about 350.000 enterprises (source: COM (2008) 113 final).

Moreover, biomass presently accounts for about half of the renewable energy used in the EU and the European Commission in 2005 set a Biomass action plan that is expected to lead to an increase in biomass use about 150mtoe in 2010 or soon after (source: Biomass action plan, COM (2005) 628 final).

Nowadays, the use of biomass resources for energy production and non-renewable material substitution is recognized as helpful for reducing dependence from oil and for mitigating environmental pressures from these sectors, especially if biomass is used in optimized chains of cascading use (e.g. for wood, paper, plastics and energy from residues). However, if not managed in a sustainable way, the use of wood fibres as fuel and material can cause direct impacts from extraction and distribution (such as excessive harvesting leading to clearance, soil erosion, loss of forest area and loss of biodiversity in plantations and secondary forest) and disturbance to material cycles (such as the reduction of the carbon storage function). Therefore it is necessary that the choice to implement these activities is made taking into account their sustainability in a broader sense, considering, for instance, the

availability of resources at local scale and the overall impacts in a life cycle perspective and ensuring that forests are managed in a sustainable way.

4.1.1 Sustainable forest management in the European legislation

At the Ministerial Conference on the Protection of Forests in Europe (MCPFE) in 1993 the countries in Europe agreed that "sustainable forest management*" means "the stewardship and use of forests and forest lands in a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity, vitality and their potential to fulfill, now and in the future, relevant ecological, economic and social functions, at local, national, and global levels, and that does not cause damage to other ecosystems*". This concept was further developed through other political commitments, resolutions and declarations, including the policy guidelines for the sustainable management of forests in Europe, and is accepted by many other organisations in Europe as a conceptual basis for their activities.

The concept of sustainable forest management in Europe legislation perspective embodies forest protection, reforestation and afforestation. In addition, from an operational point of view, there is the need to protect forest ecosystems and to ensure sustainability of forest based activities also through a sustainability assessment of the different forest-based activities, industries and supply chains. One of the main challenges of forestry policy is, indeed, to find the right balance between the different functions that forests provide for society (the "**multifunctionality**" of forestry), giving priority to the most sustainable activities in the local context, which are able to ensure the sustainability of the whole system. Otherwise, the growing interest in using biomass from forests could, for instance, endanger the material resource availability for other uses of timber and an overall excessive harvesting of wood could affect the quality of forest ecosystems.

The European Commission adopted in 1998 an **EU Forestry Strategy** (1999/C 56/01) which underlined the importance of the multifunctional role of forests and the need for sustainable forest management (SFM). In March 2005, the Commission evaluated the implementation of this strategy and proposed to develop an EU Action Plan for Sustainable Forest Management (COM (2006) 302 final). Building on the Council Resolution of 15 December 1998 on a forestry strategy for the European Union, the **Forest Action Plan** provides a framework for forest-related actions at Community and Member State level and serves as an instrument of coordination between Community actions and the forest policies of the Member States.

The five-year (2007-2011) Action Plan has **four main objectives,** that should be reached through 18 main actions**:**

1. to improve the long-term competitiveness of the forestry sector;
2. to protect the environment;
3. to contribute to the quality of life;
4. to foster coordination and communication on these issues.

1) to improve the long-term competitiveness of the forestry sector

Competitiveness of the forest sector is a necessary basis for the multiple benefits that sustainable forestry provides to society. The forest sector has

great potential to further develop high-quality and value-added products and services for the diverse and growing demands of society based on a renewable raw material source. Research and technological development, diversification, innovation and investment in job quality and human capital are needed to develop a strong and dynamic sector capable of meeting the challenges of global change.

Actions related to this objective are:

a) Examine the effects of globalisation on the economic viability and competitiveness of EU forestry

b) Encourage research and technological development to enhance the competitiveness of the forest sector

c) Exchange and assess experiences on the valuation and marketing of non-wood forest goods and services

d) Promote the use of forest biomass for energy generation

e) Foster the cooperation between forest owners and enhance education and training in forestry

2) to protect the environment

Maintaining productive capacity, resilience and biological diversity are key factors in ensuring a healthy forest ecosystem. This, in turn, is essential for a healthy society and economy. Forests play an essential role in the realisation of the Community's objectives on sustainable development and the targets set in the 6th Community Environment Action Programme, including relevant Thematic Strategies.

Actions related to this objective are:

a) Facilitate EU compliance with the obligations on climate change mitigation of the UNFCCC and its Kyoto Protocol and encourage adaptation to the effects of climate change

b) Contribute towards achieving the revised Community biodiversity objectives for 2010 and beyond

c) Work towards a European Forest Monitoring System

d) Enhance the protection of EU forests

3) to contribute to the quality of life

Forests provide goods and services that benefit citizens, their health and their quality of life, including amenities and recreation in urban and rural areas, occupation and income for millions of people, protection of soil and water and protection against erosion, desertification and natural hazards.

Actions related to this objective are:

a) Encourage environmental education and information

b) Maintain and enhance the protective functions of forests

c) Explore the potential of urban and peri-urban forests

4) to foster coordination and communication about forest issues among the States

While forest policy is a competence of the Member States, many policy initiatives with an impact on the forest sector are developed at European level. Coordination between different policy areas in the Member States, between the Member States and the Commission, and within the Commission is particularly important for the forest sector.

Actions related to this objective are:

a) Strengthen the role of the Standing Forestry Committee (responsible for the exchange of information and the consultation)

b) Strengthen coordination between policy areas in forest-related matters

c) Apply the open method of coordination (OMC)[5] to national forest programmes

d) Strengthen the EU profile in international forest-related processes

e) Encourage the use of wood and other forest products from sustainably managed forests

f) Improve information exchange and communication

4.1.2 Criteria and indicators for sustainable forest management

To ensure the continued availability of goods and environmental services that forests ecosystems provide, there is the need to develop and implement tools by which the sustainability of forestry (forest management, use of wood biomass for energy production or wood-based industries, etc) can be assessed, monitored and reported as a basis for a more conscious choice between different options.

Criteria and indicators are commonly recognized as appropriate tools for defining, assessing and monitoring the effects of forest management interventions over time and the progress towards sustainable forest management (see, among others, FAO, 1996; Castaneda, 2000; Hickey et al, 2005; Gough et al, 2008).

The most important aspects to be considered in order to evaluate sustainability of different management options are (see also Sacramento-Rivero et al, 2009):

- Availability and quality of forest resources: the amount of wood resource that can be harvested without harming the quality of the forest ecosystem depends from the rate of renewal of forest biomass, from the spatial distribution of harvesting inside the forest and from the type of wood harvested. In order to be sustainable, harvesting should be made following a management plan based on a detailed analysis of the structure and the characteristics of the forest.
- Raw-materials performance. In order to be sustainable, bio-based processes must comply with the principle of 'local solutions for global

[5] The Lisbon European Council defined the OMC as a method to help Member States to progressively develop their own policies.

problems', so this criterion refers to how good the input materials are, with respect to the products obtained and to the possibility to substitute other material (e.g. not bio-based materials or imported wood). Aspects that can influence in the raw materials performance are their physical and chemical constitution, suppliers, geography, seasonality, demand, etc.

- Environmental impact. The use of forest biomass for bio-energy or bio-based industries is recognized as a new frontier of economically sustainable and environmentally friendly processes. Nevertheless, biological processes and bio-based products do not automatically implies the absence of environmental impacts. Every process, even if it is based on bio-materials, will have emissions, effluents and/or residues and so will have an environmental load, that has to be considered in a sustainability evaluation.
- Transformation-process performance. Sustainability of different technological opportunities can be influenced also by the feasibility (technical and economical) of the transformation processes involved in the specific context considered, especially with regard to the possibility to sustain the system at the local level (e.g. the possibility to satisfy specific technical requirements such as the minimum amount of biomass or the availability of technical skills without importing them from outside the local system).
- Economic performance. Economic profit is one of the main drivers that can influence the feasibility (i.e. the choice) of different use of forest biomass, so it is one of the factors that have to be considered in the evaluation of different opportunities of forest biomass use.
- Substitution capacity, i.e. the capacity that a forest-based process has to substitute non bio-based options, that are supposed to be less sustainable. Interest in bio-based products and in renewable energy sources has increased because of energy security concerns and environmental impacts of reliance on fossil carbon for fuels, chemicals and materials. The effectiveness of forest based activities in fulfilling this objective can be measured, for instance, through its ability to reduce environmental impacts and GHGs' emissions during its whole life cycle with respect to other solutions.
- Social influence. It is a measure of the impact (positive or negative) of operating a forest based activity in a given context, with special attention to the social dimension (e.g. acceptability of the industry, job opportunities created, impacts on local development).

Therefore, in evaluating sustainability of forest based activities, these aspects should be considered comprehensively, through a set of indicators that enables decision makers to compare different solutions. Aim of the analysis should be to find the most effective balance among the possible alternatives for forest management and wood related industries, trying to ensure multifunctionality of forest ecosystems and to identify possible synergies between different use, such as energy and material use of biomass, optimizing chains of cascade use (i.e. improving the use of residues of fellings and creating short supply chains integrating energy and material uses of wood biomass).

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4.2 Technology sustainability assessment to support decision making about energy production from biomass

(to be published)

V. CASTELLANI, S. SALA

ABSTRACT

Considering climate issues, Kyoto Protocol is the most important worldwide reference aimed to reduce greenhouse gases that cause climate change; going further, the recent European Climate and Energy Policy defines binding targets for 2020, that include increasing use of renewable (wind, solar, biomass, etc) to 20% of total energy production. In order to identify the most suitable strategies to reach this objective, an evaluation of some relevant aspects that can influence the sustainability of possible renewable energy solutions is necessary. This study focus on sustainability assessment of energy production from forest biomass, defining a set of indicators to provide a decision support system for local decision makers, enabling them to evaluate the environmental impacts, the resource availability and renewability, the feasibility of the technology in the local context and the social acceptance of the plant among the local community. The case study presented in this article refers to an Italian mountain community (Comunità Montana delle Alpi Lepontine) in northern Italy, where the assessment of environmental, economic and social sustainability of a plant producing electricity powered by Syngas coming from gasification of forest biomass was performed. The aim of the research was to assess the feasibility of the application and to define guidelines for sustainability assessment of technologies for energy production using forest biomass, identifying critical issues and potential areas for optimization.

Keywords: biomass, energy technology assessment, gasification, renewable energy, energy planning

1 INTRODUCTION

Climate change represents one of the greatest environmental, social and economic threats facing the planet: changes in the atmospheric concentration of Green House Gases (GHGs) are causing a rise in global temperature, with effects on the sea level, on the frequency of extreme weather events like droughts and floods, on agriculture and biodiversity, generating great impacts also on the socio-economic side (IPCC, [1]). To contrast these effects, there is the need of actions aimed to reduce GHGs concentration in the atmosphere through the cut of anthropogenic emissions.

Kyoto protocol, signed by 195 Countries in 1997 and entered into force in February 2005, is the operational instrument of the United Nations Framework Convention on climate change. The protocol requires Industrialized Countries and Countries with transition economies to reduce

for at least 5,2% main anthropogenic emissions of GHGs during the period 2008-2012. Moreover, European Council has recently enacted the EU's Climate and Energy Policy [2] providing a major contribution to reduce climate change impact and trying to overcome difficulties in reaching Kyoto Protocol's objectives. European Climate and Energy policy by 2020 fixes a set of actions encompassing: cutting energy consumption by 20% of projected 2020 levels by improving energy efficiency; cutting greenhouse gases by at least 20% of 1990 levels; increasing use of renewable energy sources (wind, solar, biomass, etc) to 20% of total energy production.

The European Environmental Agency assessed the quantity of the potential European environmentally-compatible biomass – the quantity of biomass that is technically available for increased energy generation that does not pose threats to biodiversity, soil and water resources and that is in line with other current and future environmental objectives. Preliminary results indicate that the potential of environmentally compatible primary biomass for producing energy could increase from around 180 Mtoe in 2010 to about 300 Mtoe in 2030 (considering the bioenergy potential from agriculture, forests and waste) (EEA, [3], EU Commission, [4]). Even if forest harvesting is a serious environmental problem at the global level (e.g. for deforestation in tropical areas), in some areas, and especially in Europe, a carefully planned forest management is needed to prevent abandon and degradation of these areas (Fujimori, [5]).

The term "Biomass" covers a very large and very heterogeneous number of organic materials, vegetables or animals, which involve different ways of energy production. Energy production may be directly through combustion or indirectly through, e.g. fermentation or gasification. The development of energy systems based on the use of biomass can be advantageous for the following reasons: widespread resources are available; biomass has the capacity to penetrate every energy sector: heating, power and transport; bio-fuels can be stored easily and bio-energy produced when needed; bio-fuels are generally bio-degradable and non toxic, which is important when accidents occur. Nevertheless, bio-energy expansion encounters several barriers: costs of bio-energy technologies and resources; amount of externalities included in the cost calculations which strongly affects competitiveness; resource potentials and distributions; local land-use and environmental aspects, especially in the developing countries; administrative and legislative bottlenecks (Eubia [6]).

Indeed, there are many biomass exploitation technologies, from the boiler to produce domestic heat to central heating plants and combined heat and electricity plants for cogeneration. Thermo-chemical energy conversion processes ("dry way") are mainly used for forest biomass: thermo chemistry conversion plants are based on combustion, gasification and pyrolysis processes. In addition, some forest biomass is properly appropriate for the gasification process due to some features such as high volatility, high reactivity of carbon, low ash and sulphur content; moreover, fuels used to power electricity generating engine can be obtained from biomass gasification and pyrolysis.

The use of biomass as energy source can be considered sustainable in relation to: the reduction of energy dependency on energy imports; the increased security of supply; the climate change mitigation; the zero emission of CO_2 in atmosphere in a global balance. Nevertheless, questions

about the benefits of bio-based processes of energy production have been raised by researchers (e.g. Kanzig [7], Goldemberg [8]), underlying that biological processes and bio-based products do not automatically implies better sustainability performance and that an overall impact assessment, that takes into account resource limits, rate of consumption and indirect effects, has to be conducted in order to assess sustainability of the whole process and of the technology involved.

A discussion paper of the Wuppertal Institute ([9]) has recently highlighted the need for an integrated assessment to derive guidelines for a sustainable biomass strategy. It is not possible to assume a positive balance for processes based only on the fact that they are bio-based, but it is necessary to perform exhaustive studies in a life cycle perspective, considering also site-specific characteristics (e.g. the local availability of raw material and the distance from the processing plant to the delivery point) (Kim [10]).

1.1. Energy technology assessment

According to principle of subsidiarity, European Policy requires the involvement of local communities in energy planning at different level, so it is important for local authorities to be aware of the benefits and costs of different energy strategies, in order to find the most sustainable solution for their context, considering the economic, environmental and social perspective. This means that they need suitable instruments to assess sustainability of different policy scenarios, with specific reference to the sustainability of different kind of technological solutions for energy production at the local level.

Technology Assessment, as defined by the Society of German Engineers (VDI, Verein Deutscher Ingenieure) (VDI, [11]), is “the planned, systematic, organized procedure that analysis the state of a technology and its possibilities, estimates direct and indirect technical, economic, health, environmental, human, social and other consequences of a technology, and possible alternatives, evaluates these consequences or call for other desirable developments based on defined goals and values, recommends possibilities for action and design to make reasoned decisions possible and realizable through appropriate bodies”.

Energy technology assessment related to biomass use can be a useful tool for helping different decision-makers and stakeholders to understand which role biomass exploitation technologies can have in their energy policies and for supporting the decision-making process in moving towards a sustainable energy future. Moreover, energy technology assessment applied to a specific context can help to identify which are the strengths and the weaknesses of the system under evaluation, with the aim to highlight critical issues and potential areas for optimization in order to improve the sustainability of the system.

In fact, to ensure the best result in term of sustainability of the implementation of a technology for energy production from wood biomass, local authorities (acting as decision makers in authorizing or not the plant) has to choose the best (and feasible) option about the site, the size and the technology used for the plant. This implies considering various factors such

as the availability of wood biomass in a limited range of distance from the hypothetical site of the plant; the abundance of the biomass available for harvesting (amount of wood that can be harvested without stressing the forest renewal capacity) in order to define the most suitable size of the plant; the accessibility of the infrastructures that allow to carry the wood out from the forest and to the site; the economic sustainability of the plant (considering also possible incentives for renewable energy production) referred to the possible size options, etc.

Therefore there are lot of information, coming from different disciplines, that have to be evaluated in an integrated manner to define possible scenarios and to be translated into a usable format for appropriate decision makers (e.g. public authorities that wish to define a sustainable energy strategy at local level or private businesses that want to invest in sustainable energy production).

Considering the complexity and the multidimensional features of this kind of assessment, a Decision Support System (DSS) can be a useful tool for the evaluation; DSS can be defined as interactive systems able to produce data and information and, in some cases, even promote understanding related to a given application domain in order to give useful assistance in resolving complex and ill-defined problems (Cavallaro, [12]). To produce relevant information for decision making about the sustainability of the options under evaluation, the DSS has to be composed by a multidisciplinary set of indicators considering environmental, economic and social sustainability aspects; moreover, the definition of sustainability indicators helps to introduce quantification, measurability and comparability in technology assessment studies (Jischa, [13]).

This article presents a DSS for sustainability technological assessment of forest biomass use for energy generation at local level, that takes into account the specific local conditions: the methodology leads to the definition of a set of sustainability indicators based on local environmental, economic and social context, with the aim of enlarging the perspective of evaluation and shifting from a theoretical comparison of different technologies (as it is, for instance, in Evans [14]) to a more practical assessment of technology feasibility and sustainability in a specific context.

2 METHODOLOGY

The methodology developed for this study defines an integrated sustainability analysis process about the implementation of a system for energy use of forest biomasses, in order to address the decision making process towards the most sustainable option referring to the local context. To choose the best alternative in term of environmental, economic and social performance a comparison should be done among a number of different technologies. Considering forest biomasses, as can be derived also from literature (see, for instance, [15]), main criteria to evaluate sustainability of the technological solutions can be identified in: use of local resource considering carrying capacity of the system; short supply chain (defined following the Italian legislation reference of the resource use within 70 km distance from forest to production/supply site), greenhouse gases

compensation ability, level of environmental impact, financial profitability, capacity to generate positive economic and social effects in the local context.

In literature there is a considerable number of studies assessing the impact of RES (renewable energy sources) deployment and evaluating the amount of materials used in relation to the energy produced by a specific RES energy system [16], but only some attempts to integrate environmental, social and economic aspect in RES assessment have been made [Del Rio 17]. Moreover, besides the environmental benefits and the economic incentives provided by international, national and regional programmes for RES development, there are some other factors that can strongly influence the decision about whether or not to implement a plant using RES, such as the economic profitability and the investment rate of return, (Del Rio, [18]), and the acceptability of the plant from the local community (Assefa, [19]).

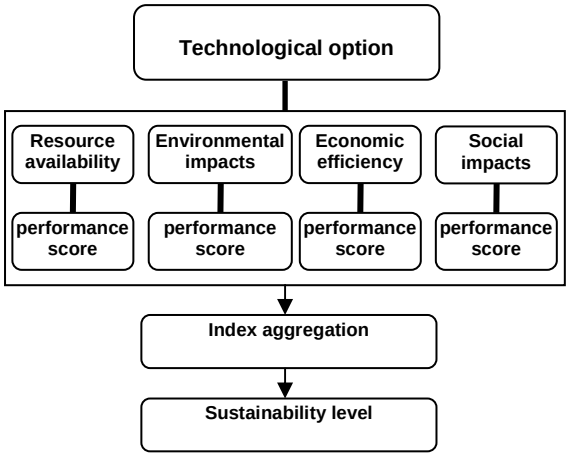
Therefore the evaluation is made through a set of indicators about technological efficiency and environmental, economic and social sustainability, some of which specifically developed referring to the analyzed case study, aimed to assess environmental, economic and social sustainability of biomass use for energy production in the local context. For each indicator a specific procedure for the implementation and the evaluation of the performance has been developed; the final result is the evaluation of the overall sustainability of the system considered and the assessment of the optimum level of development reachable from the system considering the existing conditions.

The main phases of the technology sustainability assessment methodology developed for this study may be summarized as follows:

1. development of a conceptual model for the assessment
2. analysis about available technological options for biomass exploitation to populate technological efficiency indicators
3. definition of the indicator set (composed by environmental, economic and social sustainability indicators)
4. analysis about local resources (to evaluate their energy content) analysis of environmental, social and economical condition to populate indicators of: resource availability; environmental impact; economic efficiency; social impact related to the specific technological option
5. definition of an optimum of application based on benchmark and literature values
6. score attribution to each indicator, referred to the level of achievement of the optimum and development of an aggregated index measuring the comprehensive sustainability of the system
7. comparison among the sustainability level achieved by each technological option under evaluation.

Figure 1 shows the conceptual scheme for sustainability assessment according to our methodology.

Figure 1 - Technology Sustainability Assessment



Following the steps illustrated before, a set of specific indicators is developed to assess the performance of a number of potential technological options for energy production using forest biomass. The approach adopted derives from multicriteria analysis techniques for decisions on projects/systems that may have potential environmental impacts. For the evaluation of each specific indicator, the methodology uses quantitative cardinal scales, which are a tool for multi-criteria analysis application where all the indicators are related to a conventional scale with the aim to allow comparability between different criteria and to reduce heterogeneous measures to comparable values [20]. Moreover, the use of cardinal scales can be useful in evaluation of sustainability through a set of indicators because single indicators refer to different areas of investigation not directly comparable such as environmental, economic, social and technological issues.

In the present study some of the indicators composing the set established for evaluation are directly related to the specific technological application under evaluation, while others depend on the local context (environmental, economic, social and political features) in which the technology has to be implemented.

The indicators composing the set are individually assessed by comparing the value obtained in the specific case study with potential value of optimum situation of implementation. Indices that refer to a conventional scale that takes values from 0 to 1 were associated to indicators values, depending on the performance of assessed indicator (value x) compared to the performance of potential optimal solution (value 1). Finally, the comprehensive sustainability level achieved by the technological option derives from the score level of each indicator composing the set and it is expressed as a percentage of achievement referred to the optimal condition that can be reached according to the specific conditions of the local situation. The following equations illustrate more in detail the aggregation method that is used for the assessment: the sustainability of each issue is assessed in percentage terms by summing the standardized indices of each indicator and comparing this value with the sum of standardized indices of potential optimal situation:

Sustainability level of dimension i = ($\sum x / \sum x^1$) x 100

Sustainability of the technology = [$\sum$ (xi) / $\sum$ (xi1)] x 100

x = value measured;

x1 = reference value (optimum)

i = sustainability dimension considered (environmental, economic, social, technological)

The following paragraphs illustrate the indicators composing the set and the reference values adopted for defining the optimum to which the performance of each indicator has to be compared in order to assess the sustainability level of the system under evaluation.

2.1 Technology indicators

Considering that the technology used for energy production is one of the most relevant aspects that determine the efficiency of the system and the level of environmental impacts (including either resource consumption and the amount of emissions generated), a specific group of indicators for taking into account some relevant aspects related to the technology adopted is developed. It includes: energy efficiency of the technology under evaluation; minimum amount of biomass required by the technology used and avoided CO_2 emissions.

Energy efficiency of the technology under evaluation. The thermal and energy potential of the resource stock that we would like to exploit (which is one of the element that it is necessary to know for the evaluation of the sustainability of the system in a long term period, in addition to the amount of stock available) depends from the energy efficiency of the technology that it is supposed to be use in the conversion from heat to electricity. The electricity energy efficiency is measured in electric kiloWatt per hour (kWh_e) produced with every kilogram (kg) of biomass used. The efficiency of the technology under evaluation is compared with the average efficiency of the technologies current available in the market, which is 0,5 kWh_e/kg.

Minimum amount of biomass required by the technology used. It refers to the necessity to provide a minimum amount of biomass in order to ensure the best performance of the plant under evaluation; it depends obviously from the technical features of the technology chosen. The value is compared with the actual amount of biomass available within the short supply chain condition (i.e. using biomass coming from local forests). The information coming from this evaluation are needed for the assessment of the environmental indicator “Biomass availability”, in order to compare the amount of biomass needed and the amount of biomass available for exploitation at local scale.

2. 2 Environmental indicators

2.2.1 Indicators about biomass resource

The type and the amount of the biomass available for energy production can determine the feasibility and the efficiency of the system under evaluation,

especially with reference to the availability of a local biomass stock that allows the system to be self sufficient (i.e. not to depend from imports from outside the area, that can generate significant impacts especially due to the emissions coming from the transport from the source to the plant); moreover, it is necessary to consider that due to different values of energy content in the raw material, some types of biomass can have an higher energy content, i.e. an higher potential for energy production per mass unit, i.e. can be more suitable for energy production. Thus, indicators about biomass resource included in the set for environmental sustainability assessment refers to: biomass availability; energy content of the biomass; possible environmental impacts.

Biomass availability. To determine how much biomass is available for energy use it is necessary to know which is the rate of available biomass in the area that can be used without depleting the natural capital (i.e. which is the carrying capacity of the local forest system). There are two kind of information needed for this evaluation: the total amount of biomass in the area and the rate of renewability of the stock (considering also that there could be other forms of exploitation of wood biomass already insisting on the same area).

Moreover, it can be interesting to consider also the possibility to use non-homogeneous biomass, including residues coming from forestry and agriculture activities and from the organic fraction of urban waste [21, 22]; currently it is not easy to assess the availability of the first type of residues, while there is a good monitoring about urban waste (and about the amount and quality of their organic fraction, including also garden residues) in the municipalities that have a separate collection system for this kind of waste.

Biomass energy content. The amount of energy embedded in the biomass can be expressed as kilojoule (kj) or kilocalories (kcal). To evaluate the effective energetic value of the biomass available it is necessary to consider the Lower Heating Value (LHV), that corresponds to the amount of heat generated during combustion for every single mass unit of biomass which is combusted and is expressed in kj/kg. Multiplying the LHV for the amount of biomass available (kg), it is possible to calculate the energetic value of the biomass (kj) that a specific area can provide. This value is compared with the total amount of energy consumption in the area object of the study, to evaluate to which extent this plant can contribute in providing the energy required (the values are expressed in tonnes of oil equivalent, toe, to be comparable).

2.2.2 Environmental impacts

Environmental impacts. The environmental impacts associated with biomass use for energy production have to be evaluated considering the technology used, the characteristic of the biomass and the specific conditions of the area. The possible impacts identified have to be evaluated referring to the existing environmental regulation, considering air, water, soil and biodiversity.

Avoided CO_2 emissions. Considering that biomass use for energy production is intended as a way to reduce the dependence from oil products and to reduce CO_2 emissions from combustion, for the sustainability evaluation it is

necessary to quantify the amount of CO_2 emissions avoided in respect to traditional energy plants. The method used in this study to evaluate avoided CO_2 emissions was developed by ENEA (Italian National Agency for New Technologies, Energy and Sustainable Economic Development) and considers energy conversion efficiency of the technology used (ENEA, [23]).

During all the processes for energy production starting from fossil sources, carbon contained in the fossil fuel is totally transformed in CO_2 due to the reaction with the O_2 contained in the air; the rate of conversion depends from the amount of carbon contained in the fuel, so for each kind of fuel it is possible to identify a specific "CO_2 conversion factor", that defines how much CO_2 is produced per unit of fuel combusted. Table 1 illustrates the CO_2 factor for the most common types of fuel. It is important to note that in the case of biomass, the combustion generates CO_2 coming from the amount of carbon contained in the biomass, but that this carbon has been subtracted from the atmosphere and fixed by the vegetation, so this can be considered as a closed loop that doesn't contribute to the increasing of the total amount of CO_2 in the atmosphere; for this reason, the CO_2 factor ($F(CO_2)$) for biomass is considered equal to zero.

Table 1 – CO_2 factor for different energy sources

Fuel	$F(CO_2)$
Natural gas	205
Oil	255
Coal	340
Biomass	0

Considering the CO_2 factor it is possible to estimate the amount of CO_2 emissions generated by a specific energy production plant, simply calculating the ratio between the factor and the value of electric efficiency, according to the following formula:

$E(CO_2)=F(CO_2)/ Eff$

Where:

$E(CO_2)$ = emissions (kg/MWh_e)

$F(CO_2)$ = CO_2 factor of the fuel

Eff = electric efficiency of the plant.

Comparing the value of electric efficiency of the plant with a mean value of a traditional technology producing electricity from fossil fuels, the indicator is calculated as a percentage of emissions avoided due to the use of this technology instead of a traditional one.

2.2 Logistics indicators

Logistics plays a relevant role in determining the environmental impacts (e.g. GHG emissions due to transport) and the economic efficiency of the system: difficulties in accessibility to the forest can generate higher costs for biomass extraction and energy production, resulting in lower competitiveness of the entire system. Logistics indicators selected consider the accessibility of the forests that are supposed to provide wood biomass for the plant and the

distance from these sites to the plant site (i.e. the length of road transport that the system implies).

Forest accessibility. The indicator refers to the spatial characteristics of the forest in order to evaluate the accessibility and the possibility to easily reach the biomass that has to be harvested. The indicator considers the percentage of forest roads that is accessible to trucks (the optimum for accessibility is fixed in 100%) taking into consideration the slope of the areas and the characteristics of the road network into the forest and in the surroundings.

Biomass transport. One of the aims of the implementation of a biomass energy production system is the valorisation of the local forest in order to create a short supply chain and to reduce the impacts generated by the transport of the fuel. Thus it is important to consider the total distance from the various extraction points to the site of use (the site where the plant is) in order to verify if this aim could be fulfilled by the system considered. The methodology includes two evaluations about transport: the first regards the number of trips that a truck loading 50 m^3 of biomass should take and the second regards the distance from the extraction points to the plant site. For the evaluation of the indicator in the case study presented in this article, the mean distance value for the system is compared with a reference value of 70 km, which is the maximum distance allowed for transport within a short supply chain from the current legislation in Italy.

2.2 Economic indicators

Besides the considerations about the environmental sustainability of a energy production plant using local forest biomass in a short supply chain, the economic viability of the entire system (cost of biomass and of the technology compared to the foreseen profit) is a crucial point in determining the decision of entrepreneurs or public authorities about whether or not to implement it in a specific area. For this reason, to be effectively useful for local decision makers, the decision support system has to necessarily include indicators about economic sustainability, i.e. to evaluate costs and benefits that the system can generate in the specific context considered. The indicators included in our methodology refers to: cost of the biomass, cost the technology, labour cost, production cost per energy unit, cost of emissions mitigation and profits (including possible incentives for renewable energy).

Energy production cost. The final cost of energy production per energy unit is calculated dividing the total costs of the system (including cost for the technology, cost of the biomass and labour cost) per the amount of energy produced. The final cost (€/kWh_e) is then compared to the cost per kWh_e of electricity production with traditional technologies.

Economic profitability of the system. The indicator evaluates the profitability of the system considering the predicted cash flows and the time for investment pay off and profit generation by the system (evaluating the profits coming from selling the energy produced and the possible economic incentives for using renewable sources in energy production).

Labour cost. To estimate labour cost for the entire system, it is necessary to consider the exact number of people employed (for forest management,

harvesting, biomass transport and energy production) and their salary (according to the national contract standards for each sector).The indicator measures the role of labour cost with respect to the total cost of the system.

Cost for CO_2 reduction. The cost is calculated dividing the total cost of the system per the amount of avoided CO_2 emissions.

2.3 Social indicators

Considering that one of the objectives in establishing a short supply chain using local wood biomass is to provide also social benefits to the local community through the valorisation of the forest and the creation of labour opportunities, it is important to evaluate the social sustainability of the system that is going to be created. Social sustainability indicators consider: social acceptability of the intervention, labour opportunities, the role of local actors and land ownership (public or private) of the areas that should provide biomass.

Social acceptability. Evaluation of the attitude of the local community towards the energy production plant through sample survey among the population. The indicator considers the percentage of agreement expressed by the interviewees.

Creation of job opportunities. The indicator evaluates the social benefit in term of new job opportunities created by the implementation of the system. It consists in a qualitative evaluation; the classes for evaluation are: no job opportunities = 0; part time job positions = 0,5; full time job positions = 1.

Actors involved. The indicator evaluates the feasibility of the system considering the availability of qualified actors able to implement the whole system in the local context (e.g. SMEs for harvesting and logging).

Homogeneity of forest ownership. The ownership of the forest that should provide the biomass is a crucial point in the evaluation of the system, especially regarding the price of biomass (a public owner could decide to use the biomass for a public plant with no additional costs, as is it for the case study presented in this article, while in the case of areas belonging to private owners, it would be necessary to verify the willingness to sell the biomass and its possible price). The indicator measures the percentage of homogeneity distribution of public and private areas (assuming the a fragmented path can reduce the feasibility of the system).

3 CHARACTERISTICS OF THE CASE STUDY

The case study presented in this article refers to the sustainability assessment of the implementation of a wood biomass based energy production system in the Alpi Lepontine Mountain Community (CMAL), which is a mountain area of Lombardy Region, in Northern Italy.

Alpi Lepontine area has an extent of 18.469 ha; the territory is mainly mountainous and includes 6.844 ha of forest, essentially not managed; currently, wood biomass is used predominantly in domestic biomass heating systems, which are characterized by a very low efficiency and generate a lot

of fine particulate matter emissions. For this reason, local authorities are interested in evaluating innovative uses for energy (heat and electricity) production using wood biomass, especially for public buildings supply.

The system under evaluation in this study consist of a combined heat and electricity production plant, using Syngas obtained from wood biomass gasification; the plant is composed by modules with a power size of 250kW and it is supposed to use biomass coming from the local forests managed by public authorities, according to the management plans defined by the local forest management office. Based on the results of a preliminary meeting with a technical expert and some representatives of the Regional Agency for Forest Management (ERSAF) about the most efficient working conditions for the plant and the possible amount of biomass available with respect to the carrying capacity of the local forest ecosystem, the following hypothesis for the system has been defined: plant constituted by one module of 250 kW power size, working 8.200 h/year (the remaining 560 hours left for maintenance operations), needing 2.132 t/year of dry wood biomass as raw material and producing 2.050 MW/year of electricity.

The sustainability of this hypothetical system that should be implemented in the Alpi Lepontine Mountain Community has been analyzed according to the methodology illustrated in section 2 in order to evaluate its feasibility and sustainability in the local context and to provide useful information to local decision makers about possible threats (especially referring to environmental impacts and excessive biomass exploitation) and possible improvements of the system before its actual implementation.

4 RESULTS

The set of indicators presented in section 2 was applied to Alpi Lepontine Mountain Community area, in order to support the sustainability assessment of the energy production system designed for the area and illustrated in section 3.

The following tables illustrate for each sustainability issue (environmental, economic and social) the indicators' classes and the score assessed for the case study. In addition, the performance of the area of study for each issue is compared with the reference value of the optimal solution, assumed as a 100% score and obtained by the sum of the best performance for each indicator (shown by a grey cell in the table).

As the tables show, some of the indicators included in the methodological framework cannot be evaluated because of the lack of information about those issues. Nevertheless, this lack of information was included in the evaluation and considered as a negative contribution to the sustainability of the system, applying a precautionary principle. For this reason, social sustainability of the system is scored as 16% of the optimal condition instead of 50%, as it would be if referred only to the optimal score of the accounted indicator.

Table 2 – Environmental indicators

ENVIRONMENTAL INDICATORS		Reference values	Scores	Score for the case study
TE	Technological efficiency	No info	n.a	
		0 – 0,25	0	
		0,26-0,50	0,25	
		0,51-0,75	0,5	
		0,76-0,99	0,75	
		> 1	1	**2**
BA	Biomass availability (ratio between availability and needs)	No info	n.a	
		0 – 0,25	0	
		0,26-0,50	0,25	
		0,51-0,75	0,5	
		0,76-0,99	0,75	**0,89**
		> 1	1	
AE	Avoided CO_2 emissions	No info	n.a.	
		0%	0	
		0,1-3%	0,25	**0,3**
		4-10%	0,5	
		11-20%	0,75	
		> 20%	1	
EI	Environmental impacts	No info	n.a	
		Impacts beyond law limits	0	
		Impacts within law limits	0,5	**0,5**
		Negligible impacts	1	
FA	Forest accessibility	No info	n.a	
		No paths	0	
		Paths partially accessible	0,5	**0,5**
		Paths totally accessible	0,75	
		Dedicated paths for harvesting	1	
BT	Biomass transport	No info	n.a	
		> 80 km	0	
		51-80 km	0,5	
		6-50 km	0,75	**11,6**
		0-5 km	1	
Optimal solution			**6**	**100%**
Case study			**3,75**	**62%**

Table 3 – Economic indicators

ECONOMIC INDICATORS		Reference values	Scores	Score for the case study
PC	Energy production cost	No info	n.a	
		0-0,25	0	
		0,26-0,5	0,25	
		0,5-0,75	0,5	**0,43**
		1	0,75	
		>1	1	
EP	Economic profitability	No info	n.a	
		0 – 0,99	0	
		1	0,25	
		1-1,5	0,5	
		1,6-2	0,75	
		> 2	1	**2,78**
LC	Labour cost	No info	n.a	
		>1	0	
		0,61-1	0,25	
		0,2-0,6	0,5	**0,56**
		0,1-0,2	0,75	
		0	1	
Optimal solution			**3**	**100%**
Case study			**2**	**66%**

Table 4 – Social indicators

SOCIAL INDICATORS		Reference values	Scores	Score for the case study
SA	Social acceptability	No info	n.a	**n.a.**
		0-30%	0	
		31-50%	0,25	
		51-75%	0,5	
		76-99%	0,75	
		100%	1	
JO	Job opportunities	No info	n.a	
		No jobs	0	
		Part time jobs	0, 5	**0,5**
		Full time jobs	1	
FH	Homogeneity of forest ownership	No info	n.a	**n.a.**
		<30%	0	
		30-60%	0, 5	
		61-100%	1	
Optimal solution			**3**	**100%**
Case study			**0,5**	**16%**

Table 5 – Comprehensive result of sustainability technology assessment in Alpi Lepontine

Optimal solution		**12**	**100%**
Case study		**6,25**	**52%**

The environmental and economic sustainability performance of the system under evaluation is quite good (respectively 62% and 66%) even if there are some aspects that has to be improved (e.g. environmental impacts), while the social sustainability is very low (16%), especially because of the lack of information about this issue, as explained before.

As for the comprehensive evaluation of the sustainability performance of the technological solution under evaluation, which is obtained aggregating the total results for environmental, economic and social issues as explained in section 2, the sustainability level achieved is 52%; it means that there are several aspects that should be improved before the system can be implement in the area and generate positive effects.

An overview of the scores obtained by the indicators composing the set (Table 6) can help to identify which are the issues that ensure higher sustainability performances and which are the ones that need further development in order to improve their sustainability performance (i.e. to improve sustainability of the system under evaluation).

Table 6 – Summary of indicators' scores

Indicator	**Sustainability level**	%
TE		100
BA		75
AE		25
EI		50
FA		50
BT		75
PC		50
EP		100
LC		50
JO		50

Even if TE (technological energy conversion efficiency) and EP (economic profits) get a sustainability level of 100%, BA (biomass available for energy production) gets 75% and indicators depending from local condition such as FA (accessibility related to forest paths), and JO (ability to create profitable job opportunities for the local community) gets only 50%. This means that, even if the technology is efficient and profitable, its implementation in the area of Alpi Lepontine could encounter some difficulties due to the local conditions and thence result in a system less sustainable than the optimal one.

Thus, in order to improve sustainability of the system that has been designed by local decision makers, it is necessary to identify solutions to overcome the limits highlighted by the assessment, such as, for instance, a deeper investigation about social acceptability of the plant and the involvement of local businesses to find the way to make the projected system an chance for job creation and local development improvement.

5 CONCLUSIONS

The shift to renewable energy is one of the current major tasks in facing climate change and promoting more sustainable production and consumption patterns in the energy sector, especially if referred to small scale plants using local resources in a short supply chain and providing opportunities for sustainable development at local scale. Nevertheless, the sustainability of this kind of systems has not to be taken for granted in all the operational condition, so a detailed sustainability technology assessment of the design system for energy production has to be performed with the aim to prove useful information for local decision makers and to support their decisions about the choice of the optimal solution for the local context.

Moreover, it has to be recognized that besides environmental sustainability, the economic profitability (which is related also to the technical feasibility in the local context) and the social acceptability of the system can be crucial factors in determining the choice about whether or not to implement a specific technology in a specific area, so the sustainability evaluation should consist in a comprehensive assessment of environmental, economic and social sustainability of the entire system under evaluation.

Thence the Decision Support System presented in this paper can be considered an operational and easily understandable tool for the sustainability evaluation of a local plan for biomass use in energy production. One of the most interesting aspect of this methodology is that it is possible to identify strengths and weaknesses of the system under investigation, supporting decision makers in the definition of actions able to improve sustainability with an optimal cost-benefit effectiveness.

Moreover, the methodology focuses on the feasibility assessment of the implementation of a specific technology in a specific area, considering all the relevant aspects in the local context (e.g. local biomass availability, community acceptance, environmental impact, economic costs, etc) in order to perform a sustainability assessment which considers not only the performance of the technology under evaluation in an ideal optimal condition, but also highlights the existing operational limits for an effective implementation in the area under investigation.

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4.3 Integration of LCA and C-Lean to support the evaluation and optimization of a short supply chain for wood forest uses

(to be published)

S. Sala, V. Castellani

Abstract
The challenge for developing a "green production oriented economy", is the definition of sustainable production and consumption models which are able to enlarge the current approach, oriented to the greening of single production, towards the creation of a comprehensive sustainable system, involving and integrating different supply chains in the same geographical district. The present work illustrate an attempt to create a short supply chain in Lombardy region, integrating forest management, furniture production, recycling of production residues and energy production with the aim to optimize materials and energy flows and to reduce the overall impact on environmental compartments, taking into account strategic and economic perspectives and evaluating limits and opportunities of a local system compared to traditional market models. Sustainability evaluation of this kind of systems needs a comprehensive set of tools for the analysis because it is supposed to address a wide range of questions about environmental sustainability (e.g. availability of natural resources and carrying capacity of the ecosystems that should provide them), economic sustainability (e.g. the economic feasibility of the supply chain and its possible competitiveness) an social sustainability (e.g. the ability to create new job opportunities and to foster local development). Thus, in the present work the overall process optimisation is based on the integration of two methodologies coming from different disciplines: a strategic production planning tool (Lean thinking), originally developed for the economic optimization of production processes and then enlarged to the optimization of eco-efficiency performances (C-lean) and the Life Cycle Thinking (LCT).

Introduction

The necessity of a more sustainable approach to production and consumption patterns has been widely highlighted by international resolutions and directives as a way to promote sustainable development in daily life activities. For example, in the EU SDS, a specific role is assigned to sustainable production and consumption patterns (i.e. Integrated Product Policy (IPP) and related toolbox, the Thematic Strategy on the Sustainable Use of Natural Resources and the Thematic Strategy on Waste Prevention and Recycling).

Final purpose is the definition of instruments and strategies that enable producers to decoupling economic growth and resource exploitation: current European policies for the industrial sector are aimed to develop economic activities oriented to a low CO_2 emission economy, to the sustainable use of natural resources, energy and raw materials, and to the substitution of hazardous compounds in the production cycle. Eco-innovation is, thence, based on the ability to develop consumption and production solutions that

are energetically efficient, and that assure an optimization of matter cycles through industrial processes which are reversible and with low energy loss. In this context, eco-innovation could be intended not only as the development of End of pipe and/or Clean technologies but also as the production, assimilation or exploitation of a product, production process, service or management or business methods that is novel to the firm or user and which results, throughout its life cycle, in a reduction of environmental risk, pollution and other negative impacts of resources use (including energy use) compared to relevant alternatives (Kemp and Pontoglio 2007).

Indeed, eco-innovation strategies start from a reframing of the production system through its whole lifecycle, promoting life cycle thinking approaches, with specific reference to materials, energy and flows (ISO, 1997); furthermore, recent approaches integrate more features about sustainability (Westkämper, 2001), introducing social issues and consumption patterns (Hertwich E.G, 2005).

Considering the issues illustrated before, the creation of short supply chains can help to reduce some relevant impacts (e.g. emissions coming from transport) even if there are some management concerns that has to be addressed, especially in the case of extensive and complex supply chains.

From the methodological point of view, Life Cycle Assessment represents a useful tool for the investigation of impacts and the identification of more sustainable solutions within the whole supply chain (from the choice of raw materials to the delivery services and recycle or waste processing) (Hertwich E. G., 2005) and has been identified as a useful methodology for this field of research also during the World Summit for Sustainable Development held in Johannesburg in 2002. Nevertheless, LCA it is not sufficient for a comprehensive sustainability assessment, especially considering the following issues: firstly, results of a LCA analysis could be difficult to understand from decision makers (local authorities, entrepreneurs and citizens in their role of consumers) because they refer to specific categories of impacts, that are not easily referable to the local situation and to tangible effects (e.g. acidification, depletion of ozone layer, etc.); secondly, LCA does not provide a unique final value of impact that can be used for benchmarking different solutions (Udo de Haes et al., 2004) and thirdly, life cycle assessment refer mainly to environmental issues and need to be integrated with other tools to make a comprehensive assessment of environmental, economic and social sustainability of different solutions in order to provide useful information to support decision making.

Life Cycle Thinking and its related instruments are fundamental for eco-innovation of products and processes, while the economic feasibility and the identification of solutions able to optimize the overall efficiency of the supply chain need to be supported by other kind of instruments, able to evaluate economic and social aspect influencing the management efficiency of the supply chain (e.g. existence of local businesses that can realize all the activities in the supply chain, availability of specific labour force, etc.)

Within this context, studies on existing and on designed supply chains helps to identify applicable solutions (from the choice of raw materials to the delivery services and recycle or waste processing) and to develop practical guidelines for transferring scientific results to companies, especially Small and Medium Enterprises (SMEs). SMEs represent a relevant part of the

whole European industrial sector and therefore should have a relevant role in promoting and implementing eco-innovation (COM (2005) 551); nevertheless, the characteristics of SMEs entail some practical difficulties and limits: the small number of employees, for instance, can determine a limited accessibility to information about innovation policies and instruments (e.g. because there is not a person able to speak foreign languages) and to international and national networks spreading knowledge and promoting best practice. For this reason, it is important to find new ways to reach this kind of enterprises, e.g. involving clusters of them such as trade associations or supply chains.

Following this approach, the present work illustrate an attempt to create a short supply chain in Lombardy combining the efforts of two consortia of SMEs (Consorzio Forestale Lario Intelvese, consisting of SMEs working on forest management, harvesting and logging, and Progetto Lissone, consisting of SMEs working on furniture design, production and selling); the project is intended to integrate forest management, furniture production, recycling of production waste and energy production with the aim to optimize materials and energy flows and to reduce the overall impact on environmental compartments taking into account strategic and economic perspectives. The idea is to support a group of companies willing to work on the sustainability concept with environmental knowledge and to put the conveyed knowledge into every-day practice, involving the whole related supply chain and rising awareness among the customers. Final aim is to provide a set of tools that enables to identify scenarios of business development and to define decision support systems, to improve awareness and responsibility of organizations that provide goods and of retailer and consumers.

The choice to develop a conceptual framework for a sustainable bio-based product supply chain comes from the consciousness that interest in bio-based products and in renewable energy sources has gradually increased because of energy security concerns and environmental impacts of reliance on fossil carbon for fuels, chemicals and materials. The valorisation of biomass components is recognized as a new frontier of economically sustainable and environmentally friendly processes. Nevertheless, questions about the benefits of bio-based products have been raised by researchers (e.g. Kanzig et al., 2003), underlying that biological processes and bio-based products do not automatically implies less use of non-renewable resources; moreover, not all the bio-based products are biodegradable, so also the end-of-life phase should be deep analyze in sustainability accounting. Thus, it is important that the choice of bio-based products and processes is supported by an overall evaluation made according to the Life Cycle Thinking. A benchmarking that considers, for instance, the cumulative energy of each kind of production, would be influenced not only from the type of biomass used, but also from energy sources used for production (in case of agricultural biomasses), collection and processing of the raw material, transport to the processing plant, product use and product disposal (Bi et al, 2007). There are several studies about the life cycle impact of ethanol produced from corn grain that reported a negative net energy result (Pimentel, 2002; Ulgiati, 2001), while other studies, considering different conditions of corn yields, ethanol conversion technologies, fertilizer application rates, etc., found a positive net energy for ethanol (Wang et al., 1999; Shapouri et al, 2002). This difference testifies that it is not possible to assume a positive balance for products based only on the fact that they are

bio-based, but it is necessary to perform exhaustive studies in a life cycle perspective, considering also site-specific characteristics (e.g. the local availability of raw material and the distance from the processing plant to the delivery point) (Kim et al, 2004). Following this perspective, the choice of bio-based products should be considered sustainable and environmentally friendly only if is supported by a life cycle analysis that testify their sustainability in energy efficiency, total material requirement, use of hazardous compounds during the whole process, etc.

Moreover, also the feasibility and the economic viability of the system has to be considered, to ensure that the goods or services provided by the short supply chain are competitive in the market. In a production system that is more and more competitive on a global scale, it has to be considered that a short supply chain could face some limits due to its specific features. Thence, to be competitive, the local system need to be designed in the most optimal way, using engineering solutions where applicable and limiting wastes. For this purpose, it can be useful to combine Life Cycle Thinking with Lean Thinking, with the aim to create a short supply chain able to ensure reduced environmental impact and better efficiency in the whole process.

Creating a sustainable short supply chain from wood biomass to furniture

The present work starts from the experience of two public-private business clusters that are working for improving sustainability of their activities: Consorzio Forestale della Val d'Intelvi (association of forest owners, forest managers and forest businesses working for harvesting and logging) and Progetto Lissone (public-private consortium of more than 200 SMEs working in the furniture district of Lissone Municipality: designers, craftsmen, enterprises and retailers). During the last years, the two associations have been involved in some interesting sustainability initiatives: Consorzio Forestale adopted the PEFC scheme to certify the sustainable management of the forests under its responsibility; Progetto Lissone undertook a pilot project to promote eco-innovation and life cycle thinking among SMEs of the furniture district, starting from the identification of the most important impacts trough a qualitative LCA of the entire supply chain (from cradle to grave) and a quantitative LCA of a specific piece of furniture (detailed results of the study can be found in Ciapponi et al, 2008).

With the aim to enlarge the perspective to the whole supply chain, from raw material extraction to products retailing, the two associations are now involved in the BOMO project, that consist in the attempt to create a short supply chain in Lombardy, using the wood coming from the certified forests managed by the Consorzio Forestale to produce furniture in the Lissone district, reducing the impact associated with long distance transport of wood material and valorising local resources. The project is focused on the feasibility of optimizing the use of regional wood stock to realize furniture pieces, through the creation of a short supply chain wood-furniture, characterized by the use of certified wood and by sustainable operational solutions, with the aim to optimize materials and energy flows and to reduce the overall impact on environmental compartments taking into account strategic and economic perspectives.

In order to evaluate the sustainability of the whole supply chain and to support its planning, it is necessary to integrate the analysis of input and output flows of the production systems with an evaluation of strategic aspects related to the management of the whole system, aimed to identify the possibility to reuse the outputs coming from an activity (e.g. production residues) as inputs of another activity (e.g. as raw materials or energy sources) and to evaluate the feasibility of the designed system with reference to the availability of appropriate production capacity and businesses able to produce the expected products or services in the area considered. Thence the present work defines a comprehensive conceptual model for the integration of detailed Life Cycle thinking into this specific supply chain, related to the sustainable use of biomasses, focussed on energy and furniture production. Final aim is to provide a tool that allows to identify scenarios of development and to define decision support systems, to improve awareness and responsibility of organizations that provide goods and services, with particular reference to SMEs, and of consumers.

The key factors of this kind of approach are the availability of instruments able to support a detailed analysis of different aspects of the entire supply chain and to provide useful information for decision makers, and the active involvement of all relevant actors of the supply chain. In this perspective, life cycle thinking can be the driving methodology, even if LCA is not sufficient for assessing sustainability of the entire system (Zamagni et al., 2008) and, moreover, to communicate the results in a way that can help decision makers in choosing the best option. Thus the model will include also sustainability indicators considering aspects usually not included in LCA studies, such as the availability and renewability of wood resource through time, and the economic and social sustainability of different solutions (Laquaniti et al., 2009). For this reason, the integration between LCT and Lean Thinking (in its environmental declination, C-Lean), is proposed and described in the following paragraph.

Furthermore, the appropriate translation of research results into a usable format, bridging the gap between scientific results and business choice, seems crucial for the involvement of the business sector, which represent a key stakeholder in decision making. In this context, the role of Progetto Lissone firm's consortiums is crucial in promoting and disseminating best practices among associated firms; furthermore, it is necessary to encourage both networks of producers acting in the same sector (e.g. association of furniture producers) and stakeholders of the whole supply chain (designers, producers/craftsmen, retailers, consumers), in a B2B o in a B2C perspective (Sala et al., 2009a,b).

Conceptual framework for a sustainable bio–based products economy

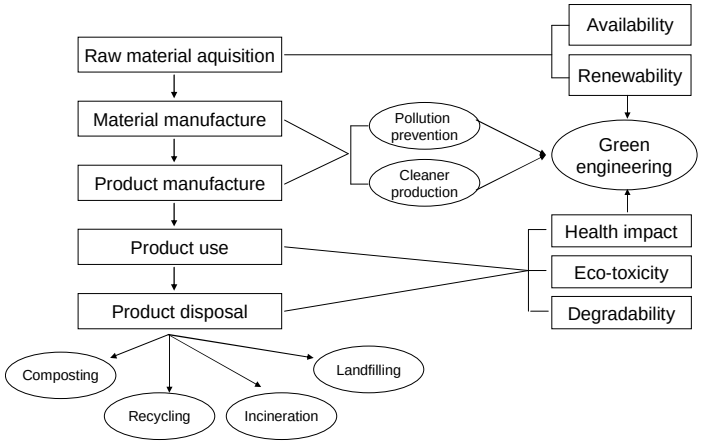
The conceptual model developed to support the BOMO project integrates the LCT approach with Lean thinking methodology to evaluate sustainability of every single phase of the process and to identify possible new areas of optimization (from forest management planning to the end of life of furniture pieces) with the aim to highlight useful information for comparing and evaluating different options during the whole entire life-cycle.

The Lean Thinking is a management model developed in the context of methods for quality improvement and processes engineering; it identifies 5

principles which should lead any reengineering and reorganization process effort (Womack et al, 1996): to identify value; to map the value stream; to create flow (leaning the phases of the production); to establish pull (linking the production to an effective demand); to seek for perfection (continuous improving). Moreover, during the last years, some attempts have been made to enlarge the principles perspective to include environmental waste in the evaluation (Rothenberg et al, 2001), creating the so-called "C-Lean".

The integration between C-Lean and LCA has the final aim to support decision makers in every phase of the process, providing relevant information about the most effective solutions from the operational and technical point of view, with specific reference to the feasibility in the local context under evaluation: for instance, to the availability and renewability of the materials and to the operational feasibility for the implementation of the selected technology (correct size of the plant with respect to the amount of resource available, coherence of the production process with the characteristics of the available materials, etc.) integrating managing optimization and process engineering with environmental evaluation.

The integrated analysis of each step of the process allows to identify internal and external variables (availability and renewability of resources, length of transportation needed, economic and logistic aspects, etc) that can influence the choice among the possible options and the most critical aspects that can determine the sustainability of the whole process (use of hazardous compounds, energy consumption due to production activities and to transport, production methods that can influence the possibility to recycle in the end of life of the products, etc). This analysis can help decision makers to chose the best technological and logistic solution with reference to the local situation, etc.; final aim should be the optimization of resource efficiency (material and energy flows) of the wood processing industry, through the development of a model that allows decision makers to evaluate different industrial symbiosis initiatives and to find improvements in the structure of an existing system, from an economic and environmental point of view (following the framework drawn by previous researches, such as Karlsson et al., 2007 and Windsperger et al., 2009). The following scheme illustrates the main phases and aspect that should be considered.



(Modified from Bi, 2007)

More in detail, the conceptual model developed in this study refers to the main principles of Lean Thinking widening the perspective of the analysis trough the integration with Life Cycle Thinking. The first aspect to be considered is that value is generally regarded only as an economic issue (value added referred to a single phase of the process or to a unit of product or service generated), while in the context of sustainability it is important to consider value also from the environmental point of view: a phase of the production can generate economic value and, at the same time, environmental costs, so it necessary to rely on a instrument that can evaluate the comprehensive effect of this two components (in this case, the C-Lean integrated with the results of the supply chain LCA). In addition, Lean thinking considers 7 kind of wastes (Transportation: moving products that is not actually required to perform the processing; Inventory: all components, work-in-progress and finished product not being processed; Motion: people or equipment moving or walking more than is required to perform the processing; Waiting: waiting for the next production step; Overproduction: production ahead of demand; Over Processing: due to poor tool or product design creating activity; Defects: the effort involved in inspecting for and fixing defects); these wastes can be easily matched with the environmental impacts that they generate during the entire life cycle (i.e. in all the phases of the considered supply chain), such as raw material and energy consumption, production of waste that cannot be reused or recycled, emission of harmful substances etc. Considering these wastes, and eventually identifying others that are specific of the supply chain considered, it is possible to identify a preliminary scheme for defining a Value Stream Map (VSM), which can help to visualize in a simple and comprehensible way the aspects that have to be considered and the possible areas of improvement for each phase of the process. Following this approach, Figure 1 illustrate the main phases of the process and the most important issues in the sustainability analysis made through C-Lean and LCA.

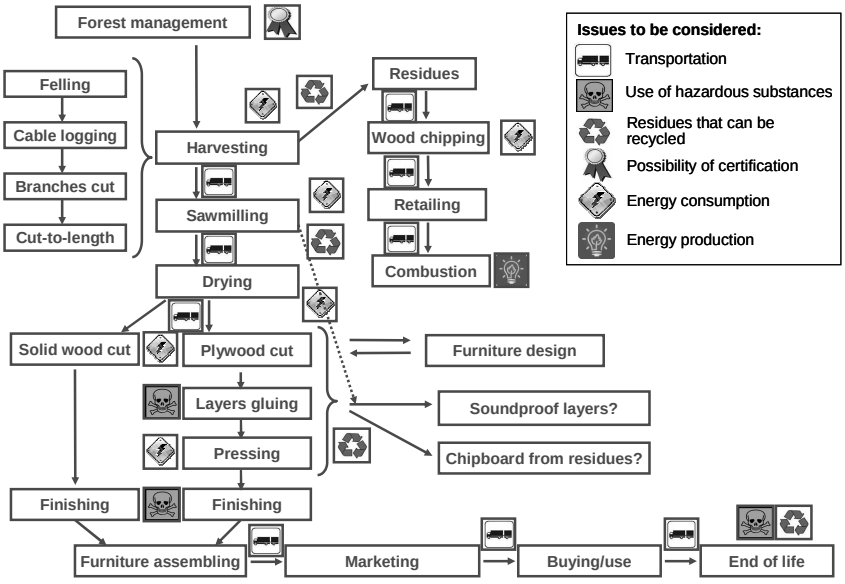


Figure 1: Issues to be considered for the evaluation of the designed wood-furniture supply chain

In addition to the 7 wastes mentioned before, the Lean method identify also 3 factors that can influence the efficiency in the value stream: outside disturbs, inefficient use of the available skills and problems of communication (incomplete information and/or inefficiency in communication). For this reason, all the relevant actors have been involved in the definition of the conceptual model, in order to ensure that all the relevant variables and the possible interactions between the actors are taken into account and to ensure the best efficiency in the information flow.

Moreover, the model developed for the sustainability analysis include also sustainability indicators able to consider aspects that are generally excluded from LCA studies, such as the availability and the renewability of wood biomass, necessary to ensure the functioning of the entire system, as well as aspects related to the economic and social feasibility (e.g. acceptability) (see for an example, Lacquaniti et al, 2009).

Conclusions

The necessity to promote sustainable production and consumption patterns, especially in the case of short supply chains, requires the integration of strategies and tools about both eco-innovation and economic and operational management within the supply chain.

The present work tries to highlight some critical aspects in the comprehensive sustainability evaluation of a production system when evaluating limits and possibilities of a local system and a short supply chain. In this case, the evaluation need to be supported by a set of instruments because it has to address a wide range of questions. Environmental sustainability should consider the resource limits, i.e. the carrying capacity of the forest ecosystem, energy and material flows (through LCA) and the possible industrial symbiosis within the supply chain (Ceppa, 2009). Economic and operational sustainability evaluation requires instruments (such as Lean thinking)to evaluate the operational feasibility of the supply chain, its competitiveness and its ability to create economic and environmental value. Social sustainability refers to the possibility for the system to be effectively implemented (e.g. presence of the relevant actors needed for each activity of the supply chain) and to provide effective opportunities for local development (local employment, training for appropriate job positions, etc).

Thence this work represent an attempt to identify appropriate instruments that can be integrated in order to create a set of sustainability indicators to support and address decision making choices.

Considering the specific supply chain object of the evaluation, there are several issues that can make the difference in promoting a sustainable bio-based products economy: first of all, it has to be recognized that all bio-based products cannot be considered sustainable without a detailed analysis of their performance (with particular reference of their cumulative energy and material consumption) in a life cycle perspective (i.e. considering the whole supply chain); secondly, there is the need to deepen the research about industrial symbiosis, to promote the integration between different supply chains, with the aim of optimizing resource use (e.g. through by-

products and residues reuse) and energy efficiency (e.g. using residues to produce energy from renewable sources).

Moreover, there are several actors that can play a relevant role in promoting eco-innovation as, for instance, public authorities (through environmental regulation, research funding and GPP) and entrepreneurs, especially SMEs, part of the supply chain, that, if adequately informed and involved, can cooperate to foster industrial symbiosis and improve sustainability performance of the supply chains.

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5. Science and society

Environmental and sustainability problems act at a global level, but need to be addressed through actions that have to be performed also? at a local level in order to be effective. In this perspective, there are three key issues about the interaction between science and policy:

- Policy needs science, and in particular sustainability science to increase level of integration of environmental, social and economic issues into action
- Policy need science to evaluate sustainability of action. Hence, science :
    - o can provide useful information to address decision making and especially the definition of policies for sustainable local development;
    - o can evaluate the effects of the policies implemented;
- Sustainability science need policy, because only a broaden approach on development problems may arise key research issues
- local stakeholders (local administrators, local business, the local community) can play a relevant role in the definition of strategies for local development (e.g. through participatory planning processes and community based evaluation);
- effective communication of scientific research results is a key aspect in supporting decision making (for policy or business) and advancing the awareness and the involvement of the local community.

The flow of information between science and policy is a two way flow (Shackley and Wynne, 1995), with a mutual exchange of objective and subjective information between science and policy. On the one hand, policy needs objective information about the local conditions in order to find the right strategies for local development. On the other hand, political processes are complex processes, built up not only on factual and objective information, but also on power, interests, ideas and institutions (Behringer et al, 2000): for this reason, the evaluation of policies can't be based only on objective information, but needs to consider also subjective information, that can be provided, for instance, by the involvement of stakeholders in the evaluation process.

The integration between objective and subjective information is useful also to avoid the risk to consider, from one side, only what is measurable and from the other side, only what is considered worthy of attention (e.g. because it is highly valued by the public opinion).

This mutual exchange at the interface between science and policy has been interestingly modelled by Turnhout and colleagues (2007) as a fuzzy area where these two domains overlap: scientific knowledge is translated into usable knowledge for decision makers (policy makers, businesses, citizens) and policy questions are translated into research questions, that drive the research to produce guidelines for solving policy problems.

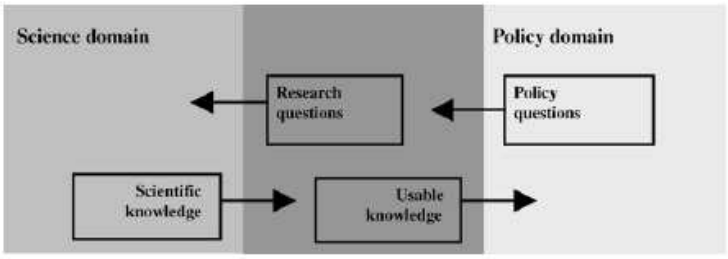

Figure 1 – Science and policy interface (source: Turnhout et al, 2007)

This structure of interaction implies the use of methodologies able to integrate different kind of information to draw guidelines which are useful for policy making. In this perspective, scientific research refers mainly to integrated assessment, while policy uses participatory planning process to ensure the involvement of local stakeholders.

Integrated assessment (IA) can be defined as

"an interdisciplinary process of combining, interpreting and communicating knowledge from diverse scientific disciplines in such a way that the whole cause–effect chain of a problem can be evaluated from a synoptic perspective with two characteristics:

1. *IA should have added value compared to single disciplinary oriented assessment;*
2. *IA should provide useful information to decision makers".*

(Rotmans and Dowlatabadi, 1997)

The implementation of participatory processes of environmental governance is recognized as useful to evaluate sustainability at the local level and to support local development planning (United Nation Economic Commission for Europe (UNECE), 1998; European Commission, 2001; van der Hove, 2006; White et al., 2006), especially when it is integrated with a scientific analysis of the situation (Behringer et al., 2000; Stirling, 2006). Moreover, the consultation of local stakeholders and their involvement in the definition of strategies for development helps to provide local inputs that ensure that what is locally important is measured (Fraser et al, 2006).

Some attempts to integrate participatory methods into integrated assessment in order to combine multidisciplinary assessment and community involvement has been carried out since the end of 20th century, and are described as Participatory Integrated Assessment (PIA).

Participatory Integrated Assessment (PIA) can be considered as a form of participatory policy analysis, which aims at supporting the policy process by designing and facilitating policy debate and argumentation (Hisschemoller et al., 2001)

PIA integrate participation into each stage of Integrated Assessment, as a way to provide subjective information in support to scientific assessment and to involve the local community in decision making, supported by objective knowledge. The following figure provides an example of how a participatory planning process can be combined to each phase of an

integrated sustainability assessment to support the definition of a strategy for sustainable local development (the example refers to the case study of European Charter for Sustainable Tourism implementation, presented in detail in the following section).

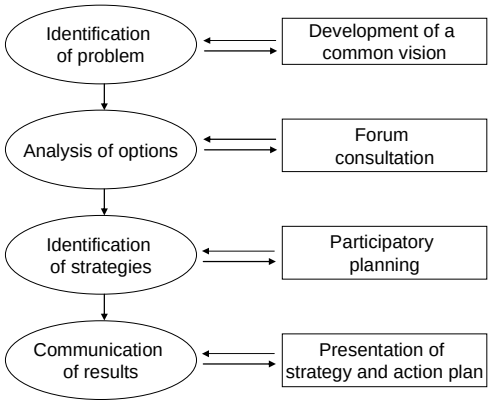

Figure 2 – Integration of participatory planning and integrated assessment (Participatory integrated assessment)

During each phase of the process the two way flow of information helps to integrate objective and subjective knowledge, in a mutual exchange that allow policy makers to develop strategies that:

1. are based on scientific findings about the most important areas of intervention that can influence local development in a sustainable way;
2. rely on community support and take into account local needs;
3. can be easily shared and understood by the local community.

Finally, the communication of results is crucial for making citizens and entrepreneurs aware about the priorities of intervention and to promote a more conscious shift towards sustainable consumption and production behaviours, in a perspective of sharing responsibility between public and private entities. Therefore, communication should be addressed to a multi-stakeholder public, composed by policy makers, entrepreneurs, citizens and young generations, with different aims:

- **policy makers** need to have reliable information to support decision making and policy planning;
- **entrepreneurs** need to be informed about the actions that they can implement and about the legislation and the tools available for making their activity more sustainable;
- **citizens** need to be informed about the impacts of their choices of behaviour and consumption (i.e. mobility, purchasing, housing, etc) in order to become more aware about their role in defining and performing more sustainable consumption and production patterns (e.g. choosing environmentally friendly products and reducing waste);
- **young generations** can play a crucial role for the future, and need to be educated through initiatives performed jointly with the schools, in order to integrate sustainability issues within the educational programmes.

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5.1 Investigating stakeholders' perspectives about local development and business strategies

Valentina Castellani, Serenella Sala

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Abstract

Stakeholders play a relevant role in determining the success of the actions for local development: without the involvement of local actors it is very challenging to obtain significant results. The involvement of stakeholders enables decision makers to identify priorities of action for relevant actors and to identify existing gaps between offer and demand in the tourism market, which is a crucial point for improving competitiveness of local enterprises. The presented case study refers to the implementation of a participated planning process (The European Charter for Sustainable Development in Protected Areas) in a tourist destination. In order to support the definition of a participated strategy for sustainable tourism development, that has to be implemented both by public and private actors, three levels of analysis were integrated: objective analysis, subjective analysis (questionnaires, one-to-one interviews and development of a common vision for the future according to EASW method) and strategic analysis. The paper illustrates the process and the main results of consultation, highlighting some evidences of the positive influence of stakeholders involvement in the planning process.

Introduction

Stakeholders play a relevant role in determining the success of the actions for local development: political processes are complex processes involving a multitude of actors and are built up not only on factual and objective information, but also on power, interests, ideas and institutions (Behringer et al, 2000), so without the involvement of local actors in local planning it is very challenging to obtain significant results (Newman et al., 2001).

Investigating stakeholders' perspectives enable decision makers to identify priorities of action for relevant actors and to identify existing gaps between offer and demand in the tourism market, which is a crucial point for improving competitiveness of local enterprises. Moreover, the involvement of stakeholders in the definition of an action plan for local development can help to enhance the involvement of private sector also in the phase of implementation, assuring cooperation and a better sharing of responsibilities between public and private actors.

On the other hand, if not based on objective data about the local situation and the objective constraints that can influence the action (e.g. technical feasibility or economic availability) and if not linked with policy objectives and targets at the higher level (e.g. regional policy), participatory planning can lead only to a "virtual" exercise, with no effective results on local development. In addition, a participatory process with no real outcome on the local situation can result in the loss of credibility from local institution and in the lack of confidence and then of commitment by local actors. Then

the most effective way of involving the stakeholders in the planning process seems to be the integration between the results of forum consultation and expert analysis, which can also help mutual understanding between different positions (e.g. institutions and local community), community capacity building and the creation of a network between public and private stakeholders (Stagl, 2006, Vasquez et al., 2006).

The presented case study refers to the implementation of a participatory planning process, the European Charter for Sustainable Development in Protected Areas, in a tourist destination. The methodology developed for the implementation integrates stakeholder consultation and objective analysis based on expert knowledge, referring to Integrated Environmental Assessment and Participatory Integrated Assessment theory in the definition of the methodology (Behringer et al, 2000, Hisschemoller et al., 2001).

To investigate priorities and expectations of local stakeholders, the project team established a consultation process, performed also through questionnaires surveys, submitted to: tourism operators, tourists and local residents. The aim of the research was twofold: firstly, to identify attitudes and expectations about the development of tourism activities in the area; secondly, to highlight priorities of each category of stakeholder and verify if there was a correspondence between the targets of tourist offer and tourist demand. As mentioned before, the results of the questionnaires constitute a part of a wider evaluation of the tourism market in the area, composed by a three-stage analysis: objective analysis, subjective analysis (questionnaires, one-to-one interviews and development of a common vision for the future according to EASW method) and strategic analysis (to assure the coherence of the final strategy with local and regional objectives and targets about local development).

The three levels of analysis were integrated to support the definition of a participated strategy for sustainable tourism development, that has to be implemented both by public and private actors. The investigation about stakeholders' perspective helped to identify the gaps that exist between offer and demand in the tourism sector and to identify possible areas of intervention to enhance the quality of local tourism activities and to improve the competitiveness of the offer and the quality of the tourist experience in the destination considered.

Methodology

The process of the European Charter for Sustainable Tourism in Protected Areas

European Charter for Sustainable Tourism in Protected Areas is a participatory planning instrument, promoted by Europarc (the European Federation of Parks) to enhance sustainable tourism in protected areas; signers of the European Charter are committed to implementing a local strategy for 'sustainable tourism', furthering cooperation and implementing joint actions with local partners (Europarc Federation, 2005).

The process of the European Charter for Sustainable Tourism in Protected Areas is planned to last 7 years: first two years are for the development of a strategy of action for sustainable tourism, the next five years are for the implementation of this strategy. At the end of every step there is an

evaluation by Europarc: the first one is for the award of Charter Certificate to the protected area and the second one is for the evaluation of results and the renewal of Charter membership (Figure 1). It is important to notice that, according to the European Charter procedure, the strategy for sustainable tourism has to be based on the results of an analysis of local situation (environmental, economic and social aspects, related with tourism sector) made by experts, and the results of the consultation and planning process done with local stakeholders.

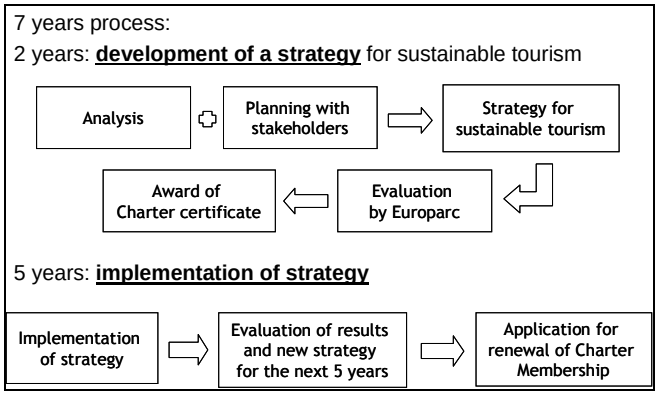

Figure 1: European Charter process

This structure of the process represents one of the most interesting features of the European Charter: the second stage evaluation by Europarc, necessary to renew the Charter certificate, implies that all the actors involved have to ensure their commitment also in the implementation phase, which is a crucial step of this kind of projects. One of the weaknesses of Local Agenda 21 processes, highlighted also by some researches about participatory processes effectiveness, is that in most cases the commitment of public and private bodies ends after the compilation of the Action Plan, with the risk of undermining all the work done before.

The Charter text provides also eight principles to address the whole process and the definition of the strategy of action. The eight principles are:

1. Protecting natural and cultural heritage
2. Meeting visitor needs – granting quality of tourist experience
3. Improving the communication about the area
4. Developing tourism products relating to protected areas
5. Provide appropriate training to protected area managers and tourism operators
6. Maintaining local quality of life
7. Providing benefits to the local economy
8. Managing visitor flows to prevent and reduce impacts

Accordingly to these principles, the aim of the process is the development of new tourism products related to the protected areas, while protecting natural environment and granting benefits and a good quality of life for local residents.

The European Charter combines economic, cultural, social and environmental aspects as a basis for the definition of future scenarios of local development. The phases of the Charter include: economic, social, cultural and environmental diagnosis of the area, with a focus on specific characteristics, strengths and weaknesses; consultation of local stakeholders about their vision of sustainable tourism development for the area; participatory planning; definition of action strategies for sustainable tourism development and, ultimately, implementation of these strategies. The whole consultation process is designed to improve cooperation and capacity building between local stakeholders, both in the public and private sectors (Castellani et al, 2007).

Stakeholders involvement in European Charter planning process in Alpi Lepontine

The tourism system of a destination is directly and indirectly influenced by various kind of stakeholders, which can at the same time affect the development of the destination and be affected by tourist activities[6], either if they are part of it (e.g. tourism operators or hotel managers) or not (e.g. local residents) (Tsaur et al, 2006). Within this context, the communication between all actors has a crucial role in determining the success of every strategy for improving the tourist system, helping to identify possible weaknesses and to address the needs of stakeholders, improving the ability of the destination to fulfil the needs of everyone involved, i.e. to improve social sustainability and to obtain better results.

Following this perspective, the involvement of stakeholders in the planning process for the definition of the strategic lines of action for the future development of the destination in a sustainable way, as happens within the European Charter process, can provide useful information about what are the key issues to be considered in order to improve the quality and the sustainability of the local tourist system (Logar, 2009). The comparison between the vision of the destination emerging from tourists and from tourist operators surveys, for instance, can help to identify the existing gaps between offer and demand, which represent a key point to be addressed in order to improve quality and competitiveness of the destination, in a efficient way (i.e. investing in actions that, according to what expressed by tourists, will provide a positive result).

Moreover, the European Charter for Sustainable Tourism in Protected Areas is an interesting mechanism for involving stakeholder in the planning process, especially because it meets the necessity of widening the concept of participation from pure consultation, that provides information for the development of the strategy, to an active involvement of all the actors in the definition of a detailed action plan for the following 5 years and in the

[6] For instance, the attitude of residents towards tourists can affect their feeling about the tourist experience and influence their will to come back again, while the proactiveness of hotel managers and tourist operators in investing in new services and improve the offer can influence the possibility to enlarge the market share and improve the quality of the offer, rising the revenues from tourist activities; on the other hand, if the tourism flow is not adequately managed by local authorities, this will result in conflicts between tourists and the local community and can affect the quality of life of residents.

implementation of these actions, commonly shared by public and private actors. This feature of the process helps to assure that the action plan defined during the participatory planning will be successfully implemented in the future.

The case study presented in this paper refers to Alpi Lepontine protected areas, which applied to the European Charter in 2006 and have been awarded with the Charter certificate in 2008; they are now at the second stage of the process, which is the implementation of the strategy and action plan, and that will be followed by an evaluation by Europarc in 2012, necessary to renew the certificate for the following 5 years.

Strategy and Action Plan for sustainable tourism in Alpi Lepontine are the result of an important activity of participatory planning, based on the integration between objective data (collected and systematized in a diagnostic report), subjective data (coming from the analysis of the perception of three basic categories of stakeholders concerned with tourism development: local community, tourism operators and tourists, surveyed through questionnaires, and from the topics of the focus groups) and strategic analysis about tourism policies and strategies at local and regional level.

The consultation of stakeholders in Alpi Lepontine implementation of the European Charter was organized as follows (Figure 2):

1. opening meeting to present the project and inform the local community about the European Charter process and the objective of the local Mountain Community about sustainable tourism development of the area;
2. EASW workshop with the participants to the opening meeting, to investigate stakeholders priorities and concern about tourism and to develop a common vision about sustainable tourism development in Alpi Lepontine;
3. questionnaire surveys submitted to three relevant categories of stakeholders (residents, hotel and restaurant managers, tourists), with the aim of enlarging the perspective about the common vision (including also people that didn't participated to the first meeting) and of highlighting the point of view of each specific category (e.g. tourists point of view, in comparison with hotel managers' one);
4. forum consultation for participatory planning of the Strategy and Action Plan for sustainable tourism development in Alpi Lepontine.

In addition, members of the project team conducted one-to-one non structured interviews on specific topics with relevant subjects of the area, such as provincial tourism and environmental authorities and representatives of local organizations, with the aim of integrating the strategic analysis based on institutional documents and plans with updated information about the priorities and the activities of local and regional administrations on tourist development and environmental protection.

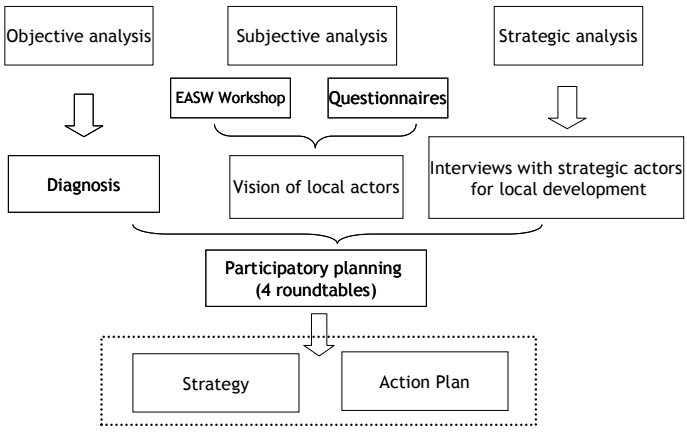

Figure 2: Scheme of the implementation process developed for Alpi Lepontine

1. In September 2006, the project team held an opening meeting in the Visitor Centre of the Riserva Naturale Lago di Piano to present the process to the population and to perform a first analysis of local perceptions about sustainable tourism and local development. Every relevant person directly or indirectly involved in tourism activities was invited, in addition to associations for sustainable tourism, local press staff and the local community at large. The meeting was organized in two sections: the first section consisted in the presentation of the characteristics and conditions of the implementation of the European Charter for Sustainable Tourism in Protected Areas: the aim of this section was to involve local stakeholders and to make them aware of the opportunities given by this process.
2. In the second section of the same meeting there was a workshop regarding the perception of local threats and trends; according to the EASW (European Awareness Scenario Workshop) method, participants were asked to list five threats and five opportunities about tourism in the area of Alpi Lepontine in order to develop two possible scenarios - one positive and one negative - for the next ten years. The results of the workshop were analysed and then clustered to identify the main topics of tourism in the Alpi Lepontine, referred to the European Charter principles.
3. Three different type of questionnaires, with closed and opened questions, were submitted to tourists, tourism operators and residents to provide further insights about some focal aspects of the local tourism system and to investigate their opinion about tourism in the area. More in detail, the surveys dealt with the following issues:
    a. Questionnaire submitted to residents:
        i. Knowledge of sustainability and sustainable tourism concepts
        ii. Interest in environment and sustainability issues
        iii. Attitude towards tourists

iv. Value judgement about quality and sustainability of local tourist offer
v. Suggestions about action needed to improve the offer and possible markets to be promoted

b. Questionnaire submitted to tourism operators:

i. Information about their activity (type and age of the hospitality structure/restaurant, nr of employees, services offered, etc.)
ii. Information about the characteristics of tourists visiting their structure (age, country of origin, length of stay, etc.)
iii. Knowledge and promotion about local heritage and tourist attractions (e.g. possibility for tourists to have practical information and suggestion for their visit, promotion of local food)
iv. Attitude towards sustainability and sustainable tourism
v. Implementation of best practice about energy and water saving, environmental certification and other actions to improve sustainability of the structure
vi. Suggestions about action needed to improve the local tourist offer

c. Questionnaire submitted to tourist:

i. Information about them and their holiday (age, country of residence, length of staying, type of accommodation, mean of transport used to reach the area)
ii. Elements that make the destination attractive in their opinion
iii. Level of satisfaction about the visit in Alpi Lepontine
iv. Knowledge of sustainability and sustainable tourism concepts
v. Interest in environment and sustainability issues in planning their holiday
vi. Suggestions about action needed to improve the local tourist offer

4. The vision developed in the first meeting, integrated with the results from the questionnaire surveys, addressed the selection of the most relevant topics for the planning process, discussed in 4 roundtables. The Forum consultation began in March 2007 and involved four categories of stakeholders:

- Tourism operators
- Local administrators and NGOs
- School operators[7]
- Farmers and trade associations

[7] Schools were involved firstly because one of the possible new tourist markets identified was educational tourism and, secondly, because in the area there is an high school for hotel and tourist managers, that need to be valorised and could represent an important strength for the local tourism system.

The decision to organize roundtables according to the type of participants (i.e. not to the topics discussed) had the aim of allowing the definition of commonly shared proposals and to create a network of subjects sharing the same goals, as asked by stakeholders in the first meeting. On the basis of this structure, the main topics of the planning process (according to the principles of the European Charter) were handled by the roundtables in relation to the fields of action and the needs of participants.

This kind of organization allowed to have forum meetings with small groups of people (around 20-30), enabling everyone to participate actively to the discussion and to provide his contribution for the identification of the lines of action and the definition of the strategy. Moreover, during the first meeting of each roundtable, the experts introducing the discussion made a brief presentation of the results of the objective and strategic analysis as a starting point for the debate; participants were asked to express comments and suggestions about them in order to have also a subjective feedback on this technical documents. To address the discussion, during the meetings some purpose of actions were presented, referring to the principles that mainly related to the interests of the group composing the consultation board: participants were asked to express their opinion about the actions presented (assigning a priority value to each action) and suggested additional actions themselves, with the aim of defining a commonly shared baseline about current situation and future targets for the planning activity.

The final outcomes of the whole participatory planning process for sustainable tourism development in Alpi Lepontine are the strategy for sustainable tourism ("Via Regina, discovering the past for a sustainable future", Tarelli et al, 2008), that illustrates the strategic lines of action for the future defined during the planning process, and the Action Plan for the year 2008-2012, consisting in more than 100 actions that have to be undertaken in order to obtain the renewal of the Charter certificate at the end of the five years, in 2012.

Considering that the Action Plan covers a mid-term period and includes a wide number of actions, there could be the risk of a failure of the implementation due to the complexity of the task and maybe to insufficient human and economic resources from the institutional body who is the leading responsible of the project (in this case, the Mountain Community).

To avoid this risk, the entire Action Plan was created in close partnership with local stakeholders, asking them to ensure their commitment also for the implementation phase: a preliminary feasibility study was performed for every action planned, with the aim of highlighting the resources needed (economic, human, technical, etc.), the existing (or possible) source of funding and the public of private subject that will hold the responsibility of the project. This last aspect is necessary to ensure that the involvement and the commitment of the local community, the economic sector and the local NGOs that participated to the planning phase will continue during time, improving cooperation between local stakeholders and creating a lasting connection between public and private bodies (as pointed out also by OECD in 2009).

The document that illustrates the Action Plan displays for each action:

- the European Charter principle to which it refers;
- the role of the Mountain Community in that action (lead partner of the project or partner of a project which has another lead partner);
- the time-schedule planned for the realisation of the project;
- information about periodicity: action undertaken yearly; project lasting more some years; action planned for only one year;
- total cost of the execution for the period of implementation of European Charter;
- information about yearly structure of the costs and quote of the cost already funded or to be funded.

Furthermore, the Mountain Community asked to all relevant actors responsible for the implementation of the Action Plan to testify their commitment signing a formal protocol for the implementation of the strategy during the period 2008-2012.

Results

The vision of stakeholders

Table 1 illustrates the results of the EASW workshop, that constitutes the basis for the development of a common vision about sustainable tourism development in the Alpi Lepontine area. The statements expressed by people interviewed have been firstly clustered according the Charter principle to which they refer, and secondly summarized to identify some fields of action to address the discussion about the planning of the strategy and action plan (numbers in brackets stands for the number of sentences listed by interviewed people for every issue).

PRINCIPLE	LOCAL PERCEPTION	FIELD OF ACTION
Protecting natural and cultural heritage	Need of conservation/preservation of natural heritage	Environmental protection (19)
	Need to increase the surface of protected areas	
	Need of improving the quality of water resources, currently in bad conditions	
	Relevance of valorisation of cultural, artistic and natural heritage	Valorisation of local heritage (9)
	Need of restoration of traditional architecture	
	Point of interest in the territory: landscape/natural beauties, climate conditions, protected areas, peacefulness, variety of tourist offer, cultural and architectural heritage	Valorisation of local strengths (20)
	Need to identify new tourist routes	Tourist path and routes (9)
	Opportunity to organize excursions in mountain areas (e.g. valorisation of trails that link the villages)	
Improving the communication about the area	Need of improving the information points in the area	Promotion and information about the territory (15)
Improving the communication about the area	Need to promote the territory in different ways (internet, magazine, leaflet,…)	Promotion and information about the territory (15)
	Need of specific promotion for mountain areas	
	Possibility of promotion among tourists of Como lake	
	Opportunity of organising events to attract new tourists	

Promoting local products		Need of promotion for local products	Promotion of local products (2)
		Need of improving wine and food tourist offer	
Granting quality of tourist experience		Need to avoid mass tourism	Quality of tourist offer (12)
		Need of improving the quality of tourism structures	
		Need of granting a good relation between quality and price	Prices (4)
		Possibility of an agreement among restaurants for a tourist menu	
		Need of improvement of bicycle path	Tourism facilities (9)
		Need of parking area for camper vans	
		Need of periodic maintenance of trails	
		Establishment of structures for sport and leisure	
		Need to create new parking	
		Need of facilities for ski mountaineering	
		Need to provide appropriate training for young people interested in working with tourism	Training for tourism operators (6)
		Need of training on foreign languages for tourism operators	
Provide appropriate training to protected area managers and tourism operators		Need of environmental education for tourists	Environmental training and consciousness (5)
		Need of environmental education for school students	
		Need of raising awareness among tourism operators	
		Need of raising awareness among agriculture operators	
		Need of actions to create environmental awareness in the local community	
Managing visitor flows to prevent and reduce impacts	Maintaining local quality of life	Problems with maintenance of drainage system	Drainage system (2)
		Need of a good urban planning to avoid high urbanisation	Urban planning (11)
		Need to limit the building of new hospitality structures and second houses	
		Need to assign the task of urban planning to a subject apart from Municipalities (to avoid the authorization for new buildings to get tourist income in return).	
		Need of order and neatness in the territory of CMAL	Order and neatness (7)
		Need of cleaning and maintenance for the trails and for the lake	
		Problems arising form the characteristic of local road system (in general)	Mobility (25)
		Problems of congestion and safety on Statale Regina road	
		Need to improve public transport (also navigation)	
Working in partnership involving all stakeholders		Lack of cooperation among public administrations and between public administrations and local stakeholders	Cooperation (12)
		Lack of cooperation among tourism operators (need of association, brands)	
		Low attitude toward tourists	People attitude (4)
		Low level of entrepreneurship and innovation (due to commuting to Switzerland)	

Table 2: results of the EASW workshop

The main topics highlighted by the local community as possible concerns related to tourist development are: “mobility” (which suggests that traffic congestion could be a problem for the area and that sustainable mobility has to be promoted) and “valorisation of local strengths”, especially of natural, traditional and cultural heritage, which is linked with “environmental protection”, and testifies the consciousness, among the local community,

about the importance of preserving the local heritage to ensure the sustainability over time of the entire system. Other relevant topics to be considered when defining the strategic lines of action for tourism planning are "urban planning" (the population expressed a concern about overexploitation of the territory and excessive urbanisation) and the necessity of providing appropriate "tourism facilities" (e.g. bicycle paths, trails, parking area for camper vans, structures for sport and leisure) to improve the quality of the tourist experience and to limit the impacts of tourist presence in the area, especially where the protected areas are involved. This last topic is an example of one of the issues that have been addressed both by the local community and by the tourists (see also the results of questionnaire survey to tourists in section 3.3).

Roundtable meetings

Table 2 illustrates the structure of the forum consultation, listing of topics discussed during the meetings, chosen according to the input coming from objective, subjective and strategic analysis and to the suggestions of the participants.

The final forum was organized to present the strategy and action plan to all the people that were involved in the roundtables, to the strategic actors at regional level and to the whole community, with the aim of collecting their feedback about planning results and of making them aware of the progress in the process and to keep their motivation alive.

ROUNDTABLE	STAKEHOLDERS	TOPICS
R 1	TOURISM OPERATORS	• Conservation of natural and cultural heritage • Actions for environmental safeguard (renewable energy, sustainable use of water resources, soil and air) • Private actions for environmental conservation • Environmental education to tourism operators and protected area staff • Managing tourist flow • Improving the quality of tourism offer • Tourist promotion • Development of new tourism routes
R 2	LOCAL DECISION MAKERS, LOCAL NGO AND OTHER ASSOCIATIONS	• Conservation of natural and cultural heritage • Actions for environmental safeguard (energy, sustainable use of water resources, soil and air) • Quality of life • Managing tourist flow • Tourist promotion
R 3	SCHOOLS	• Conservation of natural and cultural heritage • Environmental education for students • Environmental education to tourism operators • Development of new tourism routes for educational tourism
R 4	FARMERS	• Valorisation of local products • Tourism promotion
FINAL FORUM	ALL THE SUBJECTS INVOLVED IN THE PROCESS	• Presentation and submission of the Strategy and Action Plan arising from the participated planning process; gathering of formal support for the implementation of the Action plan from the stakeholders.

Table 2. structure of the forum consultation

Questionnaires survey results

Questionnaires to residents

The survey involved 3% of local population (337 people interviewed). One of the first questions submitted to residents was about their knowledge about ecotourism and sustainable tourism concepts: the answers were almost equally divided between "yes" (49%) and "no" (50%). However, what is important to notice is that the concept are more familiar to people aged over 40 than to young people: this should be considered when thinking about sustainable development of the local tourist system, and might suggest to improve education about sustainable development and sustainable tourism in local schools, especially the high school for hotel and tourist managers, to ensure that the new tourists entrepreneurs in the future will foster and improve the work began with the European Charter project. The same result emerges about their personal attitude towards environmental and sustainable themes in general.

Regarding economic and social benefits coming from tourism, more than 80% of the respondents says that tourism activities have a relevant role for the local economy (54% "very important", 33% "quite important"), even if most of them are conscious also about the negative effects that tourism generates on the area (40% of people stating that tourism brings negative effects: 14% "road traffic and pollution", 11% "over production of waste", 8% "disturbance", 6% "crowding", 1% "loss of local identity").

The opinion of residents about the efficiency of local administrators (i.e. the local Councils and the Mountain Community) in managing the tourism system highlights some elements of satisfaction but also some concerns about their action. Considering this result, the implementation of a participatory process for tourism planning seems to be very important, as a way of promoting the dialogue and the cooperation between local administrators and the local community, with the aim of finding strategies for tourism development able to improve the quality of tourism and, at the same time, the satisfaction of residents, i.e. their attitude towards tourism activities and tourists.

Finally, the last part of the questionnaire (consisting in open questions) was about suggestions from residents to improve the fruition of the area and, more in general, to improve the quality and the performance of the local tourist system. The interviewees in their answers stressed the need to preserve the nature, landscape and cultural heritage, seen as important elements that constitute the attractiveness of the territory and also the necessity to address the problem of mobility, reducing road traffic through the improvement of public transport services, the creation of bicycle paths, etc.

Questionnaires to tourism operators

Questionnaires were submitted to all the tourist structures of the area; with a response rate of 20%. The first part of the survey among tourism operators had the aim to integrate the information about the characteristics of the local accommodation and service system collected through institutional documents (e.g. statistics from the Provincial Tourist Office) with information about the age of the structures, the characteristics of the services offered, the connection with the territory, etc. The figures emerging from the survey

describe an accommodation system composed by small structures, with few employees, often family-managed; most of the structures is open all-year, even if 86% of respondents say that most of the tourists come during the summer period. One of the strengths of the local hotel managers is the knowledge of foreign languages (70% of the structures has employees speaking at least two foreign languages), which is particularly important in Alpi Lepontine area, where about 90% of residential tourists come from outside Italy.

Starting from the high importance given by residents to the local natural and cultural heritage as a factor of attractiveness for the destination, one of the questions investigated the role of hotel managers in promoting local heritage among their guests: 52% of interviewees declared that they systematically provide tourist information to their guests and 81% of them usually inform the tourists about the local protected areas, providing maps on hiking routes, practical information about sport and recreational activities in nature, etc.

Regarding the attitude of hotel managers towards environmental and sustainability issues and the implementation of best practice to improve sustainability of the structure and to reduce water and energy consumption and waste production, 52% of the sample assessed to have implemented water and energy saving actions in the structure (especially photovoltaic panels, 36%). 81% of the tourism operators interviewed doesn't know anything about eco-labels and environmental certification for tourism sector, even if 33% declared to be interested in them.

Finally, tourism operators were asked to provide their vision about the local tourism system and their suggestions for improvement: one of the most cited issues was the necessity to improve hospitality and attitude towards tourists from the local residents, that testify a certain level of conflict between tourism activities and the local community existing in the area; other interesting issues are "keeping the family-management of the structures", which could be the sign of a willingness to preserve the destination from the exploitation of mass tourism and the "colonization" by big hotel companies coming from outside the area, and "need of training for tourism operators", that testify the will of improving their skills (and therefore the quality of the offer), to be competitive with non family-managed structures.

Questionnaires to tourists

Questionnaires were submitted to about 40 tourists, both in the protected areas and in other tourist areas (near the lake or in the mountain). According to the results of the survey, tourists are attracted from Alpi Lepontine mainly because of the possibility to spend a relaxing holiday in contact with nature (31% indicated "landscape" and 31% "natural resources" as the main reason for choosing Alpi Lepontine as a destination); the main activities performed during the holiday are "walking in the mountain" (33%) and "visiting natural areas" (26%). Most of the tourists reach the area using their private car (81%) mainly because of the lack of appropriate public transport connections; the problem of mobility, also within the area, is one of the more critical aspects pointed out by tourists as a reason of dissatisfaction during the holiday. In contrast, one of the most appreciated aspect of the area is the quality of food in restaurants, even if 25% of tourists expressed dissatisfaction about the scarce possibility to find local

food products: this is an important information for local producers, because it testifies the possibility to enlarge market share for their products. Also the opinion about hospitality structures in Alpi Lepontine is positive (90% answered "good" or "sufficient").

Some useful information to address the planning process came from a question about what tourists consider fundamental for improving the fruition of the destination; there were two major aspects emerging from the answers: the need of improving communication to tourists, both with more signals on the mountain trails and on the tourist routes and the need of increase practical information available to tourists (especially in foreign languages, due to the high percentage of foreign tourists), in order to improve their knowledge about local resources and to make them able to choose the best option for their holiday, in relation to their needs and interests.

Finally, there were some questions about the attitude of tourists towards ecotourism and sustainable tourism and the importance of adopting measures to improve sustainability of tourism structures: 66% tourists in Alpi Lepontine are familiar with the concepts of sustainable tourism and ecotourism and 56% of the interviewees declared to consider "very important" the presence of sustainable measures in the hospitality structure (the percentage rises to 64% when considering only foreign tourists). Comparing these figures with the ones about the environmental consciousness of hotel managers and their knowledge about eco-labels and environmental certifications, it is possible to highlight an example of the existing gaps between offer and demand, that emerged from consultation and that was addressed in the definition of the strategy for sustainable tourism development.

Strategic lines of action

Considering the outcomes of the participatory planning process, it was possible to identify some relevant issues that are the most strategic and commonly shared lines of action for local sustainable development, focusing on sustainable tourism and environmental conservation, as stated by the European Charter.

Main project fields can briefly summarised as follow:

- Promotion of a cultural route developed along Via Regina (the main road, which has historical origins and links all the communities in the area) and in connection with the Territorial Museum System (network of local museums). **Historic and cultural routes**, valorised also by literary awards inspired to the poetry of Antonio Fogazzaro and to the sites of his dwelling place. These routes could help to develop **educational tourism**, with the aim of deseasonalizing the tourism flow in area and of raising awareness about the heritage of Alpi Lepontine among local school and local people.
- A "fil rouge" of a project linking Alpi Lepontine and Canton Ticino (in Switzerland), to which the area borders on, through tourist routes of **sustainable mobility**:
    a. bike tourism. In the territory of CMAL the bicycle path, for tourism and leisure purpose, follow the track of an ancient and

dismissed railway and is a way to connect the three lakes (Como, Piano and Lugano). Currently, the bicycle path is from Grandola to Porlezza; the next step will be the extension till Menaggio and then the connection with Swiss bike path network. There is also a new project, promoted by ASL (local sanitary agency), to create "Open air itineraries", including also the bicycle path;

b. promotion of transnational mountain trails between Italy and Switzerland in protected areas. There are some trails already existing, e.g. Via del Ferro.

c. improvement of navigation service on Lugano lake to link the two sides of the lake. The first target is to assure a boat service to the village of S. Margherita (today accessible only by private boats or by foot) and then to restore the cable railway to Intelvi valley. Moreover, a good boat service on Lugano lake, added to the new part of the bicycle path, would allow bikers from Ticino to reach the bicycle path in Porlezza by boat, then going to Menaggio by bike and then reaching by boat (on Como lake) the bicycle path in Bellagio or the one planned from Varenna to Lecco.

- Valorisation of **local products**. One of the most important tasks for the sustainable development of Alpi Lepontine is the creation of a short weaving factory and the valorisation of local food products. The most relevant action in this field is the restoration of the ancient "crotto" of Castel S. Pietro, a building located along the bicycle path, which will become the central office for promotion of local food products; this action will be undertaken by the Mountain Community in cooperation with the local school for hotel and tourism managers. Furthermore, some other activities to promote local products will be organised and extended in the whole territory: the annual event called "Traditional flavours of the two lakes: Como and Ceresio" and a new event as a "Fair of local crafts", to support the discovery of traditions and to promote local handcraft.
- The combination of tourist activities and environmental conservation, achieved through the development of **guest hospitality** (a system of small existing structures, like b&b rooms, agritourism and second houses, with a unique reception system); these action, that include also the restoration of vernacular buildings, both public and private, to create an offer of charming hospitality structures and the identification of adequate structure to host organized groups of tourists, has the aim of avoiding the construction of new buildings and to prevent the extreme urbanisation of the area. Besides, the Mountain Community will promote the diffusion of **Ecolabel for existing hospitality structures**.
- **Environmental conservation**, both in protected areas and in the whole territory, with a special attention for biodiversity conservation and the maintenance of mountain trails (with the aim to set clear routes to orientate tourists and avoid uncontrolled impacts on the whole area). It is also foreseen the development of an Informative System to integrate environmental, managing and infrastructural aspects and make them available for the planning of local tourism development.
- Specific projects about **renewable energy** and **energy saving,** with particular reference to accommodation structures.

- **Communication campaigns** to improve information and promotion of the area, especially for foreign tourists: creation of web sites, multilingual leaflets and signals, integration and diffusion of existing information.
- Organization of events linking **sport and environment**, to promote new tourism products related to nature and protected areas, in an "environmentally friendly" way.

Furthermore, all the actions will be developed with special attention to the definition of path that can ensure the fruition also for peculiar categories of users (old-aged people, people with disabilities).

The Action Plan

The Strategy for sustainable tourism development in Alpi Lepontine includes an Action Plan for the period 2008-2012, consisting in more than 100 actions, equally distributed during the five years. The actions planned refers to all the 8 areas of intervention designed by the European Charter principles and are designed to address the strategic lines of action identified in the Strategy. The stakeholders that ensured their commitment for the implementation of the action plan are more than 30 (including local councils, agencies for environmental protection, tourism entrepreneurs, associations for the promotion of local traditions and NGOs), and constitute the core group of a wider network of actors, involved in the sustainable tourism development of the area

The outcomes so far

Alpi Lepontine is currently in the second year of implementation of the Strategy and Action Plan and about 70% of actions planned for the first year (2008) has been put into operation; some of the action planned has not been yet realized because of various factors such as unavailability of sufficient funds and delay in administrative procedures (e.g. authorization for building activities), and their implementation will be shifted in 2009-2010.

However, what is more important about the outcomes of the project is that the work done together by all the public and private stakeholders involved in the process helped them to establish a long-lasting cooperation for the development of the territory, that is resulting in new operational projects for the implementation of the Strategy. Alpi Lepontine Mountain Community is now involved in two important projects for sustainable local development: the first one is an INTERREG project with Switzerland and the other one is an integrated project for sustainable local development of the whole provincial area, involving local, provincial and regional actors. Thank to this two projects, Alpi Lepontine is enlarging the network of actors involved in local development processes and will be able to implement the Action Plan set for 2008-2012.

Conclusions

The methodology designed for the European Charter implementation in Alpi Lepontine, that integrates stakeholders involvement with scientific assessment, helped to develop an information flow among experts, institutions and the local community, that, starting from the existing

knowledge about the area, integrated with objective and strategic analysis done by experts and stakeholder consultation, led to a common vision about local sustainable tourism development. This vision constituted the basis for the planning activities and helped to identify local priorities for the policy agenda, and, subsequently, the definition of a commonly shared Strategy and Action Plan involving a panel of actors, both public and private bodies, that are formally committed to its implementation.

The Action Plan is likely to be implemented successfully because of the fact that it comes from the contribution of relevant actors of the area and that each action has been carefully designed, identifying the proper responsible subject source of funding. This aspect represent a first positive outcome of the stakeholder involvement, granting a higher commitment of local actors in respect to a top-down strategy developed only by local institutions.

Even if it is rather difficult to measure the value added by participatory processes to local planning, it can be argued that in Alpi Lepontine case study there are some evidence of the positive influence of stakeholders involvement in the European Charter process. Firstly, this experience helped to create a partnership that will constitute the basis for further cooperation in the realization of actions for local sustainable development (as it is already happening with the two projects presented in section 3.6); secondly, local actors are more likely to share responsibilities and actively participate to the actions for local development, because this activities go in the direction of what they suggested as more relevant for local development.

Moreover, the active involvement of local entrepreneurs, especially in tourism sector, could help to promote local economic development (i.e. to avoid depopulation of the areas due to unemployment) and to prevent mass tourism exploitation by big foreign companies, that often don't provide any economic revenue to the local community and that can be less interested in preserving the local heritage and environment, due to the fact that, if the area becomes unattractive, they can move to another one. In this context, the integration of a subjective and a strategic analysis allows to identify relevant issues able to strengthen the relationship between internal (local managers etc) and external actors.

The European Charter audit scheduled for 2012 defines a temporal target for the implementation and provides an occasion for a more detailed evaluation of the process outcomes: Europarc will verify that the actions has been effectively implemented and that the cooperation between stakeholders is still alive and proactive in fostering and renewing the Strategy objectives. Furthermore, the project team planned to renew the assessment of some of the sustainability indicators developed for the objective evaluation made at the beginning of the process (Tourism Carrying Capacity and Sustainable Performance Index, see Castellani et al, 2007 and Castellani et al, 2009 for details) in order evaluate the changes in the situation and to measure the effects of the actions implemented.

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5.2 Communication of science

Considering that every activity, product or service, throughout all its life cycle, implies necessarily an impact on the natural environment (through the consumption of raw materials and the emission of waste), the promotion of more sustainable production and consumption patterns is identified as a priority for sustainable development policies, such as the Integrated Product Policy.

Scientific research can have a role in the promotion of more sustainable patterns of consumption and production because it can provide information aimed to raise awareness about the impacts of different behaviours and to support more sustainable choices from different kind of actors. The challenge posed to science in this context is to provide information that is effectively supporting for decision making processes at different scales and that can be easily understood by all the stakeholders involved in the process (policy makers, entrepreneurs, citizens and especially young generations). Indeed, development of a more sustainable society, especially with respect to consumption and production patterns, is a task that involves:

- **young generations**, that will be responsible for the development of future societies;
- **citizens**, that can have a role in reducing the impacts of their activities through the choice of more sustainable behaviours (e.g. sustainable mobility options, purchasing of products coming from short supply chains and using lighter packages, water and energy saving, etc);
- **entrepreneurs,** that can improve the environmental performances of their products or services through the eco-innovation of products and processes. Poor environmental performance of SMEs (Small and Medium Enterprises) has been attributed to a wide range of barriers, among which a lack of understanding of environmental issues and a lack of awareness of existing environmental regulation, that highlights the necessity of bridging the gap between science and business (as pointed out also by the EU Communication “Small, clean and competitive”, COM (2205) 551).

The following paragraphs illustrate the experiences made in these three years about education to sustainability addressed to several kind of actors. The aim was to find new methods for environmental education, combining scientific knowledge with cultural models and participation, in order to move from scientific understanding of environmental problems to an active change of behaviours an lifestyles. The experiences presented were addressed to students of primary and secondary schools, citizens and entrepreneurs; in each case we tried to identify the most effective methods to communicate the sustainability issues and to provide appropriate tools to translate knowledge into action.

Project “Il Girasole si muove” - sustainability education to students, citizens and entrepreneurs.

The project was focused on the promotion of sustainable consumption and production patterns among three main categories of actors: students, citizens and entrepreneurs. The education was organized as follow:

- theoretical lessons and practical labs with students about life cycle thinking, ecodesign, eco-labels, energy efficiency, waste, compost;
- public meetings for citizens about energy efficiency, eco-building, green purchasing
- public meetings for entrepreneurs about eco-efficiency, eco-innovation, eco-design, with reference to environmental legislation and funding opportunities for actions in these fields.
- Three-day training for entrepreneurs, professionals, local administrators and academic students about methodologies and tools for eco-innovation and eco-design.

The project involved a wide range of supporting subjects (such as Chambers of Commerce, Regional and Provincial offices and an association for citizens' patronage) with the aim of comparing different perspectives and to find the most suitable ways to involve the recipients of the educational action.

Project "Ecodesign"

The study was performed for identifying how to involve SME's of the furniture sector and how to disseminate life cycle thinking starting from the identification of the most important impacts trough a qualitative LCA of the entire supply chain (from cradle to grave) and a quantitative LCA of a specific piece of furniture. Within the project, dissemination of guidelines for sustainability of the wood-furniture supply chain was provided to SME's through a publication aimed to ensure better approaches for: finding solutions inspired by ecodesign principles; reducing environmental impacts of production; communicating effectively environmental performance to retails and to consumers.

Furthermore, also retailers were involved in the project due to their role of "translator" of environmental performance to customers. A course about ecodesign and labels was organized, to promote knowledge among retailers, and standards for an eco-label type III were defined, with the aim of communicating environmental performances of companies and products to consumers.

Exhibition "The cycle of recycle"

The exhibition is designed as a support to educational activities about sustainability and sustainable consumption and production. It presents the basic concepts of life cycle thinking, ecodesign and recycling and provides an overview of the main processes of recycling, from separate waste collection to the use of recycled materials in industrial plants.

Every edition of the exhibition can be visited by students (with a guided tour) during the week and by the families during the week-end. Aim of this activity, organized in cooperation with local municipalities, is to make students and citizens more conscious about the importance of waste reduction, reuse and recycle (according to the principles of the Thematic Strategy on the prevention and recycling of waste) and to inform them about the possible actions that citizens can implement to fulfil these objectives.

International Congress "Sustainable Tourism as a factor of local development"

The organization of the congress came from the willing of creating a connection between research, institutions, enterprises, local NGO's and cultural bodies, for the definition of new patterns and models for local development. The Brianza area, location of the event, represented an interesting context, especially because of the tourist outlook for the following years, with particular reference to tourism forecast related to Expo 2015 (29 million visitors, according to a study performed by the local Chamber of Commerce). Therefore, purpose of the congress was to highlight strength and weakness of sustainable tourism as a key factor for local development, to investigate the possibility of a sustainable approach in the development of new tourism offers, to identify new strategies for sustainable tourism and recreation in urban areas and to define the role of local actors of tourism sector in the process of planning for local development, with a focus on the occasion of a worldwide event as Expo 2015.

The issues related to sustainable tourism are complex and interconnected. There is a strategic need of consider several aspects from an interdisciplinary point of view, trying to overcome disciplinary approaches. The congress results in a counterpoint of tourism perspective in which sustainability is considered form several disciplines, giving the opportunity for debate to representatives of the scientific world, institutions and NGOs at local, national and international level, From the scientific world, representatives of the faculties of architecture, engineering, literature, sociology, economics and geography have answered to the call fostered by the Department of Environmental Science, testifying a wide interesting for an interdisciplinary dialogue about contents and methods.

6. Conclusions

The research activity focused on the development of methodologies and indicators to assess sustainability of local development, with the aim to drive and to support development policies and decision making from public and private bodies. Specific attention has been paid to two economic sectors for which availability and quality of natural resources play a relevant role in determining success and long-term sustainability of the local systems (namely, tourist system and forestry). The objective of the research has been to develop methodologies able to quantify and to evaluate the main aspects that determine the sustainability of development at the local level, providing useful information to decision makers (i.e. policy makers, economic actors and citizens) in support of their choices. Specific attention has been paid to the different dimensions of sustainability (environmental, economic, social and institutional) and to the main issues that can influence them (e.g. carrying capacity of natural ecosystems that support human activities, consumption and production patterns and the efficiency of the technologies used).

The main challenge posed by the evaluation of sustainability is the necessity to consider different aspects in a integrated manner, i.e. to evaluate and to integrate knowledge coming from different disciplines in order to provide information in support to decision making. In respect to this challenge, the use of indicator is widely recognized as useful in sustainability evaluation; more specifically, indicators can be useful for:

1. making a quantitative evaluation of environmental, social and economic conditions of the area object of the study;
2. defining measurable targets;
3. comparing results through space (e.g. different areas) and/or time (trends);
4. communicating results to stakeholders with the aim to inform and to support decision making.

Keeping in mind these objectives, the evaluation of sustainability in the tourism sector has been made through different methodologies that consider several aspects: the carrying capacity, i.e. the specific features of the destination that can determine sustainability of tourism activities in the long term; the ecological footprint of tourism, as a measure of the impacts of tourist behaviours and choices and as an effective communication tool to raise awareness among tourists, tourist operators and local managers; the Sustainable Performance Index, which is a tool developed for ex-ante and ex-post evaluation of the sustainability of policies for local tourist development and that integrates all the knowledge (objective, subjective and strategic) coming from the participatory process of the European Charter for Sustainable Tourism in Protected Areas.

Since every methodology developed or implemented is necessarily more oriented towards some aspects than others, it is interesting to compare and to integrate the results of the evaluation made from these different perspectives and to identify correspondences and differences between them. Furthermore, every methods has some strengths and some weaknesses that can be compensated by the integration of different methodologies. For

instance, the Ecological Footprint is a good tool for communication of information to the stakeholders, but the difficulty in developing equations able to evaluate the footprint of tourism starting from local tourist data (considering all the possible categories of consumption) represents a challenging task, that imply necessarily the use of proxy data. For this reason, the implementation of LCA studies about the impacts of accommodation, trips and stay could be a valuable integration for the existing model, enabling to use more detailed and local data and to strengthen the validity of the ecological footprint method.

In the same manner, the evaluation of sustainability of forestry activity has been performed considering different uses of forest biomass and trying to integrate the assessment of technical feasibility of the processes with an evaluation of the positive and negative aspects that can influence sustainability in the forest ecosystem and in the local community. Special attention has been paid to the technical, economic and social constraints that can determine the choice of one option instead of another, besides from their environmental sustainability. The results are a decision support system for sustainability assessment of technologies for energy generation from forest biomass and an hypothesis of integration of different forest uses (namely, energy generation and wood-based panels production for the furniture industry) in a short supply chain, as a possible solution to optimize economic profit, forest conservation and social benefits.

One of the main conclusions coming from this research is that sustainability science is quite a new field of research, so there is still need to define commonly shared standards and methods. In the evaluation made through indicators, this is reflected in the difficulty of defining reference values and thresholds of sustainability against which evaluate the results of the indicators selected for the assessment. Moreover, the difficulty in defining common standards is influenced also by the fact that sustainability is strongly dependent from the local characteristics and from the values and the priorities of the local community, so it is quite difficult to define a "sustainability target" which is entirely valid for a wide range of situations.

Therefore, the development of methodologies should try to balance the need to compare results through space and time and the need to consider local conditions, i.e. to ensure a more effective support to decision making at the local level. In this perspective, the development of set of indicators, that can be considered as a dashboard or aggregated into a single index, can provide useful information to decision makers about strengths and weaknesses of the situation evaluated (e.g. the technological option for energy production from biomass or the tourist destination management model) and, in the same time, provide a unique number that can be used to compare its sustainability performance against other solutions.

Another important issue that should be considered in order to improve the consideration of local features is the stakeholders involvement in the process of evaluation; the methodology developed for tourist carrying capacity assessment and the Sustainable Performance Index, strongly linked with the participatory planning process of the European Charter for Sustainable Tourism in Protected Areas, proved that this integration can provide interesting results.

Finally, besides the support to decision making in policy processes, scientific research can have a role in the promotion of more sustainable patterns of consumption and production in society, because it can provide information aimed to raise awareness about the impacts of different behaviours and to support more sustainable choices among different kind of actors. The challenge posed to science in this context is to provide information that is effectively supporting for decision making processes at different scales and that can be easily understood by all the stakeholders involved in the process (policy makers, entrepreneurs, citizens and especially young generations), and to provide appropriate tools to translate knowledge into action.

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