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# Trajectories of greening.
## The distribution, generation and articulation of ecosystem services in the metropolitan areas of Milan and Brussels

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# Introduction

Today, it is clear that the overwhelming environmental changes due to human-related activities have incremented existing inequalities, concurring to create new forms of poverty and deprivation worldwide. Rising temperatures, pollution, desertification, loss of biodiversity and increasingly recurrent disastrous meteorological events are undeniable facts. These phenomena have geographically disproportionate impacts at global and local scales.

Concepts such as sustainability and resilience have been recently discussed in a lot of diverse governmental, scientific and social contexts that span from international institutions to local grassroot movements. Urban areas are at the core of this debate. The contemporary physical and organisational urban forms are widely recognised as unsustainable, as the number of city-dwellers is expected to constantly increase in the next decades. The challenges posed by an urban transition towards sustainability involve deep and radical changes in planning, economic activities (consumption, production, distribution), cultural habits, governance, welfare and environmental policies.

This thesis focuses on few specific issues concerning urban sustainability: green spaces and ecosystem services in two European metropolitan contexts. Recent studies have underlined the multifunctionality of green infrastructures and the relevance of support, recreational, regulating and provisioning services for the liveability and the well-being of large urban areas. The topic of urban ecosystem services has been studied under different perspectives (i.e., economics, ecology, urban planning). In this research, I intend to focus on the social distribution of green spaces and of some ecosystem services, highlighting territorial vulnerabilities and inequalities. Furthermore, I am interested in understanding the political processes that underpin urban greening and, in particular, the vision of the actors involved in green governance and the dynamics of green planning and management.

The research therefore attempts to contextualise green infrastructures and ecosystem services in Milan and Brussels metropolitan areas, elaborating on the distribution of ecosystem services and on the political articulation that contribute to generate them. Greening where? For what? For whom? By whom? The comparison helps comprehend the value of green spaces against two different metropolitan contexts and sheds some light on the sustainability visions that lay behind greening.

The research topic passes through diverse academic disciplines such as urban studies, ecology, sociology. Over the past three years I have had the opportunity to share ideas and to collaborate with researchers with different academic backgrounds at the Igeat department (ULB, Brussels) and at the Environmental Science department of the University of Milan-Bicocca. I am strongly convinced that all the issues related to sustainability require interdisciplinary and transdisciplinary research activity. With all the limitations due to the individual nature of the PhD position, I have attempted to develop an interdisciplinary conceptual framework and a methodology that tends towards transdisciplinarity.

In summary, the research stems from some pragmatical, policy-oriented issues: the contribution of green spaces to territorial well-being and the political processes that define green planning and management practices in European metropolitan areas. In the thesis, I argue that semi-rural areas and periurban forests represent important potential carbon sinks, while urban parks and small green infrastructures provide essential regulating functions for climate change adaptation. Focussing on heat mitigation and water retention, I argue that the value of regulating services depends not only on the ecosystem functions, but also on the socio-territorial demands and especially on the vulnerabilities inscribed in historical and political urban processes. Finally, through the study of the governance and of the actors involved in green planning and management, I delineate two approaches towards greening: Milan's market-oriented idea of sustainability and Brussels's public driven conception of sustainable urban development.

The thesis is divided in four sections. The first one presents the conceptual framework. Chapter 1.1 introduces some essential epistemological principles that have guided the research. The chapter, drawing from various academic perspectives, briefly explains the theories that underpin interdisciplinary, policy-oriented, participative and reflexive research.

Chapter 1.2 illustrates the main environmental challenges related to urbanisation. After reviewing the literature on the social and morphological dynamics of contemporary urbanisation, the main environmental issues are presented. The chapter intends to show the significant impact of the urban dynamics on the environment and on well-being.

The following chapter (1.3) focuses on the concept of sustainability. It provides a critical overview on the theories and practices developed under the umbrella of sustainability. In conclusion, I argue that the theoretical frameworks of ecological economics, environmental justice and political ecological may contribute to shape an alternative idea of urban sustainability.

Finally, chapter 1.4 specifically faces the issues of urban green spaces and ecosystem services. After explaining the main challenges related to greening in large urban areas, I introduce the concept of ecosystem services. At the end, I elaborate on the ideas of distribution, generation and articulation of ecosystem services.

The second section of the thesis delineates the research design. The objectives and the research questions are explained in chapter 2.1, while chapter 2.2 is about the methodology. The study entails quantitative methods - such as ecosystem services assessment and GIS socio-territorial analysis – as well as interviews and other qualitative research tools.

The third and the fourth sections present and discuss the empirical results of the research. Section 3 is dedicated to the analyses of the distribution of three ecosystem services in the metropolitan areas of Milan (chapter 3.1) and Brussels (3.2). Here, I illustrate the maps on the distribution of green spaces and ecosystem services in the metropolitan areas, combining environmental indicators about the ecological functions, with spatial information on metropolitan territorial features and dwellers' socio-economic characteristics. Chapter 3.3 puts together the main results of the two cases and draws some conclusions.

Section 4 elaborates on the governance of greening processes in Milan (4.1.) and Brussels (4.2). Based on the interviews and on the analysis of the main planning documents, I attempt to understand the role of the main actors involved in green planning and management and to define their visions concerning green functions and services.

Finally, the conclusion recaps the main findings and points out the limitations of the present work and the possible future research developments.

# 1 Research theme, theory, academic debate and analytical concepts

This first part of the thesis aims at introducing the theoretical framework whereby the research has been conceived and developed.

The first chapter clarifies some epistemological principles derived from sociological, ecological and philosophical research. The second chapter is about the relevance of the natural environment in the contemporary urbanisation processes. Subsequently, in chapter 1.3, sustainability is critically presented as a key, though problematic, field of analysis for urban environmental issues. The perspectives of ecological economics, political ecology and environmental justice are then illustrated. Finally, in chapter 1.4, I present the specific issues of the urban green spaces and ecosystem services, and the analytical concepts deemed relevant for the purpose of the research.

## 1.1 An epistemological premise: some guiding principles for socio-environmental research

Environmental issues have firmly entered in the social science academic debate just few decades ago. The recent growing relevance of climate change has perhaps contributed to highlight the necessity to include the study of social components in the scientific inquiry (see, for instance, (IPCC, 2014)). On the one hand, the irreversible consequences of human activities on ecological equilibriums inevitably question human behaviours and socio-economic organisational structures. On the other hand, environmental changes necessarily push towards forms of social adaptation to new and unexpected living conditions.

Yet, well rooted epistemological dichotomies (i.e., social versus natural facts, human versus non-human) and disciplinary boundaries have hampered the consolidation of a strong and well-defined socio-environmental research tradition. For this reason, it might be worthwhile to clarify some basic epistemological principles, as general and ideal guiding criteria of research.

Admittedly, this chapter is not exhaustive of a very broad multidisciplinary debate. Indeed, it outlines some insights that I consider relevant for the purpose of the research. Starting from the foundational ideas of environmental sociology, I take in consideration Latour's social theory, integrative ecology and post-normal science, in order to define an epistemological ground upon which I develop the study.

### 1.1.1 Environmental sociology

In a 1979 seminal paper, Dunlap and Catton (1979) delineate the traits of environmental sociology, as a distinctive area of inquire, in opposition to the traditional sociological paradigms, all labelled as exeptionalist (exemptionalist in a later paper, i.e.: Dunlap & Catton, 1994). The main motivation of the article is the need for an immediate shift towards an environmental sociology, in a world in which human societies have an increasing and tangible impact upon the global environment, causing new and powerful risks and concerns. In their words:

« Environmental sociology involves recognition of the fact that physical environments can influence (and in turn be influenced by) human societies and behaviour. Thus environmental sociologists depart

from the traditional sociological insistence that social facts can be explained only by other social facts. Indeed, its acceptance of "environmental" variables as meaningful for sociological investigation is what sets environmental sociology apart as a distinguishable field of inquiry. » (Dunlap & Catton, 1979: 244)

Environmental sociology does not coincide with the sociological study of environmental issues. The latter is limited to the understanding of perception, attitudes, institutions, social movements. On the contrary, environmental sociology is conceived as the study of the reciprocal interactions that incur between the environment, human behaviour and social organisation.

Thus, environmental and natural elements are considered as significant drivers of change, not only of cognition and behaviour, but also of physiological and material aspects of living. Sociological knowledge would benefit from including biological and physical facts, and therefore from an interdisciplinary view of reality.

The authors are deeply influenced by the social and intellectual context of the '70s. "The limits to growth" (Meadows et al., 1972) has approximately represented the starting point of the worldwide scientific and public concern about climate change and other interrelated environmental issues, the putative environmental crisis (Pellizzoni & Osti, 2008). Dunlap and Catton aim at introducing these issues in the sociological debate.

### 1.1.2 Tarde and Latour's critique

From a theoretical point of view, the challenges posed by environmental sociology to the traditional exeptionalist sociology have been further elaborated. Interestingly, some historical and genealogical studies recall the contributions of Gabriel Tarde, questioning the validity of the dominant Durkheimien framework.

The anthropologist Bjorn Thomassen, for instance, argues that the predominance of social facts as sole object of interest of sociology has its origin in the academic dispute between Tarde and Durkheim (Thomassen, 2012). In short, in a foundational moment of the discipline, Durkheim's brilliant academic career imposed a strong limitation to the dissemination of Tarde's and other contemporaries' theories and strongly conditioned the future developments of sociology. Although Durkheim relied on data collected by the French rival, which were often misunderstood and misinterpreted, he clouded Tarde's main ideas, since they were in opposition to his conception of social facts as transcendent categories of reality (Ibid.).

For the purpose of this paper, it is worth noticing that the sociology of Gabriel Tarde refused the idea of a rigid separation between natural and social facts and the idea that social facts were the only object of interest of sociology. As Latour thoroughly explains:

«Durkheim deals only with human societies and borrows his ideal of science from natural scientists with whom he has little occasion to collaborate since, for him, human societies should remain radically different from biological and physical ones. Tarde's position is the reverse; for him there exist only societies. Human societies are but a particular subset of these societies because they exist in so few copies. But human societies are accessible through their most intimate features, social scientists have no need to let natural scientists dictate what their epistemology should be. » (Latour, 2012: 147).

Latour (Latour, 1993) goes beyond this critique to sociological foundations, towards a more general critique of modern scientific thinking. He claims that, in general, modern scientific thought is based on two cyclical processes: translation and depuration.

The former is the creation of new and increasingly complex hybrids, or quasi-object, as the French author defines them. In his opinion, scientific discoveries and natural facts are not distinguishable from their cultural and political context, which, indeed, are not just external frameworks, but play a pivotal role in the process of construction and definition of knowledge and natural facts. There is not such a thing as pure nature, as transcendent object of a scientifically aseptic inquiry. The most evident example is the scientific laboratorial activity through which scientists build their own artefacts and label them as natural.

At the same time, societal developments are inevitably more than culturally driven: they cope with technological, natural and material changes, which heavily condition, often in unexpected and unpredicted manners, human lives (see, for instance, Diamond's interpretation of the European colonial conquests in America. (Diamond, 1997)).

Paradoxically, the proliferation of hybrids - new natural and material (technological, medical, scientific, biological findings), social and political (ideologies, forms of government, economic structures) objects, dispositifs and ideas, which constitute modernity - depends on their depuration (the second phase of the cycle).

In fact, the modern structure of science neglects the concept of hybrids. At the same time, modern critical thinking rigidly separates facts, power and discourse and it cannot comprehend the interrelations intrinsic in the constitution of quasi-objects. If, on the one hand, this mechanism has favoured modern development, on the other hand has caused the global diffusion of complex issues - i.e. ozone depletion, climate change, world-wide spread of diseases, global economic crises (…) - that are increasingly threatening and not fully understandable in modern terms (Latour, 1993).

### 1.1.3 Integrative ecology and post-normal science

This shift towards a new theoretical and epistemological approach in the study of society and nature is not confined to social theory. In fact, natural sciences, namely ecology, have elaborated innovative methods and policy-oriented solutions to face the complexity of human-nature interrelations and to address the multiple spatio-temporal scales they involve.

The challenges of sustainability and, in general, environmental problems require a revision of scientific practices. As Gallopin et al. (2001) highlight, it is not just a matter of communication between science, lay people and policymakers, but concerns also ontological and epistemological scientific change and a revised way of contributing to decision-making. Let us consider two epistemological approaches: integrative ecology and post-normal science.

The first one, rooted in ecological sciences, delineates a separation between two distinct and complementary branches of ecology: analytical and integrative ecology (Holling, 2001). The former represents the traditional practices of science. Based on laboratorial and analyses of small samples, it tackles specific issues on single scales. It relies on experimental procedures and aims, through standard statistics techniques, at eliminating uncertainty or reducing it to a minimal, acceptable degree.

Conversely, integrative ecology deals with complex socio-ecological systems and therefore takes in consideration a multitude of spatio-temporal scales, trying to understand the underlying processes that lead to the maintenance and the development of such systems (Holling, 2001). Integrative ecology has necessarily to do with uncertainty and policymaking at different scales. It is hence multidisciplinary, dynamic and prescriptive.

In this sense, integrative ecology follows the idea of a post-normal science, advocated by philosophers of science Silvio Funtowicz and Jerry Ravetz (Funtowicz & Ravetz, 1993). Post-normal science is a new paradigm in the kuhnian sense: it envisages the overcoming of the routinely scientific activity, with the introduction of innovative methods and functions that are rooted in a new epistemological conception of science. It does not substitute traditional "normal" scientific practices, but it is complementary as it deals with topics that are not fully comprehensible with the previous paradigm.

Post-normal science addresses highly and irreducibly uncertain systems with high decision stakes that force to intervene in a short-medium temporal arch. For instance, the problems

related to technological hazard, large-scale pollution, climate change. In these cases, normal experimental science is meaningless, or even harmful, as it banishes uncertainty, relies on reproducibility and ignores spatial and temporal contexts. Post-normal science attributes value to the historical dimension, by including reflections about humanity's present and past, in order to improve the understanding of nature.

Funtowicz and Ravetz's paradigm therefore prefigures a pluralist approach to scientific practices that encompass an extended peer review community, where scientists build a constant dialogue with local communities and policy-makers. In so doing, they broaden their understanding of their object of research and they provide shared and aware information that could play an effective role in policy and decision-making.

Here the separation between facts and values is meaningless because both are determinant in addressing and defining natural processes. The need to provide assessments and decisions in high stakes contexts imposes an intimate connection between uncertainties in knowledge and in ethics.

There is not a unique rational scientific decision which is just and is equally fair to the rights of humans and of other natural living beings. For this reason, post-normal science focuses on the processes that underlie decision-making and carefully takes in consideration the voices and the features of all the social and natural actors involved in the field.

### 1.1.4 Four epistemological principles

If we put together environmental sociology with integrative ecology, Latour's or even (to a certain extent) Tarde's social theory with post-normal science, we notice that the call for a new epistemological approach in the study of society and environment comes from several, heterogeneous voices. It is induced by tangible and increasingly threatening processes and puts forward innovative insights, to improve the scientific contribution to the social and natural world.

Although the above outlined theories represent a small portion of a much broader debate, some common general principles emerge. In particular, four pivotal points may be highlighted:

- Interdisciplinarity and transdisciplinary research
- Participation in the entire scientific process
- Reflexivity

- Policy-oriented research

Interdisciplinary research is fundamental to understand issues that are not confined within academic fragmented disciplines. Environmental issues – e.g. air pollution, technological and natural hazards - concern societal, as well as natural processes, in a mutually interactive way, so that the very same distinction between human societies and natural features is often misleading. The collaboration between diverse research approaches may result in new transdisciplinary epistemological and theoretical framework. Transdisciplinary, issue-driven approaches are more effective in dissolving in toto conventional disciplinary boundaries.

The need for exchanging methods of analysis and information overwhelms academic knowledge. Participation is not just an ethical issue, as it is related to the validity and the effectiveness of scientific inquiry. Participation means involving lay people in the definition of scientific priorities, in the process of analysis and in the dissemination of results. Communication, intended as sharing information and mutually changing stakeholders and practitioners' behaviours and beliefs (Cerase, 2017), is therefore a substantial part of scientific activity.

Connected to the question of participation, reflexivity is another prerequisite to address complex socio-environmental issues. A scientific process is reflexive if it constantly monitors and questions its activities. A reflexive approach envisages being careful about the consequences of scientific discoveries and science-based actions on natural and societal processes: when, where and how it can affect them. Furthermore, a reflexive attitude questions the principle of reproducibility, as it acknowledges uncertainties and highlights spatial and temporal contextual peculiarities.

Finally, the theme of decision-making cannot be overlooked, because it concerns the responsibility of scientific activities in high stakes contexts. Scientific activity has never been detached from political and social developments (Latour, 1988). It has always been heavily conditioned by historical, geographical drivers involving power relations, politics, military and many other human-related activities. Today, the role of science in decision-making and in environmental governance represents a much-debated question. The increasing pressures of environmental problematics force science to acknowledge its role in policymaking and to debate it. For this reason, social and environmental research cannot be relegated to academic circuits, but must consider real and concrete issues at different, intersected scales.

Interdisciplinarity, participation, reflexivity and an orientation towards policymaking are ideally four epistemological pillars of this research. In fact, the implementation of this study does not always comply with such prescriptions.

The individual nature of the PhD research and its strict timing certainly limit the possibilities of complying with them. A truly interdisciplinary research would require a wider research team with diverse expertise. Similarly, a participative approach is demanding in terms of time and involve methodological tools that are hardly implementable without a team of researchers. In any case, this research takes in consideration various and heterogeneous theories and data and, by reflecting on its limits, indirectly face the issue of participation.

The following chapters introduce the general themes of the research, highlight its relevance in academic discourse and in urban policymaking and provide some conceptual tools to frame the topics. The importance of the principles here outlined undoubtedly recur in the definition of the general research issue and in the theoretical and conceptual framework.

## 1.2 The significance of the urban environment

### 1.2.1 Quantifying contemporary urbanisation

In the last decades, the urban population has been growing at an impressive rate. According to the UN, approximately two thirds of the world population will be living in urban areas by 2050 (Kacyira, 2017). The percentage of urban population did not exceed 10% at the end of the 19th century; it increased to 30% by 1950. It reached 50% in 2007, up to 55% in 2018 (Chaouad & Verzeroli, 2018). The unprecedented worldwide growth of cities and urban population brings about several questions on the modalities and the consequences of urbanising processes. As around 80% of the world GDP is produced in urban places (Seto et al., 2011), economic activities, social justice, ecological equilibriums and socio-environmental viability heavily depend on the way urban areas are planned, lived and governed.

Contemporary urbanisation mainly concerns African and Asian countries (see Fig.1.1). In Europe, the massive growth of urban areas was strictly linked to last centuries' industrialisation. At the outset of the 20$^{th}$ century, 77% of the English population lived in cities (Melosi, 2004) and several European countries had already passed through significant processes of urbanisation. At the end of the 20$^{th}$ cent., 74% of the European population already lived in cities. Nowadays, the pace of urbanisation is much faster in Africa and Asia, where population growth, migrations and cities expansion favour massive and unprecedented urbanisation. Projections for the next decades show that 66% of the Asian and 59% of the African population will live in urban dwellings by 2050 (Chaouad & Verzeroli, 2018). Overall, 90% of the global urban growth will be absorbed by these two continents (Ibid.).

Urbanisation has followed distinctive paths and presents peculiar challenges in the global South, such as extreme poverty, accessibility to essential infrastructures and widespread informal dwellings; the debate rather concerns the sustainability of existing urban dwellings, in terms of urban structure and mobility, consumption, production and urban metabolism, equity and post-industrial economic development in Europe and in the global North. However, there is no doubt that Global South and North issues are indissolubly linked, being connected by unequal economic and cultural relations. Furthermore, some common issues, concerning the (un)sustainability of contemporary urban development can be easily found: the growth of

precariousness and unemployment and the general weaknesses of the labour market, social cohesion in increasing diverse and internally unequal urban regions, and the quality of the urban environment (Véron, 2018).

This thesis specifically focuses on urban environmental issues in European contexts. Nonetheless, it might provide some insights, which could be deemed as relevant also in other contexts. More importantly, it considers also theories and epistemological approaches that are not entirely Euro-centric, such as those derived from environmental justice and ecological economics.

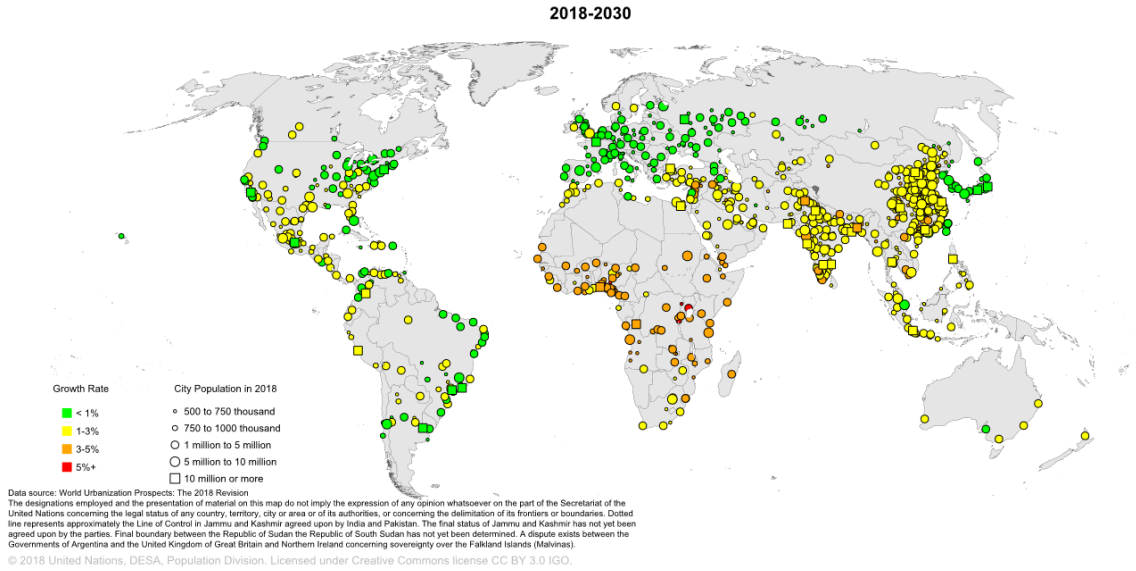



*Fig. 1.1 Growth rates of urban agglomerations by size class. Source: United Nations World Urbanization Prospects 2018. Retrievable at: https://population.un.org/wup/Maps/*

### 1.2.2 Defining the urban beyond the city and its territorial expansions

The numbers on contemporary urbanisation clearly indicate a radical and unprecedently fast shift. At the same time, they question the concepts and the categories of analysis that have been traditionally employed in the study of urban phenomena. Paradoxically, the very same methodological and theoretical bases of the UN classification and definition of urban need to be discussed.

As Brenner and Schmid (2014) demonstrate, the United Nations definition of the urban opposed to the rural relies on a questionable statistical approach and on uninterrogated theoretical claims.

Methodologically, it is based on national statistical data, which are collected following heterogeneous criteria regarding the division between administrative cities and rural areas. More importantly, theoretically, the UN concept of urban age presupposes a rigid division between city and non-urban places, which are considered as mutually exclusive entities, characterised by well-defined structural morphologies and social characteristics.

During the last century, urban studies have attempted to define the forms of the urban beyond the static form of the city. Clarifying what urban means and how it develops and diversifies is fundamental from a heuristic point of view. In effect, the claim that the globe is becoming urban is rather problematic if we do not differentiate between diverse forms of the urban and if we do not consider the processual mechanisms that lay behind urbanisation. In this regard, the optimistic idea of an urban age is quite naïve (Brenner & Schmid, 2014).

Concepts as conurbation (Geddes, 1915), metropolitan region (Mumford, 2005), functional urban area (Dijkstra & Poelman, 2012), megacity (Castells, 1996), metacity (Soja, 2003), global cities (Sassen, 2001) have theoretically and analytically depicted some of the main processes of urbanisation and their ongoing empirical outcomes. The improvement of technological and mobility infrastructures, the growth of commercial fluxes and the continuous and disruptive process of capital accumulation in the construction of the built environment (see Harvey, 1978) have favoured the territorial extension of the urban well beyond the historical cities.

Of course, these developments are inherent in urbanisation and do not represent a unique historical rupture. Interestingly, Arpad Szackolczai describes the growth of Uruk (Mesopotamia) in the 4$^{th}$ millennium b.C. as the rise of the first "global city".

«Around 3200BC, within a relatively short period, population density in Uruk increased tenfold (Matthews 2003: 110). As a result, by 2900BC the city grew to the staggering size of 5.5km2, containing nearly 100,000 inhabitants (Nissen 1990: 80-1). In comparison, classical Athens extended to about 2.5km2, while Jerusalem was only 1km2 (50AD), and even Rome at the height of the Empire (100 AD) was only about twice the size of Uruk (Ibid.)." (Szakolczai, 2016: 447). »

His analysis of historical and archaeological evidence highlights a great increase of productivity, significant quantitative and qualitative changes in the material culture (fabrication of standardised low-quality potteries) and a great territorial expansion. The social stratification became more accentuated and hierarchical, and the modes of production and consumption more standardised. The might and disruptive growth of the city ended up in violent conflicts, human sacrifices and eventually, few centuries later, in the collapse of the city.

Apart from the author's anthropological interpretation of this phenomenon and its interesting analogies with contemporary globalisation[1]- which go well beyond the scope of this chapter – here I would like to underline that phenomena of rapid and uncontrolled urbanisation had already happened, even well before modernity. This does not affect the necessity of theoretical, analytical and descriptive efforts to understand contemporary forms of urbanisation. On the contrary, the long-term historical dimension of the phenomenon is an insightful element and stimulates further research on such a fundamental issue.

The peculiarities of contemporary urbanisation are perhaps the planetary dimension and its irreversible impact on the environment. Castells (1996) describes the contemporary urban form as a megacity (or global city): a global network of knots, whose dimension and power are defined according to their position and their relations. The megacity is something different from the urban region, because it is not territorially defined. It is enormous, almost limitless. It is polycentric, with unevenly distributed small and big knots, and presents irregular, deregulated soil consumption patterns. It has no name, because the institutional developments and the administrative limits cannot cope with fast and almost borderless metropolitan processes.

In Castells's interpretation the megacity is the spatialization of a new technological paradigm, which has favoured the development of real time connections between very distal places. The most important knots - cities where financial centres and big firms attract highly specialized working force as well as a great number of unskilled immigrants for precarious activities in the service sector, and where the real estate market has been widely financialised (Sassen, 2005) – have greatly increased their value accumulation. Inequalities thus arise within and between the competing knots in the megacity network. Fear, exclusion, social diffidence and the formation of reactionary localist and nationalist political forces are the downside of this kind of global urbanisation.

Brenner and Schmid (Brenner & Schmid, 2015) further elaborate on contemporary planetary urbanisation and criticise some of the main past dichotomic categorisation: urban/rural, north/south, east/west and all the topological space divisions. According to them, every place, even the remotest, is in fact affected by urbanisation through large scale land grabbing, fossil fuels and energy extraction, industrial agriculture, touristification of natural landscapes, logistic

[1] In his opinion, the driving force of this great transformation was the combination of religious-cultic despotic practices and innovative technologies and techniques of production that created a liminal condition, which eventually brought to unsustainable growth and collapse.

hubs and global sweatshops. In their opinion, it is therefore impossible to distinguish between urban and non-urban spaces.

Politically, the weakening of state investments due to austerity, privatisation and market deregulation, favours forms of government that are not always ascribable to existing institutions. Urban governance is increasingly complex and powerful, as it comprises private and municipal actors that develop new and innovative forms of cooperation to attract capital investments in a highly competitive global market.

Brenner and Schmid therefore claim that urban and urbanisation are not fixed and static categories that correspond to spatially defined empirical objects. They believe that urban and urbanisation are theoretical categories that concern processual socio-economic transformations.

Although their description of contemporary urbanisation and their critiques to city-centred urban studies are quite compelling, their epistemological conclusions are controversial (see Walker, 2015 for a thorough critic). In fact, the urban and urbanisation are empirical objects. Just because it is difficult to grasp them and make sense of their rapid and hardly predictable shifts, it does not mean that they do not exist. As Walker notices, this is a case of confusion between ontology and epistemology (see Næss, 2015 for the critical realism critique towards post-modern and positivist epistemologies).

### 1.2.3 Analysing urban territorial developments: cities *de facto*, metropolitan areas, boundaries and intraurban differentiations

Urban sociological and territorial studies have long attempted to comprehend and to categorise the empirical differences within the urban. Phenomena of suburbanisation and peri urbanisation have been largely analysed under spatial, morphological and socio-economic perspectives (e.g., Mumford, 2005 on suburbanisation; Colleoni, 2019 on the peri urban; Nuvolati, 2002 on urban populations).

Several approaches for determining the territorial subdivision of urban places have been developed, following diverse criteria: population density, commuting, employment, consumption trends, built density and land sealing, fragmentation of the built environment. In this section three different approaches will be briefly synthetized. These are not mutually exclusive, nor exhaustive of a wider and much debated issue, that is, in fact, transdisciplinary. They give an idea of how different disciplines have dealt with urban territorial analysis. While

the first and the second approaches are both functional and morphological and are based on fluxes (of people and resources), the third privileges the morphological dimension.

#### 1.2.3.1 Economic centrality and cities de facto

The first approach aims at redefining the limits of cities *de jure*, looking at contiguous municipalities that are, in fact, part of the expanded city. Following the tradition of regional economics (Christaller, 1966; Berry & Garrison, 1958), it elaborates on the ideas of centrality and nodality (see Burger & Meijers, 2012: 1130). The borders of cities *de facto* are thus sketched following the provision of goods, services, jobs and on the capacity to attract workers or consumers from contiguous places.

John Parr (Parr, 2007) proposes four interrelated and complementary definitions of cities *de facto*: the built city, the consumption city, the employment city and the workforce city. The built city is the "continuous or near-continuous tract of territory devoted predominantly to such uses as housing, manufacturing and commercial activity, transport and public spaces" (Parr, 2007: 383). The built city is the base around which the employment, the consumption and the workforce cities grow.

The employment and the consumption cities include the municipalities whose majority of labour force and consumers works and buys goods in the built city. The workforce city takes in account the built city dependence on the outer areas: it includes the territory needed to support a significant volume of employment within the built city. The workforce city may be defined tracing some isolines at pre-defined distances from the built city and including the municipalities whose residents represent the necessary complement, in order to form almost the totality (e.g., 90-95 %) of the volume of the employment within the built city, at its present level of efficiency.

A recent analysis on Italian cities - based on commuting to work fluxes, residential and employment patterns and changes in the spatial distribution of the population - demonstrate that the main Italian cities *de facto*, include, along with the city *de jure*, the municipalities of the contiguous first and second ring (Calafati & Veneri, 2013). It is relevant to say that the city *de facto* does not correspond to the metropolitan area, as it is the effective core around which the fluxes of the metropolitan area develops. However, knowing the border of the city *de facto* is fundamental for defining the metropolitan area.

For instance - as the map in fig. 1.2 shows - the Milan *de facto* includes 45 small and mid-sized municipalities located around the municipality of Milan. These municipalities are within an

average commuting distance of 30 minutes from the pivot. During the second half of the 20th cent. (from 1951 to 2001), the population and the employment significantly increased in these 45 municipalities, creating dense dwellings around the pivot municipality, which, on the contrary, was slightly shrinking in the same years. The reduction of the temporal distance from the pivot, the growth of commuting flows and the strong spatial development in the first and the second ring municipalities created a territorial integration with the pivot municipality, definable as city *de facto*.

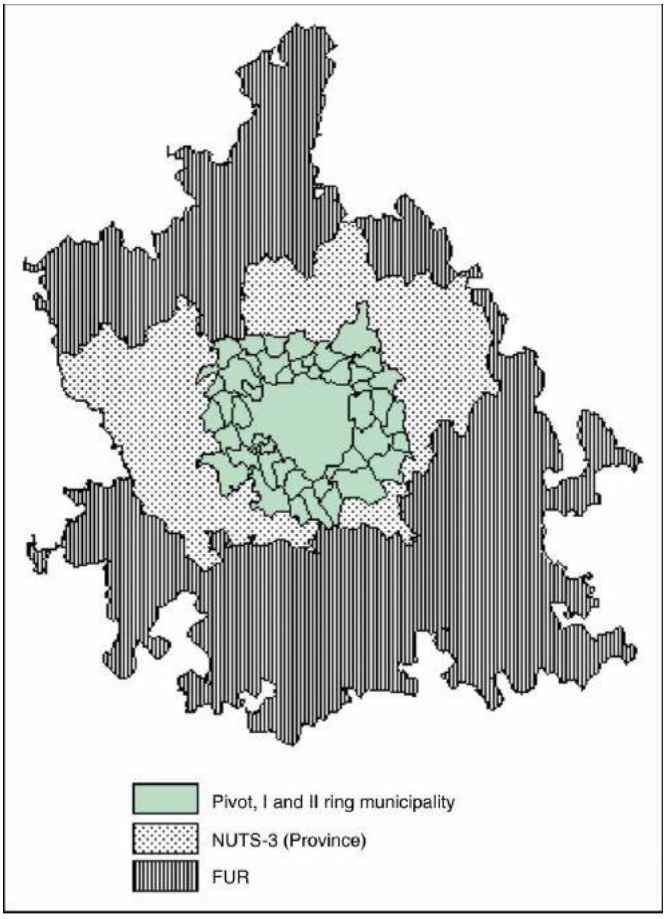



*Fig. 1.2 Different spatial aggregates in the case of Milan. In green the city de facto. Source: Calafati and Veneri, 2013: 796*

#### 1.2.3.2 Mobility fluxes and metropolitan functions: defining metropolitanism

The second approach, drawn from urban sociology (Martinotti, 1993), underlines the role of mobility practices and urban populations' behaviours and identities in shaping territorial forms. Here mobility is deemed as a constitutive element of the urban space (Pucci, 2016). In social sciences, mobility is a property of subjects, rather than a characteristic of place (Colleoni, 2016), and thus the definition of urban space encompasses the complexity of mobility practices.

Mobility practices depend on subjective psychophysical and objective socio-economic and access-related features, which can be summarised by the concept of motility, or capital of mobility, with its three dimensions – access, capacity and appropriation (Kaufmann et al., 2004). Furthermore, the city dwellers and incomers can be grouped in urban populations (e.g., residents, commuters, city-users and business men), with specific temporal rhythms, aims, attitudes, sense of belonging and demands that are often conflictual (Martinotti, 1999; Nuvolati, 2007; see also Pasqui, 2016 for a critical revision). The dynamic and interrelated spatio-temporal fluxes of the urban populations contribute to shape urban space, well beyond the limits of the city.

Against this context, the metropolitan area can be considered as the area distinguished by a high density of functions, i.e. residential, productive, tertiary (e.g., transport, health, commerce and services) and mobility. The standardised sum of the densities of residents, manufacturing activities, services and mobility fluxes result in a measure of the degree of metropolitanism and define the spatial extension of the metropolitan areas (Boffi & Colleoni, 2016). As Boffi and Colleoni's research demonstrates (Ibid.), the recently designed Italian administrative metropolitan cities do not correspond to the effective metropolitan areas.

In the map in fig. 1.3, the Italian metropolitan areas are depicted with the corresponding metropolitanism index. In the case of Milan, the metropolitan area crosses three regions and several provinces, following trajectories that do not correspond to the administrative metropolitan city.

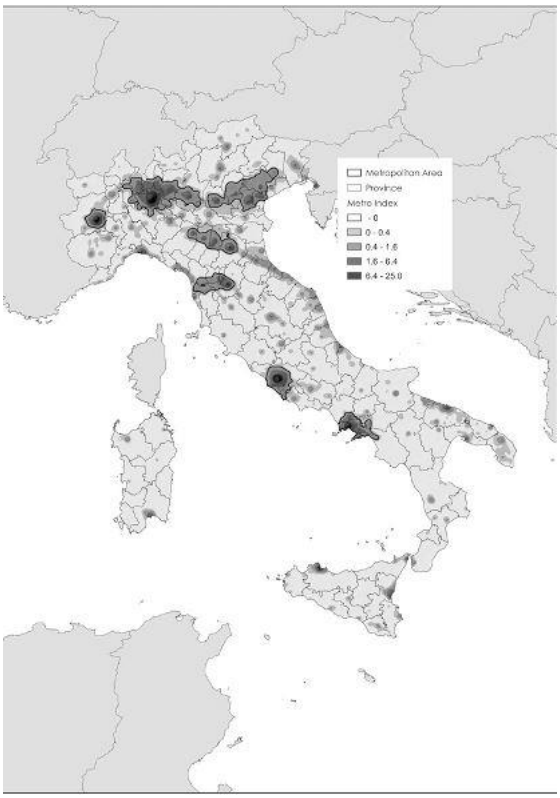



*Fig. 1.3 Metropolitan and urban areas in Italy in 2011. Source: Boffi and Colleoni, 2016: 218*

#### 1.2.3.3 The degree of urbanity

Finally, the third approach - which resides in French geography (Levy, 2013, 2017) – attempts to classify space according to a degree of urbanity, indicating a combination of density and diversity. French geographers Jacques Lévy, Jean-Nicholas Fauchille and Ana Póvoas have developed the idea of gradient of urbanity (*gradient d'urbanité*) (Lévy, Fauchille, & Póvoas, 2018: 30, 31). They define urbanity as a combination of density and diversity and therefore establish the level of urbanity in function of these criteria. In so doing, they do not define the urban in contrast to other concepts (i.e., the rural), but they measure the differences within it. Moreover, the degree of urbanity is a continuous variable and can express urban variations more subtly than strict categorisations (i.e., city, suburban, rural).

Speaking about France, Levy et al. distinguish in a decreasing order of urbanity: the urban core, suburban, peri-urban, hypo-urban and infra-urban spaces. The spatial disposition of the level of urbanity is not necessarily regular. In fact, urban cores may be located out of the city centres. Although urban cores often correspond to the historical city centre (namely in the European city), central poles may develop around new commercial, industrial or touristic activities.

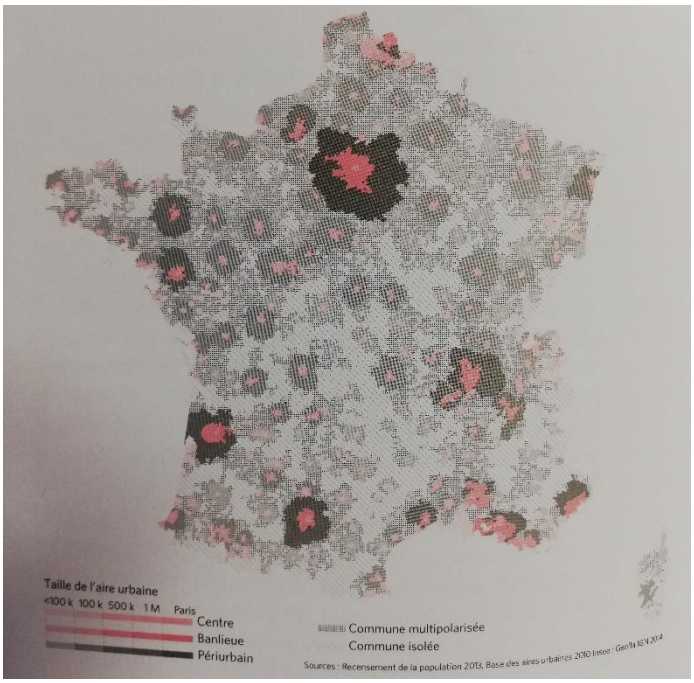



*Fig. 1.4 The gradients of urbanity in France. Source: Levy et al., 2018: 32*

According to their degree of urbanity, places have peculiar socio-economic and cultural characteristics. Residential choices reflect diverse ideas of liberty, equity and responsibility. The peri-urban residential choice, for instance, implies predilection for individual freedom over equity. In the French case, electoral maps thus show the propensity of peri-urban dwellers to vote for right wing parties and for conservative instances (Ravenel, Buléon, & Fourquet, 2003).

The idea of degree of urbanity surely explains some morphological, spatial and sociological aspects of urbanisation. However, they are not enough to grasp the complexity of metropolitan cultural practices. Even though spatial data about French electoral behaviours are quite clear, merely spatial explanations about citizens' preferences, behaviours, or even conceptions of justice may appear fairly bold. Levy et al. (2018) tend to equivalate residential choices with precise cultural preferences and attitudes, at the risk of falling in spatial determinism (see Charmes et al., 2013). In fact, places that share common spatial features (in terms of density and diversity) may differ in their populations' socio-cultural characteristics.

All in all, urban territorial analyses represent important insights for depicting some empirical information about urbanisation and for fostering spatial transdisciplinary research. By focusing on the spatial distribution of tangible morphological and social characteristics, these approaches allow combining interdisciplinary and transdisciplinary information. In this regard, they could be complementary to and enriched by urban environmental studies.

### 1.2.4 The environmental dimension of urbanisation

As I briefly summarised in the previous paragraphs, urban studies have traditionally focused on morphological and socio-economic processes. In the most relevant urban theories, the interest for environmental issues has been weak, or limited to concerns for the liveability and the quality of life within cities (e.g., levels of air pollution and health, neighbourhood quality). Apart from some notable exceptions (e.g., Geddes and Mumford), ecological dynamics have often been overlooked (see Heynen et al., 2005) and relegated to externalities, akin to the dominant neoclassical economic paradigm. Only in recent years, sustainability, resilience and urban transition (or transformation) have become widely debated themes. If we look at data about the environmental impact of urbanisation, we understand that, far from being mere externalities, human induced environmental and ecological dynamics considerably affect territorial vulnerabilities, social organisation and human wellbeing in a cross-scalar and unequal manner.

Few centuries ago, the industrial cities were clearly the heart of environmental degradation. They were unhealthy and dangerous places, where a great number of newcomers lived in polluted and overcrowded dwellings. The environmental degradation was evident, since the industrial cities were covered by a black veil of dust and soot. Between the end of the 19$^{th}$ and the first half of the 20$^{th}$ cent., these cities undertook "a deliberate redesign of water, sewer, drainage, waste management, and pollution control infrastructure to make them safer for residents" (Childers et al., 2014: 322). The resulting *sanitary cities* (Melosi, 2008) introduced fundamental engineering and infrastructural innovations for improving citizens' wellbeing. However, the recent exponential growth of urbanising processes has brought about several environmental issues that were not faced, nor even conceived in the sanitary city.

«While sanitarians, engineers, and city officials could take justifiable pride in providing urban residents with the makings of a sanitary city, these technologies of sanitation also contributed to, or failed to address, an array of new and different environmental problems. And despite their dramatic overall impact, their availability and use were not always equitable across class and racial lines. » (Melosi, 2008: 259)

New and unpredictable challenges arise both in the global north sanitary cities and in the global south cities that did not pass through the industrial and sanitary stages. Against this backdrop, the role of urban areas is manifold. On the one hand, cities are dense and lively places where social, political, and technological innovations flourish and hence where some solutions to tackle environmental degradation may be originated. In the most affluent cities, public

institutions, along with private companies and grassroots initiatives, promote the implementation of sharing mobility practices, the development of efficient infra-urban public transport services, pedestrianisation and greening initiatives. On the other hand, city-scale solutions cannot cope with the metropolitasation and the globalising processes of contemporary urbanisation. In contrast to the industrial city, contemporary environmental issues are not concentrated in cities, but are spread in the metropolitan areas or, even further, in places which are distal and seemingly have no relation with urban areas, but are in fact deeply embedded in urban processes.

In the following chapters, the topics of urban green space and ecosystem services will be treated in detail. For now, let us consider three environmental macro issues, that are among the most relevant in urban (and non-urban) contexts: land use consumption, air pollution and environmental risks and disasters (see tab.1.1).

Climate change is surely related to all of them - either exacerbating their consequences or making territories more vulnerable – and renders the interaction between social and environmental processes rather complex. For instance, land is both a sink and a source of greenhouse gas. At the same time, the ecosystem functions and services provided by land are heavily conditioned by climate change. Therefore, land use and consumption political decisions must deal both with mitigating and adapting policies (Shukla et al., 2019). The pervasiveness of climate change in every environmental and social issue and the complexity of climate-related dynamics are not reducible to a sole list of problems. However, when considering the three macro-issues below, we must bear in mind that the undeniable human-induced climate alterations will exacerbate existing environmental problems, in strong and often unpredictable ways.

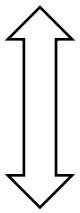
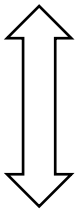
| | Socially induced causes | Impact and scale | Social science disciplines and analytical contributions (examples) |
|---|---|---|---|
| **Land use and consumption**  | Sprawl, suburbanisation, economic speculation on land (for commercial, logistic, productive, housing purposes), weak public control and urbanistic deregulation. | Local and regional:<br>• Growth of ultrafine particles, Pm 2,5 and Pm 10, Nox<br>• Heatwaves and rise of atmospheric temperature,<br>• Extreme events and environmental risks (e.g., floods)<br>• Green gentrification<br>Global:<br>• Land use teleconnections,<br>• Rise in Co2 emissions due to reduced carbon storage capacity of the land.<br>• Loss of biodiversity | Political economy and political ecology, environmental justice:<br>Social coalitions and conflicts in the appropriation and modification of land uses, e.g., (Harvey, 1996) (Robbins, 2012) (Heynen et al., 2005) (Greenberg, 2018), (Beretta & Cucca, 2019).<br>Distribution of environmental amenities, e.g., (Heynen et al., 2006), (Wolch et al., 2014) |
| **Air and noise pollution**  | Individual and freight vehicular traffic; industrial production; heating and a/c systems; large scale industrial farming; waste treatments; land use change and consumption. | Local:<br>• Nox, Pm 2.5, Pm 10 and ultrafine particles: asthma, respiratory diseases, lung cancer, cardiovascular diseases, birth defects, premature deaths.<br>• Noise: hypertension, high stress levels, sleep disturbances<br>Global:<br>• Co2 emissions: climate change | Health geography, environmental and urban sociology, political science, environmental justice:<br>exposure e.g.(Keidel et al., 2017) (Verbeek, 2019) (Kindler et al., 2018), social susceptibility and vulnerability e.g. (Richardson et al., 2013), environmental inequalities (Buzzelli, 2007); mobility and sustainable behaviours (De Witte et al., 2013) (Colleoni & Rossetti, 2018)<br>public science and participative approaches to air quality assessment e.g. (Chemin et al., 2019). |
| **Environmental risks: distribution of waste and hazardous materials; socio-natural hazards and extreme events** | Industrial production and consumption; waste treatment; weak public and legislative control;<br><br>Climate change; social and territorial vulnerability; land consumption | Local and regional:<br>• Socio-natural disasters (i.e., floods, firestorms, heatwaves): immediate devastation and long-term territorial deprivation<br>Global<br>• Desertification;<br>• Deforestation;<br>• Loss of biodiversity;<br>• International migrations | Political ecology, environmental and territorial sociology, geography:<br>environmental justice e.g. (G. Walker, 2010), social vulnerability e.g., (Cutter et al., 2003), (Azzimonti et al., 2019), risk governance e.g., (Renn, 2008). |

*Table 1.1 Three urban environmental macro issues, with socially induced causes, impact and scale, and some analytical contributions from social sciences.*

#### 1.2.4.1 Three environmental macro issues: land consumption, air quality and disasters

The worldwide shift towards urban land use is considered to have one of the most irreversible impact on the biosphere in history (Seto et al., 2011). Land consumption[2] and soil sealing[3] have short-term, medium-term and long-term effects on heat (e.g., more reflective surface and heat islands), water (e.g., less infiltration, more runoff), gas (e.g., risk of anaereobiosis), biota (loss of plants and reduced biodiversity, carbon sink), landscape (increased wind and water erosion, air pollution and erosion of adjacent areas) (Scalenghe & Ajmone-Marsan, 2009). Land consumption is therefore an impellent threat to existing ecosystems and to ecological processes that are fundamental for human well-being and survival.

Moreover, the socio-economic dynamics of contemporary urbanisation heavily influence and shape the structures and the forms of the alleged rural and urban distal places, creating a continuum constituted by multiple, interconnected processes. The rise of the demand and consumption of certain goods in multiple urban places, for instance, may affect land use in a limited number of distal places. It is the case of the demand of mining resources from African countries for electronic devices designed and distributed namely in global North countries. The traditional, static and place-based approach to detect land use cannot cope with the contemporary dynamics of urbanisation. Urban land teleconnections, intended as "the distal flows and connections of people, economic goods and services, and land use change processes that drive and respond to urbanisation" (Seto et al., 2012: 7687) go far beyond local path-dependent land use patterns. For this reason, data about land consumption within the cities administrative limits may be misleading and should be read carefully.

In Europe, after decades of uncontrolled and disruptive land consumption (see for instance fig.1.5 on the metropolitan area of Milan), the pace of the artificialisation of land has slowed down. However, data clearly demonstrate that Europe is not on track to achieve its policy target of 'no net land take by 2050' (fig.1.6). Even though the pace of the increase in artificial surface areas has slowed down, between 2012 and 2018 it amounted to 711 km2 per year (EEA, 2019).

[2] « Land take, also referred to as land consumption, describes an increase of settlement areas over time. This process includes the development of scattered settlements in rural areas, the expansion of urban areas around an urban nucleus (including urban sprawl), and the conversion of land within an urban area (densification). Depending on local circumstances, a greater or smaller part of the land take will result in actual soil sealing. » (European Commission, 2012: 40)

[3]« Soil sealing means the permanent covering of an area of land and its soil by impermeable artificial material (e.g. asphalt and concrete), for example through buildings and roads. » (European Commission, 2012: 41)

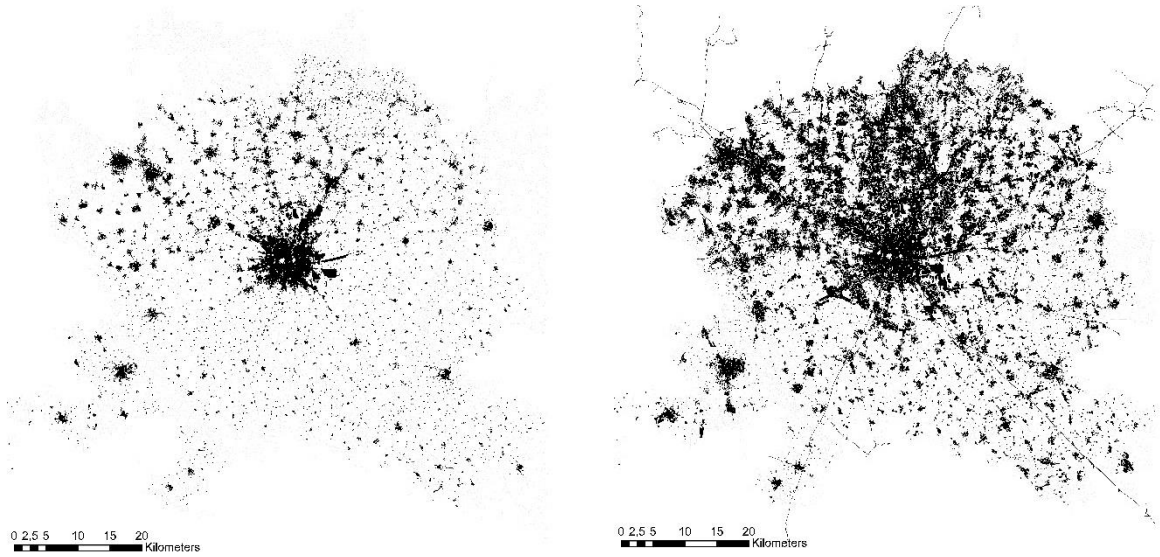



*Fig. 1.5 Milan metropolitan area, 1956: urbanised areas, production plants, railway and street networks. Source: author's elaboration on Dusaf land use data. Milan metropolitan area, 2015: urbanised areas, production plants, railway and street networks. Source: author's elaboration on Dusaf land use data.*

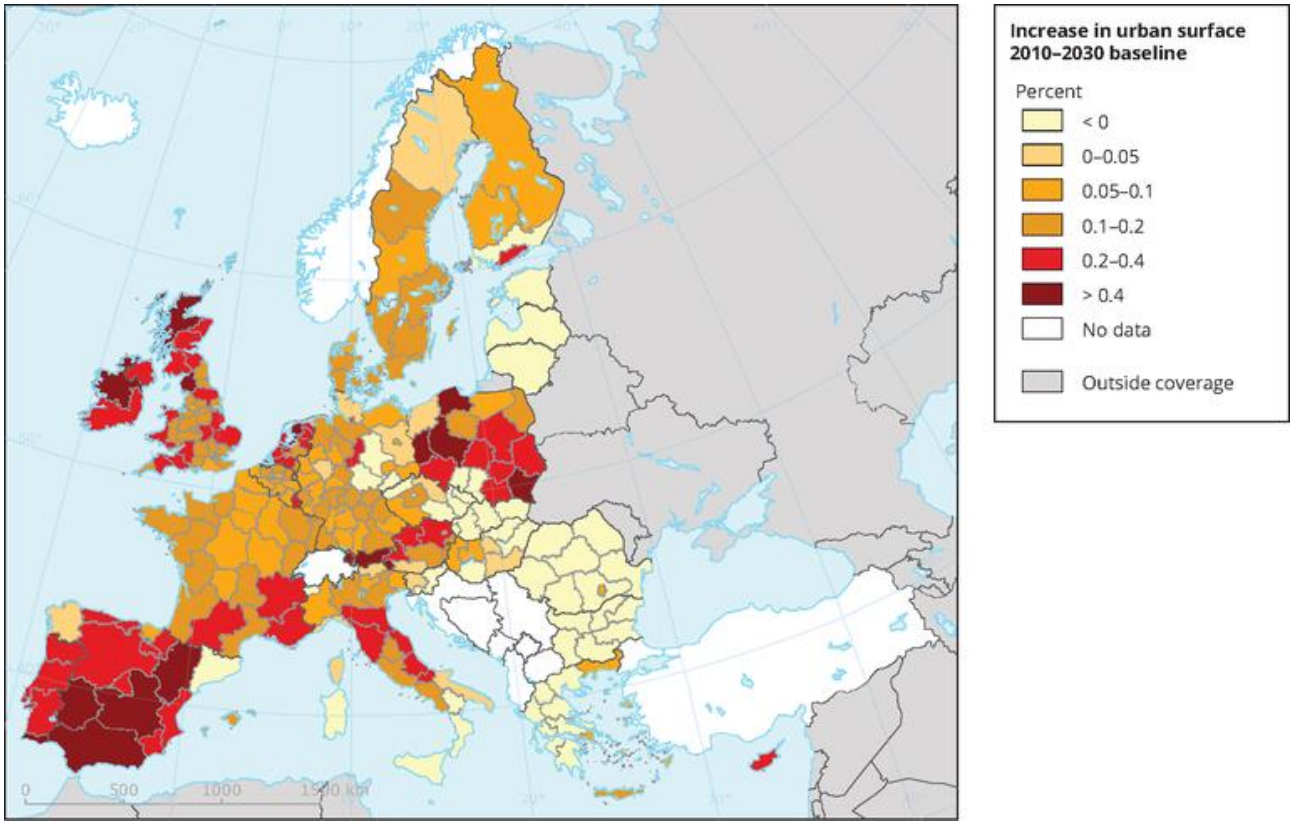



*Fig. 1.6 European Observation Network for Territorial Development and Cohesion (ESPON) forecast of land-use trends in Europe for the coming two decades. Source: European Environment Agency. Retrievable at: https://www.eea.europa.eu/data-and-maps/figures/increase-in-urban-surface-201020132030-baseline*

Due to land consumption, vehicular traffic, heating and a/c systems, cities and their surroundings tend to emit a great amount of atmospheric pollutants (Kindler et al., 2018). Furthermore, urban areas, and especially those ones in the global north are responsible for a great amount of pollutants emitted in the global south (e.g., in production plants) and in international freight transport. In this regard, the carbon and the ecological footprints are effective, albeit methodologically disputable, measures to account for ecological demand and supply mismatches (see Baabou et al., 2017; Scotti et al., 2009; Galli et al., 2016).

Although official statistics tend to ignore many aspects covered by the ecological footprint, they nonetheless depict a concerning situation regarding urban air pollution. In fact, today cities produce 75% of global carbon emissions and counts for more than 60% of the global energy consumption (S. Kabisch et al., 2018). Air pollution is the largest environmental health risk in Europe, being strictly related to heart strokes, respiratory problems and mortal diseases (EEA, 2017). The European Environmental Agency counted more than 400,000 premature deaths due to air pollution in 2015 (Ibid.).

In the European context the principal air pollutants are particulate matters (Pm2,5, Pm10), carbon monoxide, ozone, nitrogen oxides. In order to understand the impact of air quality on urban populations, various factors must be taken in consideration. The consequences of a determined class of pollutants in the air (Nox, PM 10, PM 2,5 and ultrafine particulate) heavily vary depending on the spatial (outdoor, indoor, close to a residential or an industrial zone) and temporal context (seasonal and daily variations) of exposition.

Nevertheless, several studies have demonstrated unequal tendencies in the distribution of air quality, at continental (Richardson et al., 2013), national (Colleoni et al., 2016), urban and local scale (DeSchutter et al., 2017; Salata, Ronchi, & Arcidiacono, 2017). Such a volatile phenomenon necessarily has an unequal distribution. What matters is to what degree and who is affected more by it. The uneven distribution of air quality is meaningful when the level of pollution is high and can be harmful, so that many studies consider also the impact of lungs and respiratory diseases and health conditions, as proving elements of environmental inequality (Buzzelli, 2007). Furthermore, the effects of low air quality can be exacerbated when people who suffer from it are socially and economically disadvantaged, as they have worse housing conditions, are less likely to move and to access health care.

Socio-economic inequalities, along with high population and building density, also contribute to render urban areas more inclined to environment related disasters (i.e., floodings, earthquakes, heatwaves, fires). The increasing probability of natural extreme events, due to

climate change, force to reflect on the social and political roots of the so-called "natural disaster" (Cutter, 2003). The case of hurricane Katrina is in this regard emblematic (see Cutter & Emrich, 2006): social vulnerability evidently exacerbates the magnitude of disasters and the capacity to recover from them. Urban planning, design and governance hence play a pivotal role in tackling the intersectional processes that render individuals and places vulnerable and that create the conditions for disasters to occur (Ryder, 2017).

#### 1.2.4.2 Conclusion. Challenges and topics for a socio-environmental science of cities

Overall, it is quite clear that urbanisation is related to tangible ecological and environmental changes. However, many questions challenge the methods and the practices of present science and policymaking. The spatio-temporal scale of the impact of human induced ecological changes is hardly definable. Akin to socio-economic fluxes, urban ecological dynamics extend from local to global scale. For this reason, urban ecologists have put forward the idea of an ecology *of* the city, which is complementary to the ecology *in* the city (Pickett et al., 2001). While the latter focuses on fundamental structures and functions of biota within the city, the former is a systems-oriented approach which takes in account ecological dynamics that go well beyond the city.

In a recent paper, ecologists McPhearson et al. (2016), starting from the idea of ecology of the city, advocate a science of city that includes social, political and technical knowledge. Information about urban morphology, socio-economic appropriation of land, governance, planning and design is deemed fundamental for understanding ecological and environmental changes and their interactions with social organisations and practices. Furthermore, the complexity of socio-environmental dynamics requires long-term research in diverse cities. It hence pushes towards transnational and multidisciplinary research (Acuto et al., 2018).

We have seen that environmental conditions and ecological functions play a pivotal role in defining the degree of liveability and the inequalities within and between urban areas. Furthermore, environmental and ecological changes are deeply embedded in urban socio-economic processes and the fluxes of ecological resources often follow unequal power relations. The synergies between social and environmental sciences therefore comprehend a wide variety of research topics that span the social production of the environment, environmental protection and governance, the distribution of the benefits derived from ecosystem functions, perceptions and attitudes towards the natural environment and the

discursive articulation of the values put forward by institutional, scientific, market and civic actors.

Contemporary massive urbanising processes force to rethink disciplinary boundaries and to debate existing conceptual frameworks. The UN, the EU and other international institutions have lately insisted on the ideas of sustainability and resilience (e.g., sustainable development goals, new urban agenda, 100 resilience cities). Several cities have acknowledged the role of sustainability in planning and in creating a vision for the future. However, buzzwords as sustainability and resilience often tend to hide the complexity of socio-environmental dynamics. In so doing, sustainability and resilience risk to depoliticise the debate and to cover the conflicts that necessarily occur between the actors involved in environmental production and governance (Kaika, 2017).

In the following, I will discuss in depth the concept of sustainability. Subsequently, I will introduce the theoretical frameworks of ecological economics, political ecology and environmental justice. The perspectives of these disciplines provide some conceptual and analytical tools for comprehending criteria and methods to value the environment, the formation of economic and social coalitions in environmental planning and governance, and the political principles that make environmental inequalities unjust.

## 1.3 Sustainability as a contested concept

Sustainability refers to a wide range of ideas and practices that aim at pursuing well-being without compromising the possibility of future generations to meet their own needs and to achieve their goals. It therefore problematises linear and teleological conceptions of progress and development, by introducing significant concerns about their social consequences and environmental limits.

The recent mighty diffusion of sustainability as a key concept in academic, institutional, market and civic contexts has widened its definitions and applications. Sustainability may be included among the aims of a radical social movement (e.g., Italian No Tav), as well as among the self-promoted innovative and virtuous features of private-led big regeneration projects (e.g., Santa Giulia in Milan). The institutional push towards sustainable urban development, albeit well promoted and emphasised, often result in controversial, contested, or ineffective policies.

What do we mean when we advocate a sustainable city? How do we reach sustainability? For whom? These questions often remain unanswered and are not even explicitly formulated in advance. Hence sustainable development agendas tend to remain quite abstract ideals whose implementation in policy making is hardly feasible. This chapter will briefly recall the history of the concept and will critically analyse the essential dimensions of urban sustainability, focusing on its social facet in interaction with the environment.

### 1.3.1 A brief institutional history of the concept[4]

Although it might also be traced back to ancient times, the idea of sustainability is intrinsically modern. Concerns about the depletion of natural resources and the consequent decrease in production of essential goods are the main foundational motivations for being sustainable. Only when production become standardised and at big scale, then the lack of primary resources is deemed as a tangible and concerning issue that deserves to be conceptualised.

As far as we know, the term sustainability was first used in Germany by Hans Carl von Carlowitz in 1713 (Du Pisani, 2006). It was referred to woodcutting in an epoch in which wood

[4] This paragraph privileges the reports and the international guidance of the United Nations, which is deemed to lead the sustainability discourse and to influence the behaviour of other international institutions (e.g., the EU).

was a fundamental resource for heating, mining, shipbuilding and for many other economic activities. The impelling threat of exhausting the available forests brought to the idea of a new responsible way of consuming natural resources. Techniques of reforestation and the equilibrium between cut and planted trees were thus theorised. A century later, the same kind of concern arose for carbon and other exhaustible resources.

During the second half of the 20th cent., after two decades of mighty economic growth and unquestioned post-war development, sustainability re-emerged as a necessary reflection on the environmental and social feasibility of the dominant economic model. Between the end of the 60s and the beginning of the 70s a group of academics, industrialists, and national and international civil servants gathered in Rome, in order to:

« (…) foster understanding of the varied but interdependent components - economic, political, natural, and social - that make up the global system in which we all live; to bring that new understanding to the attention of policy-makers and the public worldwide; and in this way to promote new policy initiatives and action.» (Meadows et al., 1972: 9)

In 1972, the Club of Rome published *The Limits of Growth*, where it illustrated well documented data and future forecasts on the unsustainability of the existing growth-based economic model. This report represents the first radical and scientific attempt to criticise the modern conception of development. Based on data and current trends on pollution, population growth, agricultural and industrial production, Meadows et al. came to a rather pessimistic conclusion: a sudden and uncontrollable decline in population and industrial capacity would shortly happen if radical social, political and economic changes did not occur.

*The limits of growth* stimulated a debate over the desirability, or even the feasibility of economic growth (Du Pisani, 2006). On the one side, the advocates of growth fiercely criticised the pessimistic forecasts of the report, stating that they overshadowed technological improvements, scientific progress and innovations. In their opinion, which was aligned with the increasingly hegemonic neo-liberal theories, economic activities had enough self-regulating capacities to cope with environmental and social threats. On the other side, alarmistic reactions were expressed by several new-born environmentalist and communitarian social movements. The environmental critique hence became an ethical and epistemological shift of the relation between man and the environment (Salazar, 2018), often resulting in anti-capitalistic claims (e.g., Gorz, 2015, ed. or. 1977; Illich, 2013, ed. or. 1973).

In the same year of *The Limits of Growth*, the United Nations Stockholm Conference began to pave the way for the elaboration of the sustainable development concept. The Stockholm Declaration (1973) stated that:

«(…) Both aspects of man's environment, the natural and the man-made, are essential to his well-being and to the enjoyment of basic human rights-even the right to life itself. 2. The protection and improvement of the human environment is a major issue which affects the well-being of peoples and economic development throughout the world; it is the urgent desire of the peoples of the whole world and the duty of all Governments.» (United Nations (UN), 1973: art. 1, 2, p.3)

During the 80s, the United Nations commissioned an international team, in order to discuss the theme of sustainability and to establish a sustainable development strategy. The resulting report, named *Our Common Future*, provided the first official definition of sustainable development, which is still largely in use[5]. Intergenerational and intragenerational equity concerns were clearly expressed. Moreover, the report elaborated a critique to the environmental unsustainability of past practices of economic development. At the same time, the report did not question the desirability of GDP growth. On the one hand it prefigured some forms of limitations to the present economic development. On the other hand, it stated that "technology and social organization can be both managed and improved to make way for a new era of economic growth." (Brundtland, 1987: 16).

In sum, sustainable development attempted to create a compromise between the neoliberal economicistic acritical view and the radical refuse of economic growth. In so doing, the Brundtland Report paved the way for the three main pillars that were identified as the basis for sustainable development few years later: social equity, economic growth and environmental protection. Ideally, sustainable development is represented as the intersection between these targets. The strategies of action for pursuing sustainable development presupposed the maintenance of existing institutions, with enhanced multilateral cooperation between nations and between diverse administrative layers.

The three Es were then at the core of the Agenda 21, that was elaborated first in the 1992 (Rio Conference) and then in 2002 (Johannesburg Rio+10 conference). The agenda 21 attempted to render sustainable development a local and concrete challenge, with a strong focus on the role of the governance actors at different scales and on their means of implementation.

«(…) It [Agenda 21] will be carried out by the various actors according to the different situations, capacities and priorities of countries and regions in full respect of all the principles contained in the Rio

[5] "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs". (Brundtland Report: 42)

Declaration on Environment and Development. It could evolve over time in the light of changing needs and circumstances. This process marks the beginning of a new global partnership for sustainable development.» (United Nations (UN), 1992: art. 1.6)

This bottom-up and contextual approach, based on a socio-ecological rationale, is quite in contrast with the economistic and pro-growth, universalist sustainability rhetoric, which is well confirmed in the Rio Conference, as well in the following ones (Rio+10 and Rio+20) (Salazar, 2018). As a matter of fact, also in the Agenda 2030 (United Nations General Assembly, 2015), ideated during the Rio 2012 Conference, economic growth is a crucial point. The seventeen sustainable development goals (SDGs) of the Agenda 2030 include one point dedicated to economic growth.

Along with this, the SDGs present a very wide range of themes that entails gender equality, water and energy accessibility, hunger, poverty, climate change, inequalities, peace. Notably, one of the goals (n. 11) addresses urbanisation[6]. For each goal, a group of objectives is presented with the relative indicators (that vary from country to country) for assessing the degree of fulfilment of the target and its temporal variations. The SDGs represent an innovative approach to sustainable development, namely if we take in consideration the novelty of global governance by goal setting and the participative process that involved several governments, as well as numerous representatives of civil society (Biermann, Kanie, & Kim, 2017; Giovannini, 2018). The goals are non-binding and therefore leave a high degree of freedom in the local implementation strategies.

However, the 17$^{th}$ goal clearly states that the implementation of the other SDGs must be aligned with the World Trade Organisation framework and with the Doha Development Agenda. A critical stance (Weber, 2017; Kaika, 2017 on the New Urban Agenda) may easily underline the practical implications of this prescription: the liberalisation of the financial services sectors and the commercialisation of public goods and services (e.g., water, energy, health, education) as obliged strategies for implementing the SDGs. This internal contradiction shows once again the ambiguity of the United Nations agendas and declarations.

[6] Goal number 11 is also at the core of the New Urban Agenda (UN-Habitat III, 2017). Here the main leading idea is that cities, beside arousing several environmental problems, are innovative and resourceful places where the shift to a sustainable development can be fostered and achieved.

### 1.3.2 Situating sustainabilities: practices and conceptualisations

The semantic vagueness of the idea of sustainability is confirmed in the effective processes of implementation of sustainable development. According to the prioritisation of the pillars (economy, ecology and equity) and to the social and political interpretation of the meaning of being sustainable, deeply diverse practices have been developed under the umbrella of sustainability. The field of sustainability is rather vast and is not ascribable to a coherent set of practices. For this reason, sustainability approaches have been widely criticised, namely because they are deemed to voluntarily favour neoliberal ideas and policies under the cloak of general, all-encompassing, blurred targets. However, in order to thoroughly understand the concept and, more importantly, for comprehending and informing effective sustainable development policies, it is necessary to delve into its complexity.

«As long as sustainable development is viewed as 'everything and nothing' it is weakened as a policy goal, and those wishing to promote environmental sustainability and social justice are hampered if they attempt to do so without a clear understanding of the tensions and potential conflicts between these desirable goals.» (Connelly, 2007: 260)

Subsequently, two analytical efforts are required for understanding sustainability: situating sustainable practices; and situating the theories and the conceptual frameworks adopted in the analysis (Mebratu, 1998). The former means comprehending and mapping the differences between the approaches towards sustainability, according to a pre-defined conceptual framework (i.e., the three pillars: economic growth, ecological protection and social justice). The latter consists in digging into the conceptual framework to critically analyse the criteria of analysis of sustainability and to put forward alternative lens to read sustainable practices.

Following Connelly (2007), sustainable development could be represented as a triangle, whose vertex are the three pillars: economic growth, environmental protection and social equity. Sustainability may be situated in different position in the field according to its rationale (fig.1.7). Sustainable practices may therefore tend to the idea of ecological modernisation, which prioritizes economic growth and environmental protection over social equity (e.g., smart and green cities, private led investments on energy-efficient buildings), or to eco-socialism (e.g., autonomous communities of energy, public social gardens and local municipal food markets), if they focus mostly on social equity and the environment. Finally, if sustainable practices underrate the environment, then they could be located within a traditional growth/equity debate.

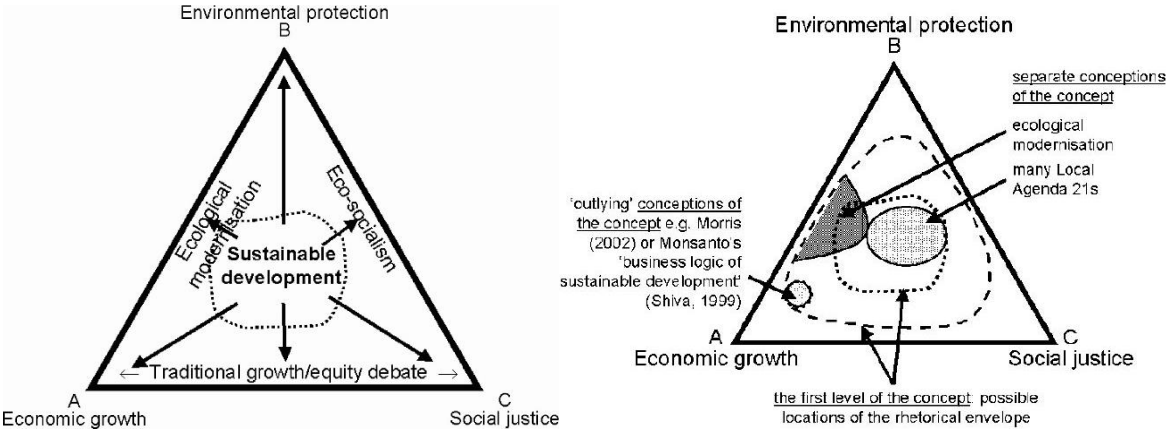



*Fig. 1.7 Sustainable development mapped in the field and as a contested concept. Source: Connelly, 2007: 270, 272*

In urban contexts, the numerous initiatives and practices linked to sustainability span private led investments, bottom-up grassroot activities and public policies and are often at the intersection of the three. The California based Critical Sustainabilities project[7] has classified them in five categories: vernacular, eco-oriented, market-oriented, justice-oriented and utopian sustainabilities. These groups are not mutually exclusive, as the majority of sustainable initiatives overlap between them. However, they represent different values, and each has its own epistemological roots contributing to shed some light on the wide field of sustainability.

The vernacular approaches consist of those everyday practices that are often overlooked in sustainability science, because they do not deliberately address sustainability issues. They include historically rooted and culturally shaped formal and informal processes, behaviours and attitudes towards the environment. The formal ones result in the large-scale grey and green infrastructures that provide the city with energy, food, water, housing and transportation (i.e., parks, roads, buildings, plants). They have evolved with the processes of urbanisation and their management is constantly negotiated between different public and private actors.

The informal approaches are generally smaller-scale, everyday practices that are rooted in citizens' cultural background. For instance, community gardens or other informal ways to take care of public green spaces, but also food and energy consumption. In general, all the habits that make possible the social reproduction of communities are part of this category. Historical, sociological and ethnographical studies are needed to understand them, also in order to provide useful information for enhancing context-based and meaningful sustainability policies.

[7] ( https://critical-sustainabilities.ucsc.edu/sustainabilities-2/; see also Sze, 2018)

Eco-oriented sustainability prioritises nature and ecological processes. It privileges non-human environment, and it is thus concerned with protecting wildlife, sustaining ecological processes and defending them from human activities. The institution of public natural parks and reserves, environmental legislation, organisations (e.g., Greenpeace in the 70s) and movements (e.g., agroecology) are among the most significant eco-oriented sustainable actors and practices. Though eco-oriented approaches valuate environmental needs more than human necessities, there are many linkages between eco-oriented practices with social justice claims (e.g., environmental justice groups for urban reforestation), or with vernacular approaches (e.g., cultural uses of autochthonous species), or even with market-oriented approaches, when environmental protection become a brand and a source of income (e.g., green tourism).

Market-oriented approaches are based on the idea that a healthy environment is an opportunity and a necessary condition for contemporary capitalism to flourish. Green economy and ecological modernisation are represented as win-win solutions for simultaneously improving environmental conditions and providing economic growth. Energy-efficient smart districts and iconic eco-friendly buildings have become profitable investments for high profile investors in urban contexts. At the same time, they contribute to re-brand contemporary cities and constitute new and valuable images in city marketing campaigns. Despite the putatively high environmental standards and rankings, urban green regeneration processes are controversial, both from an ecological and a social viewpoint. Ecologically, they create some niches within the city ignoring the overall ecology *of* the city, or indeed worsening its conditions through land consumption. Socially, urban green regeneration easily leads to gentrification and to the expulsion of local low-income populations. While all the other approaches are quite sceptical towards market-oriented sustainability, the latter attempt to incorporate the others, by self-promoting its win-win economic and ecological development projects, focusing on debatable numeric indicators and scales.

At the opposite end, justice-oriented approaches primarily focus on the social processes underpinning environmental inequalities. Just sustainabilities (Agyeman, Bullard, & Evans, 2003) highlight the political dimension of social and environmental change. Environmental justice, food justice and climate justice movements have played a pivotal role in combining environmental claims with feminist, anti-racist, labour and housing rights instances. Justice-oriented approaches act on human and non-human spatial interactions, in order to render their processes and their outcomes fairer.

Finally, utopian sustainability is about imagining future or outer more or less realistic representations of the environment. It includes fictional books and futurology forecasts. For instance, the airborne toxic event and the constant environmental threat in Don De Lillo's *White Noise* is an example of dystopic fictional representation. Utopian approaches condition the ways we conceive sustainability and encourage to think differently and with a critical attitude about the places we live in.

### 1.3.3 Situating sustainability: the perspectives of ecological economics, political ecology and environmental justice

In the previous paragraph, we have seen that each approach tends to prioritize one or another vertex of the triangle of sustainability (fig.1.7). At the same time, sustainable practices contribute to challenge and redefine the limits of the field of sustainability. For example, justice-led approaches question the traditional conception of social justice, introducing intersectional issues that comprise environmental, gender, economic deprivation, et cetera. Analogously, market-oriented approaches find new and innovative forms of profit, redefining the forms of capital accumulation. On the contrary de-growth movements criticise the idea that economic growth corresponds to well-being.

From a critical point of view, mapping sustainability therefore means not only situating sustainable practices, but also delving into the semantic coordinates of the field: economic growth, social justice, and environmental protection. This chapter will introduce the thought of ecological economics, political ecology, and environmental justice to discuss some analytical concepts that are deemed meaningful in the study of sustainability and will be also considered in the following chapters. Ecological economics is a heterodox branch of economics interested in the linkages between well-being, economics, and ecology. Political ecology regards the social and economic processes that are behind the making of the environment. Environmental justice, moving from the instances of social movements, problematise the political issue of justice in the environmental ambit.

#### 1.3.3.1 Ecological economics

Mainstream economics does not consider the significance of the contemporary, global environmental challenges and completely ignores the dynamics of ecological processes. As

Oswald & Stern (2019) pointed out, among 77,000 papers published in the 10 most influent economics journals, just 57 (approximately 0.1%) treat climate change. None of the 100 most cited economists deals with environmental themes (Laurent, 2020). Despite the undeniable environmental crisis and its impellent and actual challenges, and although the scientific community agrees on the necessity to face the issues of the ecological transition from the standpoint of social sciences, economics does not debate its main assumptions and focuses on an abstract and closed system made of institutions, enterprises and households, completely independent from the physical biosphere.

In this regard, neoliberal and Keynesian approaches are quite similar, as they deny long-term problematics and focus solely on short-medium term GDP growth and distribution (Ibid.). Interestingly, both the approaches attempt to monetise the environment and the issues linked to the environmental crisis, but do not embed economic fluxes in the physical environment. The green modernisation model put forward by neoliberal policies and the Keynesian idea of a green new deal may have positive impacts on some environmental indicators. However, they both fail in addressing the strict linkages and interdependencies between socio-economic activities and biophysical changes.

Ecological economics emerges as a heterodox and transdisciplinary approach, which challenges the main assumptions of the dominant streams of economics. Following the seminal work of Georgescu-Rogen (Georgescu-Rogen, 1971), economic activities are deemed as part of a broader metabolic system. The economy is hence entropic: it transforms low entropy inputs in high entropy and less concentrated forms of energy. Every economic activity, including services, embody an amount of energy (input and output) which should be a relevant part of its valuation. In ecological economics, the putative externalities are to be included in the process of valuation. Nonetheless, ecological measures are not the only values to be assessed.

«In ecological economics the economy is seen as embedded in the ecosystem (or, more accurately, in the historically changing social perception of the ecosystem). The economy is also embedded in a structure of property rights on environmental resources and services, in a social distribution of power and income, in social structures of gender, social class or caste, and this links ecological economics to political economy and to political ecology (Figure 2.1).» (Martinez-Alier, 2002: 21)

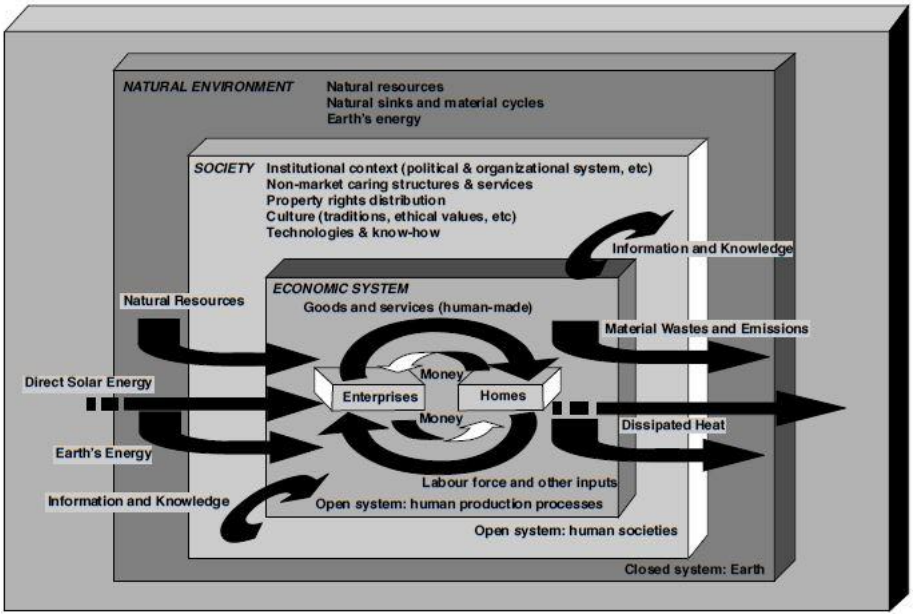



*Fig. 1.8 The economy embedded in the social system and in the ecosystems. Source: Martinez Alier, 2002: 22, Fig. 2.1*

In order to understand the economic system and its manifold and indissoluble relations with the natural environment, ecological economics researches also the open system of human societies (i.e. institutions, social contexts, cultural processes, power relations, et cetera)[8]. The complexity of this scheme is not referable to a sole economic unit of measure. In other words, the monetary valuation is just one possible form of valuation among many languages of valuation. Challenging the utilitarian assumptions of mainstream economics, ecological economy argues that the value of nature is not strongly commensurable. Indeed, there exist multiple and weakly comparable valuations of nature (Martinez-Alier et al., 1998).

Each stakeholder adopts her criteria of analysis that are not countable on the same cardinal scale, because rooted in diverse epistemological origins. According to ecological economists, the diversity in valuing nature should not be reduced to a sole cardinal numeric indicator (i.e., money), but should be accounted by policy makers. From a policy perspective multicriteria analysis and participative approaches are thus preferred to standards and numeric thresholds (e.g., De Marchi et al., 2000; van der Sluis et al., 2019).

The elaboration of monetary or non-monetary measures of the ecological functions provided by green space and of the benefits they provide to human beings is an example of an ecological economics metric (Costanza & D'Arge, 1997). The next chapter will be dedicated to the concept of urban ecosystem services and will deepen its potentialities and problematics. Following the

[8] See also Kate Raworth's idea of Doughnut economy (Raworth, 2017)

principles of ecological economics, as we will see, it is impossible to find unique and universal measures of the value of the environment. On the contrary, political processes and socio-economic characteristics must be analysed in order to contextualise ecosystem services in the processes of contemporary urbanisation.

In sum, ecological economics debates the modes of valuation of nature taking in account the ecological, the socio-cultural spheres and their reciprocal interactions. It hence challenges mainstream economics and the economic vertex of sustainability. If the economy is embedded in socio-cultural dynamics and in ecological processes, then economic monetary growth is not, or may be just a part of the economic targets. Some authors (Spinozzi & Mazzanti, 2018; Cadenasso & Pickett, 2018) therefore replace the pillar of economic growth with the idea of well-being, which is multidimensional and more inclined to transdisciplinarity.

#### 1.3.3.2 Urban political ecology

Ecological economics acknowledges the role of social and cultural processes in shaping the value and the forms of the environment. Yet it mainly focuses on the languages of valuation. Political ecology deals with the same themes, but from a different viewpoint. It specifically analyses the political aspects that underpin the historical dimension of ecosystems and its social conception. EE and PE are hence complementary, because they treat the same broad topic deepening diverse aspects (Kallis et al., 2013).

Political ecology is a very broad field of analysis and encompasses a myriad of themes of interest: land degradation (Blaikie & Brookfield, 1987), water (Kaika, 2005), ecosystem services (Depietri et al., 2016) peri-urban lawns (Robbins, 2007), greenways (Chung, Zhang, & Wu, 2018), et cetera. For the purpose of this thesis, I limit the field to urban political ecology.

Being strictly related to political economy, urban political ecology stems from the domain of Marxist theories on urbanisation (Harvey, 1978) (Molotch, 1976). It conceives the social construction of the urban environment as a commodification of nature, inscribed in the processes of capital accumulation that underpin urbanisation. The peculiarity of nature as a commodity is that it entails ecosystem biophysical properties, which, following independent, fluid and complex patterns, renders difficult the processes of commodification. As ecological economists demonstrate, there cannot be a unique, exchangeable value of the flows of water, nor of the benefits of urban forests. The process of commodification of nature is therefore incomplete and contested between a wide range of actors (Kallis et al., 2013).While the first wave of political ecology was primarily Marxist and concerned with the structural conditions

of capital accumulation, recent scholarship has embraced also actor-network theory and more contextualised and detailed research on the political meaning of diverse cultural dynamics inherent in nature (i.e., feminist and queer instances, social movement resistance, etc.) (Heynen, 2014).

One pivotal issue in urban political ecology is that of the scale of research. The previous chapter addressed some of the problematics related to the meaning of urban against the context of contemporary global urbanisation (1.2.2, 1.2.3) and the multiscale environmental impact of urbanising processes (1.2.4). The complexity of socio-ecological spatial dynamics is embedded in territorial and networked governance scales that "are perpetually disputed, redefined, reconstituted and restructured in terms of their extent, content, relative importance and interrelations" (Swyngedouw & Heynen, 2003: 913). A straightforward example of the power of scale is the recent declaration of Brazilian president Jair Bolsonaro, who has stated that the Amazon forest belongs to the state of Brazil, denying any local and transnational interest and responsibility towards the world largest tropical rainforest[9]. This clearly shows that the definition of the spatial scales of governance is itself part of the political strategies to take control of nature.

Analogously, from an analytical point of view, UPE scholarship has debated the heuristic value and the political implication of using the city as the scale of UPE research (Angelo, 2017) (Connolly, 2019). In fact, as said in the previous chapter, the metabolism of cities concerns not only the near metropolitan areas, but also very distal places. In order to investigate the socio-ecological dynamics inscribed in the manifold processes of urbanisation and not limited to the city, Angelo & Wachsmuth (2015) put forward two possible research paths. The first consists in analysing the socio-natural processes that differentiate, within specific places, the urban from the rural. In other words, how urbanisation produces, materially and symbolically, urban and rural spaces. In the following chapters we will discuss the value of greening in some contemporary processes of urbanisation. The changing role of urban green space is embedded in the global dynamics of urban governance and have a tangible symbolic and socio-ecologic impact that contribute to redefine the spatial meaning of city. The second path consists in following urbanisation out of the city, rigorously tracing the uneven ecological and economic global flows that nurture cities and the political processes that underpin them. Commodity chain analysis (Pellow, 2006) and ecological footprint analyses (Rees, 2017) are among the most

[9] https://www.bbc.com/news/world-latin-america-49815731

recurrent studies in this ambit and may help to shade light on the global political power relations.

As I tried to show in this brief outline, urban political ecology in general allows finding connections between the pillars of sustainability. Ecological processes are read through the lens of economy, intended as a social activity imbued with unequal power relations. Political ecology hence does not prioritise any of the pillars of sustainability but underlines the political dynamics that underpin the complex and interconnected relations between economic, ecological and social processes.

#### 1.3.3.3 Environmental justice

The political dimension of socio-environmental dynamics is also the focal point of environmental justice. The notion of environmental justice has been developing since the 70s, when the Civil Right Movement first introduced it in the U.S. public debate. Originally, it defined a social movement and a campaigning slogan. Discriminated ethnic and racial groups built the movement around specific cases of environmental injustice and campaigned against the unequal distributions of toxic pollutants. The protest movement, composed by academics, along with activists and campaigners, succeeded in gaining federal acknowledgment and eventually in conditioning national environmental policies.

The U.S. Environmental Protection Agency (EPA) currently defines Environmental justice as "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies" (epa.gov https://www.epa.gov/environmentaljustice/learn-about-environmental-justice). This definition includes concerns about a proportionate distribution of environmental burdens ("fair treatment") and about the involvement of lay people in the agenda setting and decision-making processes, also supported by public facilitation to participate ("meaningful involvement").

While in the U.S. the debate about environmental justice has been flourishing for decades, in Europe and at the European Union level is only beginning to develop (Laurent, 2011). The first European country that officially took care of the issue of environmental justice is Scotland in the early 2000s. The Scottish Executive highlighted the principles of distributive justice, which presuppose a proportionate distribution of environmental burdens, and procedural justice, i.e. equal access to information and to means to participate in decisions that affect the quality of the local environment. The issue was further elaborated in the UK, now the leading European

nation in Environmental Justice research, with a direct involvement of governmental bodies, namely the Environmental Agency (Stephens, Willis, & Walker, 2007).

Lately, new-born social movements (i.e., Friday for Future, Climate Action) have strongly raised the issue of justice in the ambit of climate change. Climate injustice concerns the disproportionate impact of climate change on poor and vulnerable populations (e.g., from African sub-Saharan countries) that historically are not responsible for the last century's dramatic increase in Co2 emissions and still emit a very low percentage of the total global emissions. This brings to international migration and exacerbates the existing vulnerabilities of the poorer countries. The arguments of climate justice will not be specifically developed in the rest of the thesis but remain undeniably important against the context of environmental justice.

Stemming from social movements' claims, environmental justice has become a widely debated issue also in the academic literature. Environmental justice is a transdisciplinary research field. It aims at assessing environmental inequalities and to comprehend to what extent and why inequalities are unjust. It entails a normative approach that is related to some principles of distributive, procedural, recognition, or other forms of justice (Walker, 2012). Environmental inequalities become problematic when are considered in the sphere of environmental justice issues, in other words when they are deemed to be unjust.

Distributive justice is about the (un)fair distribution of environmental threats (e.g., pollution, landfills), but also of environmental goods and amenities (e.g., parks, public green space). The idea of distributive environmental justice has necessarily to do with political principles and criteria of justice that help to justify to what extent the distribution of environmental amenities, disadvantages, threats and risks is unfair (Zaccai, 2007). The most relevant philosophical principle of distributive justice is the Rawlsian liberal conception of fairness. In a nutshell, Rawls's theory of justice presupposes an imaginary original position in which everyone is not aware of her social position, a veil of ignorance whereby everyone assumes an impartial position. Two basic, defensible principles of justice are then put forward: "everyone would have the same political rights, and the distribution of economic and social inequality in a society should benefit everyone, including the least well-off" (Schlosberg, 2007: 13). Rawls's conception of justice is hence about the political, social and economic rules that govern distribution (Ibid.). Along with the Rawlsian conception, numerous principles of distributive justice have been elaborated and applied to environmental issues (Walker, 2012: 42-47). Among many others: absolute equality (everyone gets the same, regardless of her socio-economic situation); equality plus a guaranteed standard (we should seek equality and everyone

is above a minimum standard); and a guaranteed minimum with variations above the minimum threshold according to personal preferences.

Surely, when considering distributive environmental justice issues, we have to keep in mind two fundamental caveats. Firstly, the same issue may be read according to manifold conceptions of justice (Lévy et al., 2018). Individuals and social groups' criteria of justice are historically originated in their continuous (re)interpretations of the cultural practices they are familiar with. Therefore, there will always be competing ideas and principles of justice. Environmental justice studies analyse the different viewpoints or, more often, scientifically argue for a particular instance.

Secondly, the distribution of environmental bads or goods is to be combined with information about the distribution of relevant characteristics of the stakeholders (the persons and the populations involved). Some social groups have peculiar needs. For instance, elderly people have the need of living in neighbourhood where the accessibility to essential services is high (Daconto, 2017). Furthermore, some individuals, social groups and places are more vulnerable to the harm of an unequal distribution of environmental goods or bads. Poorer people, for example, do not have economic resources to recover after a flood and or are more likely to reside in places that are prone to socio-natural disasters. In this regard, several sociological studies underline the cumulative and interrelated effects on social vulnerability brought by physiological, socio-economic, educational, health conditions (Ranci, 2011) (Castel, 2007).

While distributive environmental justice focuses on the unequal shares of resources that are available to different individuals and social groups, procedural environmental justice aims at unveiling the unbalanced social and institutional processes, which, following unjust power relations, hamper individuals and social groups' political possibilities to have a voice and influence environmental decision-making. Procedural justice is therefore complementary to distributive justice. It helps to comprehend the reasons why distributive inequities persist (Schlosberg, 2007: 25-29).

Akin to urban political ecology, procedural environmental justice focuses on environmental inequalities formation (Pellow, 2000), spanning multi-stakeholders governance historical dynamics. Yet, the political idea of justice is not only referred to the unequal outcomes, but to the process itself. In this regard, the conceptions of procedural justice are widely debated. Just decision-making processes may simply refer to the correct functioning of democratic institutional procedures. More often, in the context of environmental justice it refers to the equal possibility to influence decision-making on a particular topic. The idea of procedural equality

may favour the ones who are more involved in the environmental issue (e.g., the capacity of the population hit by frequent floods to influence on the management of the river), or those who do not have the means to make their claims visible (e.g., ethnic minorities, communities who are less likely to participate in institutional decision-making) (Bell & Carrick, 2018).

If particular attention is devoted to the social groups which are institutionally ignored and whose voice is regularly denied by formal decision-making structures, then we enter the field of justice as recognition. Similarly to the theories of the just city (Fainstein, 2015), and namely those engaged with the institutional and structural oppression of minoritarian social groups (Young, 1990), environmental justice as recognition argues for the languages of valuation and the claims of minorities and social groups which do not have the voice and the political rights to influence decision-making over the environment where they live.

### 1.3.4 Towards an alternative idea of sustainability?

The first paragraph introduced the institutional framing of sustainability underlining the ambivalence of the concept. Subsequently, the second and the third paragraphs respectively attempted to map sustainable practices and to explain the conceptual tools of ecological economics, political ecology and environmental justice to reframe sustainability. What emerges is the need to overcome the established idea of the three pillars and to formulate a new field of analysis for sustainable practices (see fig.1.9).

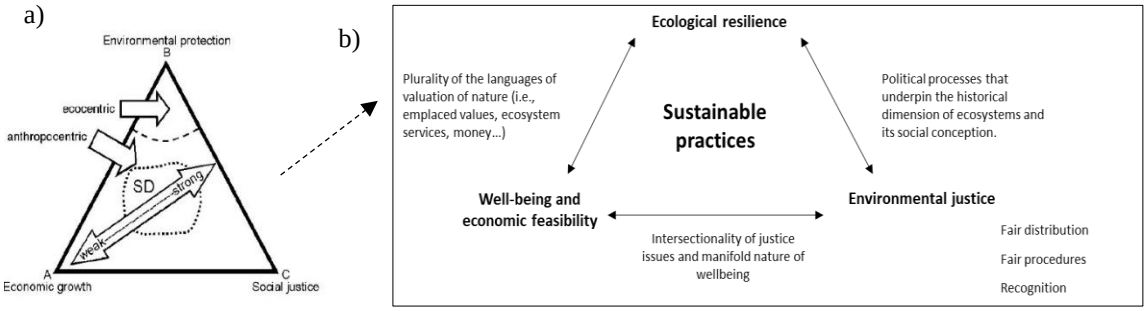



*Fig. 1.9: In fig. a): The sustainable development axis and anthropo/eco-centric faultlines. From Connelly 2007: 271. In fig. b): an alternative idea of sustainability. Well-being and economic feasibility, ecological resilience and environmental justice.*

*Note that while the conception of sustainability in fig. a) may tend towards a specific vertex of the triangle (growth, environmental protection and social justices), the alternative idea of sustainability in fig. b) envisions strong interconnections between the pillars that render them mutually dependent.*

The theoretical framework of ecological economics demonstrates the inadequacy of economic growth as a target for sustainable practices. In fact, the monetary valuation, although hegemonic, is just one among many other forms of valuing nature. Moreover, the relation between monetary prosperity and the environment has been quite clear in the last centuries: economic growth has always implied environmental degradation. If we look at the data provided by the Global Footprint Network[10] , it is clear that the lower is the national GDP the lower is the ecological footprint per person. Despite the recent sustainable development policies, the richer countries still present a much higher ecological footprint per capita.

Instead of economic growth, the framework in fig.3b sets well-being and economic feasibility as targets for sustainable practices. The idea of well-being includes a variety of aspects that are supported by good environmental conditions: mental and physical health, quality of the living environment, place attachment. Thus, in contrast to economic growth, well-being is complementary to environmental quality.

The manifold essence of the idea of well-being is also easily linkable to the intersectional elements that constitute environmental justice. Well-being cannot be reduced to GDP indicators. Similarly, justice is not only about the unequal distribution of economic resources, but it includes environmental, cultural and power issues.

While economic growth is not always desirable in sustainable development processes, economic feasibility is, along with well-being, a crucial target. As a matter of fact, sustainable practices and policies must deal with the economic possibility of implementation. In this regard there are several strategies to render policies and practices feasible: institutional and public funding, crowdfunding and self-financing, private sponsorship, et cetera. Each of these strategies implies diverse possibilities of implementation and condition the outcome of the practices. For instance, a bottom-up greening project that aims at self-financing through the donations of supporters and collaborators will differ from a greening project that is financed by the developer of a big regeneration plan. Establishing whether sustainable development is economically feasible and how it becomes feasible is therefore linked to the analyses of political ecology and to procedural environmental justice issues.

In fig. 3b, the pillar of social justice is re-elaborated through the conceptual lens of environmental justice: the principle of fair distribution, fair procedures and recognition help combine intersectional elements (i.e., environmental, socio-economic, ethnic, gender, power,

[10] http://data.footprintnetwork.org/?_ga=2.75097754.962012619.1582559936-78227745.1582559936#/

governance (…) issues). While the idea of social justice traditionally ignores the spatial and environmental dimensions of inequalities, environmental justice asserts the strict linkages between everyday environmental conditions and the reproduction of injustice.

Finally, the environmental pillar has not been analysed in detail in this chapter, as the thesis focuses mainly on the social facets of sustainability. The scheme here proposed (fig.1.9) follows Cadenasso and Pickett's conceptual model of ecological resilience. "Resilience is defined as the ability of a system to absorb disturbances, respond to and reorganize from the disturbance, and retain the same basic structure and ways of functioning" (Cadenasso & Pickett, 2018: 40). Differently from the limited idea of protection, environmental resilience span the complexity of ecosistemic processes.

The fundamental aspect of this stronger idea of sustainability is the reciprocal relation of interdipendence between the pillars. Well-being needs ecological resilience, which depend on the fairness of the underlying political procedures. Knowing the diverse and competing languages of valuation of nature is therefore necessary to comprehend the relations between nature (what is socially conceived as nature) and well-being. A sustainable policy should first take in account each stakeholder's language of valuation of nature and its relation with socio-ecological resilience and then be implemented according to clear and accountable criteria. Moreover, the processes of political appropriation of the environment create a strict bond between justice and ecological resilience. Procedural and distributive injustices are more likely to hamper ecological resilience, as they create unbalanced relations that favour just a minority of stakeholders.

Thus, comparing to the traditional pillars of sustainability (fig.1.9a), this conception does not imply clear and systemic trade-offs between the pillars (eg., more economic growth, less social equity). Analysing the degree of sustainability through this lens helps comprehending what renders the project unsustainable and which socio-political processes may be improved. The frame proposed in fig. 3b focuses not only on the outcomes of sustainability, but also on the processes that underpin the sustainabilty of practices and policies. In so doing it tries to ripoliticise sustainability, highlighting the existing and the potential alternatives to traditional development models.

The next chapter focuses on the urban green space. After describing the functions and the role of urban green space in contemporary urban places, it defines the concept of urban ecosystem services and their euristic value in the valuation of the environment. The chapter will also delve

into the problematics linked to this kind of valuation, underlying the necessity to contextualise the values by researching the socio-political processes that underpin urban greening.

## 1.4 Urban Green Space and ecosystem services. The changing roles of green in the processes of contemporary urbanisation

Urban green spaces can be broadly defined as "any vegetation found in the urban environment, including parks, open spaces, residential gardens, or street trees" (Kabisch & Haase, 2013: 113). Despite cities and urban places are predominantly "grey", being characterised and identifiable by built infrastructures, green spaces have always been essential for their development.

In the past, the role of green space was mainly taken for granted. Excluding some notable exceptions (see for instance Mumford, 2005 on the late Roman necropolis), the ecological equilibrium of cities was guaranteed by their limited seize, by their strict relations with the nearby rural areas and by the persistence of vacant land within the city limits. When urbanisation became a massive phenomenon and rural areas moved far away from the growing and densely populated cities, then the issue of urban green space started to be problematised.

Throughout the past centuries, the urban green space has assumed manifold roles that span from recreational uses to ecological local and large-scale functions. An increasing number of stakeholders is now involved in designing, planning and managing urban green spaces, creating diverse and innovative forms of governance. Hence, the governance of green against the context of contemporary urbanisation processes is contested between several actors that, at different spatio-temporal scales, value the urban green according to diverse principles and interests.

This chapter, after briefly introducing the historical development of the green spaces in the modern European city, will present the relating emerging challenges in the contemporary urban areas. After a review of academic and policy documents, five main challenges are defined: urban morphological transformations, mobility, accessibility, climate change and contemporary environmental issues, governance. Subsequently, the chapter will critically consider the concept of ecosystem services as a means of analysis. The definition and the classification of the main urban ecosystem services will be followed by some reflections on the necessity to integrate the assessment of ecosystem services with other relevant information about the social and the political dimensions that underpin urban environmental dynamics.

### 1.4.1 Urban green space in European urban areas

#### 1.4.1.1 An historical overview

The urban green space has acquired a public recognition in the European context since the late 17th cent. Gardens and green spaces had always been present in cities. However, the urban green space was composed either of private gardens or of unmanaged vacant and marginal land. Some royal and noblemen's gardens were converted to public spaces and new parks started to be ideated towards the end of the 17th cent. Later on, the idea of public park was further developed under the lens of the illuminist concepts of public space, public utility, nature and sociability (Hennaut & Benedetti, 2019).

Two main aesthetic models of public gardens and parks were elaborated[11] (Lambertini, 2006): the English type, which is based on the idea of keeping some areas of countryside within the city, against the context of the urbanisation processes that were occurring (e.g., well maintened big lawns and forests where citizens' uses are regulated); and the French type, which is more elaborated and aims at reproducing natural forms in harmony with the grey parts of the city (e.g., parks and gardens designed following regular architectural structures, with statues and fountains, but also boulevards and tree-lined squares).

In the 19th century, urban green space gradually developed in many European cities in the form of parks, public gardens, boulevards, wall gardens. The growth of urbanisation and the massive transformations brought about by industrialisation created rather unhealthy and unbearable environmental conditions. Along with sanitary infrastructures and health-care facilities, parks assumed a public role for improving citizens' hygiene, health and recreation. The issue of urban green space as a necessary urbanistic reform for unhealthy cities was already debated in the British parliament during the 1830s (Ibid.). Throughout the 19th century parks and green gardens hence started to be conceived also for working-class citizens, including areas specifically designed for recreational and sport activities, such as petanque, cricket, ball games (Panzini, 1993).

At the same time, parks, boulevards, gardens and tree-lined squares became an essential element of the modern radical urbanistic renovation that was inspired by Haussman's principles and ideas in several European cities. Green was functional to the fluxes and the mechanisms of the

[11] This is a rather basic and essential classification. For sure, the landscape architecture of parks includes a greater variety of styles and aesthetic models that have been developed for centuries (neo-classical, romantic…). This thesis does not deepen the architectural aspects of parks. See Lambertini, 2006 for a thorough inquiry.

city, against the context of urban transformative plans, designed to facilitate and stimulate the mobility of soldiers, citizens and goods in a healthy and sanitised environment, without any impediment due to the urban form, nor to social dissent. Moreover, the processes of haussmanisation of many European cities implied numerous private investments in real estate development. Green boulevards and well-maintained urban green spaces contributed to raise the land value in the burgeoning upper middle-class districts (Lambertini, 2006).

Urban green space therefore assumed, on the one hand, a compensatory function for working-class citizens against the context of unbearable living conditions. On the other hand, parks, boulevards and other forms of greening became essential elements in the new urbanistic theories, as green infrastructures for the urban mechanisms, but also as embellishment for new residential districts. The greening projects were funded by manifold actors, according to the scope and the type of the project and to the economic capacities of the public administrations. Along with private investors and state-financed projects, in some cases – for instance, the industrial Manchester - public subscriptions provided the funds for designing and implementing parks.

Between the end of the 19$^{th}$ and the beginning of the 20$^{th}$ century, eminent planners and architects, such as Frederick Law Olmsted in U.S., Jean Claude Nicolas Forestier in France and Antony Gaudì in Catalunya envisioned parks and green spaces as essential elements that guide urban growth, guaranteeing the presence of nature in the expanding built environment. Innovative ecological ideas were applied to urban planning, resulting in landmark projects that still inspire contemporary landscape architecture and urbanism. Olmstead designed the first greenway in 1887, a 16 km system of interconnected parks in Massachusetts[12]. In the same years, Ebenezer Howard's movement put forward the idea of garden cities surrounded by greenbelts, whereby proportionate areas of residences, industries and agriculture coexist.

In some European countries, namely in Germany and other Northern countries, several parks were planned. They followed a systemic logic, functional to the working-class need of recreational public spaces, providing some contact with nature in highly urbanised contexts (Panzini, 1993).

The urban plans of many European cities were defining urban green space as standardised infrastructures for citizens in the first decades of the 20$^{th}$ century. However, the attention to urban green space dramatically fell in the second post-war years. Except for the Scandinavian

[12]see https://www.umass.edu/greenway/Greenways/2GR-his.html

and few other central European countries, in general the post-war reconstruction did not provide for enough and decent urban green spaces. During the economic boom, the construction of big grey infrastructures, such as streets, highways and commercial malls was prevailing. The urbanistic plans designed some green standards that were clearly low in terms of quantity of squared metres for inhabitant. Moreover, the lack of financial and creative commitment in design and planning often resulted in anonymous and unattractive places (Lambertini, 2006).

Towards the end of the 60s, the ecological thought underlined the importance of green infrastructures to maintain the urban ecosystems[13]. The wounds created by decades of uncontrolled urbanisation were clearly visible in the degradation of the urban environment in many European cities. Ecological intents, along with the idea of sustainability, slowly began to influence urban planning. The green infrastructures of the city were thus seen as part of a wider and interconnected system that requires specific ecological knowledge to be safeguarded and improved.

Furthermore, the de-industrialisation of the European cities has left several vacant spaces and has created the need to re-organise the basic structures of the urban areas, according to new habits and needs concerning working conditions, housing preferences, mobility and, more generally, cultural practices. At the same time, due to austerity policies and to the increasing interest of private capitals in real estate investments, the urban governance has changed (Harvey, 1989). The global competition between cities has led to manifold governance forms that aim at favouring cities attractiveness. Greening public or private-led projects become part of the strategies of urban renovations undertaken in the last decades. In this case, parks and urban green spaces assume an iconic value, often emphasised by peculiar architectural styles, or innovative visual relations with the built environment.

#### 1.4.1.2 Contemporary challenges

In the contemporary European urban contexts, existing and newly planned urban green spaces are undoubtedly significant. The tangible symptoms of the environmental crisis have forced to a rising public and political awareness about the sustainability of urbanisation processes. Several studies have demonstrated clear correlations between the presence of green in the proximity of the living environment, health and well-being (Markevych et al., 2017) (Bertram

[13] Green infrastructure refers to "a strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services' in both rural and urban settings" (European Commission, 2013)

& Rehdanz, 2020) (Krekel, Kolbe, & Wüstemann, 2016). Moreover, the urban green space necessarily falls into the issues concerning low-carbon transition, being linked to several environmental problems (Kabisch et al., 2018). As a matter of fact, several greening policies have been recently undertaken in many European cities. In Western and Southern European cities, the amount of green space has increased since 2000 (N. Kabisch & Haase, 2013).

However, the complex scenario of European urban areas renders the issue of green space quite challenging. Many interconnected elements are at stake: the development of the urban morphology against the context of historical existing urban structures, the manifold demands of the urban populations and their spatio-temporal horizons, the ecological equilibria and the changing environmental conditions, the governance of large urban areas. Such a multifaceted issue requires a transdisciplinary approach able to connect the insights and the analytical tools of urban planning, sociology, ecology, and many other disciplines. In the following, I will briefly describe the main challenges for urban green spaces planning and management. Afterwards, I will critically focus on the concept of ecosystem services and on its heuristic potential in the study of the urban green space.

After a review of academic and policy documents, I here consider five main intertwining macro-challenges:

1 Adapting to the urban morphological transformations.

2 Mobility and connectivity.

3 Accessibility and urban populations' needs and demands.

4 Climate change and contemporary environmental issues.

5 Governance: planning, projects, management and maintenance.

*Urban morphological transformations.*

The first challenge has a place in the territorial developments of large urban areas. As described in chapter 1.2, urban areas have been expanding well beyond the limits of cities. The metropolitan areas include rather diverse territorial characteristics, in terms of landscape, economic activities, mobility, population. Therefore, urban green spaces are not limited to the historical parks within the city limits, but contemplate also other forms of natural places, such as suburban parks, peri-urban forests, lawns and vacant land.

The peculiar features and the potential socio-ecological functions of the urban green spaces in each territorial area (i.e., densely populated city centre, former industrial periphery, suburban

sprawl…) must be considered when it comes to green planning and management. The spatial disposition and the shape of green space within the metropolitan areas heavily influence their social and ecological benefits (Meerow & Newell, 2017). Furthermore the spatial relations between the green patches is also a determinant of the character of green spaces (Grafius, Corstanje, & Harris, 2018). For instance, a well-connected net of several small green spaces may be the habitat for a broader biodiversity, comparing to a large and isolated park.

The debate over sustainable urban forms has widely underlined the benefits of dense urban areas and compact cities, such as less traffic, walkability, less co2 emissions from transport, less sprawl and soil sealing, higher energy efficiency (Jabareen, 2006) (OECD, 2012) (Jenks, 2019). However, cities undergoing densification may encounter some negative effects (Haaland & van den Bosch, 2015): the loss of public and private urban green space due to suburban infill development and to the sealing of vacant spaces; inequalities in the access to parks and green gentrification (Quastel, Moos, & Lynch, 2012); the decrease of the quality of the green (e.g., small and isolated patches); the rise of compensation travelling to second homes outside the city.

The shape of urban morphology therefore influences the quality of urban green space. Planners and policy makers are to consider the sustainability trade-offs and the possible effects caused by urban morphological transformations (Westerink et al., 2013).

*Mobility and connectivity*

Strictly connected to the urban morphology is the challenge of mobility (Hansen et al., 2016). Urban green spaces provide connections for human and non-human beings, and for abiotic fluxes (e.g., air, energy). On the one hand, from a landscape ecology perspective, connectivity counters the effects of the fragmentation of the patches, allowing diverse species to proliferate. On the other hand, from an urbanistic and sociological perspective, it creates chances for soft mobility in the city.

Today, the ideas of green-belt and green corridors have been developing in European urban areas and the regeneration of abandoned tramways or railways is an opportunity to implement green mobility (e.g., the functioning green tramway in Grenoble). Furthermore, the renovation of abandoned and marginal places (e.g., old unused stations) may constitute a green connection between formerly separated districts.

*Accessibility and urban populations' needs and demands.*

The theme of urban mobility touches upon the challenge of accessibility to urban green spaces. The provision of decent and accessible green spaces in the proximity of the households throughout the city has been a policy objective since the fifties. In 1952 the Stockholm General Plan, inspired by Patrick Abercrombie's work in the UK, prescribed a maximum distance of 300 m from home to playgrounds (Stessens et al., 2017). Since then, several green standards have been developed, regarding the maximum distance from the household, the block or the district and the minimum dimension of the urban green space (see tab.1.2 for a synthesis).

| TFL | Min. surface (ha) park or green space | Max. distance from home (m) |
|---|---|---|
| Residential green | 0.06 (0.1) | 136 (150) |
| Play green | 0.52 (0.5) | 348 (350) |
| Neighbourhood green | 1.8 (2) | 585 (600) |
| Quarter green | 5.9 (6) | 958 (1000) |
| District green | 13 (15) | 1345 (1400) |
| City green | 69 (70) | 2697 (2700) |
| Metropolitan green | 450 (450) | 5903 (5900) |

*Table 1.2 "Literature-based theoretical functional levels (TFLs) with parameter values used for the proximity modelling. Rounded values in brackets. The TFL names correspond to the type of area they serve" (Stessens et al., 2017: 334, table 8)*

Proximity and dimension are two essential issues to comprehend the availability of green space, a fundamental prerequisite for accessibility. However, the theme of accessibility comprises a broader range of issues, including the quality of green infrastructures (i.e., presence of benches, green maintenance, fountains…) (Ekkel & Vries, 2017), and, notably, city dwellers' socio-economic characteristics (Hoffimann, Barros, & Ribeiro, 2017) and cultural preferences, attitudes and perceptions (Schindler et al., 2018) (Zhang et al., 2017) (Rossi, Pickering, & Byrne, 2016).

The demand side is indeed rather important in determining accessibility. Some demographic groups, i.e. young children and elderly people need to live closer to green space because of their limited motorial capacities. Furthermore, according to the age, the cultural background and the socio-economic status, park users have diverse ideas about their preferred type of green space. Yet the issue is not only spatial, but also temporal. It is often the case that the same public green space radically changes throughout the week, depending on the temporal habits of the urban populations. For instance, commuters may walk through parks in the morning and in the late

afternoon or may have their lunch there, while residents may prefer to organise activities during the weekends.

Given the strong relations between well-being and the presence of green space in the living environment, accessibility is a matter of environmental justice (Heynen et al., 2006) (Sister, Wolch, & Wilson, 2010) (Wolch et al., 2014) (Byrne, 2017). Low-income neighbourhoods often lack public urban green spaces or are in the proximity of overcrowded and degraded public parks. Poor city dwellers are also less likely to have private gardens. Plus, park design and management often fail in comprehending vulnerable social groups' needs and demands, privileging other targets, such as city branding, land value and/or ecological rationales. The social distribution is therefore an essential element for critically understanding the role of green spaces in urban contexts.

*Climate change and contemporary environmental issues.*

Several local and international institutions and researchers have lately stressed the centrality of cities in tackling climate change. The UN narrative depicts cities as both the main responsible for climate change and the potential frontrunners in developing mitigating and adapting solutions (UN-Habitat III, 2017). Big cities have created transnational networks (e.g., 100 resilient cities; C40 cities[14]) employing the financial support of private multinational corporations, in order to discuss and create urbanistic, technological, and social innovations. The logic behind these initiatives is that of stimulating the economic and cultural creative resources of big cities for implementing good practices, which afterwards could be exported elsewhere.

Against this context, the urban green space is deemed as an element for both mitigating and adapting to climate change. Urban trees may represent a significant means for carbon storage and sequestration. Surely, planting few thousand trees in a city does not make much difference, considering the global amount of Co2 in the atmosphere. The objective of climate change mitigation through urban green space, though, is to build innovative urban greening initiatives and hence to increment green spaces world-wide. For instance, roof-top greening is an innovation initially developed in few big cities, which could be implement in other places. Considering the massive processes of urbanisation that are occurring around the globe, urban trees will potentially play a role in climate change mitigation. Yet, without any significant cut

[14] https://www.100resilientcities.org/; https://www.c40.org/

of the sources of Co2 emissions, the carbon storage from urban forest will not be enough to tackle climate change (Baró et al., 2014).

The consequences of climate change are clearly visible in European cities. Global warming has exacerbated pre-existing environmental problems, such as urban heat islands and floods. Extreme hazardous events recur with an increasing frequency. Droughts, storms and extreme events contribute to increment transnational migrations to cities.

Urban environmental issues (see chapter 1.2) may be tackled with the aid of green space. Urban green spaces may function as nature-based solutions[15] to improve soil drainage and limit flooding. Furthermore, the tree canopy and the green surface provide shadow and absorb less solar radiation than concrete and asphalt and thus may reduce urban atmospheric temperatures. Urban green spaces contribute to reduce air pollution. Unsealed soil provides the habitat for biodiverse species. These regulating and habitat functions (see the following paragraph on ecosystem services) are essential in order to render cities and urban areas liveable.

In sum, contemporary environmental issues are among the most important challenges for green governance. Urban green space design and planning surely condition the green space capacity of providing ecosystem services (Meerow & Newell, 2019). However, the best practices to counter environmental problems may be controversial under a social or urbanistic viewpoint, limiting accessibility, hindering the conservation of existing historical landscapes, or creating spatial inequalities. The decision-making over these trade-offs depends on urban governance structure and mechanisms, political will and power relations between the stakeholders (Haase et al., 2017).

*Governance: planning, projects, management and maintenance.*

Considering their multifunctionality and their social importance, the governance of urban green spaces is itself a challenge. Parks and forests often transcend administrative limits, even more so if green corridors and connections are considered as unitary systems. Moreover, the spatial location of the green spaces does not always correspond to the spatial distribution of their benefits. For instance, a large peripherical forest may play a fundamental role in impeding

[15] "There is growing recognition and awareness that nature can help provide viable solutions that use and deploy the properties of natural ecosystems and the services that they provide in a smart, 'engineered' way. These nature-based solutions provide sustainable, cost-effective, multi-purpose and flexible alternatives for various objectives. Working with nature, rather than against it, can further pave the way towards a more resource efficient, competitive and greener economy." European Commission definition of Nature-Based solution. https://ec.europa.eu/research/environment/index.cfm?pg=nbs

floods in the city centre. Green governance must have a large-scale vision, without ignoring local and neighbourhood needs and demands. The administrative struggle in coping with contemporary urban socio-economic dynamics (see ch. 1.2 on cities *de facto* and metropolitan areas) is as evident as the difficulties to plan urban green space and manage socio-ecological issues at different scales.

Furthermore, fiscal austerity and the decrease of local public administration funds have favoured the flourishing of private-led greening initiatives. Therefore, manifold forms of governance have been experimented lately in Europe, involving public institutions (regions, provinces, municipalities), private developers, environmentalist NGOs, civic associations, informal organisations (Hansen et al., 2016).

The planning and design of urban green spaces have overcome the 20$^{th}$ century idea of municipal park and districts green standards. Municipalities still play an important role. However, along with traditional public planning tools, greening has emerged in the design of private-led renovation projects. In this case, municipalities collaborate with private developers establishing guidelines and monitoring private projects. At a smaller scale, communal administrations also coordinate and facilitate kitchen gardens and other forms of neighbourhood greening, as well innovative projects, such as green rooftop for water drainage, or for food production.

Regional, provincial and metropolitan administrations design and plan wider green areas that cover the territory of different municipalities. They also promote green corridors and connections between existing green spaces. Regional, interprovincial and metropolitan parks and large-scale green initiatives are usually more inclined to nature conservation and other ecological objectives. Surely the coordination between different institutional actors is fundamental in order to develop urban green spaces with an eye on ecological functions, as well as on local social needs and demands.

The management and the maintenance are other focal points, strongly influencing the quality of existing urban green spaces. Numerous forms of park management and maintenance have been developed. The recent increase of greening initiatives and the lack of public financial resources have favoured the development of private or mixed forms of maintenance. The ordinary maintenance of public green spaces managed by municipalities is subcontracted for cost-efficiency reasons to private companies in many European cities. Civic associations are encouraged to participate in green management providing volunteering workforce. Some newly

developed parks follow an entrepreneurial model, establishing private sponsorships and aiming to be financially self-sufficient, or even to generate profits.

Each of these governance models has its own economic capacity and is able to provide for different qualitative standards. The economic funds for management and maintenance clearly impact the quality of urban green spaces. Deeply diverse management models and capacities of maintenance may foster inequalities in terms of green quality and accessibility. Private-led big greening projects are located in wealthy areas, or in areas that are going to become exclusive as they elicit significant growth of land value. Different capacities of management and maintenance therefore may create inequalities in green provision between poorer districts where public parks are the only available and richer districts where private managed parks are better equipped and maintained.

### 1.4.2 Ecosystem services in the study of urban green space

As urban green space is assuming a significant ecological, economic, social and political role, analytical attempts to comprehend the value of green have been proliferating. On the one hand, the scientific research focuses on the topic increasingly employing an interdisciplinary approach. On the other hand, public institutions have gradually introduced some of these valuation methods in policy making and planning, either as descriptive tools or as prescriptive policy-measures.

The idea of ecosystem services is one of the most developed in the field of scientific and policy-oriented valuation of nature. Ecosystem services assessment is internationally regarded as a means for including ecological concerns into planning, providing a scientific, solid measure of the services guaranteed to people by nature (TEEB, 2010).

#### 1.4.2.1 The concept of ecosystem services

The concept of ecosystem services has been elaborated since the early 70s, building on the idea of ecological functions. In ecology, the idea of ecosystem function has been referred to a set of ecological processes operating within an ecological system (Gómez-Baggethun et al., 2010). Some of these functions (e.g., soil evapotranspiration) directly or indirectly provide essential services for human well-being (e.g., improving air quality and enhancing local rain-driven water cycle). During the 70s and the 80s, a growing number of authors demonstrated that the

existence of the human species depends on the services provided by nature. The idea of natural or ecosystem services therefore originated as a metaphor for enhancing biodiversity conservation.

Only in the late 90s, though, ecosystem services became a widely debated concept in the scientific arena (Geneletti et al., 2020). In particular, Costanza et al.'s 1997 paper on the monetary value of the world's ecosystem services and natural capital (Costanza et al., 1997) stimulated great interest on the topic among environmental and ecological economists, other than among conservation ecologists. The Millennium Assessment (2005), launched under the umbrella of the UNEP (United Nations Environment Programme), firmly introduced the concept of ecosystem services in the policy agenda. The MA provided a definition and a classification of the main ecosystem services.

«Ecosystem services are the benefits people obtain from ecosystems. These include provisioning services such as food, water, timber, and fiber; regulating services that affect climate, floods, disease, wastes, and water quality; cultural services that provide recreational, aesthetic, and spiritual benefits; and supporting services such as soil formation, photosynthesis, and nutrient cycling. The human species, while buffered against environmental changes by culture and technology, is fundamentally dependent on the flow of ecosystem services.» (Hassan et al., 2005: vii)

Since the MA, international projects and studies on ecosystem services have proliferated. Ecosystem services research has included studies on the ecological structures and functions – i.e., quantifying and modelling ecological functions (e.g., air pollution removal from trees) – and, notably, the valuation of the services for human well-being.

Several attempts to quantify the value of the services in monetary terms have been developed. The leading instruments within this line of thought are markets for ecosystem services and the payment for ecosystem services (Gómez-Baggethun et al., 2010). The former consists in trading commodified ecosystem services between a range of actors. The international carbon emission trading schemes are the most renewed example: the country or the polluter who emits more is able to purchase the right to overcome emission limits from countries or entities which are less polluting.

Payments for ecosystem services "have been defined as voluntary and conditional transactions over well-defined ecosystem services between at least one supplier and one user" (Ibid: 1214). In other words, they are economic incentives to produce some ecosystem services (i.e., carbon sequestration, provision of habitat for endangered species, protection of landscapes, various hydrogeological functions). Environmental economics therefore elaborates methods and tools for fixing market failure and for including the commodified ecosystem services, formerly

considered as mere externalities, in neoliberal market transitions. The marketisation of ecosystem services is often presented as a win-win solution, because it is deemed to protect the environment while fostering the economy (Muradian et al., 2013).

However, the monetarisation and the commodification of ecosystem services are highly problematic[16]. As explained in the previous chapter, the valuation of nature is a not a linear process. The utilitarian principle underpinning the quantification of services hinder the comprehension of the complexity of the real ecological spatial and temporal fluxes. Ecosystem services are not stable in time, refer to various spatial scales and may interact with each other. Moreover, from a political viewpoint, the commodification of ES institutionalises the principle of differential access to ecosystem services according to the ability to pay, which raises evident issues of inequalities, namely in the global south countries, where local populations tend to have less purchase power than foreign investors (Gómez-Baggethun & Ruiz-Pérez, 2011).

In sum, the monetary valuation and the consequent possible commodification of ecosystem services imply several pitfalls that may hinder the improvement of the ecological conditions and may cause increasing inequalities. Following Kallis et al. (Kallis et al., 2013), the monetary valuation of ecosystem services may be beneficial only if: it faces the issues of long term environmental improvements; it considers power dynamics problems between the stakeholders; it does not overshadow diverse languages of valuation; and it does not respond to the neoliberal logics of accumulation by dispossession.

Although the monetary valuation and the commodification of ecosystem services represent widely debated and controversial themes, the concept of ecosystem services has been implemented and debated also in other ambits. Non-monetary valuations of ecosystem services provide rather useful information on the extent to which natural degradation may jeopardize well-being. Scientific knowledge on the contribution of ecosystems to human well-being may raise awareness on the importance of nature and biodiversity conservation against uncontrolled human practices. In this regard, even monetary valuations may result incisive, recalling a language of valuation which is easily understandable.

Considering the complexity of the impellent environmental challenges (see chapter 1.2.) and the essential roles of green space (see previous paragraph), ecosystem services represent a very insightful analytical tool against the context of the urban environment. European urban policy

[16] In this thesis the topic of the payment of ecosystem services is not developed in depth. See (Kosoy & Corbera, 2010), (Norgaard, 2010), (Frame, 2011), (Gómez-Baggethun & Ruiz-Pérez, 2011) for a thorough critique.

makers have recently attempted to implement the concept in planning procedures as international institutions stimulate and finance research on urban ecosystem services (Ronchi, 2018) (Geneletti et al., 2020).

#### 1.4.2.2 Urban ecosystem services

Urban ecosystem services (UES) are the ecological functions benefitting human well-being, which are provided by the blue and green spaces located in urban areas. Given the fact that the urban ecosystems go well beyond the administrative limits of cities, UES are generated by parks, tree canopy, peri-urban forests, gardens, vacant lots, landfills, rivers, streams, ponds, lakes, canals (…) within large metropolitan areas (Elmqvist et al., 2015).

Urban ecosystems have peculiar characteristics. They are shaped by strong and relentless human interventions and they suffer continuous stresses from high population density. The urban demand of services necessarily overwhelms the local capacity of supply (Rees, 1997). In fact, urban provisioning services provide only a very limited amount of the goods (e.g., food, timber) consumed in urban areas. Considering the mighty environmental impact of urbanisation, urban ecosystem services are also rather inadequate to cope with the quantities of pollution and waste generated by urban consumption.

However, urban ecosystems are especially important in providing services addressing health and security issues, such as air purification, noise reduction, run-off mitigation, urban cooling (Gómez-Baggethun & Barton, 2013). The contribute of the services evidently vary depending on the context. For example, in Milan, where the concentration of harmful pollutants is rather high and temperatures are extremely hot in summer, air purification and urban cooling represent essential services provided by ecosystems. In Genova, where devastating floods regularly recur, run-off mitigation is an essential service.

The following table (tab.1.3), adapted from Gómez-Baggethun and Barton (2013), provides a list of the main urban ecosystem services.

*Table 1.3 Classification of important ecosystem services in urban areas and underlying ecosystem functions and components. Adapted from: Gómez-Baggethun & Barton, 2013: 237*

| *Functions and components* | *Ecosystem services* | *Examples* | *Examples of indicators/proxies* |
|---|---|---|---|
| Energy conversion into edible plants through photosynthesis | Food supply (provisioning) | Vegetables produced in urban kitchen gardens and peri-urban areas | Production of food (tons per year) |

| | | | |
|---|---|---|---|
| Percolation and regulation of run-off and river discharge | Water flow regulation and run-off mitigation (regulating) | Soil and vegetation percolate water during heavy and/or prolonged precipitation events | Soil infiltration capacity: % sealed relative to permeable surface (ha) |
| Photosynthesis, shading and evapotranspiration | Urban temperature regulation (regulating) | Trees and other urban vegetation provide shade, create humidity and block wind | Leaf Area Index; Temperature decrease by tree cover×m2 of plot trees cover (°C) |
| Absorption of sound waves by vegetation and water | Noise reduction (regulating) | Absorption of sound waves by vegetation barriers, specially thick vegetation | Leaf area (m2) and distance to roads (m); noise reduction dB(A)/ vegetation unit (m) |
| Filtering and fixation of gases and particulate matter | Air purification (regulating) | Removal and fixation of pollutants by urban vegetation in leaves, stems and roots | O3,SO2,NO2, CO, and PM10 μm removal (tons yr−1) multiplied by tree cover (m2) |
| Physical barrier and absorption on kinetic energy | Moderation of environmental extremes (regulating) | Storm, floods, and wave buffering by vegetation barriers; heat absorption during severe heat waves | Cover density of vegetation barriers separating built areas from the sea |
| Removal or breakdown of xenic nutrients | Waste treatment (regulating) | Effluent filtering and nutrient fixation by urban wetlands | P, K, Mg and Ca in mgkg−1 compared to given soil/water quality standards |
| Carbon sequestration and fixation in photosynthesis | Climate regulation (regulating) | Carbon sequestration and storage by the biomass of urban shrubs and threes | CO2 sequestration by trees (carbon multiplied by 3.67 to convert to CO2) |
| Movement of floral gametes by biota | Pollination and seed dispersal (support/habitat) | Urban ecosystem provide habitat for birds, insects, and pollinators | Species diversity and abundance of birds and bumble bees |
| Ecosystems with recreational and educational values | Recreation and cognitive development (recreational) | Urban parks provide multiple opportunities for recreation, meditation, and pedagogy | Surface of green public spaces (ha)/inhabitant (or every 1000 inhabitants), accessibility metrics |
| Habitat provision for animal species | Animal sighting (habitat, recreational) | Urban green space provide habitat for birds and other animals | Abundance of birds, butterflies and other animals valued for their aesthetic attributes |

Among the provisioning urban ecosystem services, food supply is perhaps the most important. Urban agriculture and urban allotments have recently been promoted in many European and Northern American cities against the context of sustainable food policies (Colli, 2017) (Deakin, Borrelli, & Diamantini, 2019). The interest on provisioning urban ecosystem services is growing also in other fields, i.e. timber provision for urban manufacturing activities (e.g., the sonian wood cooperative project in Brussels[17]). Provisioning services are important for developing solid short production chains and therefore contribute to strengthen the local urban economy and reduce freight transport pollution.

Most of the services in table 2 falls into the regulating ones. Environmental scientists have developed several models to comprehend to what extent green areas improve air quality (Nowak, Crane, & Stevens, 2006)(Escobedo & Nowak, 2009). It has been demonstrated that vegetation in urban areas reduce pollutants from the atmosphere, including ozone ($O_3$), sulphur dioxide ($SO_2$), nitrogen dioxide ($NO_2$), carbon monoxide (CO) and particulate matter ($PM_{10}$, $PM_{2.5}$). Polluting particles deposit on the leaves and, in part, are absorbed by the plants. The capacity of air purification varies both daily and seasonally, as it mostly depends on the leaves and on their stomata.

Urban trees act also as sinks of $CO_2$, sequestering and transforming atmospheric carbon into biomass during the process of photosynthesis and are therefore a climate regulation asset (Nowak, 1993). Furthermore, urban vegetation reduces noise pollution by absorbing sound waves and absorb heat through shading and evapotranspiration. Unsealed soil and vegetation help water flow regulation and run-off mitigation.

While the effects of regulating ecosystem functions directly improve human well-being, the benefits provided by supporting services are indirect. Although less visible, supporting and habitat services are fundamental for guaranteeing biodiversity and for enhancing other ecological functions.

Finally, recreational and cultural services include all the opportunities provided by urban green spaces for recreation, meditation, pedagogy, sport, artistic inspiration et cetera. The value of these services is rather subjective, and it is hardly quantifiable in indicators. Assuming that green spaces provide the opportunity for many essential cultural and social activities, availability and accessibility can be considered as proxy indicators. Surveys and qualitative studies (direct observations, ethnographies) may provide more detailed information on the

[17] https://urban-ecology.be/swc

activities carried out in parks and on the populations involved (Fischer et al., 2018) (Canedoli et al., 2017).

#### 1.4.2.3 The distribution, the generation and the articulation of urban ecosystem services

Ecosystem services assessment follows scientific models for quantifying in situ ecological functions contributing to human well-being. Ecosystem services science has been developing for more than two decades, managing to build solid theories and methods of analysis. For example, by elaborating data on trees and land use, ecosystem services assessment may easily provide a quantification of the pollutants removed by the vegetation of a park or of an entire city. Such information is no doubt useful for planners and policymakers.

Yet the mere assessment of the ecosystem services provided by a single (or a group of) green space(s) overlooks some of the main challenges described in the previous paragraph. In fact, ecosystem services assessment ignores the importance of landscape structure and ecological connectivity. Furthermore, the scientific knowledge about ecosystem services need to be complemented with information about socio-economic, cultural and political dynamics. Urban green spaces and the services they provide are entangled in a network of relations between human actors and broader ecological dynamics. Without contextualising ecosystem services, essential information about urban morphology, mobility, governance, inequalities is missing.

Taking a cue from Ernston's frame of analysis (Ernstson, 2013), in the following I will highlight three complementary themes of analysis: the distribution, the generation and the articulation of ecosystem services.

Each urban green space belongs to a broad ecological network which heavily influence local functions. Thus, the distribution of the urban green spaces entails their spatial relations and their ecological connections. Landscape ecology analytical tools for studying spatial metrics and ecological connectivity between patches are then required to better understand local ecological functions. The distribution of the benefits derived from urban green spaces spans differential scales according to the type of ecosystem service. Some environmental benefits, such as CO2 storage and mitigation of heat island are effective at a city-wide scale, while other ecological processes that occur in urban green spaces produce benefits to residents only at local scale (N. Kabisch & Haase, 2014). For instance, UGS reduction of noise is perceivable only in the proximity of green as well as the direct benefits on health and well-being. Although the scale of the benefits of ecosystem services is not always clear and cannot be defined with precise metrics, it is important to remark that, for some services, the beneficiaries are those who live in

the proximity of green, while, for others, are all the citizens. Thus, the spatial distribution of functions and services within urban areas is essential for valuing green spaces (Meerow & Newell, 2019).

Moreover, the analysis of the distribution entails the characteristics of the urban populations. The extent to which an ecosystem service guarantees benefits to the population depends on the degree of access to the service. The benefits provided by ecosystem services therefore change in relation to the distribution of the urban population. Densely populated areas necessarily require more public green space. Furthermore, the demand for ecosystem services vary according to the demographic, social and cultural characteristics of the individuals. Thus, also the social context where green spaces and ecosystem services are located conditions the valuation of their benefits.

In urban contexts, where several heterogeneous social groups coexist, assessing the demand for ecosystem service is quite challenging. Qualitative and participative approaches help understanding citizens' preferences at small scale (i.e., neighbourhood green, park), and are especially useful for detecting the demand for recreational ES among diverse groups of residents and urban populations. Quantitative studies provide a clearer idea of the spatial distribution of the socio-economic features of the population and therefore a broad comprehension of the spatial dynamics of social vulnerability within the urban areas. For example, some demographic groups (i.e., elderly) are more vulnerable to heat waves (Depietri, Welle, & Renaud, 2013). The demand of regulating ecosystems services is proportional to the presence of these demographic groups. In general, unequal access to ecosystem services may reinforce existing territorial vulnerabilities, contributing to create environmental injustices (Marshall & Gonzalez-meler, 2016).

Distributive issues are strictly linked to the processes of generation and articulation of ecosystem services. Indeed, nature does not simply exist "out there". Urban green spaces are planned and managed by several institutional, civic and private actors, which put forward and negotiate a wide range of ways of valuing nature. The governance of urban green spaces generates ecosystem services since the first planning and design phase, by establishing land use and management of land. Subsequently the economic and social capacities of maintenance, as well as the political prioritisation of green values affect the provision of services from existing green spaces. Furthermore, depending on their management, green spaces have differential capacities of sustaining ecological flows through the individual green areas in the ecological network (Ernston, 2013).

The urban actors (institutional, scientific, private developers, local communities…) - with different resources and degrees of legitimacy - participate in the process of construction of green value. Scientific knowledge, political values (i.e., equity, individual freedom…), economic interests, citizens' needs are constantly negotiated in the social articulation of ecosystem services.

«Articulation is the practice and process through which for instance local groups or biologists construct their arguments to protect urban parks, creeks or wetlands and engage in planning processes—often in contestation to developers that articulate opposing values and arguments for how to use land. It is in these heightened moments of struggle, or formalized procedures of decision-making that the empirical researcher can understand how discourse, power and institutional procedures play out among different groups, and how this shapes biophysical processes and the composition of urban land use over time. » (Ernston, 2013: 8)

The study of the distribution, the generation and the articulation of ecosystem services therefore implies a transdisciplinary approach. Relevant socio-economic, cultural and political information in fact completes and enriches the ecosystem services assessment. The study of urban green spaces cannot be reduced to a technical assessment of functions and services, as nature is socially conceived and regards rather complex interactions between ecological and political historical processes.

#### 1.4.2.4 Is urban green sustainable?

The development of green spaces is one of the most promoted themes in the urban strategies for sustainability and resilience. Greening the city is a remarkable objective in many European cities. In this chapter the principal challenges related to contemporary urban green spaces were presented along with the ecosystem services analytical framework. In sum, the chapter has shown that greening is not just a matter of quantity, nor can it be valued by mere in situ assessments of ecological functions.

In fact, greening projects and policies are entangled in complex socio-ecological processes. If greening is considered an objective on its own, decontextualized from the existing urban large-scale dynamics, then it may reinforce inequalities (e.g., green gentrification (Quastel, 2009)), deny local population needs and demands, and ignore large-scale ecological fluxes.

Following the framework presented in the previous chapter, it can be asserted that urban green spaces are sustainable only if are conceived paying attention to ecological resilience, environmental justice and well-being. Well-being entails the benefits from ecosystem services and the conditions that enable ES to provide benefits (Andersson et al., 2019), including the

connections with existing green (the ecological network) and non-green infrastructures (i.e., mobility infrastructures), the institutional setting (i.e., land use norms, institutions and value articulation) and the social perceptions and the local valuation of green. Ecological resilience concerns the capacity to support ecological fluxes. It depends on biophysical processes and on the capacity of maintenance and protection of the ecological conditions (Ernston, 2013). Ecological resilience is hence also embedded in political processes. Finally environmental justice sets the framework for debating issues concerning the distribution and the decision-making process underpinning green management and planning (Rutt & Gulsrud, 2016).

# 2 Research Design

Following the theoretical insights of the previous chapters, this research aims at investigating some of the benefits provided by the urban green space and the inherent political dynamics related to green planning and management in Brussels and Milan. In this section of the thesis, I will delineate the research design. In the first chapter of the section, the objectives of the study and the research questions will be illustrated in detail. Thereafter, the second chapter will be about the secondary and primary tools of analysis, and the study area.

## 2.1 The scope of the research

The urban natural environment poses several challenges at the times of the Anthropocene. This research specifically focuses on the urban green space, which represents just one of the many impellent themes that concern the contemporary environmental crisis. The urban green space, though, is a rather relevant topic, because it directly and indirectly affects the urban population's well-being. Furthermore, given the massive growth of urbanisation and the proliferation of its manifold forms, the urban green space and the urban non-built areas importantly contribute to local and distal ecological equilibria (see chapter 1.4).

This research intends to shed some light on the role and the services provided by the urban green space against the context of the contemporary urbanising processes in Europe. It focuses on two metropolitan areas, i.e. Milan and Brussels. Milan and Brussels represent rather different historical and present approaches to the green space, in two contexts that are comparable for dimension, territorial and socio-economic features. Notably, the study includes not only the urban core, but also the suburban and peri-urban semi-rural places that constitute the metropolitan areas.

The research activity follows two main paths. The first part of the study analyses some of the ecological functions and services guaranteed by the urban green spaces located within the metropolitan areas. The distribution of green and the supply of relevant ecosystem services are read in relation to the socio-territorial characteristics of the metropolitan areas.

The second part of the study attempts to deepen the political dimension underpinning green management and planning. Based on a review of the main planning documents and on some interviews to the leading stakeholders, the actors involved in green governance are identified. Each actor tends to prioritise some peculiar functions and holds a well-defined position regarding the role of green space in the urban milieu. The diverse visions may favour collaborations, tensions, and conflicts within administrative institutions or between public institutions, private developers, and citizens. The aim of this part of the research is to highlight the stakeholders' ideas and preferences about greening and their influence on the development of urban green spaces and on the provision of ecosystem services. More generally, the objective is to comprehend the trajectory of greening and sustainability in different urban contexts.

Finally, this study aims to define the main emerging challenges related to urban green space and to the distribution and the generation of ecosystem services in the two metropolitan areas. By combining the insights coming from the first and the second part of the research, this thesis aims to put forward some critical considerations about existing greening policies and few insights and prescriptions about possible future scenarios.

### 2.1.1 Research questions

This study builds on two macro-questions. Each of them has evolved into more punctual issues during the research activity. The initial general questions are about the reciprocal interactions between the green space and large urban areas: on the one hand the benefits derived from ecosystem processes and their distribution within metropolitan areas; on the other hand, the political processes of urbanisation conditioning the value and the forms of the green space.

1) How do urban green space and ecosystem dynamics contribute to the territorial wellbeing of the metropolitan areas of Milan and Brussels?

2) What are the main political dynamics that underpin greening in Milan and Brussels contemporary urbanisation processes?

These macro-questions have been refined adopting some of the concepts treated in the first section of the thesis. In order to comprehend the impact of the urban green space in large metropolitan areas, the first question is elaborated focussing on the idea of distribution of ecosystem services (Ernstson, 2013), keeping in account the territorial differences within the metropolitan areas (see chapter 1.2).

1.1) Where are urban green spaces located in the metropolitan areas? Which territorial layers are better provided with green space?

1.2) What kind of ecosystem services are provided in central, peripherical, suburban and periurban areas?

The information about the ecosystem services needs to be contextualised referring not only to the supply, but also to the demand of ecosystem services. The research questions therefore focus on the distribution of the urban populations, highlighting vulnerabilities and other relevant socio-economic characteristics. The following question, in fact, contributes to raise the argument of distributive environmental justice.

1.3) Does social vulnerability spatially correspond to a lack of green space and ecosystem services? Is green a matter of justice?

The second macro question looks at the processes of generation and articulation of urban ecosystem services. It is articulated in the following questions.

2.1) What is the structure of green governance? What is the profile of the main actors? How do they conceptualise the green space and its functions in the city and in the metropolitan area?

2.2) What kind of divergences, conflicts and agreements emerge in the governance of green space?

2.3) What are the main trajectories of greening policies?

The planning and the management of green space are embedded in broader political dynamics. The comparison between two metropolitan areas is meant to underline different ideas, visions, organisational structures, and political attitudes towards greening (Pierre, 2005).

2.4) What are the differences between the metropolitan areas? What are the historical, institutional, and political elements that influence the governance attitude towards greening?

In conclusion, the research intends to depict the main challenges and problematics related to the green space in Milan and Brussels, and to analyse them following the sustainability framework presented in chapter 1.3. The following questions hence aim to put together the two macroquestions and to raise other issues for future urban policies and planning.

3) What are the main problematics and challenges related to urban green spaces in the metropolitan areas? What idea of sustainability prevails in the two urban areas? What policy recommendations could be formulated?

### 2.1.2 Policy implications

Sustainability has certainly become a key issue in urban policymaking. The proliferation of sustainability agendas touches upon several policy spheres: urban renovation, planning, urban economic development (…). At the same time, urban resilience and the transition towards a low-carbon society are widely debated themes that have recently carved out a notable interest in urban studies.

Greening the city is a recurrent objective in European urban agendas, as the development of parks and other forms of green is one of the focal points of sustainable policies. However, the

benefits provided by urban green spaces are often taken for granted and not discussed in detail. City-scale indicators on the quantity of green per capita or catchy decontextualized information about some ecosystem services (i.e., carbon storage) often hide deeper social and ecological dynamics that affect citizens' well-being, such as green gentrification, inequalities in the access to parks, lack of ecological connections (…)(Badiu et al., 2016) (Quastel et al., 2012) (Anguelovski et al., 2019).

Against this context, the contribution of the research consists in providing transdisciplinary insights about the value of the green space in large metropolitan areas, beyond the administrative limits of the cities. The study intends to contextualise the urban green spaces underlining the territorial features of the supply and demand of ecosystem services. The results may be meaningful for planning purposes and for informing greening projects.

The second part of the research may also contribute to support greening plans and projects, as it attempts to situate the actors involved in green governance according to their visions and conceptualisation of sustainability and urban green. By informing public policymakers on the priorities and the vision of diverse actors and on existing governance problems, the research may improve the awareness of the impact of decision-making process on the quality of the green space and on the ecosystem services they provide. Moreover, the study of two diverse political context helps comprehending the historical and institutional constraints, and the main factors which may influence the political articulation and the production of ecosystem services in European urban contexts.

## 2.2 On methodology

The research encompasses a wide range of methods and tools of analysis, as the methodology was crafted in function of the objectives of the research and is not ascribable to a sole disciplinary ambit. The first part foresees a spatial analysis of environmental and socio-economic territorial data with GIS tools. The second part is based on the review and the analysis of planning and policy documents and on in-depth interviews with policymakers, urban planners, park managers, and other relevant practitioners in green management and planning.

### 2.2.1 Secondary analysis of environmental and socio-territorial data

The first macroquestion about the distribution of ecosystem services demands a quantitative, spatial approach. Three main streams of analysis may be distinguished:

- Ecosystem services assessment.
- Socio-territorial analysis.
- Populations' socio-economic features and vulnerabilities.

#### 2.2.1.1 Ecosystem services assessment

This research focuses on three urban ecosystem services which are considered quite relevant in the context of Brussels and Milan metropolitan areas: carbon storage, runoff retention and urban cooling.

The first is an essential element of climate change mitigation strategies. In particular, the 2050 European target of climate neutrality necessarily raises the issue of land use change and urban forestation, next to the enormous challenges linked to consumptions, transportation, energy, housing and to all the other main causes of GHGs emissions. Carbon storage indicates the amount of carbon currently stored in the landscape. Terrestrial ecosystems store carbon in wood, other biomass, and soil, keeping CO2 out of the atmosphere. Many ecological systems (e.g., young, and not already mature forests) continuously accumulate carbon and hence sequestrate CO2 from the atmosphere. Land use changes (afforestation, reforestation, changes in agricultural practices) may lead to carbon sequestration and thus contribute to curb climate change.

The other ecosystem services taken in consideration – i.e., runoff retention and urban cooling– are regulating services that are part of climate adaptation strategies. Run-off retention refers to the natural infrastructure capacity to reduce runoff production by slowing surface flows. Both Brussels and Milan are prone to floods, especially in light of the increasing likelihood of extreme rainfall events due to climate change. Green infrastructures and permeable soils represent fundamental nature-based solution to reduce hydrogeological risk. Urban cooling is a priority for Milan and Brussels, as both cities have undergone increasingly severe heat waves in the last decades. Vegetation can help reduce the urban heat island effect by providing shade and through evapotranspiration.

The assessment of these 3 ecosystem services is certainly not exhaustive of the numerous benefits provided by urban vegetation to citizens' wellbeing. The reduction of atmospheric particulate matters, for instance, is another fundamental UES for both Brussels and Milan. This study is limited to three ecosystem services because of evident time and resource limits. Yet the same approach may be applied to others in future research.

The values of the ecosystem services and their spatial distribution are assessed using InVest[18] models. Invest software models are chosen among a wide range of ecosystem services assessment tools because they are spatially explicit, include a section on urban ecosystem services and have a tiered approach to deal with data availability (Tallis & Polasky, 2009). The land use and land consumption input data are those of Copernicus Urban Atlas, which allow a comparison between the two metropolitan areas. Tree canopy cover is estimated for each LULC category[19]. The urban green space category is divided in 5 subcategories according to the tree canopy (from very low to very high). Data about the urban temperature are retrieved from ARPA (Milan) and IRM (Brussels).

#### 2.2.1.2 Socio-territorial analysis

The territorial features of the metropolitan area are studied analysing LULC and urban populations characteristics. Several indicators are taken in consideration. In particular,

[18] "InVEST is a suite of free, open-source software models used to map and value the goods and services from nature that sustain and fulfill human life." Retrieved at: https://naturalcapitalproject.stanford.edu/software/invest. See InVest user guide for further details on the models: https://storage.googleapis.com/releases.naturalcapitalproject.org/invest-userguide/latest/index.html

[19] The tree canopy cover has been calculated in collaboration with researchers of the Department of Earth and Environmental Science. The satellite images processing software is ENVI (https://www.ittvis.com/envi/)

following the main theoretical insights highlighted in chapter 1.2, indicators about mobility fluxes, density and land consumption.

A two-step procedure is adopted for each metropolitan area. First, a grouping analysis based on the values of three standardised indicators in each census sector – i.e., soil imperviousness, population density and outward commuting - is performed with the ArcGIS Grouping Analysis tool. The grouping analysis create a predefined number of groups based on the similarities of the features within the groups and on the differences between the groups. After a series of trials, five groups are created in each metropolitan area. Four groups have clear territorial characteristics and are interpreted as in tab. 2.1[20] :

| | **Soil imperviousness** | **Population density** | **Outward commuting** |
|---|---|---|---|
| **Urban** | High | High | Very low |
| **Suburban** | High | High | High |
| **Highly dense urban** | Very high | Very high | Very low |
| **Periurban** | Low | Low | Very high |
| **Other** | Mid-Low | Mid-Low | Mid-Low |

*Table 2.1 Grouping analysis output and territorial subdivision.*

Afterwards, in the second step, the output of the grouping analysis is refined. Semi-rural and industrial areas are identified where the density of land used respectively for agriculture and industrial activities is very high. Furthermore, the sections lying mostly on regional and

[20] See annex A for the detailed results of the Grouping analysis

provincial natural reserves are identified as protected areas. Finally, the most evident outliers are corrected in light of the classification of their neighbouring groups.

This procedure allows mapping the metropolitan areas according to their essential territorial features. Although it oversimplifies the complexity of the metropolitan dynamics, it provides a clear idea of the territorial composition of the metropolitan area.

#### 2.2.1.3 Urban populations: metropolitan socio-economic characteristics and vulnerabilities

The analysis of ecological functions and territorial features is accompanied by the study of the spatial distribution of some populations' characteristics. The research focuses on some elements of vulnerability that are related with the provision of ecosystem services and interfere with the capacity to cope with extreme events (i.e., heatwaves, floods).

In particular, the research highlights demographic and socio-economic features. Young and elderly people are those who suffer the most, not only from heat waves, but also from respiratory diseases connected to air pollution. The presence of green infrastructures in the proximity of the living place is even more essential in light of the reduced motility of young and elderly citizens.

From a socio-economic point of view, an index of social vulnerability is developed at census track level, considering data about income, nationality, education, employment, housing conditions[21]. Not only are these indicators related to the economic capacity of the resident populations but also provide information about the housing conditions, and hence the everyday material conditions of living. Citizens who live in overcrowded houses, who are less likely to afford air conditioning, to go on holiday in summertime, or to own a secondary home, necessarily demand good quality public spaces and green infrastructures. It is a matter of distributive environmental justice.

The social vulnerability index is the result of a PCA analysis performed on standardised census indicators[22]. An overall value of social vulnerability is attributed to each census track.

[21] The indicators slightly differ in the two metropolitan areas, according to the availability of data. Furthermore, the indicators are chosen in light of the explained variance, after some PCA trials. In Milan, the following indicators are finally elaborated: size of the dwelling, rate of foreigner population, education level. In Brussels: education level, unemployment rate, rate of foreigners coming from poor countries, income level (rate of people in the first income decile), number of rooms per person in each household.

[22] See annex B for the PCA results

At the same time, beyond the current distribution of urban populations and green spaces, it is important to focus on the processes of greening and urban regeneration. In fact, green gentrification against the context of urban regeneration is a growing phenomenon in Europe and contribute to expel local populations to more peripherical or marginal areas. This thesis does not study in detail the long-term gentrifying processes related to urban greening. However, the interviews to policy makers touch upon the issue, looking at the processes of greening from the stakeholders' perspective (see next paragraph).

#### 2.2.1.4 Combining diverse spatial data

Ecosystem, territorial and socio-economic data are then combined. The carbon storage ecosystem service is read under a territorial perspective highlighting the differences between different metropolitan layers with the ArcGis zonal statistics tool.

For the regulating services whose benefits are spatially circumscribed, the ecological functions are read in parallel to local populations' features. The level of hydrogeological risk, population density and social vulnerability are strictly linked to the soil capacity of retention. Demographic features and social vulnerability are essential information to comprehend the necessity for green infrastructures for urban cooling. In some cases, ArcGis Raster calculations are implemented to combine different maps, while in other the maps are just visually compared.

This integrated spatial analysis aims to provide a holistic territorial approach to ecosystem services assessment, by contextualising the ecological functions and services in the metropolitan social and urban dynamics. Being quantitative and at a large metropolitan scale, it does not delve into the complexity of local societal processes.

On the contrary, the primary analysis described in the next paragraph elaborates on the political articulation of the ecosystem services, focusing on the main actors involved in planning and policymaking. However, this thesis does not envisage a participated assessment of ecosystem services value and surely the final output would be improved by further qualitative and participative research on more specific case studies.

### 2.2.2 Analysis of primary data and documents

The second part of the research starts from a general review of essential historical information on the development of parks and green spaces in the cities and in the metropolitan areas. A

literature and document review on the evolution of planning instruments related to parks and greening helps introduce the contemporary landscape of green governance in the two contexts.

The primary analysis then consists in semi-structured interviews and direct observations. Eighteen interviews are carried out in Milan and Brussels. The interviewees are selected in base of their influence on green management and planning. The selection of the interviewees starts from a preliminary inquiry on planning documents and on the general structure of the green governance. After the first interviews a snow-ball effect is generated, establishing networks, and gaining information about new potential informants. The interviews follow predefined flexible structures which vary in base of the stakeholders.

For the Milan's case, park managers and directors, executives of the municipal green and planning departments, and a Metropolitan City councilor are chosen. Executives from diverse regional agencies – the management and planning sector of Bruxelles Environnement, the planning and urban regeneration sectors at Perspective Bruxelles – and a municipal councilor from Bruxelles Ville are the respondents in Brussels[23].

The interviews are done in parallel to the analysis of planning documents. On the on hand, interviewees often advise the consultation of planning documents; on the other hand, they are asked to delve into concepts and ideas that are omitted or not fully explained on official documents.

The interviews aim to shed light on green governance dynamics, in order to comprehend how different actors involved in green management and planning value the green space and the role they have in shaping the decision-making process on green planning and management. Overall, the main topics of the conversations are:

- Ecosystem services definition, conceptualisation, and implementation.
- Planning of urban green spaces: legislative tools and guiding principles.
- Management, maintenance, and funding: criteria, economic capacity, conflicts between stakeholders.
- Role of the green space for the district, the city, and the metropolitan area.

The questions on the ecosystem services aim to understand whether the stakeholders know the concept and their opinion about the possibilities of implementing it in green planning and management. The ambit of planning includes not only the description of the existing planning

[23] See annex C for a complete list of the interviewees. Unfortunately, the interviews in Brussels have been limited by the outburst of the Covid-19 related restrictions and have been carried out on Skype.

tools, but also a deeper layer of analysis on the actors' criteria and priorities in green planning. This is strictly linked to the approach towards urban sustainability (e.g., market, or eco-oriented[24]) and to the way it reflects on greening.

Similarly, management, maintenance, and funding are essential aspects for defining the quality of green space. The selection of vegetal species and the economic, but also ecological (in terms of know-how) capacity of maintenance inevitably affect the green spaces and their provision of ecosystem services. The management structure is responsible for these delicate issues. The interviews with park managers therefore entail questions about citizens' participation and, more generally, the decision-making process behind the organisation of ordinary and extraordinary activities. Public administrators are asked to explain the functioning of public green maintenance mechanisms (e.g., contracted out work, direct maintenance).

Finally, the role of the green space at diverse spatial scales (from the neighbourhood to the metropolitan area) helps comprehending the actors' vision on the role of the green spaces against the context of the metropolitan area: the attention to local, urban and metropolitan dynamics in park management and planning.

The interviews are recorded, transcribed and analysed with the assistance of the NVivo software package, namely for clustering and grouping the main issues. The final considerations are drawn by combining the output of the spatial analysis with the information gathered with the interviews. The principal insights and recommendations derived from the first part of the research are read in relation to the actors' attitudes towards greening and to the main political tendencies.

### 2.2.3 Milan and Brussels metropolitan areas

The Copernicus Urban Atlas Functional Urban Areas (FUAs) of Milan and Brussels represent the study area. Among the numerous attempts to measure the European metropolitan areas, Copernicus FUAs are chosen as they are built on the same functional (e.g., commuting) and morphological (e.g., building continuity) criteria and guarantee a solid degree of comparability (see ch.1.2 and Dijkstra & Poelman, 2012 for further details).

[24] see chapter 1.3

The metropolitan area of Milan occupies an area of roughly 3,766 km$^2$ [25]. It comprises the metropolitan city of Milan and significant portions of the Lombardy provinces of Lodi (including the provincial capital), Pavia, Cremona, Bergamo, Monza (including the provincial capital), Lecco, Como and Varese. The total population of the area is approximately 5 million.

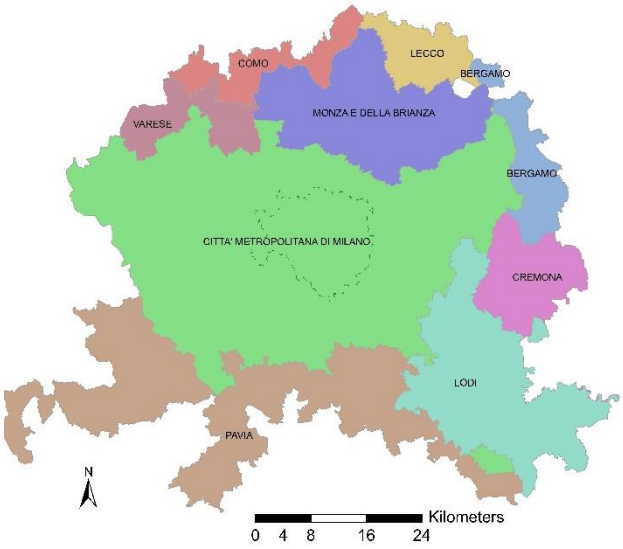



*Fig. 2.1 Metropolitan area of Milan (Copernicus Urban Atlas FUA) with provinces. Source: author's elaboration on Lombardy geoportal and Copernicus Urban Atlas data*

The metropolitan area of Brussels is extended on approximately 3,265 km$^2$ and crosses all the Belgian regions: the 19 municipalities of the Bruxelles Capital Region (BCR); part of the provinces of Anvers, Flemish Brabant, Eastern Flanders in the Flanders region; Hainaut, Liege, Namur and Wallon Brabant in the Wallone region. The population is around 2,800,000 people.

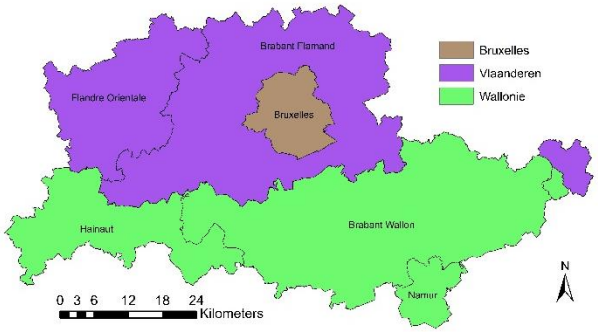



*Fig. 2.2 Metropolitan area of Brussels (Copernicus Urban Atlas FUA) with regions and provinces. Source: author's elaboration on Belgian geoportal and Copernicus Urban Atlas data*

[25] This study does not include the small portion of the FUA which is located in Piedmont (part of Novara's province) because of data uniformity reason.

Milan and Brussels are both dynamic and attractive cities with increasing populations, which face similar challenges: post-industrial economic development and increasing inequalities, uncontrolled tertiarization and unaffordable rents, traffic congestion due to intense commuting, air pollution, heatwaves, floods and climate change related issues.

Furthermore, both the cities have recently put significant efforts on urban sustainability. Milan, for instance, is active in both the 100 resilient cities and C40 international networks (Milan), while Brussels, namely through Bruxelles Environnement, has developed several projects on the urban nature (e.g., Plan Nature) and is characterised by a strongly progressive and green political landscape[26].

The comparison intends to shed some light on different approaches towards urban greening in two European contexts that share common socio-economic and political challenges, but also differ from a territorial and historical viewpoint. Look at two different contexts may facilitate the comprehension of local specificities (in opposition to each other) and highlight common issues. The role of the historical, institutional, and political influences on the articulation and provision of ecosystem services is more easily understandable by means of comparison.

[26] Ecolo, the green party, was the second party in the last regional elections with almost 20% of the total votes and is the leading party in many municipalities. Moreover, several grassroots movements are committed in environmental issues. The Fridayforfuture demonstrations, for instance, gathered tens of thousand pupils every week in 2019.

# 3 The distribution of urban green spaces and ecosystem services in Milan and Brussels metropolitan areas

Section 3 gathers the results of the spatial analyses on the distribution of three ecosystem services in the metropolitan areas of Milan (chapter 3.1) and Brussels (3.2). After highlighting the main territorial features of the metropolitan areas, three ecosystem services are taken in consideration: carbon storage, water retention and heat mitigation. The values of the ecosystem services are read in relation to the socio-territorial characteristics of the metropolitan areas. Finally, chapter 3.3 draws some conclusions on the results presented in the previous chapters.

## 3.1 Three ecosystem services in the metropolitan area of Milan

### 3.1.1 Milan metropolitan area: essential territorial features

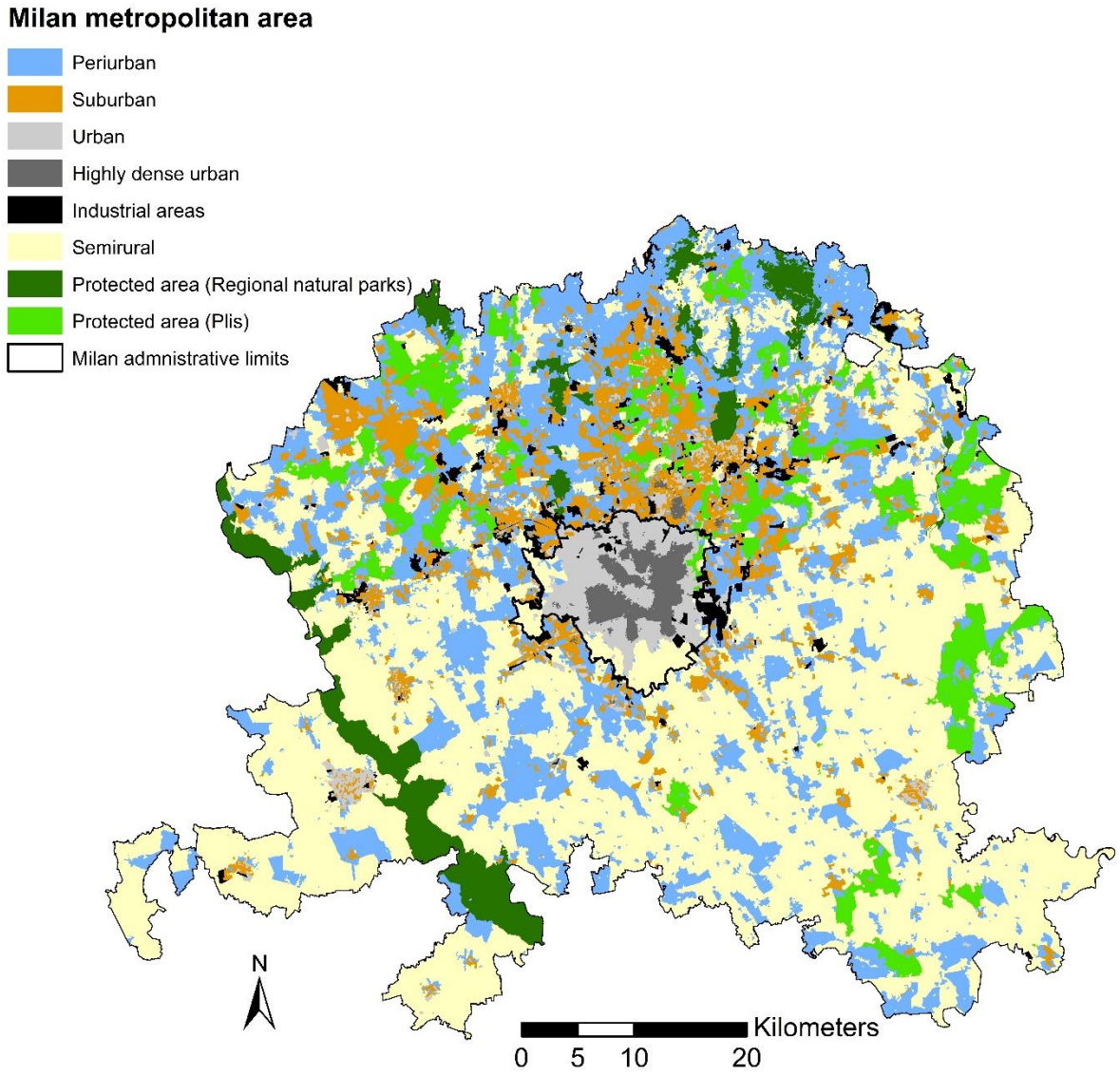



*Fig. .3.1 Metropolitan area of Milan with territorial subdivisions. Data source: Author's elaboration on Urban Atlas, Dusaf, Census data.*
*See § 2.2.1 for the methodological details*

The map in fig. 3.1 shows a territorial subdivision of the metropolitan area of Milan. The metropolitan area includes diverse urban poles, as the influence of Milan has expanded to other

historically relevant towns, such as Lodi, Vigevano and Monza, and has pushed the growth of new densely dwelled urban centres (i.e., Sesto San Giovanni, Cinisello Balsamo, Rho).

The urban development around the city of Milan follows clear trajectories. On the one hand, continuous suburban and sprawled urban fragmented dwellings prevail north of Milan, where the 20$^{th}$ cent. industrial and economic development has favoured a massive urbanisation. On the other hand, semi-rural areas, with few interspersed peri-urban dwellings and suburban villages characterise the South.

Milan is by far the main node of the mobility fluxes, attracting several city-users, commuters, and tourists. However, also other cities in the metropolitan area – e.g., Lodi and Vigevano – have incoming commuters from the neighbour municipalities, besides being well-connected to Milan.

Less than 30% of the metropolitan population lives in the city of Milan. The population of the city resides namely in the belt between the city centre and the periphery, out of the 16$^{th}$ century Spanish walls, which today represent the second urban ring. The most peripherical areas comprise rather densely populated popular neighbourhoods, as well as parks and rural areas namely towards the South and the West borders.

The rate of public green per capita has been growing in the city, reaching almost 18 m$^2$ per inhabitant. Except for few historical parks in the city centre, the main urban green spaces in the city are located in peripherical areas. The metropolitan area includes 17 local parks with intermunicipal interest (PLIS[27]) and 8 regional natural parks[28]. The most relevant forests are located in the proximity of the rivers Ticino, Adda, Lambro and towards the northern border of the metropolitan area.

[27] *Parchi Locali di Interesse Sovracomunale*

[28] We do not consider here the regional national parks (e.g. Parco Agricolo Sud), which represent larger areas (including also urbanised places).

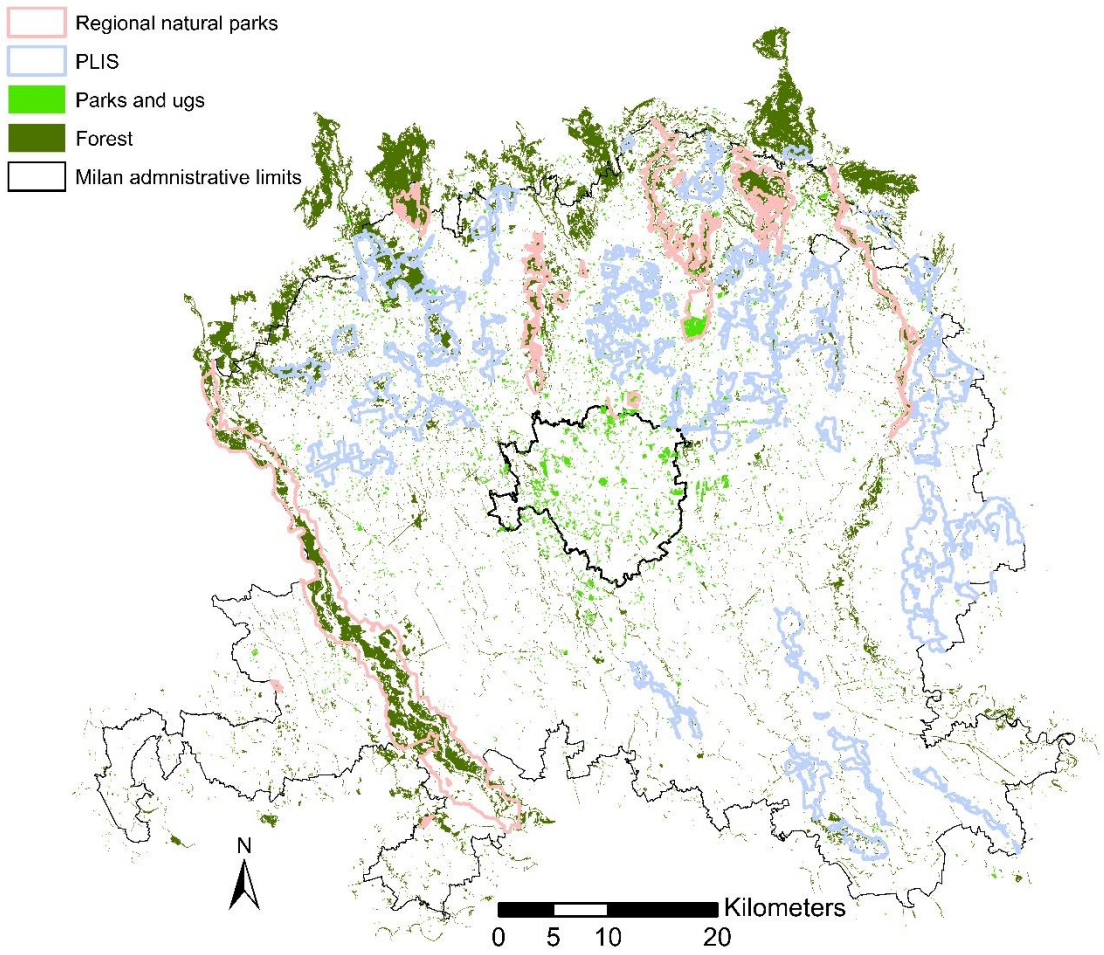



*Fig. 3.2. Urban green spaces, forests, regional and natural parks and PLIS in Milan metropolitan area. Data source: author's elaboration on Lombardy geoportal and Dusaf data*

### 3.1.2 Carbon storage

The estimated total value of carbon stored in terrestrial ecosystems is equal to 20,313,408 tons in Milan metro area. Semi-rural areas, which covers most of the metropolitan territory, stock 11,651,597 t of carbon, more than half of the total value. Periurban areas also play a pivotal role, reaching a value of 3,831,692 t. On the contrary, the contribution of urban and suburban areas is rather insignificant if put in relation to the total amount of the metropolitan area (see table 3.1). Interestingly the urban areas are more effective than the suburban ones in terms of relative carbon storage. This is due, on the one hand, to the presence of several green spaces in the periphery of Milan, and on the other, to the lack of green infrastructures in the suburban villages around Milan.

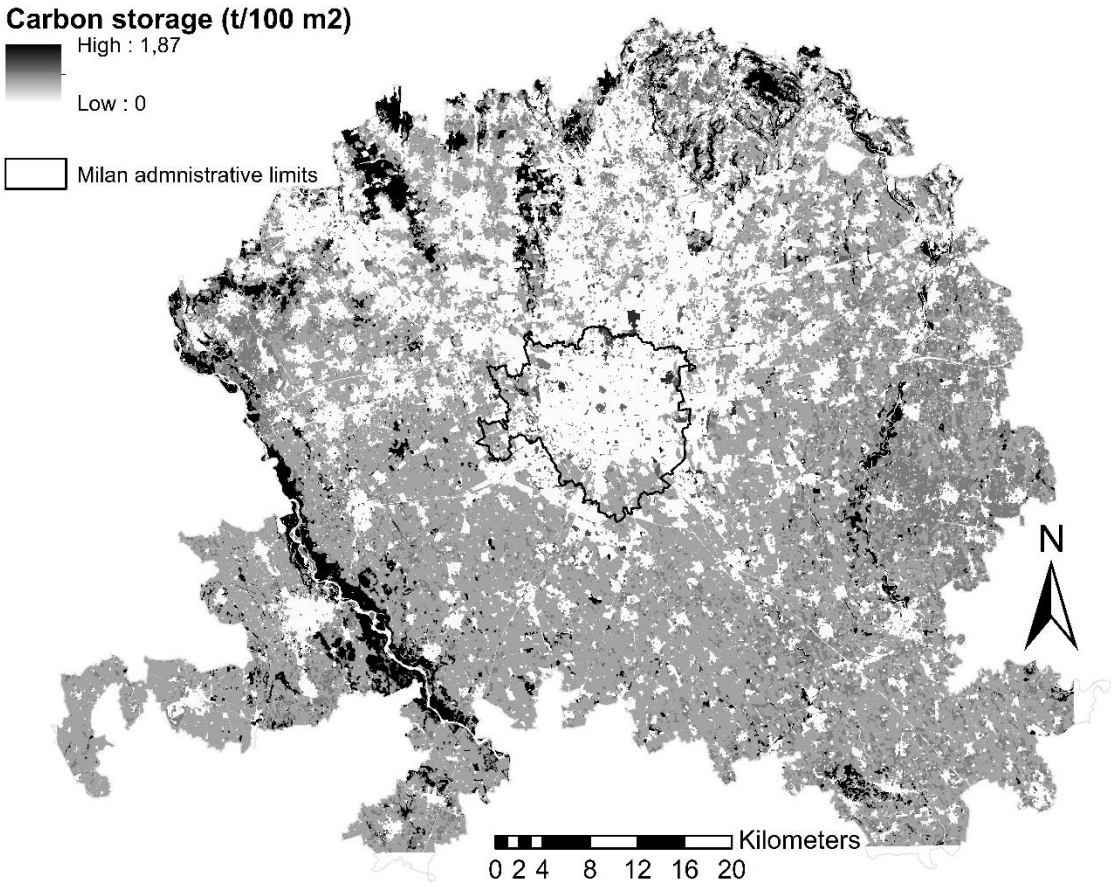



*Fig. 3.3. Carbon storage in Milan metropolitan area. Data source: author's elaboration on Copernicus urban atlas land use data*

| TERRITORIAL AREA | SIZE (h) | CARBON STORAGE (t) | CARBON STORAGE (t/h) |
|---|---|---|---|
| Semirural | 175,988.25 | 11,651,597 | 66.21 |
| Periurban | 92,147.72 | 3,831,692 | 41.58 |
| Urban | 15,586.78 | 245,969 | 15.78 |
| Suburban | 34,473.06 | 250,980 | 7.28 |
| Highly dense urban areas | 4,887.33 | 19,733 | 4.04 |

*Table 3.1. Territorial areas, size and carbon storage in Milan metropolitan area. See paragraphs 2.2.1.2 and 3.1.1 for further information on the territorial subdivision.*

If we look more closely to the green spaces, we notice that the regional and metropolitan protected green spaces (i.e., regional natural parks and PLIS), which comprise a large rate of the metropolitan forests, represent important carbon sinks. The green network of the PLIS contribute for approximately 1,544,535 t of carbon storage and the eight regional natural parks for 2,100,095 t. The natural Park of the Ticino Valley stocks alone 1,307,328 t of carbon. The

contribution of the urban parks, in comparison, is negligible. The amount of carbon storage guaranteed by all the parks located within the city of Milan is approximately 93,041 t.

In sum, this ecosystem service is provided mainly by agricultural areas and by large forests in the metropolitan area of Milan. In order to understand what kind of planning interventions could potentially improve carbon storage capacity, let us consider three ideal scenarios of land use change:

1) Afforestation of the unused agricultural land.

2) Partial afforestation of urban parks (10% increase of tree canopy in each park).

3) Introduction of conservative agricultural practices.

Unused agricultural land are those areas classified as agricultural, without a current productive use[29]. More than 1 million tons of carbon would be sequestrated if every inch of this consistent portion of agricultural land was afforested. Although it is an ideal scenario that certainly overrates the potential of the land use change[30], this figure remains astonishingly high, reaching more than 5% of the current total carbon storage capacity.

On the contrary, the scenario that prefigures an increase of tree canopy in every urban park (+10%) has a rather limited impact. Afforesting 10% of each park would be equal to approximately 57,000 t of carbon sequestrated, that is less than 0.3% of the total. The scenario contemplates just a reasonable growth of tree canopy in urban parks, insomuch as the recreational activities would not be impacted too much.

Finally, a transition of the existing farming activities towards conservative agriculture[31] would certainly improve the land capacity of carbon storage. If all the crops would convert to conservative agriculture practices (i.e., no till), approximately 1.2 million tons of carbon would be sequestrated.

These scenarios highlight the fundamental contribution of agricultural land to curb carbon emissions. The semirural areas around the city constitute precious carbon sinks that could potentially improve the magnitude of carbon storage and sequestration through feasible interventions. If we consider also the provisioning functions, which become fundamental

[29] SIARL data retrieved from http://www.geoportale.regione.lombardia.it/news/-/asset_publisher/80SRILUddraK/content/carta-uso-agricolo-dati-siarl-dal-2012-al-2019

[30] It would be impossible to afforest the entire unused agricultural land as it includes also walking paths and other functional areas.

[31] "Conservation Agriculture is a farming system that promotes minimum soil disturbance (i.e. no tillage), maintenance of a permanent soil cover, and diversification of plant species. It enhances biodiversity and natural biological processes above and below the ground surface, which contribute to increased water and nutrient use efficiency and to improved and sustained crop production." (http://www.fao.org/conservation-agriculture/en/)

against the context of the EU Farm to fork strategy (European Commission, 2020), the semi-rural places provide essential services in the metropolitan area and must therefore be valorised, sustaining the farmers and facilitating the transition towards more sustainable practice, such as conservative agriculture.

### 3.1.3 Runoff retention in Milan metropolitan area

Despite the absence of big rivers, the territory of Milan is rich of watercourses and hydric resources. Natural watercourses have been shaped since the Romans, who created a complex network of canals, brooks, and ditches, in order to engineeringly exploit the natural hydric abundance for public, domestic and agricultural uses. Watercourses have been modelled also for trade purposes since the Middle Ages, hence contributing to the economic and political rise of the city. Several waterways have been buried during the past two centuries, with the aim to build larger roads for terrestrial vehicles and to improve the hygienic conditions of an increasingly dense urban area.


*Fig. 3.4. Milan's hydrographic network: open-air watercourses (in blue), covered active watercourses (red), covered dried-up watercourses (green), internal circle of artificial canals (not existing anymore) (brown). Data source: Milano al quadrato (https://www.milanoalquadrato.com/2014/11/24/milano-quasi-come-venezia-alla-scoperta-di-una-citta-sullacqua/)*

Today's hydrographic system is a mix of open-air and covered rivers and streams. The territory is prone to frequent floods, especially in the areas North of Milan, where the permeability of the soil has been deeply compromised by the uncontrolled urbanisation processes that

characterised the second post-war development. The Seveso is responsible for frequent floods in densely populated areas, such as Paderno Dugnano, Bresso and the district of Niguarda in the municipality of Milan. Similarly, the river Lambro puts at risk areas of Monza, Cologno Monzese and some eastern districts of Milan.

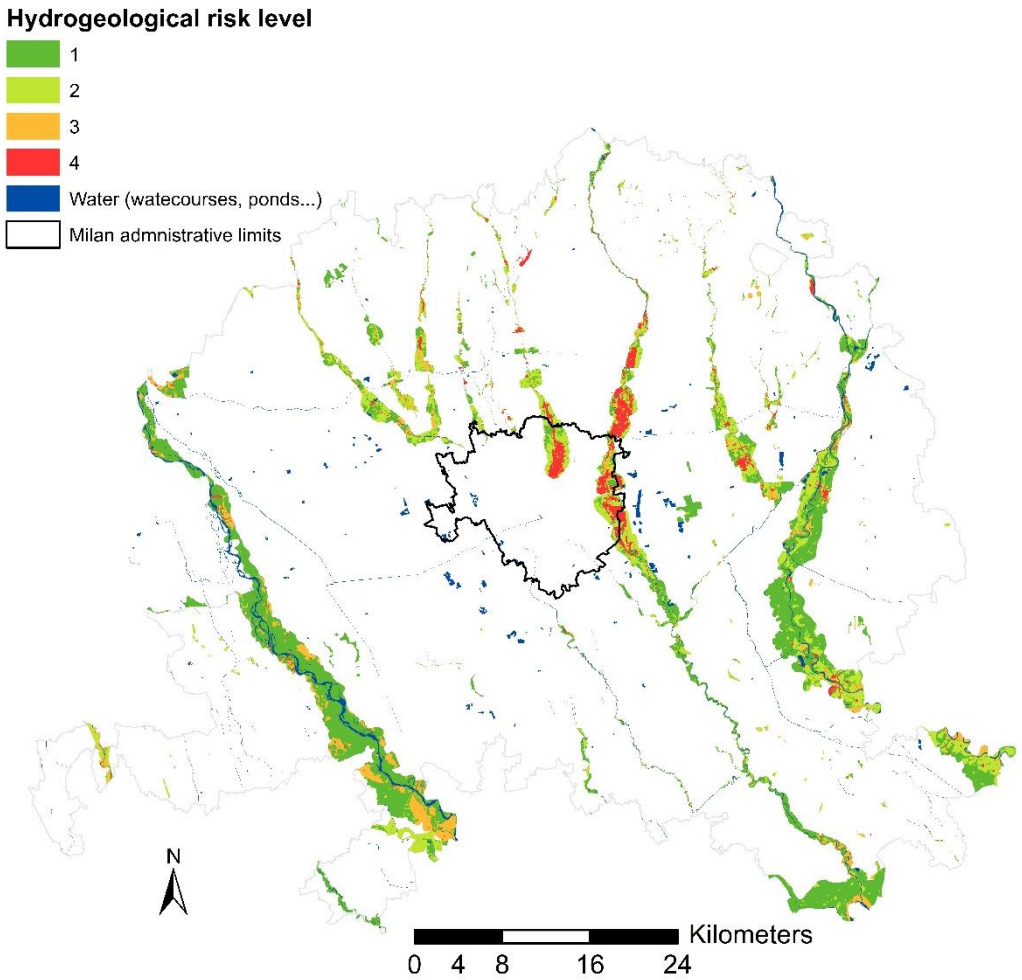



*Fig. 3.5. Hydrogeological risk level (classes from 1 low to 4 very high) and watercourses. Data sources: Author's elaboration on Lombardy geoportal data*

The increasing likely of extreme rainfall events, which is one of the most visible consequences of climate change, will exacerbate the risk of floods in an area which has already made vulnerable by the high impact of human activities. Against this context, the urban green space plays a fundamental role. Understanding the land capacity of water retention in relation to the risk of floods may help the development of adapting nature-based solution in the most vulnerable places.

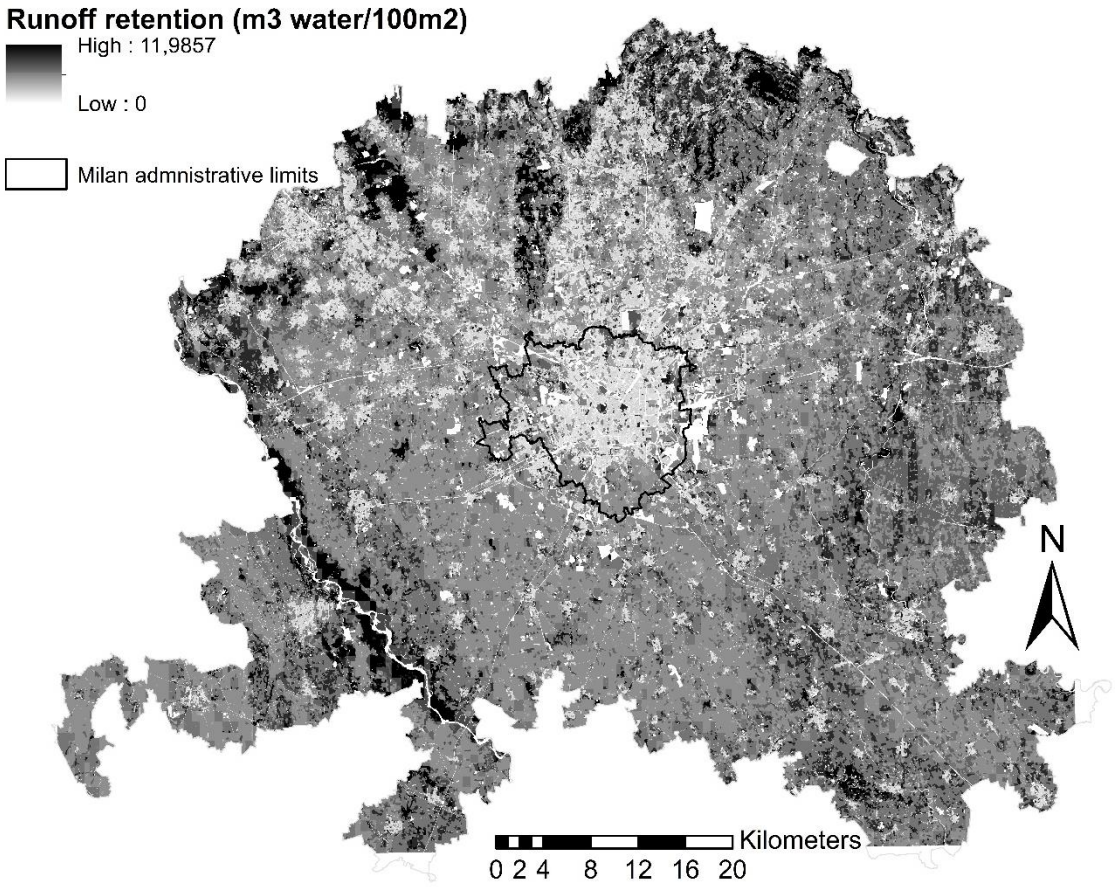



*Fig. 3.6. Run-off retention in Milan metropolitan area. Data source: Author's elaboration on Copernicus Urban Atlas data*

The maps in fig. 3.7 represents the ratio between flood risk - calculated as the product of the regional risk classes and population density – and land run-off retention in $m^3$ of water/100 $m^2$. The areas that register the highest value (in red) are those in need of green infrastructures, where the risk is exacerbated by extreme soil sealing.

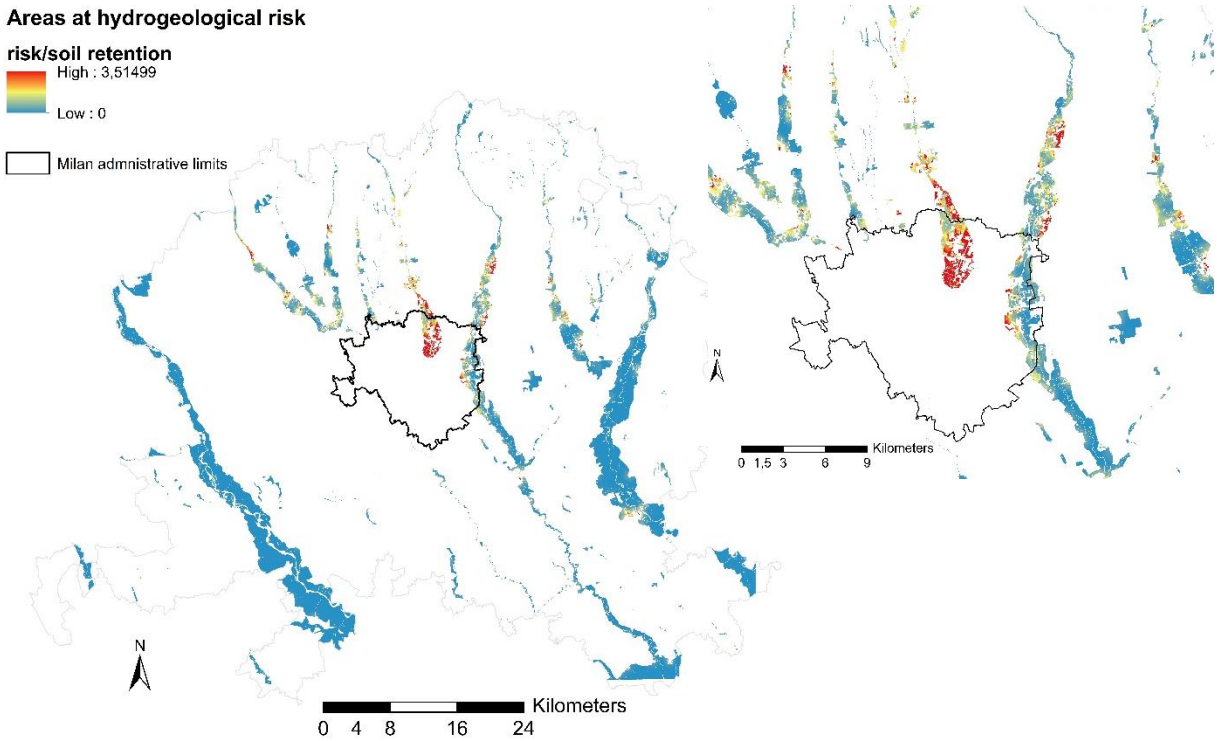



*Fig.3.7. Areas at hydrogeological risk in Milan metropolitan area (on the right the zoom on the city): risk level (regional risk classes multiplied by a coefficient of population density) over capacity of soil retention. Data source: Author's elaboration on Copernicus Urban Atlas, Lombardy geoportal and Census data.*

Looking at the maps in fig. 3.7, it is clear that the areas North of the city demand particular interventions in terms of green infrastructures. The Northern districts of the city and the neighbour municipalities register a rate of land consumption between 50% and 70%. Whilst the drastic land use changes that have brought to this situation of soil degradation occurred between the 60s and the end of the 00s, the rate of soil sealing is still augmenting in many municipalities (Munafò, 2020).

In such urbanised areas, the room for manoeuvre is limited. Yet, punctual interventions on small scale nature-based solution (i.e., shrubs, street trees, green roofs) would improve the existing drainage system, which is based on traditional hydraulic engineering practices (i.e., artificial canals and basins) (Masseroni et al., 2017). A good knowledge on the drainage systems and on the right ecological species, which could potentially tolerate the stress of growing in an urban environment and guarantee water retention, would favour a significant improvement of the current situation. The map in fig. 3.7 intends to precisely locate the areas more needy of this kind of interventions.

### 3.1.4 Heat mitigation in Milan metropolitan area

Highly urbanised areas are increasingly prone to extreme weather conditions due to climate change. Cities are warmer than the surrounding areas, especially at night, because of the urban heat island effect caused by the lower albedo of sealed surfaces, the lack of green spaces and the morphology of the buildings. Continuous and intense periods of heat stress, exacerbated by the urban heat island effect, are recurrent phenomena which put at risk several cities across the world. Heatwaves increase the mortality and the morbidity caused by cardiovascular, cerebrovascular, and respiratory conditions (Depietri et al., 2013).

The combination of hot temperatures, high humidity and air pollution creates the conditions for severe stresses in Milan during summertime (Ronchi, Salata, & Arcidiacono, 2020). In the course of the heatwave that hit Europe between June and August 2003, 559 excess deaths were registered in Milan, 23% more than the reference period (Michelozzi et al., 2005). Elderly people are particularly vulnerable. The mortality among citizens over 75 increased by 40 % in Milan throughout the 2003 summer (Ibid.). The socio-economic conditions also affect the susceptibility and the adapting capacities of the urban population (Wilhelmi & Hayden, 2010).

The following maps show the estimated average temperature anomaly in the metropolitan area and the heat mitigation capacity index. The former refers to summertime night temperatures and is benchmarked against the average rural temperature. The warmest districts are located in central and north-eastern Milan and in the municipalities to the north of the town (i.e., Sesto San Giovanni, Cinisello Balsamo, Cologno Monzese).

The heat mitigation capacity index measures the cooling effect of the combination of albedo, evapotranspiration and shade. It is therefore a proxy measure for the urban cooling ecosystem service. Parks, forests and agricultural areas are visibly the coolest areas.

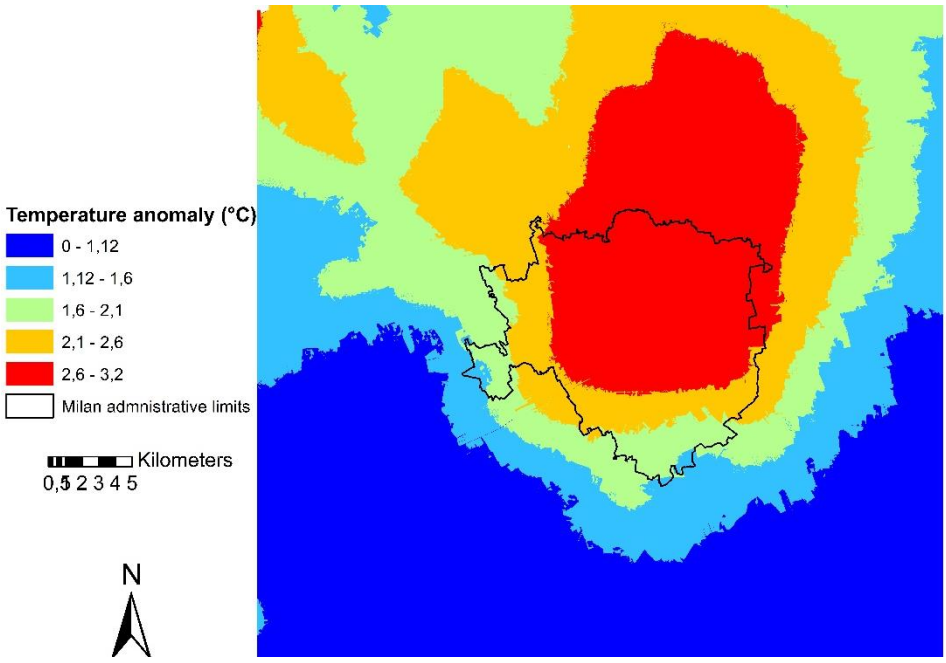



*Fig. 3.8 Night-time temperature anomaly in Milan and surroundings. Source: author's elaboration on Copernicus Urban Atlas*

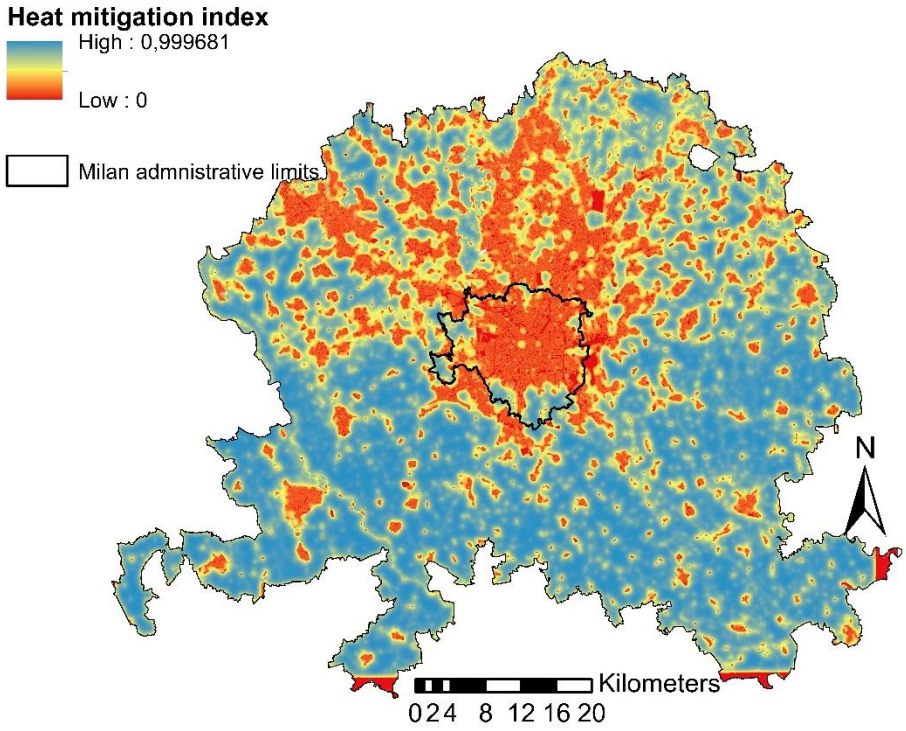



*Fig. 3.9 Heat mitigation index in Milan metropolitan area. Source: author's elaboration*

Let us consider the intensity of the cooling capacity in the inhabited census tracks where the temperature anomaly is very high (>2.6 C°). This indicator tells something about the green infrastructures for heat reduction in the warmest places: where the value of cooling capacity is

low, those areas do not have significant green spaces in close proximity. The value is very low in the belt around the city centre of Milan and in the municipalities of Novate, Sesto San Giovanni, Monza, Lissone, Cologno Monzese (fig. 3.10).

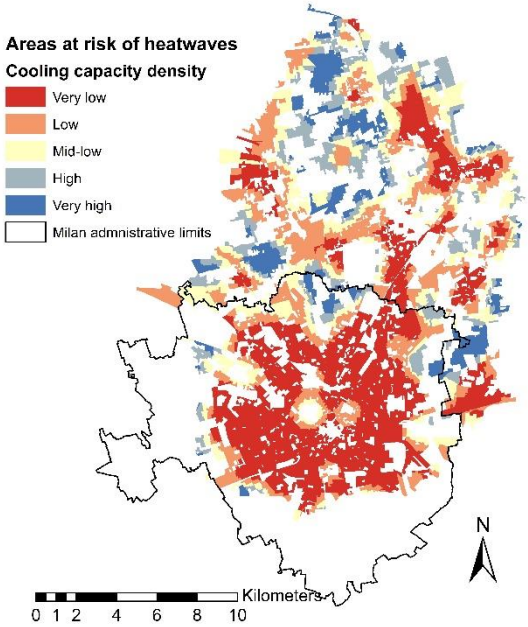
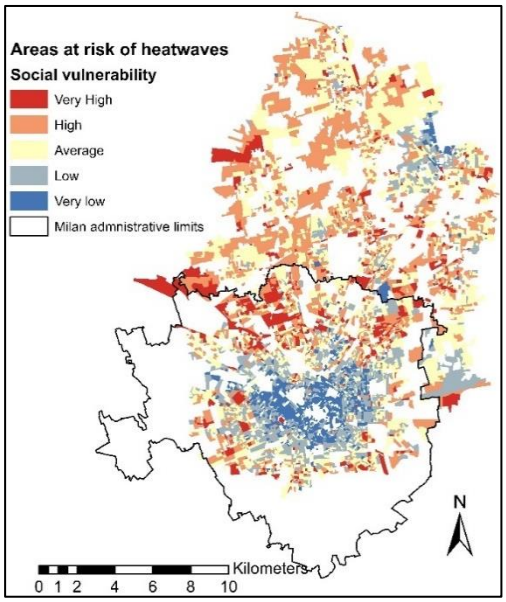



*Fig. 3.10 Cooling capacity density in areas at risk of heatwaves. Source: author's elaboration*



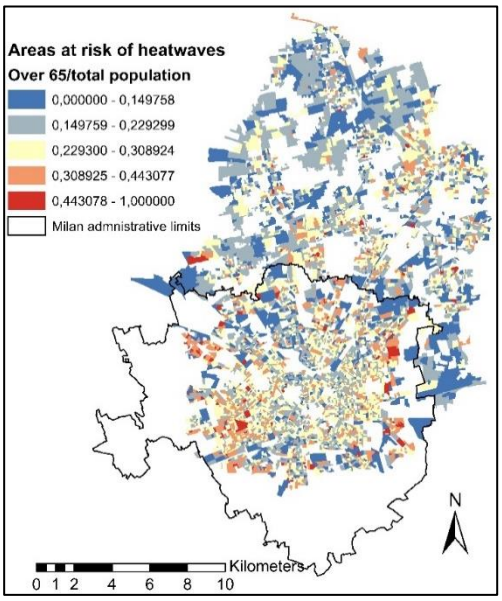




*Fig. 3.11 Social vulnerability and rate of elderly people in areas at risk of heatwaves. Source: author's elaboration. See § 2.2.1 for the methodological details*

The maps of social vulnerability and of the rate of elderly people (fig.3.11) integrate the analysis with indicators on the residing population. Social vulnerability is high namely in the districts

north of Milan and in the confining municipalities. The function of suburban and periurban parks - i.e. Parco Nord, Parco Lambro - is then critical, as these green spaces guarantee heat mitigation in disadvantaged areas. Conversely, the rate of elderly people is higher in the central part of Milan and in the centre of the main municipalities north of the city (i.e., Sesto San Giovanni, Monza and Cologno Monzese). The lack of green in the proximity of the living space may therefore represent a health issue, both in Milan and in the surrounding suburban municipalities.

## 3.2 Three ecosystem services in the metropolitan area of Brussels

### 3.2.1 Brussels metropolitan area: essential territorial features

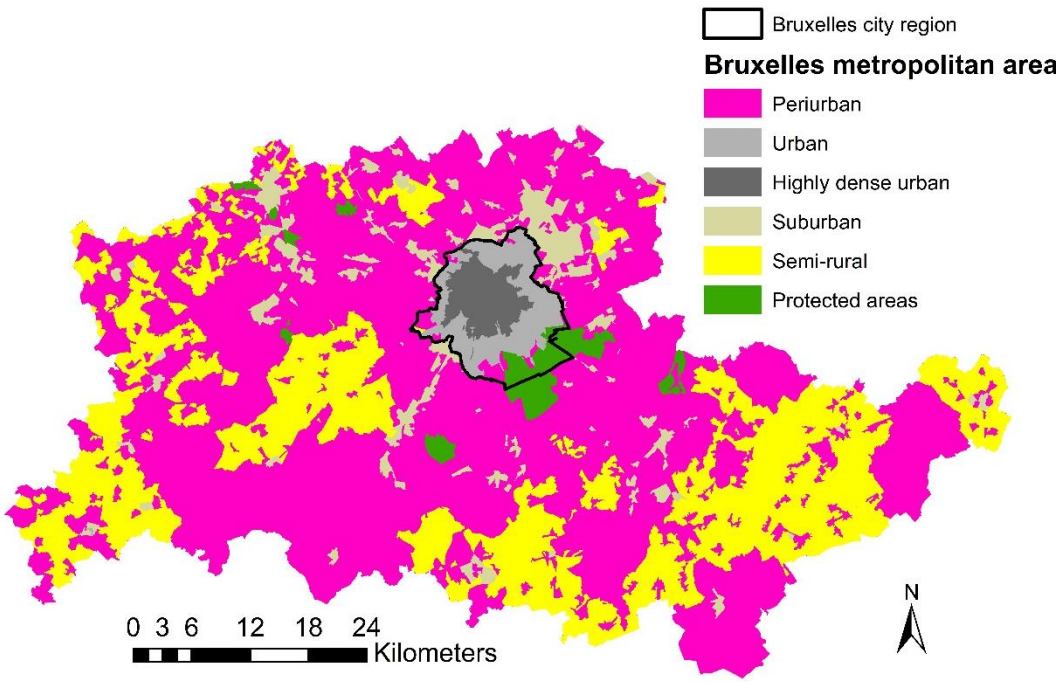



*Fig. 3.12. Metropolitan area of Brussels with territorial subdivisions. Data source: Author's elaboration on Urban Atlas, Census, Flemish and BCR geoportal data.*
*See § 2.2.1 for the methodological details*

The rate of population of the metropolitan area residing in the Brussels Capital Region (BRC) is approximately 45%. Within the BCR the demographic distribution is quite heterogeneous. The districts that surrounds the Canal – i.e., the municipalities of Anderlecht, Molenbeek, Bruxelles ville, St. Gilles, Forest – and around the city centre - i.e., Schaerbeek, St. Josse ten-Noode, part of Ixelles - are the most densely populated areas. The residential density is much lower in the Southern and Eastern areas of the BRC. These internal differences have deep historical roots. The areas around the canal that follow the North-East/South-West axis have long been densely populated by working class people, while the Southern and Western districts developed as middle-high class residential areas with parks, gardens and other amenities (Vandermotten, 2014).

After decades of population decline and emigration towards the suburban Flemish and Walloon confining municipalities, the BCR population has been growing since the mid-90s, due to an

outstanding rise of international immigration. However, the growth of periurban and suburban primary dwellings that gravitate around the city has not stopped. The Flemish and Walloon municipalities in the metropolitan area registered a solid trend of population growth in the past 20 years. Small towns such as Mechelen, Zaventem, Halle, Aalst have grown at rates between 10 and 30% in the period that runs from 2000 to 2020.

Looking at the map in fig. 3.12, we notice that beyond the northern border of the capital region, Vilvoorde, Mechelen and Zaventem constitute a dense suburban landscape in continuity with the city, including also essential infrastructures (the airport) as well as industrial areas. The remaining territory of the metropolitan area is mainly peri-urban with small villages interspersed with scattered dwellings. Semirural areas are predominant in the Pajottenland subregion (South-West) and in the Walloon south-east.

The BCR is characterised by the presence of several parks, some of which have considerable tree canopies. The urban parks are located mainly in the southern and western districts. Few historical parks are in the city centre, while the Domains Royal - which is not publicly accessible -, the Laeken Park and the Ossinghem Park constitute the main green spaces north of Brussels. The Sonian Wood (4,421 ha), that runs throughout the south-eastern edge of the BCR, the Flemish and the Walloon region, represents the largest forest in the metropolitan area. Several periurban forests and protected areas are located in the Flemish area (see map in fig. 3.13).

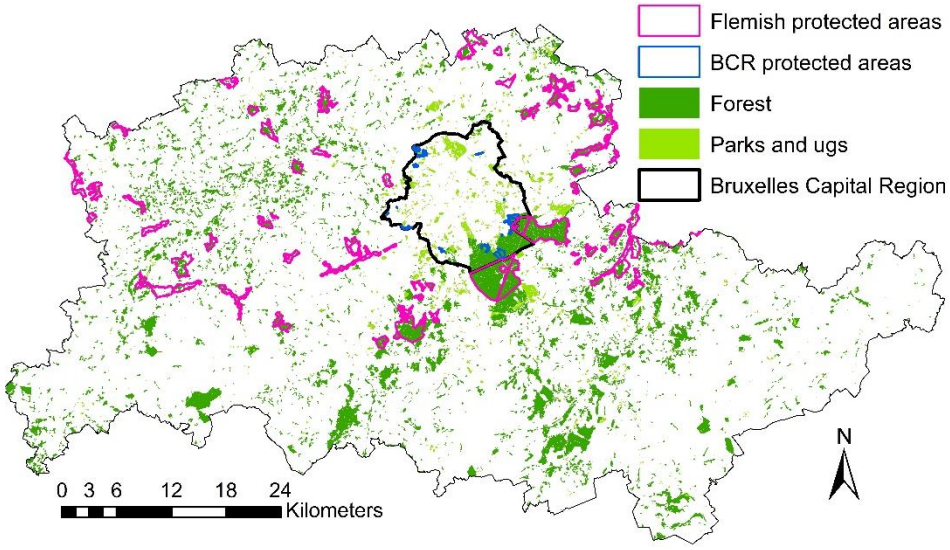



*Fig. 3.13 Urban green spaces, forests, natural parks in Brussels metropolitan area. Data source: author's elaboration on Copernicus Urban Atlas, Flemish Geoportal and BCR geoportal data*

### 3.2.2 Carbon storage

The terrestrial ecosystems in the metropolitan area contribute for approximately 20,400,000 t of carbon storage. In comparison, the value of this ecosystem service is considerably higher than Milan's score (62.7 t/h versus 54.1 t/h). Periurban forests and open spaces play a pivotal role, as periurban areas store almost 13 million t of carbon, slightly less than 2/3$^{rd}$ of the total. Periurban areas score the highest also in relative terms (65.6 t/h), slightly more than semirural areas (63.2). The low-density urban areas in the BCR also register a significant relative value, higher than the suburban towns (see tab.3.2).

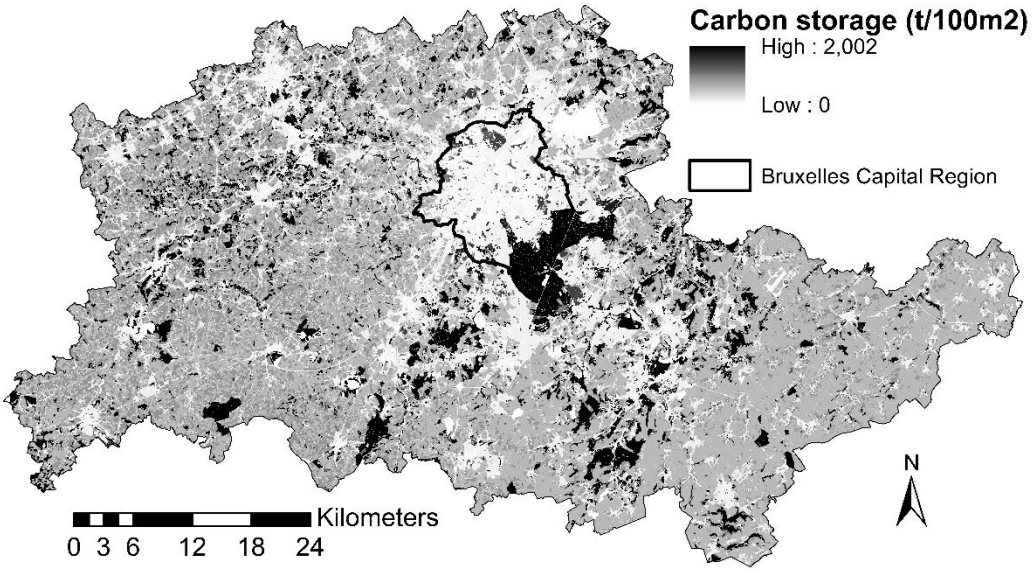



*Fig. 3.14. Carbon storage in Brussels metropolitan area. Data source: author's elaboration on Copernicus urban atlas*

| TERRITORIAL AREA | SIZE (h) | CARBON STORAGE (t) | CARBON STORAGE (t/h) |
|---|---|---|---|
| Periurban | 197,902.17 | 12,987,950 | 65.62 |
| Semirural | 90,169.40 | 5,704,583 | 63.26 |
| Urban | 8,291.00 | 232,370 | 28.03 |
| Suburban | 16,743.92 | 329,010 | 19.65 |
| Higlhy dense urban | 5,061.87 | 52,721 | 10.41 |

*Table 3.2 Territorial areas, size and carbon storage in Brussels metropolitan area.*

The Flemish protected areas contribute for approximately 1,326,378 tons of carbon storage, while BCR protected areas for 43,771 t. The Sonian Wood is the biggest carbon sink in the metropolitan area, storing more than 500,000 carbon tons.

Let us look at three possible scenarios of land use change, similar to the ones put forward in the previous chapter about Milan:

1) Afforestation of land without current use;

2) Partial afforestation of urban parks (10% increase of tree canopy in each park);

3) Introduction of conservative agricultural practices.

The first scenario prefigures the afforestation of the areas classified as "without current use" in the Urban Atlas land use and land cover data. These areas include patches that are not classifiable otherwise, which are quite heterogeneous and not always convertible to urban forest (highly urbanised areas undergoing regeneration processes). The scenario of afforestation is therefore just an approximation of the greening potential of the metropolitan area. However, it provides an idea of the potential carbon sequestration that would derive from urban and peri-urban afforestation. The scenario foresees approximately 162,015 t of sequestrated carbon.

The second scenario on the afforestation of parks (10% increase of tree canopy) results approximately in 257,934 t of carbon sequestration, which is a considerable figure in comparison to Milan's. Brussels, in fact, has numerous urban parks and therefore a considerable quantity of urban space available for forests.

Finally, the scenario on the conversion towards conservative agricultural practices is by far the most productive in terms of carbon storage, reaching a value of 2,387,149 t carbon sequestrated. In the case of Brussels metropolitan area two elements could be therefore underlined. First, the significance of the urban environment and of the parks within the city to mitigate climate change. Second, similarly to Milan, the function of the semi-rural areas and the essential services provided by agricultural land[32].

[32] On the agricultural transition see the study carried out by Brussels MetroLab (Decléve, Grulois, de Lestrange, Bortolotti, & Sanchez Trenado, 2020)

### 3.2.3 Runoff retention in Brussels metropolitan area

The territory of Brussels has always been rich of water, so much that even the name "Bruxelles" derives from the old Dutch Bruocsella, that means swamp dwelling. The historical development of the city has been heavily conditioned by the capacity to govern and utilise watercourses, in a similar way to the history of Milan. The Senne and its numerous affluents provided a fundamental way of communication, as well as the source of energy for the activity of the watermills since the Middle Ages. The Willebroek Canal immediately became the main waterway since its creation (16$^{th}$ century), guaranteeing a safe way of communication on the North-South axis. The industrial development of the city spread along the axis traced by the Canal, which, three centuries after its creation, was navigable from Charleroi to Antwerp (Bologna, 2017).

The growth of the industrial city brought about massive problems of water pollution, as well as hygienic and sanitary issues. The Senne and many of its affluences were hence covered towards the end of the 19$^{th}$ century as part of the grand urbanistic reforms of the period. Today, 35% of Brussels hydrographic system runs underground[33].

The Brussels Capital Region is prone to several floods in a vast portion of its territory (Beke, 2018). The areas more at risk are not only those in the proximity of the Canal (i.e., Molenbeek, Anderlecht, Bruxelles ville) but also Jette and Ganshoren in the North-West, Etterbeek, Ixelles and the valley of the Woluwe in the East. The map in fig. 3.15 shows that the risk is concentrated in the city, while the rest of the metropolitan area is less prone to hazardous floods.

[33] The BCR is working on the uncovering of watercourses and on the reconstruction of water ecosystems. See the *maillage bleu* document for further details (Davesne, De Villers, & Squilbin, 2017).

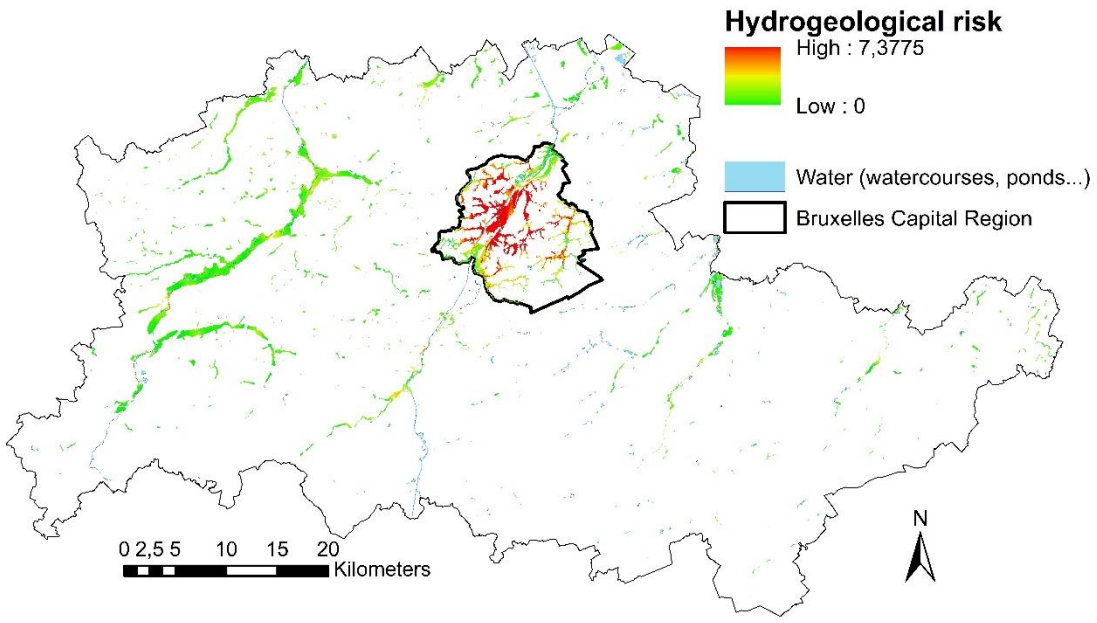



*Fig. 3.15. Areas at hydrogeological risk in Brussels metropolitan area: regional risk classes multiplied by a coefficient of population density. Data source: Author's elaboration on Flemish geoportal, BCR, Walloon geoportal and Census data.*

The soil capacity of runoff retention is rather low in the city centre and in the densely dwelled areas around the Canal, as well as in the municipality of Saint-Josse-ten-Noode, Saint-Gilles and Etterbeek (see map in fig. 3.16). These areas (in red on the map) are those where nature-based solutions for runoff retention are strictly necessary.

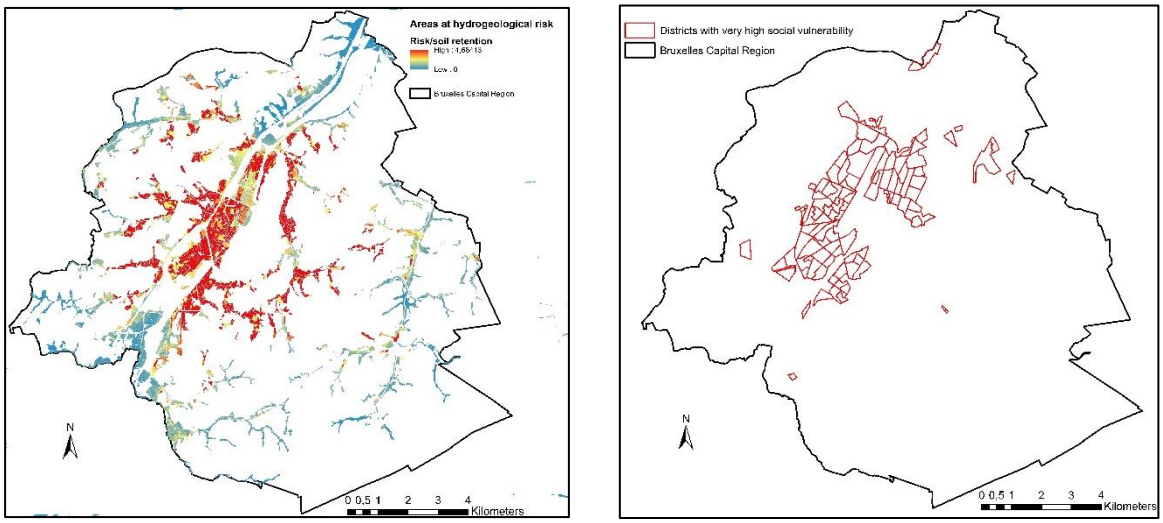



*Fig. 3.16 Areas at hydrogeological risk in Brussels Capital Region: risk level (regional risk classes multiplied by a coefficient of population density) over capacity of soil retention. Data source: Author's elaboration on Copernicus Urban Atlas, BCR geoportal and Census data. On the right: districts where social vulnerability results very high in BCR. Data source: author's elaboration on census data.*
*See § 2.2.1 for the methodological details*

The Canal area, which has been the industrial core and has always been among the poorest areas in the city, clearly lacks good quality public spaces and green infrastructures. The post-industrial development of the city has long disregarded densely dwelled districts, such as Cureghem, Anneessens, Birmingham, where the international immigration from Northern African and Middle Eastern countries has contributed to a massive population growth. There, the unemployment rate almost reaches 40% and the median income per capita is less than 16,000 euros, approximately half of the wealthiest areas in the city. The capacity to cope with floods and extreme events is low.

The risk of floods is therefore exacerbated by the disadvantaged socio-territorial conditions that have evolved throughout the past decades and centuries. The development of public green spaces and green infrastructures for runoff retention should hence be framed as issues of environmental justice and contextualised in the specific social milieu of the place with participated processes. Top-down technical interventions or big regeneration projects may easily be misunderstood by the local populations or may cause green gentrification leading to the expulsion of the local populations.

The Plan BKP (Perspective.brussels, 2019), recently edited by Perspective Bruxelles[34], aims to radically redesign the areas of the canal devolving particular attention to the public space and the ecosystem landscape, functions and services. It recognises the need for green infrastructures and puts forward participative processes for the design of some parks and public spaces (e.g., Heyvaert, Porte de Ninove). At the same time, the plan includes Tour and Taxis, a big regeneration project that will provide diverse accommodation (including social accommodation), offices for the tertiary sector, venues for conferences and events, and green spaces.

The Canal area is hence undergoing deep renovation processes that will radically change its social and ecological features. In the next sector the current governance approach to green spaces will be discussed more in detail. For now, let us analyse the last ES in Brussels.

### 3.2.4 Heat mitigation in Brussels metropolitan area

It has been estimated that the annual average temperature will grow by approximately 1.6° C in Brussels by 2050 (Hamdi et. al, 2015). In July 2019, the highest temperature peak ever

[34] BCR planning agency

recorded, 39.7° C, was registered in Uccle (BCR). In fact, heat waves are a major risk in Brussels, where the increasingly hot weather is made even worse by the urban heat island effect. The 2019 heat wave heavily hit the city of Brussels, as the deaths raised by 35%[35] between 19th and 27th July[36].

The warmest places in the metropolitan area are located on the axis that cut the Brussels Capital Region from North-East to South-West, starting from the Flemish municipalities of Machelen, Zaventem and Kraainem and crossing the BCR down to to Anderlecht and Forest (see fig. 3.17). In this area (red on the map) the night-time temperature anomaly (in relation to rural temperature) is more than 2.7° C.

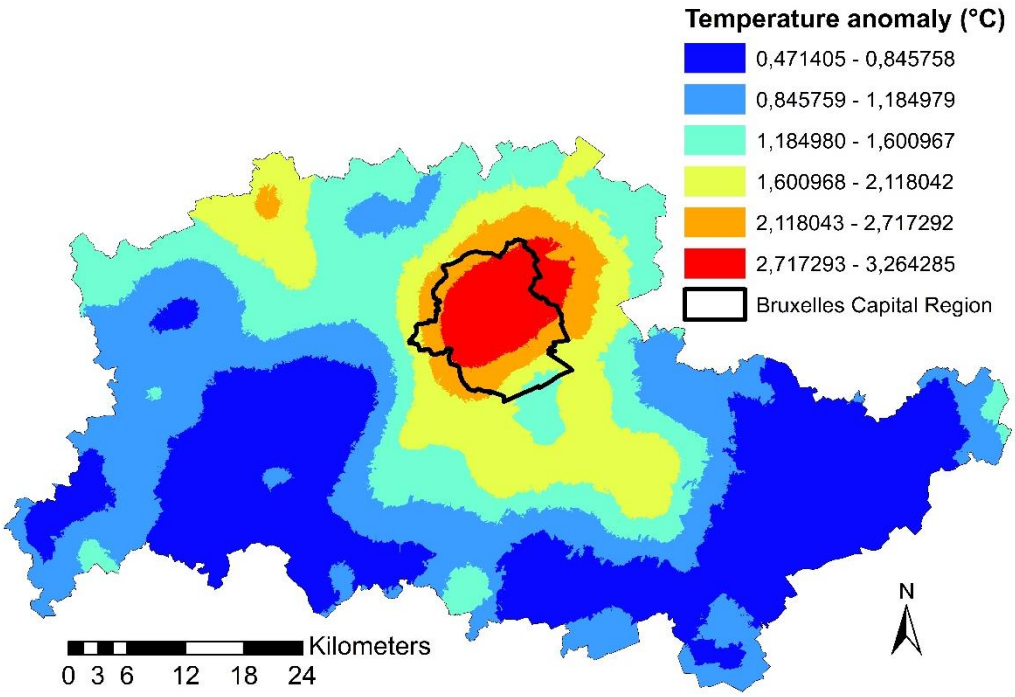



*Fig. 3.17 Night-time temperature anomaly in Brussels metropolitan area. Source: author's elaboration*

The heat mitigation index (fig. 3.18) clearly shows the cooling contribution of parks and forests in Brussels Capital Region. The *Forest des Soignes* and the big parks located South (i.e., *Bois de la Cambre*, Woluwe Park) are clearly visible in blue and beige on the map, as well as the other green spaces scattered in the city.

[35] In relation to the previous years average

[36] https://www.lesoir.be/251242/article/2019-10-03/les-vagues-de-chaleur-2019-ont-tue-au-moins-716-personnes, retrieved in October 2020

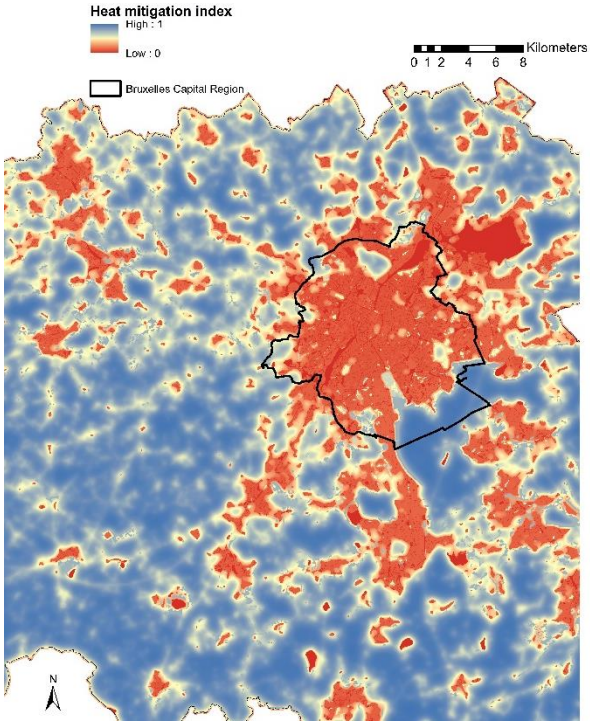



*Fig. 3.18 Heat mitigation index in Brussels Capital Region and surroundings. Source: author's elaboration*

If we zoom on the inhabited census tracks where the temperature anomaly is very high, we notice that the cooling capacity is rather low in the city centre and in the proximity of the canal, towards south-west (fig.3.19).

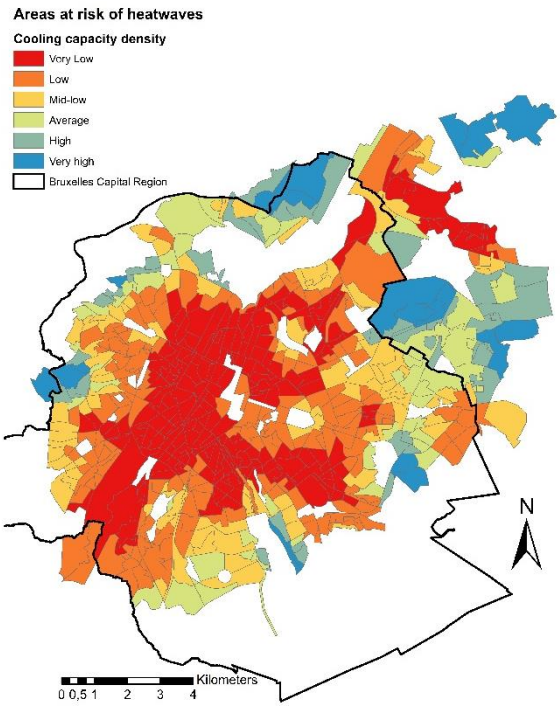



*Fig. 3.19 Cooling capacity density in the census tracks at risk of heatwaves*

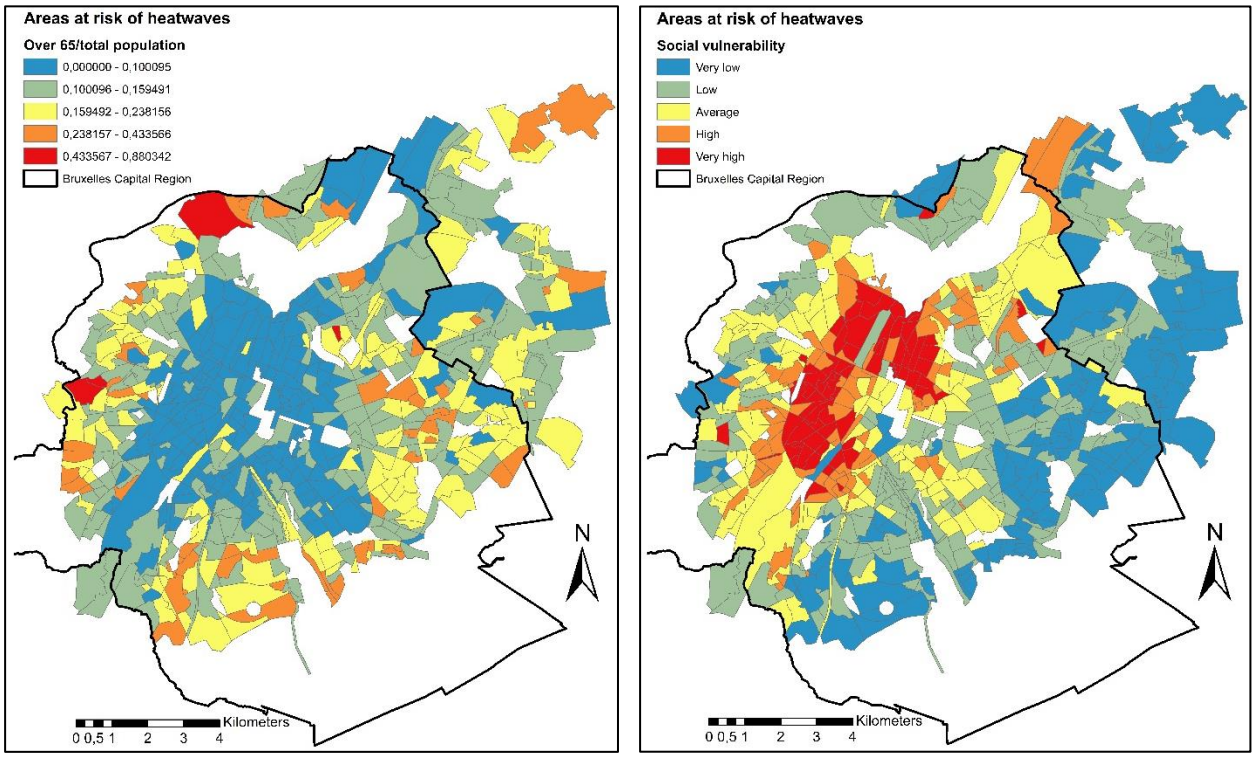



*Fig. 3.20 Rate of elderly people and social vulnerability in the census tracks at risk of heatwaves. See § 2.2.1 for the methodological details*

The rate of elderly people is higher in the census tracks towards the periphery of the Brussels Capital Region, where green infrastructures are well diffused. The distribution of social vulnerability follows the opposite trend, being strictly correlated to the presence of young foreign immigrants coming from poor countries. In the central and in the canal districts, poor housing conditions and overcrowding surely exacerbate the stress from heatwaves.

## 3.3 Final considerations on the analysis of three ecosystem services in Brussels and Milan

In conclusion of this section few considerations may be drawn. Chapter 3.1 and 3.2 summarise the assessment of three ecosystem services and their distribution in relation to some socio-territorial features. The main objective of this part of the research is to find an interpretative key to look at green spaces and ecosystem services against the context of two contemporary European metropolitan areas. Although the methodology here proposed presents some evident limitations and could be refined, the outcomes of the research follow clear directions and may lead to the following conclusive indications.

1) Periurban areas provide a tangible contribution to climate change mitigation. The forests and the agricultural land located on the fringes of the urbanised places in the metropolitan areas are essential elements to curb carbon emissions, by far more effective than urban parks. Urban sprawl and the periurbanisation processes that threaten the existence of forests and open spaces may therefore hinder carbon storage and sequestration. Thus, the target of urban carbon neutrality should be faced in a metropolitan perspective, beyond the city limits.

2) In both the metropolitan areas, semi-rural places are significant carbon sinks. Investing on new agricultural practices and sustaining the transition towards conservative agriculture would improve their carbon storage potential. This is true namely in Milan where the South of the metropolitan area is largely semi-rural. The Parco Agricolo Sud, a regional park constituted in 1990 in order to valorise the agricultural economy and to safeguard existing ecosystems, gives a clear idea of the value of the rural places in the metropolitan area. The ecosystem services approach may further valorise semirural areas, beyond the idea of the Parco Sud, by highlighting functions previously ignored, such as carbon storage and sequestration, and food and energy (e.g., biogas) provision for the urban demand.

3) Regulating ecosystem services and green infrastructures for climate change adaptation are transdisciplinary local issues. Urban green spaces for water retention and heat mitigation are to be designed considering territorial (i.e., watercourses and hydraulic system, urban heat island effect) and, importantly, social features (i.e., vulnerabilities, adapting capacity, susceptibility)[37].

[37] This is true also when it comes to other ecosystem services that are not treated in this research, i.e. pollutants and noise reduction.

In chapter 3.1 and 3.2, socio-economic, territorial and ecological data were combined with GIS tools at the district (census sector) level, in order to underline existing risks and vulnerabilities. From a policy point of view, ecosystem services assessment may facilitate the integration between traditionally isolated sectors, such as green, health and risk assessment. The methodology here presented attempts to combine diverse data but lacks a participative approach. Further qualitative studies on the perception of ecosystem services and on the co-design of green infrastructures are necessary.

4) There are some places and districts in the metropolitan areas that deserve peculiar attentions. An integrated valuation of the ecosystem services, along with the assessment of socio-economic indicators and geographical and historical information on land uses and territorial development, may facilitate public interventions. However, it is often the case that these particular places are not attractive for investors, or, conversely, may undergo processes of gentrification in the aftermath of big regeneration projects. The areas north of Milan and the Canal area in Brussels are two examples mentioned in chapter 3.1 and 3.2. As we will see more in detail in the next chapters, the densely inhabited municipalities on the northern border of Milan do not have the economic and political capacities to attract private investments, nor to plan and coordinate expensive greening interventions. Thus, the role of supramunicipal bodies (i.e. the region and the metropolitan City) becomes essential to coordinate and finance local greening projects. On the contrary, the Canal area in Brussels represents a rather attractive area for private investments and is the main focus of the BCR regeneration projects. The risk of gentrification and green gentrification is therefore quite high and the participation of the local populations in the projects is the only way to hinder gentrification processes.

To summarise, the process of greening is fundamental in defining ecosystem services provision: the type of governance, the actors involved, the collaborations between institutional layers, and the participation of the local population surely affect the multifunctional dimensions of greening projects. The next section will focus on some of these themes.

# 4 Shaping the green. The governance of green spaces and ecosystem services in Milan and Brussels

This final section of the thesis intends to study the political processes that underpin green planning and management in the two cities and metropolitan areas. Starting from a brief revision of the historical legacies which clearly condition the contemporary territorial provision of green and ecosystem services, this section delves into the current political landscape. The reading of the principal planning and legislative tools and a series of semi-structured interviews to relevant policymakers and stakeholders help comprehend how the urban green space is conceived by diverse actors, and the influence they have on contemporary greening plans and projects, and on the related ecosystem services provision. This section focuses mainly on the political dynamics within the cities of Brussels and Milan, but it does not overlook the metropolitan level of governance, which - as the previous section demonstrates - is essential in urban ecosystem services provision.

## 4.1 The governance of urban green spaces in Milan

### 4.1.1 A brief historical introduction to urban parks and green planning in Milan and in the metropolitan area

The first public parks in Milan date back to the second half of the 18th century. The Porta Venezia garden and the Sempione park are the oldest public green spaces in the city and still remain the largest in the city centre. The former, inaugurated in 1784, originally was a private parcel, abandoned or dedicated to small scale farming. It was converted to public park during the Austrian domination. The latter (1893) was a place of arms for the soldiers residing in the Sforza castle. It was converted to public park on a popular initiative, after it had been designated for private allotments.

The first urbanistic plan of the city, the Beruto Plan (1884), originally had the noble objective of reaching 10 $m^2$ of green per inhabitant and prefigured small-scale gardens and tree-lined avenues distributed all over the municipal territory. The following urbanisation processes, however, ignored many of the prescriptions of the plan, as the private speculation on land hampered the development of public green and open spaces. Highly dense districts were hence constructed without sufficient public space.

The following plans (Pavia-Masera in 1912 and Albertini in 1933) did not foresee any significant new green space, in spite of the massive population growth (more than 560,000 new inhabitants expected in 25 years in the Pavia Masera plan) (Oliva, 2002). However, the demand for new public spaces created the conditions for the development of public parks in formerly private vacant land or gardens. It is the case, for example, of the Villa Finzi and Villa Litta parks. New parks hence were developed in the first post-war years, without any urbanistic criteria, nor any coherent planning coordination (Boatti, 2007).

The 1953 Reunited Architects Plan needed to respond to urgent housing issues in the context of the reconstruction of the city and was also overwhelmed by building speculations and bureaucratic caveats (Oliva, 2002). The second post-war parks therefore developed as isolated episodes – e.g., Monte Stella park on a hill made of war ruins – or in peripherical and hardly accessible areas, like Forlanini park. The central and namely the intermediate areas of the city

were destined to an urgent and fast reconstruction, without any particular attention to green spaces.

At the same time, few new peripherical districts experimented innovative urbanistic solutions. QT8 is perhaps the most renewed example. Designed by the architect Piero Bottoni and conceived in 1947 at the 8th *Triennale* of Milan, the project dedicated particular attention to urban green spaces and, in general, to the liveability of the spaces (Boriani, Morandi, & Rossari, 2007). Small playgrounds, residential green and a large park (the above-mentioned Monte Stella park, 375,000 $m^2$) were put in place. The district is still one of the most green and liveable in the city, despite being a working-class area.

To summarise, green planning has always been episodic, or limited to certain districts in Milan. An organic idea of parks and green spaces has always been missing in the city, while innovative experiences have sporadically grown (Boriani et al., 2007). By the end of the 70s Milan was one of the least green European cities, with only 2.5 $m^2$ of green per inhabitant (Boatti, 1992). However, important civic and institutional greening initiatives had their origins between the end of the 60s and the 70s.

On the initiative of the PIM (Piano Intercomunale Metropolitano) - an intermunicipal body – a new urban green space was promoted in the Northern periphery of the city in 1967. The objective was to stop the uncontrolled urbanisation processes that had heavily marked the north of the city and the confining municipalities. The *Parco Nord* has been continuously developing since then, under the impulse of numerous citizens' associations. It has developed on formerly industrial areas and gradually expanded in the limiting territory, incorporating abandoned industrial structures or vacant land, and even a small airport (the Bresso airport)[38]. The park was officially acknowledged as Regional Park in 1975. It is now distributed on seven municipalities and represent one of the most appreciated parks in the metropolitan area, as it is the centre of several cultural and recreational activities and includes urban gardens, playgrounds and many other amenities. At the same time, it is an important biodiversity hotspot and a fundamental green lung in the Northern periphery of Milan.

Another pivotal initiative was that of Boscoincittà in the Western periphery. Boscoincittà was the first initiative of urban reforestation in Italy[39]. Driven by the cultural association Italia Nostra, it has involved several volunteers, NGOs, schools, since its inauguration in 1974. The park - which comprises urban gardens, lawns, a farmstead and some hectares of forests - today

[38] See (Giorgianni, n.d.) for further information about the story of the park

[39] See http://www.boscoincitta.it/boscoincitta/

reaches a size of 110 ha and has always been managed in a unique participative way. Along with the Parco delle Cave and other five parks, Boscoincittà constitutes an essential green infrastructure in the western periphery of Milan, covering more than 400 ha.

From an institutional point of view, the creation of the Regional Parks as new administrative bodies (1975) has favoured the protection of large green and agricultural areas located out of the city in peri-urban areas which were clearly threatened by the fierce urbanisation of those years. Along with the *PLIS* (local parks with intermunicipal interest), whose network is coordinated by the Città Metropolitana, the regional parks aim to foster nature conservation and ecological corridors, protecting and managing the existing natural and territorial heritage. For instance, the institution of Parco Agricolo Sud (1990) has preserved a large portion of agricultural land in the south and in the west of the Metropolitan City. In the previous chapter, some of the numerous and fundamental ecosystem benefits provided by these areas have been underlined. The regional and metropolitan legislative intervention on the protected areas has set fundamental limits to suburban and periurban building speculation and is still an important stronghold for nature conservation against urbanisation.

Within the borders of the city, however, the urban green spaces remained a marginal issue. The 1979 plan dedicated particular attention to the green areas, imagining a green belt in proximity of the city limits and foreseeing a growth of green space from 2.5 to 10 $m^2$. Yet, the implementation did not fulfil the expectations. In fact, the public green was a rather marginal issue in the political agenda in the 80s (Boatti, 2007).

In the 90s, the amount of green per capita was around 5.5. $m^2$. The financial austerity imposed a profound cut of the public investments. Public green spaces, thus, began to be integrated in private projects. New enclosed green spaces arose next to new commercial units or residential buildings (Boatti, 2007). Even the plan of developing nine new parks (*Nove parchi per Milano*) was strongly influenced by the lack of public funds and the increasing privatisation of public spaces. Many of those projected parks were very controversial and were never implemented (e.g., Ippodromo park, Parco delle Rogge) (Ibid.). Moreover, as the planning of the city was undertaking the fragmented path of isolated private-led urban regeneration projects (i.e, Porta Nuova, Santa Giulia, Citylife, Scali Ferroviari), the urban green spaces became important amenities for city branding and for increasing the land value.

The largest new parks inaugurated in the last two decades have been thought against the context of the new municipal planning tools - PRU (*Programmi di Riqualificazione Urbana*) and then PII (*Piani integrati di intervento)* – that have delineated the development of strategic urban

regeneration plans under the influence of rather diverse governance actors (local entrepreneurs at the beginning, and then foundations, international developers, insurance companies and investment banks)[40]. Portello, Citylife, Biblioteca degli alberi (*BAM*) are all parks that belong to big regeneration projects on disused formerly industrial or logistic areas. The common feature of these parks is the elaborated and refined architecture structure, designed by internationally renowned studios (e.g., Gustafson Porter, Piet Oudolf, Charles Jencks). They are designed to become new landmarks along with the iconic vertical architecture that surrounds them, and they often become busy walkable paths that connect different parts of the city.

Moreover, sustainability is a fundamental asset in the projects. The renowned *bosco verticale* (vertical forest) perfectly exemplifies the attention towards sustainable practices, as well as the luxury and exclusive nature of the projects. The green spaces of these projects have been carefully designed including several vegetations species with particular attention dedicated to the symbolic value of nature. This fact clearly differentiates this kind of green spaces from the traditional public green spaces and introduces the need of a costly ordinary and extraordinary maintenance.

### 4.1.2 Contemporary green governance: main actors, roles and visions

In sum, the contemporary governance of the green spaces in Milan involves a heterogeneous and large group of actors. Let us analyse in detail four main actors: the municipality of Milan; private developers and investors; associations and non-profit organisations; the Metropolitan City.

#### 4.1.2.1 Municipality of Milan

The municipality of Milan has a leading and coordinative role in green planning and is responsible for the management of the vast majority of the existing green spaces in the city. The green sector deals mainly with management and maintenance issues, while the planning and urbanistic sectors elaborate the plans and contribute to the design of the projects. Furthermore, the environmental transition sector follows the Forestami project.

[40] See Pasqui, 2019 or Moini, Pizzo, & Vicari Haddock, 2019 for detailed analyses on the governance of urban regeneration processes.

*Municipal planning vision*

The attitude of the municipal government towards sustainability and green spaces has changed in the past decades. The most recent urban plan (*PGT*, 2019) includes the objective of a green, liveable and resilient city as one of the main 5 targets for the 2030 strategy of development. The plan, complying with the regional and metropolitan indications, aims to stop soil consumption, and reduces the previously planned residential areas converting some of them to agricultural land use. Furthermore, it prefigures a Metropolitan Park connecting the existing green and agricultural spaces in a coherent and vast ecological network. Hence the idea of developing – in collaboration with private actors – twenty new green spaces along unused railways and stations (670,000 $m^2$), or in marginal and disused areas, in order to create connections between central urban parks and periurban agricultural and green areas. The target is to develop 470 ha of green space by 2030 (18% more than the actual 18.5 $m^2$ per inhabitant). Furthermore, for the first time, the plan develops the concept of ecosystem services against the context of climate change adaptation and mitigation.

« It is the first time that the municipality of Milan calculates ecosystem services in the assessment of services for construction costs. » [I3]

Article 10 of the PGT Rules Plan obligates carbon neutrality for new constructions and establishes a monetary compensation scheme, based on carbon quotations, for those who do not comply with it. The fees are to be invested in the Metropolitan Park, or in other public greening projects. Conversely, construction fees are decreased in case of carbon negative building interventions (i.e., when the climate impact index is more than 10% higher than the standard green ratio of 20%, adopted by the municipality). This represents a first attempt of implementing an ecosystem services payment scheme in the municipality.

The municipal strategic guidelines for green management (*Linee di indirizzo strategiche per la riforma della gestione del verde della città di Milano*, 2013) set some fundamental principles for urban greening. The green spaces are considered as a unitary citizens' heritage, essential for the urban quality of life and for the identity of the city. Historical parks are to be preserved and all the green spaces should be accessible and well maintained. Furthermore, the document highlights the metropolitan dimension of the green spaces, focusing on ecological interconnections, corridors and biodiversity. The relation between blue and green spaces is also underlined, mentioning the great heritage of watercourses in the city and the essential relation between them and the nearby parks.

From a governance viewpoint, the guidelines attribute to the municipality a coordinative and directive role among a plurality of other actors. Public-private subsidiarity is encouraged, along with collaborations with other administrative institutions (Città Metropolitana, Lombardy region). Moreover, participative models of green management, involving private citizens, are envisioned.

Lately, the municipality has elaborated an urban afforestation project, which attempts to put in practice the greening guidelines in an innovative format. The project, named *Forestami* (https://forestami.org/), has the objective of planting 3 million trees in the metropolitan area by 2030. The initiative, inspired by a research carried out by the *Politecnico of Milan*, involves a manifold group of actors: the municipality, *Città Metropolitana*, *Parco Nord Milano*, *Parco Agricolo Sud Milano* (regional park), ERSAF (regional environmental agency), *Fondazione Comunità di Milano*, *Fondazione Comunitaria Nord di Milano* and the *Fondazione Ticino Olona* (some of the main foundations active in social projects in the city and in the metropolitan area). The project is developed with the financial support of *Fondazione Falck*[41] and *Sistemi Urbani F.S.*, a subsidiary of the Group *Ferrovie dello Stato*, which is the owner of several disused areas of the city, and the main partner of the municipality in many urban regeneration projects. The foundations have the mission of gathering diverse funds from private actors. Enel and Snam, for instance, are among the first financers. An interuniversity and transdisciplinary scientific committee led by the *Politecnico of Milan* is responsible for the scientific research activity.

*Forestami* is still in its preliminary phases, as it was launched by the end of 2019. It aims to gather the local know-how and to develop an inclusive and incremental project of afforestation in the metropolitan area with a new and innovative mixed governance. The afforestation concerns disused areas, rural tree lines, parking lots to be depaved and many other diverse landscapes. The scientific committee (namely ERSAF and the Politecnico of Milan) locates the spots to be afforested. Municipalities can voluntarily participate in the project, collaborating with the scientific committee and then implementing the afforestation on their territories. The scientific committee will provide also technical consultation about the maintenance, accompanying in the whole process of afforestation the municipalities and all the public and private actors (e.g., individuals, ngos, companies) involved.

[41]A foundation financed by Falck, formerly one leading iron and steel company, now reconverted to renewable energies production.

*Municipal green management and maintenance*

The green sector is responsible for the maintenance of the public green space. It adopts two different strategies:

1) Municipal management through contracted-out societies (about 18,800,000 $m^2$ in 3,166 localities).

2) Other actors' management (about 6,000,000 $m^2$): autonomously directed parks (e.g., *Parco Nord, Boscoincittà*) and private sponsorships (e.g., *Biblioteca degli alberi*).

For now, let us consider the direct municipal management. The green sector has developed a platform named *Global Service*, which provides an integrated tool to work hand in hand with the contracted-out company. The *Global Service* system allows a constant check of the maintenance activities of the contracted-out company, with a well-defined system of fines in case the works do not comply with the standards stated by the municipality. Both ordinary and extraordinary maintenance are carried out by the contracted-out society. The former follows the strict indications of the municipality on pruning, lawn mowing and so on for a total cost of 16.7 million euros. The interventions for extraordinary maintenance are divided in three categories (each category has one third of the total budget of 4.6 mln): the green sector deals with security issues (e.g., potholes, falling trees, broken swings in the playground); the submunicipalities (nine decentralization zones) decide on small-scale interventions (e.g., districts small parks); finally, the communal department of urbanistic, green and agriculture spends its share of the budget on strategic city-scale projects (e.g., afforestation, sport promotion).

The overall budget for green maintenance is rather low. The last call for tender started from a starting price of € 1.50 per $m^2$ (per year), and the consortium company Miami won the call with a 36% bidding discount. The final budget for ordinary and extraordinary maintenance is then around € 1 per $m^2$ (per year). The interviewees representing the green sector complained about what they defined a very narrow budget comparing to other European big cities.

« We keep a level of expenses which is rather low in relation to the quality of the green spaces, that we would like to have much improved. » [I1]

In their opinion the efficiency of the Global System tool provides a standardised decent level of quality, despite the low budget. However, they highlighted some basic criticalities, such as lawn mowing in spring and night tree irrigation in summertime. Moreover, they acknowledged the fact that the new parks developed against the context of private-led urban regeneration processes demand peculiar activities of maintenance that the municipality cannot afford.

«Portello [park] is now on our expenses, but when they had the duty of maintenance, they spent 7 euros per $m^2$. We drastically fell to 1 euro and then it is clear that the quality is a bit lower, perhaps more than a bit [laughing]. » [I1]

In the cases of the PII (urban regeneration projects), the green spaces are designed and implemented by the private developers under the supervision of the different sectors of the municipality. The private actors take the duty of implementing public spaces, which is normally a public duty, in return for consistent discounts on construction fees. Then they stipulate agreements with the municipality for the management of the spaces: they take over the parks, whose maintenance is too expensive for the municipality. Initially, the agreements were temporary (two to five years). Lately, the municipality has been working on permanent agreements, named sponsorships. The private actors get the duty of managing the park, as well as the permission of organising, within certain limits, private sponsorships and promotional activities for self-financing. The *Biblioteca degli Alberi* at Milan Porta Nuova is the first case of a sponsorship agreement, but others (e.g., *Citylife*) will probably follow soon. The interviewees representing the planning sector (I3 and I4) confirmed that the municipality aims to encourage this kind of management.

«Yes, reading in the intentions of the plan, it means that we incentivise the fact that the private can directly take care of the public property area. We see it as a positive thing. I know that the sponsorships are working very well, especially lately. » [I4]

The sponsorship model is therefore wished also for the twenty new parks envisioned in the plan.

#### 4.1.2.2 Developers and private big investors

As we've seen in the previous paragraphs, big private entrepreneurs, developers and financial institutions have gained a predominant role in urban regenerative projects and also, more specifically, in the development and management of public green spaces. *Biblioteca degli Alberi* at Porta Nuova and the park of *Citylife* are the most important examples of privately developed and managed parks in the city.

*Developers and big private actors' greening attitude*

The green spaces in these cases are to be read as functional to the broader context of urban regeneration. They are fundamental amenities in high profile projects.

«This park was born as an urbanistic standard in a complex regeneration plan. The principle function is urbanistic: providing the renovation of a disused area of the city (…). Then for what concerns the project

Biblioteca degli alberi I can tell you that the primary function is that of connecting bits of the city that were completely isolated from each other». (I6)

«We, as a private operator, obviously we have the objective of selling the houses and selling or renting [the offices in] the towers and, obviously, guaranteeing the quality that the plan must have. And then the park is one of the quality aspects of the project. On this issue [the park], the project Citylife developed in an operative manner. That is the private operator faces these issues with an approach which is functional to the development of the overall project. In this sense, the park, comparing to other projects, has developed hand in hand with the development of private allotments (…). Thus the park of Citylife works as a connection between Sempione park, Pallavicini park, connecting to all the pedestrian axis of the Fair and reaching Portello park and all the green system in the North-West of Milan». (I7)

*Citylife* park and *Biblioteca degli Alberi* are thought as pathways, pedestrian connections in new dynamic districts destined to become important centralities in the city. They are both spaces thought for a large group of users and for diverse temporalities. Office workers populate the spaces in weekdays afternoons, local residents in the evenings, and tourists and other citizens attracted by the place during the weekends.

The setting-up and the management of green spaces is not the core business of *Coima*, which is the real estate investment and development company in charge of the Porta Nuova project, nor of *Generali Assicurazioni*, the insurance company responsible for the development of *Citylife*.

«The park was to be carried out by the municipality. At a certain point the municipality asked the privates to fulfil it, because otherwise the municipality would have been in trouble [because of the costs of the project]. And lately [the municipality asked to the private] even to manage the park. It is clear that we [Coima] usually make another kind of job, so…However, as Lucia[42] told you, we set up a structure in order to manage this park at best. What does it mean? That all the functions you told me about [ecosystem services] are clearly implicit. I do not have knowledge, nor the tools [to assess them] …» [I6]

The choices on vegetation and on the landscape architecture are based on aesthetic and symbolic values, and are functional to the projects aims of place attractiveness. Developers have, admittedly, a weak awareness on ecological processes and functions. In the case of *Citylife*, the project, designed by Gustafson-Porter, aims to allegorically recreate the diverse landscape and vegetations of the Lombardy region: the Po plan in the South and then going North pre-Alps landscapes and vegetation species. *Biblioteca degli alberi*, on the other hand, designed by Petra Blaisse Piet Oudolf, introduces a new idea of public space, completely different from the common Italian parks.

[42] Invented name. It refers to I5

«(…) In the sense that you have on green infrastructure that is composed by three principle elements: the paths, the diverse fields between the paths and the trees microsystems that are between the two in a completely autonomous way. This park does not have tree lines, nor benches (…). The designers are from Northern Europe and have therefore brought a culture of public spaces that is relatively new in Italy. » [I6]

*Private management and maintenance: the sponsorship model*

*Biblioteca degli alberi Milano* (BAM) is, for now, the only park which is permanently managed through a private sponsorship, and is widely recognised as a successful pilot project. *Citylife* and other parks are also privately managed. They follow temporary agreements and are currently negotiating the terms of permanent sponsorships with the municipality.

*Coima* has delegated the management of BAM to *Fondazione Catella*, which is a subsidiary foundation. *Fondazione Catella* takes care of the maintenance, that is contracted-out through a public call, and organises all the events and the activities in the park. The foundation is financed by *Coima* and aims to establish solid self-financing activities to cover most of the high costs linked to park management[43].

The park has a cultural and general director who oversees the financial management and takes the decisions on the organisation of the activities and of the spaces. The current directory follows four pillars: education, nature, wellness, and open-air culture. The self-financing is sustained through three methods: sponsorships (e.g., Edison, Nike..), commercial events (e.g., Armani fashion catwalk), and the annual contributions from the BAM friends community. The sponsorships consist in agreements with partner companies which advertise the events and the activities organised in the park. For instance, Nike is the sponsor for the wellness activities. Commercial activities are events directly organised by private companies in the park. These represent the biggest voices of self-financing. Finally, the BAM community involves 400 people who pay an annual quote to sustain the project.

The directory of BAM intends to build a strong identity of the park, by facilitating cultural events and by building a network of actors who gravitate around the park.

«Obviously, we must work a lot because we have just started, but, in my opinion, the thing that distinguishes us is this identity, a bit like a soul, an identity with a soul. I mean, you go to BAM because you know not only that is a beautiful park, clean and well maintained. But you know also that you'll find stimulating cultural experiences. It is the sum of these things that I'd like to become a soul. I mean,

[43] The annual budget is around € 3,000,000.

a park with its own soul, with a strong attractive capacity because it speaks, because it has its own iconic quality. » (I5)

The management of BAM takes inspiration from the American models of New York's Highline and Bryant park.

«For sure we were inspired by American models. But I'd like to say that made in Italy is made in Italy. I mean, without any arrogance, nor presumption, we were inspired by New York's Highline and Bryant Park, but I dare to say that BAM…I mean, we got inspired, we even copied some things, in the sense that we have seen the formula, etc. However, I think that the quality, the network, the capacity of valorising a territory that is Milan… (…) My role is to think about cultural initiatives and put to system a cultural environment, which is already rich. So we've collaborated with La Scala, Brera, with the associations, with Piccolo Teatro… So this Italian DNA is unique. » (I5)

Milan offers a uniquely rich cultural ground whereby the initiatives of BAM can grow. Green management is therefore strategic, functional to the connections with the cultural institutions and actors. The common feature of the events and the cultural activities is the sustainability framework.

« The artists must help me to reflect on the 17 SDGs and to create events that make reflect on that. » (I5)

In the case of *Citylife*, the park is not provided with a cultural manager. However, the sponsorship agreement with the municipality will probably facilitate an organisational structure similar to BAM's. The park has already begun to organise sport and cultural events.

«We, as temporary managers, are already working on these [cultural and sport events in collaboration with the municipality of Milan] (…). So [we intend to] potentiate this sport vocation and to build a cultural vocation next to it. » (I7)

The decision-making process follows private managerial models. Both the parks are open to collaborations with private and public entities. Yet the organisation of the activities and of the events is, ultimately, in charge of the manager in case of BAM, and of the managers involved in the project for *Citylife*.

«Conflicts in the decision-making process? Bah, to date no, because, honestly, I schedule the activities by myself…I mean, I have been doing this job for more than 20 years, I have always worked for the institutions so I always ask myself many things and I always aim to understand where I am, so I often ask myself: am I thinking [the programmed activities] for the old man? Am I thinking for the young, the rich, the poor? So [the objective is] to seek, being a public space, to seek to satisfy diverse targets. »

#### 4.1.2.3 Associations and non-profit organisations

Milan has been the place of innovative greening experiences since the 70s. The chronic lack of public green spaces and the weak political interest on the topic stimulated the initiatives of civic associations and non-profit organisations. The most renowned examples are *Boscoincittà* and *Parco Nord*[44], but also other experiences have bloomed in the city and in the metropolitan area, such as *Parco delle Cave* and *Bosco della Giretta*. A network of civic associations has been working on the urban green spaces in constant dialogue with administrative institutions, creating innovative governance forms and new ways of conceiving the green spaces in the city.

*From grassroot afforestation to territorial planning.*

For the purpose of the research, representatives from *Parco Nord* and *Boscoincittà* were consulted. Their greening vision is strictly linked to the stories of the parks. Both the parks have grown under the impulse of citizens' associations and are still the venue of several citizens' and grassroot initiatives. At the same time, the bottom-up push has favoured innovative ecological decisions. In fact, these parks brought to Milan the idea of urban and suburban afforestation, overcoming the traditional idea of urban park.

« When Boscoincittà was born, in 1974, making a forest in Milan was a folly. And everybody was against us. I mean, the graduates in forest science told us that forests were not supposed to grow on the plain, because forests grow in mountains. The agronomists told you that the forest could not grow for a bunch of reasons. The architects told you that you must not grow forests to make parks. [That was] In 1974. By 1985 we have started to grow forests everywhere. Italia Nostra used to say: making the park by growing a forest is different than [making] the garden for the city. Afterwards the park will also take the function of a garden in the city. Yet it is also a natural area that gives a bunch of benefits to the city, to the environment and to those who frequent it (…). So the concept of ecosystem services here is inherent [to the park]. But it has never been formalised. In this sense I say that is part of its DNA. » (I 10)

« It is evident that in our experience of a park built from scratch, which was born on a former industrial area, the generation of ecosystem services (…) is in our nature. The fact that today we use the ecosystem services language is new, but we just rename things that we have always done in carrying out this project. This project was born as a great urban afforestation. I mean, the idea of Parco Nord is that of bringing back nature in the city and then [we realised] the great afforestation – we planted around 450,000 trees in 30 years – and today we need to analyse this thing with the lens of the ecosystem services. Because they help us to see things that we did not see before and because they are clearer to communicate. » (I8)

[44] Parco Nord is officially a regional park, and therefore an institutional actor. However, considering the peculiar story of the afforestation and of the park, it could also be considered as the collective effort of associations and grassroots organisations.

The interviewees from *Parco Nord* and *Boscoincittà* underlined the fundamental ecological functions that the parks provide to the city and to its inhabitants: water retention, carbon storage, reduction of pollutants, soil fertility. In the case of *Parco Nord*, they wished for a monetary valuation of some regulating services that clearly contribute to reduce public expenses.

« There are many services, which we offer and are not correlated to the traditional contribution given by the municipalities (…). Today this contribution should not be only for green maintenance. That is something that we always do, but it is not the heart of the services that Parco Nord provides. So, the rules of the financial statements and the public contribution to the park should be changed, adopting a more current economic framework. Because some services can be monetarily valued, other cannot. I'm convinced that not all the ecosystem services could be monetised. Wellbeing, for instance, how much is it? (…) However, we can calculate [the value of] some [ecosystem services]. For instance, how much is the permeability of this soil, kept free from concrete, that guarantees the percolation of rainwater in critical moments? (…) So, also the financial statements of the park, that traditionally foresee a fixed share from each shareholder (7 municipalities, region and Città Metropolitana), should be changed. There should be a fixed share and a share which is proportional to the ecosystem services that the park effectively offers to the citizens. » (I9)

On the contrary, the interviewee representing *Boscoincittà* was firmly against the monetisation of ecosystem services. In his opinion, nature must be valued, but not monetised. The public administration therefore should not consider parks as a cost, but as places that create solid ecological and social values. According to him, reducing parks to monetary values means losing much of the intrinsic value of the park.

Moreover, in both cases, the interviewees insisted on the social and cultural values of parks.

« In my opinion, if we include social services in the ecosystem services, I mean the quality of life of the citizens who directly and indirectly frequent the park, they [the social services] are the most important. Also indirectly. I mean, there are some people who tell you: they live in the nearby districts and they say: "I haven't been to the park for two years, but for me Boscoincittà is a landmark. » (I10)

*Parco Nord* and *Boscoincittà*, apart from being large scale afforestation projects and providing important regulating and support services, in fact constitute places of sociability. They include playgrounds, kitchen gardens, sport facilities (e.g., bocce). Moreover, both the parks organise and are the venues for several cultural events that attract citizens not only from the nearby districts, but also from the rest of the metropolitan area: educational activities, orienteering, scout activities.

From an urbanistic point of view, these parks have brought radical changes to the contexts in which they have evolved.

« The role that the park [Parco Nord] has played (…) is that of being a project that has managed to condition also the urban form of the cities. Bresso is one of the densest municipalities in Europe. However, through the park it has come to rethink its development model (…) In these years we have built cycling lanes. The park did it. And we created [pedestrian and cycling] connections with the Villoresi park to the North, with Milan to the South, with Novate and Cormano to the West and with Sesto and Cinisello to the East. We are also well-connected and this is another service we offer to the city. » (I8)

The experience of urban afforestation is therefore overcome. The territorial practices and activities of *Parco Nord* and *Boscoincittà* transcend the mere idea of park, as they involve mobility, connectivity, sport, social services.

«Our will is not so much increasing the public green spaces, but it is to take care of the territory. One of the things that I always like to say is that in my opinion parks should be abolished. We should abolish the word "park" and abolish parks. We have a territory, that is one whole (…). While until few years ago the emergency was to stop urban spreading, so we made the demonstration for the institution of Parco Sud and so on… Now that danger is still there, but we feel the need to mend, fix, to give a function to all the small corners, the fringes…The agricultural areas, the areas free from buildings are the back side of the city, but they must become the new front (…). You take [as an example] Via Novara. Now we have this new project, named West Road Project, in which we put forward tree lines and cycling lanes. Our project for the future is to take care of the territory in a holistic way. » (I 10)

Put in another way, at *Parco Nord* the interviewees spoke about a park that incorporates the rest of the metropolitan area, absorbing and improving places that in the past were considered in opposition to parks, such as an old dry cleaner's (Rosina) which has improved its ecological standards, a cemetery (in Bruzzano) or the airport of Bresso, which has been limited by the park, but it is still there in between green areas.

« Basically, in our idea, the evolution of the park consists in transforming the metropolitan city in a big park. Because within a park, there could be infrastructures, gates, cemeteries and so on… A metropolitan city is highly urbanised, but a metropolitan park improves the quality of life, allows nature to perform its strength, improve the quality of the air and allows a quality of life much higher than we have today. » (I8)

*Parco Nord*, being an important institutional actor, participates in the Forestami project and is also involved in the discussion on the Metropolitan Park, along with the other administrative actors.

*Management practices*

*Parco Nord* and *Boscoincittà* have both unique management and maintenance structures. *Boscoincittà* is managed by the non-profit association *Italia Nostra*. Based on a nine-year

agreement, it gets 80% of the budget from the municipality of Milan. The remaining 20% is self-financed through donations, sponsorships and calls. The key characteristic of *Boscoincittà* is the direct management. *Italia Nostra* has about 15 employees, who work, along with volunteers, on the ordinary and on most of the extraordinary maintenance of the park. Very few particular activities are contracted out. In their opinion, this form of management is more resilient than contracting-out all the maintenance activities. It favours freedom of choice and flexibility, without bureaucratic procedures. In this way the park is more resilient and is able to adapt to changes, both to the weather occasional changes and, with the volunteers who are in strict contact with the visitors, also to the demand of the visitors.

Similarly, 80% of the budget of *Parco Nord* comes from the institutional shareholders (seven municipalities, and Milan Metropolitan City), while about 20% is self-financed through property assets and fundraising. In this case the management is mixed. A group of gardeners and workers directly employed by the park is assisted by contracted-out cooperatives. Volunteers represent a determinant help for the park. The so-called ecological guards are 150 volunteers that work around 27,000 hours per year ensuring the liveability of the park.

Both the parks aim at organising the activities and the events in a participative way, open to all the association and the territorial context. *Parco Nord* has an office named *Vita nel Parco* that takes care of the public relations with all the stakeholders.

«I mean, we have a relation with our users. We have almost 800 artists, we have those who cycle at the velodrome…I mean every person who is in the park is in relation with the structure and I think this constitutes an unicum. » (I8)

«[The scheduling of the activities] is always a complex activity, multidisciplinary, in the sense that we have landscape architects and many other competences…But it is always a collective work. The people in charge of environmental education say what they think on some projects or things…etc. etc. I always say that is a matter of reading the needs. It is not about listening. It is about reading, which is different. « I10»

Reading the territorial needs means understanding, through multidisciplinary and participative practices, not only the demands of the local populations, but also deeper social dynamics that are often hidden. Conflicts between different stakeholders may easily emerge in such open arenas: simple disagreements between groups of users, or broader administrative institutional divergences. The inherent characteristics of these parks, inscribed in their origins and stories, is the ability to accept and mediate conflicts, providing solid means for territorial development.

#### 4.1.2.4 Milan Metropolitan City

Lombardy Region and Milan Metropolitan City draw up territorial plans – the *Piano Territoriale Regionale* (PTR) and the *Piano Territoriale Metropolitano* (PTM) – which provide municipal planning with law regulations and indications. Furthermore, both the institutions elaborate research and planning documents on specific issues. The *Piano d'indirizzo forestale* (PIF), drawn up by the Metropolitan City, specifically deals with urban and periurban forests.

The PIF and the latest PTM explicitly refer to ecosystem services. The former, which dates back to 2015, provides fundamental guidelines to forest management and express the need to monitor ecosystem services and to establish forms of payment for ecosystem services. The 2020 Metropolitan Territorial Plan elaborates the idea of a metropolitan ecological network, as a system of territorial ambits, adequately vast and compact, that presents abundance of natural elements, connected through territorial belts provided with a good vegetational equipment. The metropolitan ecological network has several targets (Città Metropolitana di Milano, 2020): favour citizens' fruition and the public knowledge on the landascape, constitute new parks, reinforce the cycling and walking paths, water retention, heat waves mitigation, reduction of soil consumption and $CO^2$ emissions, regeneration of periurban ambits and of degraded contexts, urban sprawl limitation. The multifunctionality of the green and natural spaces is therefore fully acknowledged.

« The theme of the ecosystem services becomes a fundamental component of the process of planning that we define. Therefore, we overcome the past definitions on the presence of green and nature in the territorial plans. (…) Therefore, we envision a series of services that overall offer the urban and territorial quality and also the overall values of the ecosystem. » (I11)

The PLIS, along with the regional parks, are fundamental green infrastructures in the network. However, the Plan highlights the fragmentation of the governance of parks and green infrastructures. The management of the green spaces, in fact, follows different regulations. Regional parks and PLIS have their own territorial plans and the urban green follows different municipal planning rules. The Metropolitan Plan therefore envisions the constitution of a Metropolitan Park, which will ideally govern the ecological network in a coherent and uniform way, promoting the greening interventions and potentiating the effectiveness of the governance.

« [The metropolitan park] is not the simple union between Parco Nord and Parco Sud, but it is something more complex, where there is an overall vision of the system of the metropolitan green, where the local parks, the PLIS, the regional parks, projects as Forestami, connect to each other and find a sole subject which manages the system. This is a complex operation that here in Italy is hard to put in practice, overcoming resistances and difficulties. I am a convinced supporter of the metropolitan park. I believe

that in this process the intermediate body, the Metropolitan City, should have a primary role, that cannot be delegated to other subjects. (…) Because the vision of the metropolitan park cannot be the same as that of an urban park which manages the system of the metropolitan network, following the reasoning of an urban park. We have always thought in a metropolitan logic, so the most recommended subject is the Metropolitan City. » (I11)

However, the interviewee representing the Metropolitan City complained about the marginal political role of the institution in park planning and management. In his opinion, the influence of the institution has been negatively affected by the recent cut of funds. The Metropolitan City does not have any fund for incentivising municipal greening initiatives anymore. It can coordinate and promote municipal greening initiatives, but it does not have the resources to fund them.

Moreover, the Metropolitan City is not involved in important projects, such as the regeneration projects on the unused stations and railways (scali ferroviari), in spite of their strategic metropolitan importance for ecological connections and mobility. The project Forestami includes the Metropolitan City in its governance, but, for now, it does not attribute to the institution a coordinative role.

« Forestami is a great idea. It has a fantastic objective. Yet this project has to discuss with the urbanistic choices of the municipal plans of the 133 municipalities that are around Milan. It is not a project exercise, but it is a territorial-urbanistic operation and, as such, it must create a dialogue with the tools of territorial and municipal government. In my opinion the project Forestami has started without this component. And namely on the availability of the areas [for planting trees]. The municipality provide some areas. (…) What kind of coherence with the overall project do they have? Because there must be an overall design of this operation. It is not just about the number of trees planted by 2030. To me it looks like this dimension has not been thought yet. (…) The process is managed by Milan (municipality). But this is a metropolitan dimension, a planning dimension and so…the Metropolitan City should have an active role (I11). »

To summarise, the Metropolitan City is potentially a fundamental actor in coordinating and promoting green networks and connections. Yet, admittedly, it has a restricted role, limited to planning indications and to the participation in the management of the regional park and of the PLIS.

### 4.1.3 Concluding remarks: Greening governance models and sustainability

The mosaic of actors described in the previous paragraphs constitutes coexisting governance models of greening. The relevance of green spaces in urban and metropolitan dynamics has in

fact exponentially grown throughout the last decades, so that diverse competing or complementary planning, project and management practices have been developing. In tab. 1, five models are sketched. In fact, these models are well interconnected and hardly completely separable. However, they attest diverse conceptions of urban sustainability that will undoubtedly affect the future urbanisation processes.

| | **Traditional 20th cent. model of municipal greening** | **Greening as territorial planning from below** | **Greening in big private-led urban renovation projects** | **Public greening for nature conservation and ecological connections** | **Resilient metropolitan area** |
|---|---|---|---|---|---|
| **Actors** | Municipalities | Associations, NGOs, private citizens, region and municipalities | Private developers, municipality of Milan | Region, Metropolitan City, municipalities | Municipalities, metropolitan city, foundations, NGOs, universities, private companies, private citizens |
| **Management and maintenance tools** | Standardised contracted out maintenance (in Milan: Global Service system) | Direct management with municipal contribution and self-financed resources: directly employed work force, volunteers, and few contracted-out jobs. | Sponsorship: Management by private developers, or through foundations owned by private developers. Maintenance contracted out. Private funds, also with self-financing activities (e.g., sponsorhips) | Standardised management with regional and municipalities funds | Not clear (still in implementation): municipalities with private funds? |
| **Planning and project tools** | Traditional planning tools (Pgt) | Incremental planning from below: initial afforestation and park planning. Then territorial planning and partial institutionalisation (e.g., Parco Nord is a regional park) | Urban renovation projects (PII), developed by developers in collaboration with the municipality | Regional parks, intermunicipal parks (PLIS), metropolitan park (in fieri) | Forestami: urban forestation project, involving municipalities, foundations, universities. |

| | | | | | |
|---|---|---|---|---|---|
| **Prioritised greening functions and ecosystem services** | Recreational green, climate change adaptation | Recreational and cultural ecosystem services, support services (soil and biodiversity), stop to uncontrolled urbanisation in peripherical areas | Increasing urban attractiveness and land value.<br>Urban connectivity.<br>Cultural and sport activities | Nature conservation against uncontrolled urbanisation, support and regulating ecosystem services, mobility | Regulating ecosystem services<br>Climate change adaptation: heat reduction, water drainage.<br>Pollution reducton<br>Climate change mitigation |
| **Challenges and problematics** | Chronic lack of funds for planning and maintenance: poor quality of public green space. | Conflicts between stakeholders.<br>Scaling up of the initiatives from parks to territorial institutions | Privatisation of the public spaces.<br>Expensive maintenance.<br>Green gentrification. | Lack of metropolitan funds. Metropolitan city is limited to a coordination role. Municipalities with few economic resources have to deal with the implementation | Innovative governance involving several diverse actors. Unstable and unclear funds for afforestation and maintenance, based on foundations and donations |

*Table 4.1 Forms of governance of the green spaces in Milan metropolitan area.*

To sum up, two general trends may be underlined. First, the decreasing influence of public institutions on green design and management: municipalities and the Metropolitan City are still relevant actors, but mostly in cooperation with other civic and private bodies. Second, the recent public and private attention towards sustainability and green spaces. On the one hand, the public institutions have lately recognised the multifunctionality of the green spaces and the fundamental services they provide to territorial development. The latest planning documents explicitly refers to ecosystem services, nature-based solution and climate change mitigation and adaptation, including also rather detailed research and data[45]. On the other hand, municipalities and the Metropolitan City do not have the economic and political means to implement greening projects on their own.

Thus, the traditional ways of designing and managing public parks through municipal planning and maintenance tools have opened up to new forms of governance. Perhaps two main kinds of governance may be cited. One is that of private led regeneration processes. In this case, the municipality collaborates with private developers and entrepreneurs in order to carry out and manage green spaces through sponsorships. The outcomes are well-designed and iconic parks in regenerated central districts. This is clearly a market-oriented idea of sustainability whereby

[45] See, for instance the last Metropolitan Plan on heat waves and nature-based solutions (Città Metropolitana di Milano, 2020) and the project Life Metro Adapt (http://www.lifemetroadapt.eu/it/)

green infrastructures are functional to isolated urbanistic projects driven by big private investors. It is a way of conceiving the green spaces as attractive amenities and soft mobility infrastructures in highly affluent areas. This governance model brings about some distributive and procedural issues, as the green spaces are developed only in certain areas of the city, where residents are wealthy, and are privately managed following top-down entrepreneurial models. If, on the one hand this model has certainly contributed to increment the amount of green space in the city, on the other hand it may exacerbate internal inequalities, ignoring the social dynamics of the city. Furthermore, this model seems to lack an overall vision of the ecological processes in the metropolitan area.

The other model of governance, which we may define as territorial planning from below, consists of collaborations between associations, non-profit organisations and the institutional actors (municipalities, Metropolitan City and Lombardy region). In this case the green spaces emerge as territorial needs, interpreted by local associations and big non-profit organisations, and are implemented through innovative private-public agreements. Urban and periurban afforestation projects and big parks have emerged in peripherical and poor areas, limiting the urbanisation and providing the dwellers with ecosystem services and public spaces in disadvantaged places. This model represents an idea of sustainability which is more inclined towards social than economic values, sustaining at the same time ecological resilience, well-being and environmental justice.

It is clear that these projects go beyond the mere ideas of public parks, involving territorial planning issues (e.g., mobility, but also welfare and social services). Therefore, the challenge here consists in scaling up these initiatives, finding institutional forms that can sustain this kind of territorial development, especially in the municipalities out of Milan where the economic and technical resources of the public administrative offices are rather weak. The idea of a Metropolitan Park may go in this direction. However, looking at the metropolitan scale, it is hard to find an institutional coordinator of these processes. In fact, the Metropolitan City is excluded from several important projects or has a marginal role due to the lack of financial resources. The development of an overall metropolitan vision therefore results quite complex and hardly feasible, and hence divergences between different actors, such as *Parco Nord* or other regional parks, the Metropolitan City, Milan and other municipalities may emerge.

The urban afforestation project *Forestami*, which is still in its preliminary phases, seems to confirm the lack of coordination between the metropolitan actors. From a governance viewpoint, the model of *Forestami*, which we may define the resilience model after the recent

popularity of the semantic field of resilience, represents a mix between the two previously mentioned (private investors and bottom-up organisations). In fact, it introduces a new form of governance involving foundations, private companies, associations, and universities, but it lacks a unitary planning vision, and it follows an entrepreneurial model, based on incremental fundraising and private investments.

In conclusion, let us come back to the indications drawn from the previous chapter on the distribution of ecosystem services. The analyses have shown on the one hand the fundamental contribution of periurban vast agricultural and green spaces and, on the other hand, the need to contextualise regulating services in the social and territorial local dynamics. An institutional metropolitan logic, able to coordinate small-scale initiatives and broader afforestation projects would help to foster these processes. The latest Metropolitan Territorial Plan clearly moves in this direction. However, the weak influence of the Metropolitan City and of the municipalities in the design and the management of green spaces may hamper the collaborations between existing bottom-up projects, private-led greening investments and public efforts.

## 4.2 The governance of urban green spaces in Brussels

### 4.2.1 The historical heritage

Brussels has a remarkable green heritage which comprises many historical parks and urban forests. The total amount of green per capita (considering both parks and forests) is more than 25 $m^2$ in the Brussels Capital Region. Yet some of the green spaces are not publicly accessible or are located in peripherical areas, far away from the densely populated districts in the city centre. In spite of the strong tendency towards suburbanisation and periurbanisation, the Flemish and Walloon municipalities in the metropolitan area have not undergone the massive urbanisation that occurred on the outskirts of Milan and have therefore maintained well preserved natural open spaces and forests.

The first park in the city was conceived in the second half of the 18$^{th}$ century against the context of the creation of the royal district. Designed as a classic garden, the Parc de Bruxelles is still an important landmark and represents one of the largest green spaces in the city centre. At that time, the city was limited to the central pentagon and had less than 80,000 inhabitants.

The majority of the existing green spaces dates back to the 19$^{th}$ century, when the city of Brussels became the capital of the new-born state of Belgium and, dealing with an unprecedent population growth, underwent drastic urbanistic changes. Under Leopold II's reign (1865-1909), the city expanded on the territory of the confining municipalities and, following Hausmann's planning models, took on the appearance of a European capital city with large boulevards, squares and monuments. The urban green spaces were fundamental elements in Leopold II's conception of the capital city. Several big parks were planned and carried out on the outskirts of the city throughout the second half of the 19$^{th}$ century. The limitless resources guaranteed by the ruthlessly exploited colonial properties contributed to the realisation of grand and picturesque green landscapes, such as the *bois de la Cambre*, the Woluwe park, Forest and Duden parks.

Apart from the notable size, these green spaces are characterised by the unique attention towards botanic species, the carefully designed landscape forms and the integration with the overall urbanistic project of the city (Hennaut & Benedetti, 2019). These parks comprise several aesthetic amenities, such as ponds, slopes, waterfalls, navigable small lakes, and are often

located in correspondence of big boulevards that connect them to the central landmarks of the city. For their iconic and landscape functions they are mainly in the wealthy middle-class hilly south and south-east suburbs. The geographical distribution of green spaces exacerbated the pre-existing division between the north /south-west working class swampy and unhealthy districts, and the outer suburbs - especially the south and south-west ones - wealthy, hilly and carefully planned.

In the first half of the 20th cent. the development of the green spaces followed the same path as the previous century. Other parks were implemented with different and innovative architectural styles, but always on the outskirts of the city. Between the first and the second world war, the *Société nationale des habitations et logements à bon marché* promoted the development of public housing in new green and pedestrian friendly districts named *cites-jardins*. It was an attempt to provide the working-class population with healthy dwellings in green peripherical areas. After the first succeeded experiments (in Anderlecht, Schaerbeek, Woluwe-Saint Lambert, Evere), the projects fell apart because of the lack of public funds to implement them and because of the increasing need for housing. In fact, the idea of the *cites-jardins* fostered the spatial division between the central decaying districts and the outer wealthy and well-finished new districts, as it ignored the impellent needs of some areas of the city (Kesteloot & Saey, 2002).

The second post-war urban development did not follow any coherent urban planning idea. In fact, the term Bruxellisation was coined referring to the scattered development and redevelopment projects that continuously altered the urban morphology without any consistent public planning criteria between the 60s and the 90s. Several historical districts were demolished and replaced with modern buildings destined to host offices for the rapidly expanding tertiary sector. The European district and the northern area between Schaerbeek, Bruxelles Ville and Saint Josse ten Noode - where more than 10,000 people were evicted to make room for new skyscrapers – demonstrate the weak public control over urbanistic dynamics in those years (De Beule, 2010; Martens, 2009). Against this context, public green spaces remained a rather marginal issues in the second half of the 20th century.

After the institution of the Brussels Capital Region in 1989, planning and environmental issues became regional prerogatives. Since then, regional public agencies – i.e., *Bruxelles Environnement* and *Perspective Bruxelles* – have gradually taken the lead of urban planning and have eventually developed a greening attitude.

The challenges posed by the urban fabric inherited from the previous season of profound private-led urban changes concern also the green spaces. The spatial division within the city is quite evident. On the one hand the city centre and the districts in the west and south-west of the canal lack public spaces and green infrastructures; on the other hand, the rate of green per capita is among the highest in Europe in the outer districts and in the municipalities south and south east.

Both the city and the metropolitan area have been growing in terms of population and have undergone densification processes lately. In spite of the evident socio-ecological connections between the BCR and the nearby Flemish and Walloon municipalities, the complex institutional architecture of Belgium does not provide for any metropolitan administrative body. Three regional governments, three Flemish provinces and more than 140 municipalities are involved in environmental and territorial planning in the metropolitan area. The government of issues such as mobility, green infrastructures and ecological fluxes is therefore shared between several institutions.

The next paragraphs will describe the main actors involved in Brussels green planning and management and will attempt to compare the governance of the green space in Brussels with that of Milan, highlighting the differences and the possible consequences on the forms of the green spaces and on the generation of ecosystem services.

### 4.2.2 Contemporary green governance: main actors

After decades of laissez-faire attitude, Brussels urban and territorial planning has lately taken a green turn. Under the impulse of a political shift towards green politics, both in institutional and grassroot contexts, the relevance of urban greens spaces in the planning and urbanistic agenda has certainly growth.

The governance of the capital region is shared between diverse public agencies. *Bruxelles Environnement* deals with environmental issues and has a division dedicated to the green spaces. *Perspective Bruxelles* is the planning agency and is responsible for the *Plan Regional de Developpement Durable* (PRDD), the regional urban plan. The *Société d'Aménagemement Urbain* (SAU) deals with the development of the public projects. *Bruxelles Mobilité* is responsible for mobility and the green infrastructures along railways, in stations and other places of mobility.

The regional institutions share their powers with the 19 municipalities. Each municipality develops its own *Plan Communal de Developpement Durable* (PCDD) and represents a partner of the region in territorial planning and policies. Beyond the limits of the BCR, the metropolitan planning involves the Flemish region and provinces, and the Walloon region.

Table 4.1 summarises the main actors involved in green governance in the metropolitan area of Brussels: their contribution to green planning, management and their priorities concerning ecosystem functions and services. The following paragraphs will be dedicated to a more detailed description.

| | **Bruxelles Environnement** | **Perspective Bruxelles** | **19 Municipalities in BCR** | **Private developers** | **Citizens and ngos** | **Flanders and Wallonie** |
|---|---|---|---|---|---|---|
| **Projects, Planning role and contribution** | - Green strategies: research on natural issues, ecological corridors and networks (Plan Nature, Plan Climat, Promenade Verte);<br>- interregional projects (Metropolitan Landscapes, Werken aan de Ring);<br>- counselling for Perspective and other regional and municipal institutions | Urban planning (PRDD, PRAS), projects (contrat de renovation urbain, PADs).<br>Implementation of the strategie designed by Bruxelles Environnment: from strategy to legislation.<br>Interregional projects (Labo Ruimte, Metropolitan Landscapes, T-Op Noordland) | Local planning (PCDD, PPAS), local projects (contrat de quartier). Active role in the CRU and in the other regional projects | Large-scale projects to be discussed in the quality chamber with Bruxelles institutions, under the supervision of the Chief architect (Perspective). | -Active role in the contract de quartier since the beginning.<br>-Possibility to intervene on well-defined project in the CRU.<br>-Small-scale initiatives coordinated and financed by municipalities or region (e.g., greening the street) | Metropolitan planning in collaboration with Bruxelles institutions: mobility, peripheries, landscape<br>(Metropolitan Landscapes, Weken aan de Ring, Labor Ruimte: XX Cent. Peripherical Brussels) |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Management role and contribution** | - Management of several parks in the city, urban forests, Forest de Soignes (with Flanders and Wallonie);<br>- Natural reserves (16,mostly Natura 2000 sites).<br>- Maintenance: directly employed workforce and subcontracted workers | None | Management of some local parks in the municipality. Strong attachment to the park, but fewer resources than regional management.<br>Unequal resources between the municipalities. | None | Small scale management:<br>Incentives and guidelines for the management of private green in compliance with ecological network. | - Natural and forest reserves (Flandres);<br>- Collaboration in the management of the Forest des Soignes (Flanders and Wallonie) |
| **Prioritized functions** | Green infrastructures as nature-based solution for heat stress, noise, air pollution…<br>Shift from landscape and recreational function to nature-based solutions for the environmental issues of the city | New awareness of ecosystem services in the plan (e.g., climate regulation), but no valuation yet. Mediation between other specialised actors' priorities (ecological priorities from Brussels Environnement mobility, private property rights…) | Green infrastructures for nature-based solution, accessibility, events, participation…It varies depending on the municipal government | - Increase real estate value and urban attractiveness: quality landscapes.<br>-Urban regeneration | Access to public space and participation in the urban fabric | Landscape quality, ecological connections, nature conservation, mobility. |
| **Economic resources** | Regional funds. Big budget for management and strategic plans. | Regional funds. | Municipal and regional funds (contrat de quartier) for planning.<br>Municipal funds for the management | Private | Municipal, regional, NGOs | Regional, European |

*Table 4.2 Main actors involved in the management and planning of urban green spaces in Brussels.*

#### 4.2.2.1 Bruxelles Environnement

*Bruxelles Environnement* is the regional agency that deals with environmental issues. The *division espaces verts* takes care of the management, the maintenance of parks, as well of the greening projects and of biodiversity assessment and protection. The role of *Bruxelles*

*Environnement* concerning the green spaces is manifold. On the one hand it is operational, as it foresees the management and maintenance of parks and green spaces. On the other hand, *Bruxelles Environnement* provides regional and municipal planning agencies with consultation and guidelines about green infrastructures, ecosystems, biodiversity and all the main environmental themes. It therefore carries out a substantial research activity and importantly contributes to territorial planning and, more generally, to the environmental policies of the region.

*Regional green management*

*Bruxelles Environnement* is responsible for the management of 530 ha of the BCR green space, distributed on 106 sites. The remaining green space (slightly more than 600 ha) is managed by *Bruxelles Mobilité* and by the 19 municipalities, while the *Domaine Royale* (approximately 200 ha) is part of the Belgian Royal Trust[46].

*Bruxelles Environnement* has its own team of gardeners (127 FTE employees) for ordinary and extraordinary maintenance. However approximately 60% of the ordinary and extraordinary maintenance activities are subcontracted to specialised companies. The workforce and the economic effort for green maintenance are hence rather conspicuous. The interviewee representing the sub-division *gestion des espaces verts* claimed that the budget has been continuously growing for years, opening possibilities for innovative forms of management of the green spaces. The use of pesticides has been interdicted and new natural methods have been implemented, such as sustainable gardening techniques (*gestion différenciée*) that encompass specific maintenance activities according to socio-ecological needs, integrated management of rainwater, differentiated mowing methods.

The main issues for the next years are related to climate change: extreme weather events such as droughts and heavy rains will definitely condition the maintenance activities. According to the interviewees, the main future priority is to integrate the objectives of green maintenance with all the urbanistic projects and to adapt them to climate change. In other words, the idea is that of planning and managing the green spaces prioritising the ecosystem functions and services according to the specific contextual urban needs. Another great challenge for green maintenance is the increasing human pressure on the green space due to the population growth

[46] The natural reserves (125 ha) and the forêt de Soignes (1665 ha in the BCR) are not included in these data because they have peculiar management structures. However, Bruxelles Environnement is the leading institution in the management of those green spaces as well.

and to the events organised in the parks. The overuse of parks is a complex issue that touches upon many governance layers, namely the local and municipal ones and is therefore hardly controllable by *Bruxelles Environnment*.

*Bruxelles Environnment* collaborates with the Flemish and the Walloon environmental agencies for the management of the *Forest des Soignes* and works hand in hand with them on specific subjects – e.g., pollinators, biodiversity – for improving and coordinating green management practices.

*Bruxelles Environnement green vision*

The interviewees representing the subdivision *Stratégie et projets* firmly sustained the necessity to reorient the landscape and recreational functions that have characterised Brussels' parks since their foundation, towards an ecosystem vocation. Climate change adaptation, risk reduction, biodiversity conservation, agricultural production are the new priorities in planning and managing green and natural open spaces. The concept of ecosystem services is therefore essential.

« I think [the concept of ecosystem services] it's very important from an analytical point of view because up till now the … our operational strategies were never really measured. We had planning behind them but we never really knew what was the real impact on the city with regards to the specific problematics which we face in cities such as heat stress, such as air pollution, such as noise, water problematics; so it's quite a new concept to look at green as being a nature based solution for those problematics but so we need this approach to also measure what the impact is. And up till now we didn't do that. » [IB2]

The *Plan Nature* (Bruxelles Environnement (IBGE), 2016) establishes clear objectives about green spaces and biodiversity for the short (2020) and long term (2050). The document provides other regional agencies, the municipalities and the citizenry with guidelines and with a greening vision that integrates and supports the existing planning and green policies. The long-term ambitions consist mainly in co-constructing a greener and more biodiverse city. On the one hand, the *Plan Nature* focuses on accessibility to green spaces, biodiversity for wellbeing and on citizens' awareness and participation in greening initiatives. On the other hand, the 2050 objectives focus on natural capital as an asset for urban attractiveness and for urban sustainable development.

In the short term, the document prefigures 7 well-defined objectives. First, greening the city centre, and all the areas that clearly lack green infrastructures, not only with parks but also with street trees and other small-scale interventions, in order to guarantee accessibility to nature for every citizen. Ideally, there should be a green space of any kind at max 200 metres from the

living space, and a green space of at least 1 ha at 400 m. Objectives 2 and 3 are about ecosystem networks and multifunctional management for ecosystem services against the context of densification and increasing urban pressure. At this regard, the *Plan Nature* highlights the significance of railways, streets and interstitial green and puts forward an indicator of coefficient of biotope for new urban projects, as well as a figure of nature facilitator to sustain planners. Objective 4 aims at the management of green spaces. It wishes for a common management framework that could unify the currently diversified management landscape. Objective 5 targets wildlife and biodiversity by implementing new protected sites, fighting invasive species and valorising fringe natural spaces (e.g., railways). Finally, objectives 6 and 7 are about dissemination and multiregional governance. The plan envisions participative green management programmes and educational activities with citizens and associations. Moreover, it intends to foster partnerships with private companies and the other regional administrations.

In sum, the *Plan Nature* shows a thorough scientific multidisciplinary attention towards the themes of green spaces, ecosystem services and urban biodiversity. However, the indication of the plan must be adopted by other regional and municipal institutions. The division between *Perspective* and *Bruxelles Environnement* and the institutional fragmentation of specific competences (i.e., urbanism and environmental studies) often hamper the possibility to integrate urban planning with innovative environmental policy tools.

« Even if we still feel that today, of course, the different instances talk to each other and exchange a lot with each other, it's true that we [Bruxelles Environnement and Perspective] are perhaps not on the same objectives and on the same ways of shaping the city, or to envision the city. And suddenly that can generate discrepancies. » [IB3]

The interviewees complained about the superficiality of the PRDD – the regional territorial plan of sustainable development redacted by *Perspective Bruxelles* - regarding green infrastructures. In the plan, there is not any attempt to operationalise the concept of ecosystem services and the topic of nature-based solutions is merely quoted. They underlined the issue of temporality. In fact, the plan underwent a long process of elaboration (more than ten years) so that, when it was finalised in 2018, it was already outdated and did not include important innovative concepts. Gradual updates to the plan would help integrate new concepts and prepare the city to the challenges related to climate change and to the new arising environmental risks.

However, the representants of *Bruxelles Environnement* noticed that *Perspective Bruxelles* has undergone a shift towards sustainable politics lately, following the path designed by them. The division into regional agencies, in this sense, may be considered as an asset.

« […] the complexity of the Brussels institutions sometimes makes that it's not easy to… let's say part of policies is made in one institution part of policies is made in another one… But for instance with regards to planning it's also sometimes an advantage that we are not part of Perspective. So we can really be an extra power with regards themes such as sustainability, because we are independent of them. If we would be [were] part of the main institution and just another subdivision, for instance, we would have less power on territorial strategy than we have now. » [IB3]
« I think sometimes there are discussions and indeed they [Perspective] don't have the a priori sustainable mindset when doing planning, although this is a bit slowly shifting. But they don't have it yet. This is our core business so sometimes there are conflicts, that's true. There is also sometimes a good competition between the institutions. If, for instance, Perspective wants to develop a program around sustainability, around "Cool Planning" et caetera, we feel O.K. It's actually our competence so this competition sometimes also makes that we lift the ambitions, so that's good! ». [IB2]

The BKP (Perspective.brussels, 2019) was quoted as an example of good collaboration between the regional agencies (i.e., *Perspective Bruxelles*, *Bruxelles Environnement*, *Bruxelles Mobilité*). This urban regeneration plan designs the new landscape of the canal area, taking care of ecological connections, the forms and the quality of green infrastructures, water management and soft mobility in a truly multidisciplinary manner.

*Bruxelles Environnement* actively participates in the process of planning and often sits around the table with *Perspective* – which is the leading regional agency in this field – and with other public and private actors, providing a solid expertise on environmental issues. Moreover, BE fosters the participation of private citizens in green projects and management. Article 66 of the *Ordonnance Nature* (Bruxelles-Capitale, 2012), for instance, establishes a financial contribution for the private actors (e.g., households and companies) who manage their natural allotments according to the ecological principles stated by *Bruxelles Environnement*. The co-construction of green spaces and natural venues is in the DNA of *Bruxelles Environnment*. Several bottom up initiatives are sustained by BE, i.e. fair trade local farms (e.g., Parc Farm), community centres (e.g., Allee du Kaai), kitchen gardens throughout the city (see Mercier & Mercier, 2018 for a detailed account).

The next paragraph is about the main actor when it comes to planning: *Perspective Bruxelles*.

#### 4.2.2.2 Perspective Bruxelles

*Perspective Bruxelles* is the regional agency which is responsible for the urbanistic and territorial plans of the BCR. It issues the *Plan Régional de Developpement* (PRDD) and the

*Plan Régional d'Affectation du Sol* (PRAS), on behalf of the regional government[47]. Along with the 19 municipal plans (PCDD and PPAS), the PRDD and the PRAS represent respectively the territorial strategies and the urbanistic laws of the BCR. Moreover, *Perspective* issues the *Plans d'Aménagement Directeur* (PADs), which regard specific strategic plans and urbanistic rules on particular projects in the city (eg., *Tour &Taxis*, *Pole Reyers*).

*Perspective Bruxelles* is a multidisciplinary team which comprises planners, sociologists, economists, statisticians and many other competences. The agency, with its *observatoires*, is committed in thorough research activities on the economic and socio-territorial conditions of the city and strictly collaborate with the other regional agencies (*Bruxelles Environnement*, S.A.U., *Mobilité*…).

The newest PRDD (Bruxelles-Capitale, 2018) is built on four axes: housing and territorial development in a densifying context; sustainable and attractive territorial development for quality of life; urban and proximity economy; and multimodal mobility. The second axis includes the strategies about the urban green spaces and the natural landscape. The plan highlights the spatial differences in the provision of the green spaces. As we saw in the previous section, the central and the canal areas clearly lack public green spaces. This area, named *zone de verdoiement*, is the context of big renovation projects that, according to the plan, must include relevant portions of public green spaces, along with residential and office buildings (e.g., *Tour & Taxis*, *Port de Ninove*). Similarly, new public green spaces in big renovation projects (e.g., *Heysel*, *Josaphat*) are foreseen in more peripherical areas, where the population is not as dense as the city centre, and the interiors of the building blocks have also a great potential of greening. Finally, the second couronne – the south and the outskirts of the city – must preserve the rich green heritage that constitutes a fundamental resource for the metropolitan area.

Strategy 5 of the second axis aims at reinforcing the natural landscape. The plan talks about the optimisation of the ecosystem functions and the integration between the green infrastructures and the urban fabric, to reinforce ecological corridors and foster biodiversity. It advises to design the urban green spaces according to the specific social and ecological objectives that are to be defined by carefully studying the contextual territorial characteristics.

In opposition to the opinion expressed by *Bruxelles Environnment* employees, the interviewees from *Perspective Bruxelles* claimed that the latest plan is the first which explicitly talks about

[47] The latest PRDD was issue in 2018 while the new PRAS is still under negotiation and will be issued soon (the latest dates back to 2001)

ecosystem services and which prioritises natural and landscape structures. However, they admitted that it is difficult to put in practice the general indications of the PRDD, because *Perspective* has to take in consideration many different voices, such as landowners and private companies, and then find a legal resolution in the land use rule plan (PRAS).

« At Perspective, we will transfer these strategic plans into the plan of the land use rules (PRAS). The strategic plan (PRDD) doesn't imply any legal obligation. In the plan of the rules (PRAS) there are some legal rights linked to land use. The negotiation begins when we have to translate the intentions of the strategic plan into legal rules […] and these negotiations happen a lot with Bruxelles Environnement, because they have very important demands – it's normal, this is their role – and we have to find an equilibrium between the objectives related to ecosystems and the legal rights of the citizens who own the land». [IB4]

*Perspective Bruxelles* negotiates between different positions and facilitate common agreements. However, the final decisions are taken by the politicians who govern the region and the municipalities.

« I would say that there are some conflicts between, for instance, the regional institutions, there is always a part of discussions at the political level, but, when it comes to transfer certain things into regulatory plans, then there are some discussions that sometimes could be long, in order to decide what can be transferred and what cannot be transferred. I'll make an example: urban agriculture. There have been many debates on the idea of transferring into the law, that is into the PRAS, a maximum of square metres that can be utilised for urban agriculture. Bruxelles Environnement has made some studies, but it's Perspective that is in charge of the PRAS. So now we will have to discuss with Bruxelles Environnement, but also with the politicians of the region, in order to decide. Bruxelles Environnement has drawn up an inventory of all the non-built parcels. But we have to see which, among them, can be used for agricultural purposes. And it will also be a matter of negotiating with respect to an acquired right that people have to build. There are plots that today are in a constructible zone, and what do we do? At that point it's more of a political decision: is the politician willing to pay, for example to expropriate, to get those plots back? So there is a whole balance that must be found […]. So eventually it's a discussion, I would say, with regional and communal administrations, and with the politicians who ultimately decide. At the end of the day, it's the politicians who decide. » [IB4]

Perspective Bruxelles therefore collaborates with other regional and municipal institutions and with the political governments, in order to mediate different positions and to facilitate the political decisions regarding planning and urbanistic rules. Perspective also coordinates and collaborates with municipal and regional institutions and private developers in urban regeneration projects.

The *contracts de renovation urbain* (CRU) are large-scale projects that involve regional institutions and public and private developers. The political administration decides the priorities and subsidises the projects, while the regional institutions concur to implement them,

sometimes with private developers. The CRUs in progress include relevant green spaces, namely the *Parc de la Sennette* (*Heyvaert*) and the park at the West Station. Some participative tools have been implemented to design the places with the local dwellers. However, in the CRUs the participation is not so much in planning, but it is in the management and maintenance phases, stimulated by *Bruxelles Environnement*.

« In the case of the urban renovation project, you can see more regional ambitions and in the first series[48], it was not really much participation. It was more like projects that the region already had planned a long time before and didn't find the money [to realise them]. Because it's kind of multi-disciplinary and it's a transversal project, so you need to have development but also to develop urban ecosystems, so you involve Bruxelles Environnement, and you also need to involve la Régie Foncière, the developers, the public developers and the private developers. They didn't have the tool to develop that before. And so, the first series wasn't really bottom-up, it developed projects that were already planned for a long time, and just needed money and the management to get implemented. » [IB5]

« That means that [in the CRUs] all the planning is really top-down, but, once the projects are under way, then sometimes some participative activities are organised. » [IB6]

The other urban renovation tool is the *contrat de quartier durable* (CQD), small scale participative projects developed by the regional institutions and the municipalities in collaboration with local dwellers. In this case citizens are involved since the beginning of the projects and actively participate to the planning process. Small pocket parks and green streets (e.g., Parc Marconi in Forest) have been developed with this planning tool.

Finally, *Perspective* has a leading role in the regeneration projects developed by private actors. The projects developed in private allotments are discussed in *chambres de qualité*, where the chief architect[49] coordinates the debate between the private developer, the regional agencies (i.e., *Perspective*, BE, *Mobilité*…) and the political communal and regional administrations. The debate is not only on architectural style and quality, but also on the quality of public spaces and green infrastructures. Private-led greening projects are therefore carefully supervised by *Bruxelles Environnement* under the coordination of the chief architect and *Perspective Bruxelles*. The management of green spaces is then in charge of *Bruxelles Environnement*.

[48] The CRUs are divided in 2 slot: the first has been developed since the beginning of the regional legislation; the second will start at midterm

[49] The chief architect is a professional figure introduced by Perspective Bruxelles in 2009. "The chief architect's main role is to help clients to ensure the quality of regional public projects in terms of architecture, urban planning and public space. That role was now extended to projects carried out by the municipalities and the private sector, given that these have a major impact on the urban development of Brussels. Thus, the bouwmeester and his team are responsible for assisting, advising and encouraging public and private clients, using a variety of tools that have been developed since the creation of the function." https://bma.brussels/en/homepage/about-en/

To summarise, Perspective Bruxelles works hand in hand with Bruxelles Environnement and other regional institutions and leads and coordinates the initiatives of private developers. However, the management and the planning of the urban green spaces is not just a regional issue as it involves also the 19 municipalities in the region.

#### 4.2.2.3 Brussels municipalities

The municipalities manage approximately half of the green space in the region and actively participate in the planning processes[50]. Each of the 19 municipalities issues, in collaboration with the regional institutions, a *Plan Communale de Developpement Durable* (PCDD) and a *Plan Particulier d'Affectation du Sol* (PPAS). Moreover, the municipalities are the coordinators of the *Contrats de quartier durable* (CQD) and have an active role in the negotiation for the CRU and other renovation projects. The following paragraphs will focus on the general differences between municipal and regional green management and planning. They are based on the interviews with the regional actors and on an interview with the city councilman who is responsible for the green spaces in Bruxelles Ville.

*General differences between municipal and regional green management*

The interviewee representing Bruxelles Ville agreed with the ones from *Bruxelles Environnement* on the fact that the municipal management differs from the regional one. In general, *Bruxelles Environnement* can rely on a greater amount of workforce and economic resources, comparing to the municipalities. Bruxelles Ville, which is responsible for the management of many important parks (e.g., *bois de la Cambre*), is one of the municipalities with the largest budget for green spaces. Nevertheless, the parks managed by *Bruxelles Environnement* differ from those managed by Bruxelles Ville, in terms of quality and capacity of renovation. The municipality struggles to cope with the overuse of green spaces, especially in case of big events and festivals. Although the new government of Bruxelles Ville has been investing on the maintenance of green spaces and has experimented forms of sustainable management, it cannot guarantee the same quality of green maintenance as Bruxelles Environnement.

[50] In general, the region (Bruxelles Environnement) takes in charge the maintenance of the green spaces located on the border between two or more municipalities, or those located on strategic regional routes. However, there is not any clear criteria to distinguish regional and municipal parks.

Despite many municipalities are investing on green infrastructures and green maintenance under the impulse of the success of green parties in recent elections, the capacity of green maintenance still greatly differs. In the cases where the municipal quality is evidently bad, then the maintenance may shift to *Bruxelles Environnement*.

« I would say that the main difference between the municipalities and the region is that the management of green spaces is not always the same and doesn't always follow common criteria. And therefore there is really this question of management, which is very important.[…] And in general, when Bruxelles Environnement takes over the management of municipal parks and municipal green spaces, it is precisely linked to poor [municipal] management of the green space. […] I think there are some municipalities that have very good management and who also consult a lot Brussels Environment to learn regional maintenance tools […] The important thing is really to have an overall coherent management in the Brussels-Capital region. The way in which we can get there is disputable. I am convinced that the municipalities are perfectly capable of managing their green spaces but indeed we would have to have a global policy to build a better green network in Bruxelles Capital Region. » [IB2]

*Municipal planning tools and governance issues*

Municipalities play an essential role in Brussels' planning processes and represent the most immediate link between citizens and public institutions. Municipalities bring up territorial instances in the regional regeneration projects (e.g., CRU) and facilitate citizens' participation in small districts projects (e.g., CQD). Several bottom-up greening initiatives are fostered and subsidised. For instance, many municipalities (e.g., Ixelles, Uccle, Anderlecht) promote forms of green streets where dwellers are encouraged to plant and to raise greenery, with the technical or financial support of municipal institutions.

The municipal administrations strictly collaborate with *Bruxelles Environnement* and *Perspective* both for the regional and the local planning. The interviewee representing Bruxelles Ville affirmed that the regional and the municipal administrations follow the same objectives and share a common vision on natural open and green spaces. Since the large majority of the municipalities is governed by green and centre-left parties, there is not any big interinstitutional political conflict. However, the complex architecture of the urban governance may slow down the implementation of projects. In fact, the negotiations for the local territorial plans, or the ones for the regeneration projects may involve many different administrative layers and governments, as the municipal and the regional governments change respectively every six and five years. And with the introduction of new political governments, the projects must be rediscussed and renegotiated.

« There is an issue of different temporalities. Because the municipality proposes the contrats de quartier at the beginning. Then there is a regional process [for subsidising and discussion between regional institutions] and finally there is all the participative process and the implementation. And the political actors always change in that span of time. There are not conflicts, because everything is built all together: the region is always in the direction cabin as well as the municipality. Everything that is validated is valid for everyone: the region, the municipality and the citizens […]. On the issue of temporality I take as an example the case of the contrat de quartier Marolle. The contrat de quartier was launched by the former political administration of Bruxelles Ville and has been accepted by the region. But the new government of Bruxelles Ville doesn't want to do this contrat de quartier. But the projet has already been approved and subsidised by the region and we [the new government of Bruxelles Ville] could not say no. This could create problems. I'll make another concrete example: the contrat de quartier Junction. Everything had been decided before 2018. We arrived in 2018 and we inherited this problem…project, pardon! [laughing]. In this project, we didn't take any important strategic decision. And it is very difficult for the citizens who don't comprehend why the new municipal government cannot change the project. But everything has been already decided, the building permits have been issued, the enterprises have already been selected…». [IB7]

Interestingly, the same issue was raised at *Perspective Bruxelles* speaking about the *contrat de renovation urbain.*

« What is sometimes very complicated is that these are projects that take many years. And in fact the people who take care of these projects change, whether in administrations or at the political level, and so that also is a waste of time because the intentions, the ambitions, the way of working, are different from one person to another. » [IB6]

#### 4.2.2.4 Metropolitan green planning and management tools

The governance of Brussels green space is not limited to the institution that operate in the Brussels Capital Region, as the metropolitan area goes beyond the limits of the capital region. Socio-ecological processes such as ecological connections, mobilities and urban densification require a broader political sight. Since the Belgian institutional configuration does not include any metropolitan actor, the governance of Brussels metropolitan issues is shared among the regions, namely the BCR and the Flanders.

The *foret des soignes*, which is the largest forest in the metropolitan area, has been co-managed by the three regions (BCR, Flanders and Wallonia) since 1983. Moreover, several research projects and plans have been carried out jointly in recent years. Some of them concern the territorial planning of specific areas. For instance, the *Plan Directeur interrégional pour Neerpede-Vlezenbeek-Sint Anna Pede*, elaborated by the regional environmental agencies (Bruxelles Environnement and Vlaamse Landmaatschappij) aims to reinforce the landscape

structure and to foster the green and blue infrastructures in Brussels South-West hinterland. Other projects regard larger areas. The project *Werke aan de Ring*, which is sustained by the three regional administrations, has the objective of improving mobility, ecological connections and quality of life around the Brussels external ring (R0). The research named *Metropolitan landscape*, carried out by a consortium of Brussels and Flemish administrative agencies, highlights the main challenges regarding metropolitan landscapes and ecologies.

The Flemish and Brussels environmental and planning agencies have developed several forms of collaborations for the metropolitan governance. However, the implementation of the plans and the policy making process are rather complicated because they involve two political governments that have often conflictual visions. The problem consists not only in harmonizing two different legislative framework, but also in finding a common political ground between the BCR and the Flanders.

« What we notice is that these are all initiatives launched by the Flemish and Brussels administrations, and after that, politics has to follow. Politics must get hold of these questions after that. Sometimes it's okay, but sometimes we feel that there are sometimes little political tensions…» [IB6]

### 4.2.3 Concluding remarks: a comparison with Milan

The analysis of the governance of Brussels clearly shows a strong public commitment towards green spaces. The BCR agencies have elaborated thorough strategies of green management and planning and, with the support of the regional political government, have been implementing relevant greening initiatives. The public maintenance of parks and green spaces has shifted towards sustainable and diversified techniques that prioritise ecosystem functions and services against the context of climate change adaptation. The regional territorial plan partially acknowledges the role of ecosystems in planning, although it does not provide any specific indication to translate concepts such as ecosystem services and nature-based solution into urbanistic regulations. However, all the variegated forms of urban regeneration projects (i.e., PADs, CRUs, CQD) involve *Bruxelles Environnement*, which provides a solid scientific expertise and strongly advocates truly sustainable projects, influencing Perspective and the other actors involved. The municipalities importantly collaborate with the region, representing territorial interests and facilitating participative processes that involve local dwellers. The historical green heritage represents both a great value for the city and a challenge, as it is concentrated namely in the outer wealthy districts. At this regard, the regional institutions aim

to improve accessibility to green spaces all over the city and have elaborated several projects in the canal area, which, in spite of the strong population pressure, is very poor in terms of green infrastructures (see chapter 3.2). At a metropolitan level, the Flemish and the Brussels environmental and planning agencies jointly work on many research and operational projects on periurban landscape and ecosystems, despite the lack of metropolitan administrative institutions.

To summarise, after decades of private led urban development, the public institutions have recently taken the lead of urban planning and regeneration projects, promoting sustainable forms of urban development. However, the research has also highlighted some problematics regarding green governance. Let us remind three macro issues.

First, the institutional fragmentation hinders a unitary vision of the green space. That is true at a city level, with the different standards of green maintenance guaranteed by the 19 municipalities and the region, and at a metropolitan level, where the interregional political and administrative divisions hamper the implementation of consistent environmental planning and policies. For sure, this is a rather diffused problematic inherent to the complex Belgian institutional architecture. It is interesting to notice, though, how this may affect greening and sustainability policies.

Second, linked to the institutional fragmentation, the slow pace of the policy making processes may affect the implementation of the projects and the scientific solidity of planning. The elaborated governance of Brussels - which comprises diverse regional and municipal institutions – demands a great amount of time to design and implement plans and projects. The slow elaboration of the regional territorial plan, for instance, was deemed as the main cause of the missing scientific updates on concepts such as ecosystem services and nature-based solutions. In fact, the scientific knowledge on these themes has progressed in the last few years, while the elaboration of the plan took more than ten years. Moreover, regional and municipal political and administrative figures change throughout the long timespan of project making, hence further complicating the process.

Finally, the population of the metropolitan area has been growing for more than a decade and the PRDD envisions a densification of the second couronne and of the municipalities on the border between Brussels and the Flemish region. The lack of a common legislative and political framework may hamper a coherent and consistently sustainable urban development.

#### 4.2.3.1 Milan and Brussels: sustainability and green governance structures

In conclusion, it can be affirmed that the green governance structure of Brussels widely differs from that of Milan. In the previous chapter, five coexisting green governance models were detected in Milan metropolitan area. Each model involves diverse actors and expresses a peculiar vision of greening. Civic associations, foundations and private developers have played a pivotal role in green planning and management over the last forty years. Innovative bottom-up urban afforestation experiences have grown in highly urbanised peripherical areas, while private developers have recently designed and begun to manage green spaces in formerly disused renovated districts. The lack of public funds destined to the green spaces have favoured civic and private forms of green planning and management initiatives. In particular, the municipality has lately encouraged the private management of public green spaces and has recently launched, along with the metropolitan city, an ambitious metropolitan afforestation projects that depends on foundations and private companies.

On the contrary, Brussels green governance is clearly guided by public institutions. The Brussels Capital Region and the 19 municipalities share a leading position in green planning and management. Despite the institutional fragmentation, Brussels green governance is not diversified as Milan's. The 19 municipalities and the Brussels Capital Region do rely on heterogeneous economic means and planning tools. Yet they strictly collaborate with each other under the coordination of *Bruxelles Environnement* and other regional institutions.

It is interesting to notice that, while both the cities have lately put sustainability at the core of urban planning, they have very different governance models and political structures to implement and manage green spaces. This may affect the future characteristics of urban development and, in particular, the forms and the distribution of the green spaces and therefore the generation of ecosystem services. Milan's mixed governance entails, on the one hand, a bottom-up civic approach that follows the example of *Parco Nord* and other innovative experiences and, on the other hand, a market-oriented approach that embeds the green spaces in private-led urban regeneration processes. The latest greening projects (i.e., Forestami, Scali Ferroviari) and forms of management (i.e., private sponsorships) go towards a privatisation of sustainable policies, hence prioritising urban attractiveness and economic growth over ecological protection and social cohesion. Surely, the renovated public and private interest in sustainability has fostered greening initiatives and has contributed to increase the green spaces in the city and its hinterland. However, the weak coordination and the lack of resources of the public institutions hinder a coherent ecological planning that looks at important social and

environmental issues (i.e., distributive justice, ecological connections and socio-ecological resilience). Thus, the risk inherent to this kind of governance is to develop isolated projects under a market-oriented idea that stimulates urban attractivity but ignores the actual socio-ecological conditions of the city and of the metropolitan areas.

Conversely, the public-led Brussels green governance prioritises accessibility and dwellers' participation in the new projects (CRU and CDQ) and climate adaptation in the maintenance and management practices. It is therefore embedded in a conception of sustainability that privileges procedural and distributive environmental justice as well as ecological resilience over urban attractivity and economic growth.

# Conclusion

This thesis stemmed from the assumption that green and open natural spaces represent essential resources for contemporary large urban areas and play a pivotal role in sustainable planning. The research elaborated on the social and territorial benefits guaranteed by green spaces in the metropolitan areas of Milan and Brussels. On the one hand, I studied the distribution of three ecosystem services in relation to the socio-territorial characteristics in the metropolitan areas. On the other hand, I focused on the governance of green planning and management, to comprehend the political dynamics and the vision that underpin greening.

In the first section, I worked on the theoretical framework and I tried to refine the research issues, by delving into different topics. Chapter 1.2 outlined the main debate on the socio-territorial forms of contemporary urbanisation and on the relating environmental problematics. I underlined the relevance of environmental issues for urban liveability and for societal well-being at different scales. Moreover, I noticed that urban studies have long overlooked environmental dynamics and I put forward some possible convergences between environmental and urban territorial studies.

I hence provided a critical definition of sustainability in chapter 1.3, exploring the broad semantic field and the multifaceted practices developed under the umbrella of the concept. The chapter stressed the importance of situating sustainability and highlighted the contribution of ecological economics, environmental justice and political ecology to reframe the concept.

Finally, in chapter 1.4, I reviewed the main challenges related to urban green spaces. The chapter introduced the concept of ecosystem services, with a particular attention to the socio-territorial distribution of the benefits and to the political articulation and generation of green infrastructures. I argued that the value of ecosystem services is not just a mere ecological function but depends on the socio-territorial characteristics in which green infrastructures and their benefits are entangled.

The first section of the thesis paved the way for the empirical research. I illustrated the research design in the second section and the empirical results in the third and in the fourth. Chapter 2.1 defined the scope of the research and the research questions. The research has built on the following two macro-questions:

1) How do urban green spaces and ecosystem dynamics contribute to the territorial wellbeing of the metropolitan areas of Milan and Brussels?

2) What are the main political dynamics that underpin greening in Milan and Brussels contemporary urbanisation processes?

Given its broad extent, the first macroquestion was further articulated employing the concept of ecosystem services. In particular, the research aimed to understand the distribution of ecosystem services in different territorial layers (e.g., urban, suburban, periurban) and to combine it with dwellers' socio-economic features. This allowed comprehending inequalities and environmental injustices in relation to the provision of ecosystem services. From the second macroquestion, more specific questions on the governance of green planning and management were elaborated.

In Chapter 2.2, I illustrated the methods and the tools of analysis. The research utilised a broad range of methods. The spatial analysis of ecological, territorial and socio-economic data addressed the first macroquestion. Conversely, qualitative methods of analysis were implemented for addressing the second macroquestion.

Section 3 and 4 presented the empirical results of the research. In the third section, I illustrated the results of the spatial analyses on three ecosystem services in Milan and Brussels, while the fourth is dedicated to the study of the governance and the political articulation of green infrastructures and ecosystem services.

In this conclusion, I would like to summarise the main findings of the thesis, as well as the limitations and the possible future research developments. The analysis of the socio-territorial distribution of three ecosystem services – carbon storage, heat mitigation and water retention – brought to the following conclusions.

- Periurban and semi-rural areas contribute for the large majority of the carbon stored in the terrestrial ecosystems of Milan and Brussels metropolitan areas. The conservation of periurban forests and open spaces is therefore essential in urban carbon neutrality strategies. Sustainable planning and environmental policies should go beyond the administrative cities and the urban core, embracing metropolitan logics. Agricultural areas represent a great resource for large urban areas, not only for provisioning, but also for regulating purposes.
- The lack of green infrastructures and the weak provision of ecosystem services reinforce existing spatial inequalities and territorial vulnerabilities, especially against the context of climate change adaptation. This is true in the city centre and in the Canal area of Brussels. Here the poorest areas in the region are at risk of heatwaves and floods and

are not provided with adequate green spaces and regulating ecosystem services. The northern periphery of Milan, which was deeply marked by uncontrolled industrialisation and urbanising pressures during the second half of the 20th century, also presented some social and territorial vulnerabilities, related to the risk of heatwaves and floods.

- The ecosystem services assessment proved the complexity of the multifunctional nature of green spaces and the necessity to keep together different territorial exigences in sustainable planning and greening policies. On the one hand, the planning and the management of periurban green spaces, agricultural and natural open spaces demand intermunicipal coordination and involve large administrative bodies (i.e., provinces, regions). On the other hand, urban greening requires a thorough attention towards local intracommunal social dynamics. Neighbourhood and districts socio-territorial vulnerabilities should be taken in consideration in greening policies. In this sense, the assessment of ecosystem services may help combine urban planning with welfare and disaster risk reduction policies.

The governance of urban green spaces is therefore essential to grasp the complexity of multifunctional green infrastructures. In fact, the ways in which a park or a green space is conceived or maintained strongly condition the provision of ecosystem services. I will try to summarise the main findings on the governance of greening and of the vision and the attitude of the main actors in the following points.

- Milan's green spaces are governed and managed by a large range of institutional and non-institutional actors. The public institutions have been losing their influence over green maintenance and design. The lack of public funds, the consolidated role of associations and foundations, and the emerging role of private developers in green design and management have resulted in new and innovative forms of governance (e.g., the urban afforestation project named Forestami). As it tends towards privatisation, Milan's mixed governance model privileges scattered big projects and private forms of management of the green spaces. The Municipality and the Metropolitan city are committed towards climate change adaptation and mitigation and acknowledge the relevance of a unitary vision on green infrastructures. However, the governance lacks a strong planning coordination that can articulate the green infrastructures and the provision of ecosystem services listening to territorial needs.
- On the contrary, Brussels' governance is strongly guided by public institutions. *Bruxelles Environnement* shares the maintenance of the green spaces with the municipalities and participates in the planning processes, along with *Perspective Bruxelles* and the municipal institutions. This form of public-driven governance is committed towards ecological connectivity, regulating ecosystem services, accessibility to green spaces and participative processes of green maintenance and design. However, the complex institutional architecture of Brussels hampers a linear and fast decision-

making process. The long temporality of decision-making may result in ideas and plans that are not up to date. Furthermore, the Belgian institutional architecture does not include any metropolitan administrative institution, and the metropolitan governance is therefore shared between diverse regional governments, which are often in political conflict.

- In sum the research shows two different governance structures and models of greening and attempts to delineate the differences in terms of ecosystem services generation and articulation. On the one hand Milan's model is more oriented towards recreational functions, attractivity and aesthetic values. On the other hand, Brussels' idea of greening is more inclined towards ecological connections and regulating ecosystem services for climate change adaptation and mitigation, and accessibility and participation for environmental justice.

These conclusive points are meant to provide stakeholders and policymakers with valuable insights for sustainable planning and greening policies. As the thesis explores unconsolidated transdisciplinary research paths, I would finally like to point out the limitations of this work and the possible future research developments.

For sure, the assessment of three ecosystem services represents just a little portion of the numerous territorial benefits provided by green infrastructures. Other regulating (e.g., pollution and noise reduction), provisioning (e.g. food and timber production for the local market), recreational and support services (e.g., pollination) are rather significant against the context of Milan and Brussels metropolitan areas. A more comprehensive idea of the ecosystem services distribution would certainly improve the validity of the research.

Furthermore, this research overlooks the relevance of the dwellers' perception of green and the participation of grassroot movements in the maintenance and planning of parks and green spaces. The perception of the local value of ecosystem services would help understand the supply of ecosystem services in relation to the demand. The study of local societal dynamics would enrich the analysis of the governance of greening processes.

From a methodological point of view, it is clear that the methods and the tools of analysis here employed are widely improvable. The assessment of ecosystem services may be refined utilising more detailed and precise data on trees and greenery. The spatial analyses and the mapping representations could rely on more sophisticated statistical and graphic tools. For instance, GIS map algebra tools of analysis may help combine socio-economic, ecological and environmental data. Further collaborations with geographers and environmental scientists would have surely improved the methods of analysis.

This thesis is meant to open the way to new research paths that integrate urban sociological and territorial research interests with those of ecological and environmental sciences. It would be interesting to research the issues raised in this thesis at different scales. At a smaller local scale (eg.district, neighborhood) it would be possible to implement participative methods of analysis and to dig into dwellers' uses and perception of green spaces. At a larger scale, it would be helpful assessing ecosystem supply and demand in urban and non-urban marginal places to understand the territorial connections and to acknowledge the contribution of alpine and internal areas to urban places. For sure, this kind of studies would benefit from collective forms of research that involve diverse academic disciplines, as well as stakeholders and practitioners.

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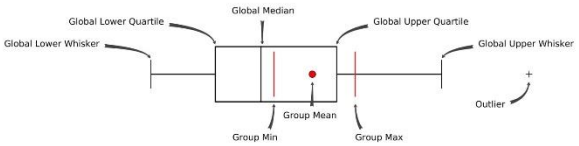
# Annex A. Grouping analysis

Grouping analysis: Brussels

Group-Wise Summary




**Overall Variable Statistics: Count = 3639; Std. Distance = 1,7318; SSD = 1771,4260**

| Variable | Mean | Std. Dev. | Min | Max | R2 |
|---|---|---|---|---|---|
| ZDENS_POP | 0,0000 | 0,9999 | -0,6066 | 4,9213 | 0,8734 |
| ZPENDO | -0,0000 | 0,9999 | -1,7746 | 2,3659 | 0,8346 |
| ZC_SUOLO | -0,0000 | 0,9999 | -0,8752 | 3,2511 | 0,8051 |

**Group 1: Count = 1070; Std. Distance = 0,5353; SSD = 306,7081**

| Variable | Mean | Std. Dev. | Min | Max | Share |
|---|---|---|---|---|---|
| ZDENS_POP | -0,4200 | 0,1617 | -0,6066 | 0,3575 | 0,1744 |
| ZPENDO | 0,9851 | 0,3826 | 0,3716 | 2,3659 | 0,4817 |
| ZC_SUOLO | -0,4810 | 0,3377 | -0,8752 | 0,4768 | 0,3277 |

**Group 2: Count = 363; Std. Distance = 0,9902; SSD = 356,0087**

| Variable | Mean | Std. Dev. | Min | Max | Share |
|---|---|---|---|---|---|
| ZDENS_POP | 0,8582 | 0,6385 | -0,5271 | 2,7967 | 0,6013 |
| ZPENDO | -1,6218 | 0,1020 | -1,7746 | -0,6371 | 0,2747 |

Group-Wise Summary (cont.)

| Variable | Mean | Std. Dev. | Min | Max | Share |
|---|---|---|---|---|---|
| ZC_SUOLO | 0,7047 | 0,7499 | -0,8752 | 2,9493 | 0,9269 |

**Group 3: Count = 1441; Std. Distance = 0,5529; SSD = 440,6188**

| Variable | Mean | Std. Dev. | Min | Max | Share |
|---|---|---|---|---|---|
| ZDENS_POP | -0,4930 | 0,1126 | -0,6066 | 0,2384 | 0,1529 |
| ZPENDO | -0,1299 | 0,4490 | -1,7746 | 0,4446 | 0,5360 |
| ZC_SUOLO | -0,6178 | 0,3023 | -0,8752 | 0,5999 | 0,3575 |

**Group 4: Count = 333; Std. Distance = 0,9864; SSD = 324,1012**

| Variable | Mean | Std. Dev. | Min | Max | Share |
|---|---|---|---|---|---|
| ZDENS_POP | 2,6665 | 0,8215 | 0,8655 | 4,9213 | 0,7337 |
| ZPENDO | -1,6111 | 0,0900 | -1,7746 | -1,4702 | 0,0735 |
| ZC_SUOLO | 2,1202 | 0,5385 | -0,2413 | 3,2511 | 0,8464 |

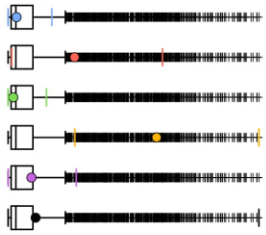
**Group 5: Count = 432; Std. Distance = 0,8922; SSD = 343,9892**

| Variable | Mean | Std. Dev. | Min | Max | Share |
|---|---|---|---|---|---|
| ZDENS_POP | -0,0919 | 0,3097 | -0,6034 | 0,8958 | 0,2712 |
| ZPENDO | 0,5981 | 0,5854 | -0,6435 | 2,3659 | 0,7268 |
| ZC_SUOLO | 1,0256 | 0,5979 | 0,1895 | 2,9636 | 0,6723 |

Variable-Wise Summary

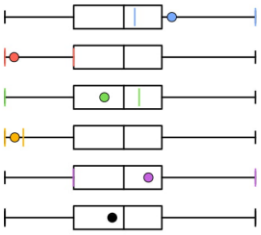
**ZDENS_POP: R2 = 0,87**

| Group | Mean | Std. Dev. | Min | Max | Share |
|---|---|---|---|---|---|
| 1 | -0,4200 | 0,1617 | -0,6066 | 0,3575 | 0,1744 |
| 2 | 0,8582 | 0,6385 | -0,5271 | 2,7967 | 0,6013 |
| 3 | -0,4930 | 0,1126 | -0,6066 | 0,2384 | 0,1529 |
| 4 | 2,6665 | 0,8215 | 0,8655 | 4,9213 | 0,7337 |
| 5 | -0,0919 | 0,3097 | -0,6034 | 0,8958 | 0,2712 |
| Total | 0,0000 | 0,9999 | -0,6066 | 4,9213 | 1,0000 |



**ZPENDO: R2 = 0,83**

| Group | Mean | Std. Dev. | Min | Max | Share |
|---|---|---|---|---|---|
| 1 | 0,9851 | 0,3826 | 0,3716 | 2,3659 | 0,4817 |
| 2 | -1,6218 | 0,1020 | -1,7746 | -0,6371 | 0,2747 |
| 3 | -0,1299 | 0,4490 | -1,7746 | 0,4446 | 0,5360 |
| 4 | -1,6111 | 0,0900 | -1,7746 | -1,4702 | 0,0735 |
| 5 | 0,5981 | 0,5854 | -0,6435 | 2,3659 | 0,7268 |
| Total | -0,0000 | 0,9999 | -1,7746 | 2,3659 | 1,0000 |

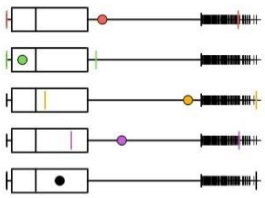


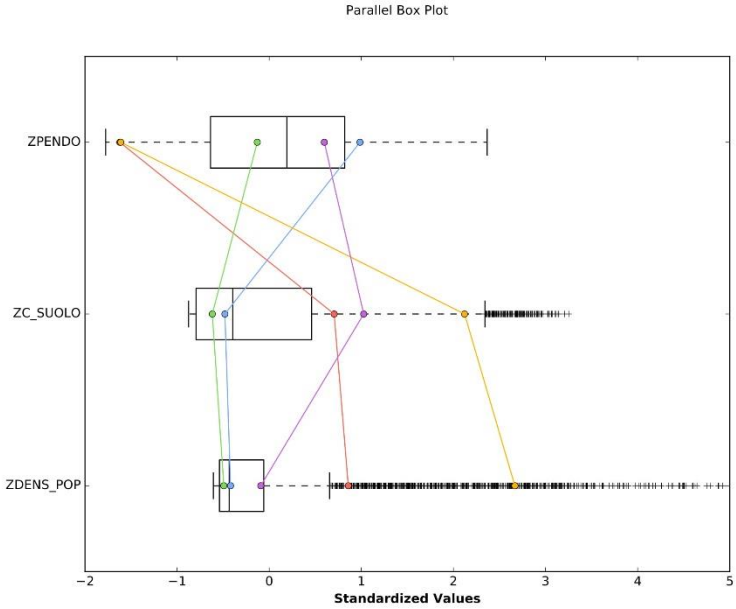
**ZC_SUOLO: R2 = 0,81**

| Group | Mean | Std. Dev. | Min | Max | Share |
|---|---|---|---|---|---|
| 1 | -0,4810 | 0,3377 | -0,8752 | 0,4768 | 0,3277 |

Variable-Wise Summary (cont.)

| Group | Mean | Std. Dev. | Min | Max | Share |
|---|---|---|---|---|---|
| 2 | 0,7047 | 0,7499 | -0,8752 | 2,9493 | 0,9269 |
| 3 | -0,6178 | 0,3023 | -0,8752 | 0,5999 | 0,3575 |
| 4 | 2,1202 | 0,5385 | -0,2413 | 3,2511 | 0,8464 |
| 5 | 1,0256 | 0,5979 | 0,1895 | 2,9636 | 0,6723 |
| Total | -0,0000 | 0,9999 | -0,8752 | 3,2511 | 1,0000 |



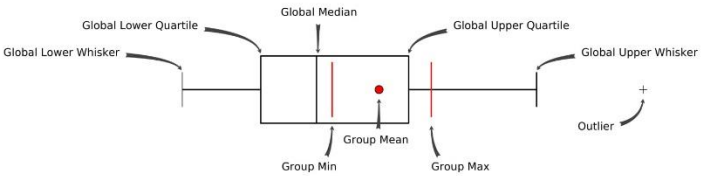



Grouping Analysis Parameters

| Parameter Name | Input Value |
|---|---|
| Input Features | bru_dppecsz |
| Unique ID Field | OBJECTID_1 |
| Output Feature Class | None |
| Analysis Fields | ZDENS_POP |
| | ZPENDO |
| | ZC_SUOLO |
| Spatial Constraints | NO_SPATIAL_CONSTRAINT |
| Distance Method | EUCLIDEAN |
| Number of Neighbors | None |
| Weights Matrix File | None |
| Initialization Method | FIND_SEED_LOCATIONS |
| Initialization Field | None |
| Selection Set | False |

# Grouping analysis: Milan

Group-Wise Summary




**Overall Variable Statistics: Count = 23236; Std. Distance = 1,6991; SSD = 19171,5660**

| Variable | Mean | Std. Dev. | Min | Max | R2 |
|---|---|---|---|---|---|
| ZDENS_POP | -0,0000 | 1,0000 | -1,1205 | 3,3106 | 0,7541 |
| ZPEND_POP_1 | 0,0001 | 0,9418 | -1,5300 | 4,6900 | 0,7339 |
| ZIMPERV | 0,0000 | 1,0000 | -1,9389 | 1,8991 | 0,6870 |

**Group 1: Count = 3507; Std. Distance = 0,9832; SSD = 3445,9822**

| Variable | Mean | Std. Dev. | Min | Max | Share |
|---|---|---|---|---|---|
| ZDENS_POP | 0,1402 | 0,5886 | -1,1205 | 1,6250 | 0,6196 |
| ZPEND_POP_1 | -1,0213 | 0,3520 | -1,5300 | 0,0100 | 0,2476 |
| ZIMPERV | 0,3396 | 0,7046 | -1,4990 | 1,8991 | 0,8854 |

**Group 2: Count = 7065; Std. Distance = 0,8419; SSD = 5168,1343**

| Variable | Mean | Std. Dev. | Min | Max | Share |
|---|---|---|---|---|---|
| ZDENS_POP | -0,1459 | 0,5323 | -1,1205 | 2,1625 | 0,7409 |
| ZPEND_POP_1 | 0,3441 | 0,4213 | -0,6400 | 2,6100 | 0,5225 |

Group-Wise Summary (cont.)

| Variable | Mean | Std. Dev. | Min | Max | Share |
|---|---|---|---|---|---|
| ZIMPERV | 0,5512 | 0,4980 | -0,7742 | 1,8991 | 0,6965 |

**Group 3: Count = 3624; Std. Distance = 0,9285; SSD = 3208,0578**

| Variable | Mean | Std. Dev. | Min | Max | Share |
|---|---|---|---|---|---|
| ZDENS_POP | 1,8853 | 0,5723 | 0,5933 | 3,3106 | 0,6132 |
| ZPEND_POP_1 | -1,0007 | 0,4263 | -1,5300 | 1,0100 | 0,4084 |
| ZIMPERV | 0,9731 | 0,5939 | -1,7607 | 1,8991 | 0,9536 |

**Group 4: Count = 4912; Std. Distance = 0,8881; SSD = 4100,0035**

| Variable | Mean | Std. Dev. | Min | Max | Share |
|---|---|---|---|---|---|
| ZDENS_POP | -0,6350 | 0,3464 | -1,1205 | 2,0027 | 0,7048 |
| ZPEND_POP_1 | 1,1735 | 0,6005 | 0,1300 | 4,6900 | 0,7331 |
| ZIMPERV | -0,5463 | 0,5551 | -1,9389 | 1,6044 | 0,9232 |

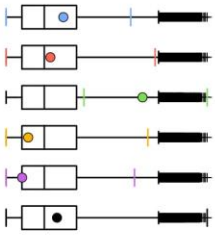
**Group 5: Count = 4128; Std. Distance = 0,8631; SSD = 3249,3882**

| Variable | Mean | Std. Dev. | Min | Max | Share |
|---|---|---|---|---|---|
| ZDENS_POP | -0,7688 | 0,4178 | -1,1205 | 1,7079 | 0,6383 |
| ZPEND_POP_1 | -0,2388 | 0,5753 | -1,5300 | 0,9600 | 0,4003 |
| ZIMPERV | -1,4361 | 0,4894 | -1,9389 | -0,1444 | 0,4676 |

Variable-Wise Summary

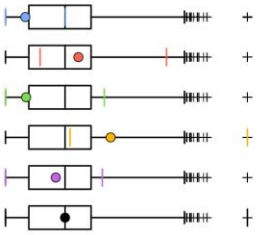
**ZDENS_POP: R2 = 0,75**

| Group | Mean | Std. Dev. | Min | Max | Share |
|---|---|---|---|---|---|
| 1 | 0,1402 | 0,5886 | -1,1205 | 1,6250 | 0,6196 |
| 2 | -0,1459 | 0,5323 | -1,1205 | 2,1625 | 0,7409 |
| 3 | 1,8853 | 0,5723 | 0,5933 | 3,3106 | 0,6132 |
| 4 | -0,6350 | 0,3464 | -1,1205 | 2,0027 | 0,7048 |
| 5 | -0,7688 | 0,4178 | -1,1205 | 1,7079 | 0,6383 |
| Total | -0,0000 | 1,0000 | -1,1205 | 3,3106 | 1,0000 |



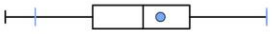
**ZPEND_POP_1: R2 = 0,73**

| Group | Mean | Std. Dev. | Min | Max | Share |
|---|---|---|---|---|---|
| 1 | -1,0213 | 0,3520 | -1,5300 | 0,0100 | 0,2476 |
| 2 | 0,3441 | 0,4213 | -0,6400 | 2,6100 | 0,5225 |
| 3 | -1,0007 | 0,4263 | -1,5300 | 1,0100 | 0,4084 |
| 4 | 1,1735 | 0,6005 | 0,1300 | 4,6900 | 0,7331 |
| 5 | -0,2388 | 0,5753 | -1,5300 | 0,9600 | 0,4003 |
| Total | 0,0001 | 0,9418 | -1,5300 | 4,6900 | 1,0000 |



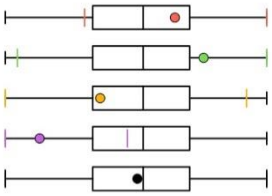
**ZIMPERV: R2 = 0,69**

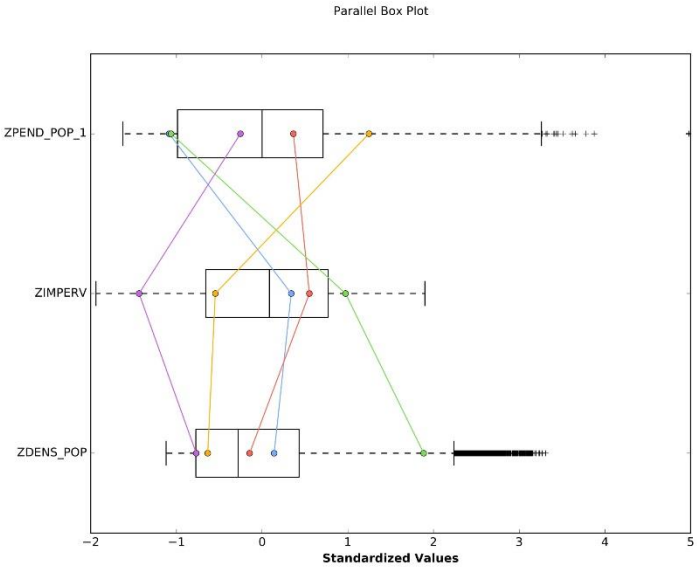
| Group | Mean | Std. Dev. | Min | Max | Share |
|---|---|---|---|---|---|
| 1 | 0,3396 | 0,7046 | -1,4990 | 1,8991 | 0,8854 |



Variable-Wise Summary (cont.)

| Group | Mean | Std. Dev. | Min | Max | Share |
|---|---|---|---|---|---|
| 2 | 0,5512 | 0,4980 | -0,7742 | 1,8991 | 0,6965 |
| 3 | 0,9731 | 0,5939 | -1,7607 | 1,8991 | 0,9536 |
| 4 | -0,5463 | 0,5551 | -1,9389 | 1,6044 | 0,9232 |
| 5 | -1,4361 | 0,4894 | -1,9389 | -0,1444 | 0,4676 |
| Total | 0,0000 | 1,0000 | -1,9389 | 1,8991 | 1,0000 |






Grouping Analysis Parameters

| Parameter Name | Input Value |
|---|---|
| Input Features | urb_area_sez_edpiainz |
| Unique ID Field | FID_1 |
| Output Feature Class | None |
| Analysis Fields | ZPEND_POP_1 |
| | ZDENS_POP |
| | ZIMPERV |
| Spatial Constraints | NO_SPATIAL_CONSTRAINT |
| Distance Method | EUCLIDEAN |
| Number of Neighbors | None |
| Weights Matrix File | None |
| Initialization Method | FIND_SEED_LOCATIONS |
| Initialization Field | None |
| Selection Set | False |

# Annex B. PCA analysis

Bruxelles social vulnerability PCA

**Comunalità**

| | Iniziale | Estrazione |
|---|---|---|
| Punteggio Z(edu_index) | 1,000 | ,506 |
| Punteggio Z(Mt_tauxchom) | 1,000 | ,763 |
| Punteggio Z(N_poudevpop) | 1,000 | ,692 |
| Punteggio Z(rev_d1totmen) | 1,000 | ,850 |
| Punteggio Z(Npiec_poctot) | 1,000 | ,750 |

Metodo di estrazione: Analisi dei componenti principali.

**Varianza totale spiegata**

| | Autovalori iniziali | | | Caricamenti somme dei quadrati di estrazione | | |
|---|---|---|---|---|---|---|
| Componente | Totale | % di varianza | % cumulativa | Totale | % di varianza | % cumulativa |
| 1 | 3,561 | 71,215 | 71,215 | 3,561 | 71,215 | 71,215 |
| 2 | ,588 | 11,767 | 82,982 | | | |
| 3 | ,394 | 7,876 | 90,859 | | | |
| 4 | ,304 | 6,071 | 96,929 | | | |
| 5 | ,154 | 3,071 | 100,000 | | | |

Metodo di estrazione: Analisi dei componenti principali.

**Matrice dei coefficienti di punteggi dei componenti**

| | Componente |
|---|---|
| | 1 |
| Punteggio Z(edu_index) | -,200 |
| Punteggio Z(Mt_tauxchom) | ,245 |
| Punteggio Z(N_poudevpop) | ,234 |
| Punteggio Z(rev_d1totmen) | ,259 |
| Punteggio Z(Npiec_poctot) | ,243 |

Metodo di estrazione: Analisi dei componenti principali.

Metodo di rotazione: Varimax con normalizzazione Kaiser.

Punteggi componente.

Milan social vulnerability PCA

**Matrice di correlazione**

| | | zdim_abit_ | zstr_pop | zliv_edu |
|---|---|---|---|---|
| Correlazione | zdim_abit_ | 1,000 | -,263 | ,598 |
| | zstr_pop | -,263 | 1,000 | -,140 |
| | zliv_edu | ,598 | -,140 | 1,000 |
| Sign. (a una coda) | zdim_abit_ | | ,000 | ,000 |
| | zstr_pop | ,000 | | ,000 |
| | zliv_edu | ,000 | ,000 | |

**Comunalità**

| | Iniziale | Estrazione |
|---|---|---|
| zdim_abit_ | 1,000 | ,776 |
| zstr_pop | 1,000 | ,240 |
| zliv_edu | 1,000 | ,697 |

Metodo di estrazione: Analisi dei componenti principali.

**Varianza totale spiegata**

| | Autovalori iniziali | | | Caricamenti somme dei quadrati di estrazione | | |
|---|---|---|---|---|---|---|
| Componente | Totale | % di varianza | % cumulativa | Totale | % di varianza | % cumulativa |
| 1 | 1,713 | 57,111 | 57,111 | 1,713 | 57,111 | 57,111 |
| 2 | ,899 | 29,957 | 87,068 | | | |
| 3 | ,388 | 12,932 | 100,000 | | | |

Metodo di estrazione: Analisi dei componenti principali.

**Matrice dei componenti[a]**

| | Componente |
|---|---|
| | 1 |
| zdim_abit_ | ,881 |
| zstr_pop | -,490 |
| zliv_edu | ,835 |

Metodo di estrazione: Analisi dei componenti principali.

a. 1 componenti estratti.

# Annex C. interviews

Interviews in Milan

| REFERENCE | PARTICIPANT PROFILE | INSTITUTION/ORGANISTATION |
|---|---|---|
| **I1** | Public servant | *Green, agriculture and urban furniture* area. Municipality of Milan |
| **I2** | Public servant | *Green, agriculture and urban furniture* area. Municipality of Milan |
| **I3** | Public servant | *General urban planning* area. Municipality of Milan |
| **I4** | Public servant | *General urban planning* area. Municipality of Milan |
| **I5** | Senior manager | *Biblioteca degli alberi Milano (BAM)* |
| **I6** | Architect | *Biblioteca degli alberi Milano (BAM)* |
| **I7** | Architect | *CItylife* |
| **I8** | Manager | *Boscoincittà* |
| **I9** | Manager | *Parco Nord* |
| **I10** | Manager | *Parco Nord* |
| **I11** | Council member | *Città Metropolitana* |

Interviews in Brussels

| REFERENCE | PARTICIPANT PROFILE | INSTITUTION/ORGANISTATION |
|---|---|---|
| **IB1** | Public servant | *Division Espaces Verts. Bruxelles Environnment* |
| **IB2** | Public servant | *Division Espaces Verts. Bruxelles Environnment* |
| **IB3** | Public servant | *Division Espaces Verts. Bruxelles Environnement* |
| **IB4** | Public servant | *Direction Stratégie Territoriale. Perspective Bruxelles* |
| **IB5** | Public servant | *Direction Stratégie Territoriale. Perspective Bruxelles* |
| **IB6** | Public servant | *Direction Stratégie Territoriale. Perspective Bruxelles* |
| **IB7** | Council member | *Bruxelles Ville* |

Notes:

- The interviews in Brussels have been conducted via Skype or Zoom, because of the outburst of the Covid-19 pandemic.

- The interviews in Milan have been conducted in Italian language. The interviews in Brussels have been conducted in English and French languages.