Chapter 1
Introduction

1.1 Ecosystem Services in Decision-Making

Human life on Earth depends on ecosystems. This is the main message conveyed by the concept of ecosystem services (ES), which has gained an ever-increasing attention in the scientific (McDonough et al. 2017) and policy debate (e.g., CBD 2011; European Commission 2006, 2010) of the last two decades. The success of the term 'ecosystem services' is arguably due to its encompassing all "the direct and indirect contributions of ecosystems to human wellbeing" (TEEB 2010a), thus providing a comprehensive framework to describe the multiple relationships between humans and nature.

The term 'ecosystem services' appeared for the first time in 1981 in a book by Ehrlich and Ehrlich as an evolution of the term 'environmental services' (Ehrlich and Ehrlich 1981), but it remained for some time confined within the disciplinary boundaries of conservation ecology. Only in the late nineties two pioneering works brought ES to the forefront of the scientific debate. In 1997, a comprehensive overview of the ES through which nature underpins human wellbeing was provided (Daily 1997), while a group of ecologists and economists made the first attempt to estimate the total economic value of the biosphere based on ES (Costanza et al. 1997), generating a rapidly-growing interest in the topic. In 2005, the publication of the *Millennium Ecosystem Assessment* report (MA 2005) under the umbrella of the United Nations Environmental Programme (UNEP) put ES high on the world policy agenda. The ES concept was proposed as an innovative way to communicate the growing concerns for the unprecedented rates of ecosystem degradation and biodiversity loss, thus providing an additional justification for nature conservation based on what nature does *for* people (Mace 2014, 2016).

What characterized the ES concept since its origin was the explicit link with decision-making. Gretchen Daily and colleagues identified in this link the main innovation of the ES approach, where ES values are acknowledged and assessed

D. Geneletti et al., *Planning for Ecosystem Services in Cities*, SpringerBriefs in Environmental Science, https://doi.org/10.1007/978-3-030-20024-4_1

with the specific purpose of informing decisions (Daily et al. 2009). Highlighting the dependency of human wellbeing on nature, the ES concept definitely makes clear that no trade-off should exist between sustainable human development and nature conservation (de Groot et al. 2010). Consequently, identifying, mapping, quantifying, and valuing ES is expected to improve decision making, ultimately promoting more sustainable development trajectories (TEEB 2010b; Díaz et al. 2015; Guerry et al. 2015). In the last years, efforts have been made to include ES in different decision-making processes to support the identification and comparison of costs and benefits of different policies (TEEB 2010b) and to contribute to the assessment of their impacts (Geneletti 2013).

At the international level, the acknowledgement of the need to secure a sustainable and fair provision of ES was explicitly at the basis of the adoption of the *Aichi-targets* by the *Convention on Biological Diversity* (2010) and of the creation of the *Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services* (2012). The European Union is at the forefront in pursuing these obligations and is leading the way toward mainstreaming the ES approach by progressively embedding the ES concept in its policies (Bouwma et al. 2017). Through the *EU Biodiversity strategy to 2020,* EU Member States committed to map and assess ES in their territory, thus setting the base for continuous monitoring and the inclusion of ES in the system of national accounting and reporting across the EU (Maes et al. 2012, 2016). Comprehensive ES assessments have also been carried out at national level, both in the EU and in other parts of the world (Schröter et al. 2016). Furthermore, several local experiences have proven the effectiveness of the ES approach in driving policy changes toward more sustainable outcomes in different contexts and scales (Ruckelshaus et al. 2015). Topics addressed include river basin management, climate change adaptation and mitigation, green infrastructure planning, and corporate risk management, to name just a few (Ruckelshaus et al. 2015; Dick et al. 2017), with a wide range of stakeholders involved in different decision-making processes, from landscape and urban planning (Hansen et al. 2015; Babí Almenar et al. 2018) to impact assessment (Geneletti 2016; Rozas-Vásquez et al. 2018).

The spread of the ES concept and its progressive inclusion into decision-making at various levels raised the interest on how ES and related values could be assessed in a way that allowed comparison across space and monitoring through time. Considering the type of values that they aim to capture, ES assessment methods are commonly classified in biophysical, socio-cultural, and economic methods (Harrison et al. 2017). Biophysical methods quantify ES in biophysical units based on the analysis of structural and functional traits of ecosystems, or on biophysical modelling (e.g., hydrological and ecological models, production functions). Socio-cultural methods capture individual or social preferences expressed by stakeholders in non-monetary terms (e.g., time use assessments, photo series analysis). Economic methods quantify ES values in monetary units (e.g., market prices, replacement cost, hedonic pricing). Although the distinction is sometimes blurred (e.g., methods to investigate social preference can be used to assign monetary values), it helps to understand the variety of methods from different disciplinary backgrounds that can be adopted in ES assessments (Santos-Martin et al. 2018).

While today several methods for ES mapping and assessment are well-established and have demonstrated their potential to provide useful information to decision-making (Burkhard et al. 2018), the challenge is on how multiple ES assessments can be integrated to contribute to answer real-world policy questions. On the one hand, decisions usually affect not a single but a bundle of ES (Jopke et al. 2015; Spake et al. 2017), hence assessments able to account for multiple ES and their multiple values are needed to investigate synergies and trade-offs potentially arising from decisions (Geneletti et al. 2018). On the other hand, ES assessments should be able to reflect views and opinions of the different stakeholders involved, including those that are normally under-represented (Jacobs et al. 2016). Urban planning is an example of decision-making process where complex policy questions are addressed, a broad range of stakeholders is engaged, and multiple ES values emerge. In cities, land-use decisions made during the planning process determine the availability of ES fundamental to the wellbeing of urban population. Hence, the inclusion of ES in planning is essential to promote sustainable urban development.

1.2 Planning for Ecosystem Services in Cities

Even though cities may seem to have little to do with the concept of ES, except for largely benefitting from them while threatening their provision through urbanization processes (MA 2005), this view has progressively shifted during the last years. While the ES science was developing, cities started to be seen not just as consumers of ES supplied from outside urban areas, but also as producers themselves, as already noted in the seminal work by Bolund and Hunhammar (1999). The study of urban ES, i.e. of the “ES provided by urban ecosystems and their components” (Gómez-Baggethun and Barton 2013), became a focus of ES research (Haase et al. 2014; Luederitz et al. 2015). Regulating and cultural ES emerged as the most relevant in urban areas (Gómez-Baggethun and Barton 2013; Elmqvist et al. 2016). By regulating stormwater runoff and flows, purifying the air, regulating micro-climate, reducing noise, and moderating environmental extremes, urban ecosystems affect the quality of the urban environment and control the associated hazards. Moreover, by providing suitable space for recreation, increasing the aesthetic quality of urban spaces, offering opportunities for cultural enrichment, and preserving local identity and sense of place, they provide a range of non-material benefits that are essential for human and societal wellbeing in cities (Gómez-Baggethun and Barton 2013; Elmqvist et al. 2016).

Preserving, restoring, and enhancing urban ES is therefore necessary to ensure liveable, sustainable, and resilient cities (McPhearson et al. 2015; Botzat et al. 2016; Frantzeskaki et al. 2016). Urban ES and associated benefits are linked to many of the most pressing challenges for cities. Mitigating and adapting to climate change, promoting citizens’ heath, enhancing social inclusion, and reducing the environmental footprint of cities, to name just a few, all have a direct relation with the provision of urban ES (Bowler et al. 2010a; Demuzere et al. 2014; McPhearson et al. 2014). Furthermore, many urban ES produce effects only at the local level (Andersson et al. 2015) and man-made substitutes, when existing, are often characterised by high costs and impacts (Elmqvist et al. 2015). While urban population continues to grow, maintaining healthy and functioning ecosystems appears therefore of utmost importance to guarantee that the increasing demand for ES in met in a sustainable way.

Urban planning affects urban ES in multiple ways (Cortinovis 2018). First, the provision of urban ES depends on the availability and spatial distribution of urban ecosystems and their components, hence on the strategic decisions on land-use allocations that are made during urban planning processes (Langemeyer et al. 2016). Second, by defining the spatial arrangement of land uses, urban planning also determines the distribution of population and urban functions, which affects the demand for urban ES (Baró et al. 2016). Third, planning decisions also contribute to define some physical properties as well as institutional and management arrangements of the city (e.g., property type, accessibility) that play a key role in defining who can benefits from urban ES (Barbosa et al. 2007). Hence, making urban planning aware of ES and their values, and assessing the impacts of planning actions on ES provision, is fundamental to ensure that benefits from ES are preserved and enhanced.

Acknowledging the presence of nature within cities as beneficial is not an innovation in the urban planning discipline, and references to the importance of green spaces in cities and to their positive influence on the wellbeing of urban population can be traced back to the very initial stage of modern planning (see e.g. Howard 1902). However, in the last century, a view of nature in cities as only related to aesthetic and recreational values prevailed, and a strong focus on urban form as a determinant of the environmental performance of cities made other strategies, such as compactness, density, and functional diversity, prevail even when the then new paradigm of sustainability emerged (Jabareen 2006). Only recently, also thanks to a growing scientific evidence, 'greening the city' has become an imperative for urban planning. The concepts of 'ecosystem-based actions' (Geneletti and Zardo 2016; Brink et al. 2016) and 'nature-based solutions' (Raymond et al. 2017) applied to cities suggest the active promotion of urban ES and related benefits to sustainably tackle a wide range of urban challenges.

Within this framework, the integration of ES knowledge and approach in urban planning is indicated from many sides as a valuable strategy to address some of the 'wicked' problems of todays' urban development, from the necessary transition to resilience (Collier et al. 2013) to the need for sustainable approaches to address urban peripheries (Geneletti et al. 2017). That's why the inclusion of ES in urban plans started to be considered an indicator of their quality (Woodruff and BenDor 2016), ultimately measuring their capacity to put in place strategic actions towards more sustainable and resilient cities (Frantzeskaki et al. 2016).

Integrating the ES concept and approach in urban planning processes is expected to provide multiple benefits. First, to clarify the ecological – structural and functional – foundations of ES provision, thus highlighting the links between human wellbeing and the state of ecosystems (Haines-Young and Potschin 2010), hence the role of ecological knowledge in supporting effective planning actions (Schleyer et al. 2015). Second, to raise awareness on the whole range of ES and associated benefits that are produced by urban ecosystems, thus providing a comprehensive understanding of the values at stake and of the trade-offs that may arise from land-use decisions (de Groot et al. 2010). Third, to support the explicit identification of beneficiaries, including those normally under-represented in decision-making processes, thus promoting concerns for environmental justice (Ernstson 2013) and strengthening planners' arguments in balancing public and private interests (Hauck et al. 2013b).

In spite of these expectations, the integration of ES in urban planning is still limited (Cortinovis and Geneletti 2018). Haase et al. (2014), Kremer et al. (2016), and Luederitz et al. (2015) summarized the main challenges to face. Among others, they identified the need for more appropriate methods and indicators able to capture the heterogeneity and fragmentation of urban ecosystems, a scarce investigation of the relation between urban ES and biodiversity, the uncertainty about the degree of transferability of data and results, and the lack of analyses that account for ES demand by integrating people's preferences and values, particularly in the assessment of cultural ES. This book intends to contribute to address some of these challenges, promoting a full integration of the ES concept and approach in urban planning.

1.3 Book Objectives and Outline

This book analyses the integration of ES knowledge in urban planning showing and discussing how it can be promoted, to which purposes, and with what results. The overall objective is to provide a compact reference to the state of the art in this field, which can be used by researchers, practitioners, and decision makers as a source of inspiration for their activity. The books addresses the topic by: (i) investigating to what extent ES are currently included in urban plans, and discussing what is still needed to improve planning practice; (ii) illustrating how to develop ES indicators and information that can be used by urban planners to enhance plan design; (iii) demonstrating the application of ES assessments to support urban planning processes through case studies; and (iv) reflecting on criteria for addressing equity in urban planning through ES assessments that consider issues associated to supply, access, and demand of ES by citizens.

Chapters 2 and 3 review current practices, and investigate the extent to which ES are included in different types of planning instruments for cities. The ultimate objective is to understand what kind of ES knowledge is already used, and what is still needed to improve the content of plans, and their expected outcomes. In both chapters, a review framework is developed and applied to analyse the ES-related content of planning documents, irrespective of the terminology adopted. Chapter 2 focuses on urban spatial plans, and examines how nine urban ES are addressed in a sample of 22 urban plans of Italian cities. The review considers both breadth (i.e., the ES inclusion across different plan components) and depth (i.e., the quality of ES information). Chapter 3 focuses on urban climate adaptation plans, an increasingly common type of plans where ES knowledge is instrumental to inform strategies for so-called ecosystem-based adaptation (EbA) to climate change. The chapter proposes a classification of EbA measures, and reviews the extent to which they have been included in the climate-adaptation plans of 14 European cities, and the quality of the related information.

The bottlenecks of ES inclusion in current practice that emerged from Chaps. 2 and 3 set the basis to propose the way forward illustrated in the remaining of the book. Particularly, Chap. 4 presents the development of an ES model that can provide information directly usable in urban planning. The chapter focuses on micro-climate regulation provided by urban green infrastructure. The model developed assesses the supply of this ES by different types of green infrastructure, relying on data that are widely available in modern urban planning practice. The application of the model is illustrated for the city of Amsterdam, The Netherlands.

Chapter 5 takes the use of ES information in urban planning a step further, by illustrating a case study where the outcomes of ES mapping and assessment are used to inform planning decisions. The micro-climate regulation model presented in Chap. 4 is applied in the city of Trento (Italy), together with a model to assess the opportunities for nature-based recreation provided by green spaces. The outcome of both models are combined with spatial information on the potential beneficiaries of the selected ES, and used to compare planning scenarios related to brownfield redevelopment. The case study demonstrates the importance of including information about ES demand and beneficiaries to understand the social implications of planning decisions, particularly in terms of equity and environmental justice.

Equity implications related to ES in urban planning are the subject of Chap. 6. This chapter identifies and discusses the key elements for analysing equity in the distribution of ES in cities, namely ES supply, access and demand. A case study application demonstrates how ES assessments should be designed, and their outcomes used, to pursue an equitable distribution of ES in cities through urban planning decisions. Finally, Chap. 7 draws come conclusions and formulate recommendations for enhancing the use of ES knowledge in planning practice.