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Mestre em Engenharia do Ambiente

**Integration of ecosystem services
in spatial planning:
a mixed methods approach**

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To my parents, Ulrike and Amelie

Nothing ever goes away until it has taught us what we need to know.

Pema Chödrön

*Boy: Do not try and bend the spoon.
That's impossible.
Instead only try to realize the truth.*

Neo: What truth?

Boy: There is no spoon.

Neo: There is no spoon?

*Boy: Then you'll see that it is not
the spoon that bends,
it is only yourself.*

Dialogue from "The Matrix"

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Abstract

Land-use and land cover (LULC) changes are an important driver of global ecosystem change, with consequences in terms of biodiversity and the benefits humans get from nature, known as ecosystem services (ES). Spatial planning, a process dealing with the spatial expression of human activities in an integrated way, supported by instruments like Strategic Environmental Assessment, can play an important role in balancing those activities against their consequences. Although literature on ES is growing considerably, some of it covering the planning context, a coherent and integrated approach for practical application of the ES concept in spatial planning and decision-making is still needed, while knowledge gaps and challenges remain. This research aims at expanding current knowledge on the integration of ES in spatial planning. Through a mixed methods approach, firstly a profile of ES integration was drawn, based on a questionnaire survey and document analysis covering European to regional levels, using Portugal as example. Then, a set of relevant ES and drivers of change was identified through a participatory approach, with the Lisbon Metropolitan Area as case study. Subsequently, alternative scenarios of future LULC and ES changes driven by combined demographic and urban development patterns were explored. The profile revealed mismatches between ES integration as perceived by planning stakeholders and as found in planning documents, where integration (mainly implicit) needs improvement. The scenario exercise suggested that land take can be minimized through spatial planning, but effects on ES might be mixed. A conceptual framework for ES integration in spatial planning is proposed, based on the insights gained. Recommendations for further research and planning practice mainly concern broadening the range

of stakeholders involved, the stages of stakeholder involvement and the scope of document analysis, as well as exploring more extreme scenario assumptions and adding ES demand to the supply analysis.

Keywords: ecosystem services; land-use and land cover change; spatial planning; strategic environmental assessment; stakeholder engagement; mixed methods.

Resumo

As alterações de uso e ocupação do solo (UOS) afectam globalmente os ecossistemas, com impactes na biodiversidade e nos benefícios que a sociedade obtém da natureza, conhecidos como serviços dos ecossistemas (SE). Ao lidar com a expressão territorial das actividades humanas de forma integrada, o ordenamento do território, apoiado por instrumentos como a Avaliação Ambiental Estratégica, pode ser crucial para equilibrar actividades e impactes. Apesar da crescente literatura sobre SE, parte da qual focando o contexto de planeamento, é necessária uma abordagem coerente e integrada para a aplicação prática do conceito de SE no ordenamento do território. Esta investigação tem como objectivo expandir o conhecimento existente sobre a integração de SE no planeamento e ordenamento do território. Através de métodos mistos, foi efectuado inicialmente um perfil da integração dos SE no planeamento, com base num inquérito por questionário e em análise documental cobrindo vários níveis (Europeu ao regional), adoptando Portugal como exemplo. Um conjunto de SE e factores de mudança relevantes foi identificado através de uma abordagem participativa, adoptando a Área Metropolitana de Lisboa como caso de estudo. Subsequentemente foram explorados cenários alternativos de alterações de UOS e SE, resultantes de diferentes padrões de desenvolvimento populacional e urbano. O perfil elaborado revelou desfasamentos relativos à integração de SE, entre a percepção dos actores de planeamento e a análise documental que demonstrou ser necessário melhorar a integração. O exercício de cenarização sugeriu que a artificialização do solo pode ser minimizada através do planeamento, mas que os efeitos sobre os SE podem ser mistos. É proposto um quadro conceptual para

a integração de SE no ordenamento do território. As recomendações para futura investigação e aplicação prática referem-se principalmente a: representatividade das partes interessadas e momentos de participação; âmbito da análise documental; pressupostos para cenários; procura versus oferta de SE.

Palavras-chave: serviços dos ecossistemas; alterações de uso e ocupação do solo; ordenamento do território; avaliação ambiental estratégica; envolvimento de partes interessadas; métodos mistos.

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List of Abbreviations and Acronyms

CICES	Common International Classification of Ecosystem Services
CLC	CORINE Land Cover
EC	European Commission
EIA	Environmental Impact Assessment
ES	Ecosystem service(s)
ESDP	European Spatial Development Perspective
EU	European Union
GIS	Geographic Information System(s)
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
LMA	Lisbon Metropolitan Area
LULC	Land-use and land cover
MA	Millennium Ecosystem Assessment
MAES	Mapping and Assessing of Ecosystems and their Services
MEN	Metropolitan Ecological Network
NUTS	Nomenclature of Territorial Units for Statistics
RSP	Regional Spatial Plan
PNPOT	National Program of Spatial Planning Policy
SD	Sustainable Development

SEA	Strategic Environmental Assessment
TAEU	Territorial Agenda of the European Union
TEEB	The Economics of Ecosystems and Biodiversity
UN	United Nations
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Program
WCED	World Commission on Environment and Development
WWF	World Wide Fund for Nature



Introduction

1.1 Background and aim

Land is a finite resource with competing demands (Jaeger and Schwick, 2014). It provides humans with a wide range of ecosystem services (ES), generally defined as the benefits people obtain from ecosystems (MA, 2003). However, human activities are transforming the terrestrial environment at unparalleled rates and scales (MA, 2005a; Seto et al., 2011), with land and fertile soil disappearing at an alarming rate (Haber, 2007). Land-use and land cover (LULC) changes are main drivers of anthropogenic ecosystem change (Burkhard et al., 2010). Such changes have resulted in a substantial and largely irreversible loss of biodiversity (MA, 2005a) and potentially undermine the capacity of ecosystems to supply ES like sustaining food production, maintaining freshwater and forest resources, regulating climate and air quality, or ameliorating infectious diseases (Foley et al., 2005).

It is for spatial and land-use planning that the effects of plan's decisions on ES provision and use are perhaps more evident and straightforward. Hence, spatial planning decisions in particular would benefit from systematic considerations of their effects on ES (Geneletti, 2011). By bringing together different sustainability dimensions (ecological, social, economic), acting as a sustainability boundary object and supporting problem-oriented and systems-based approaches (Abson et al., 2014), the ES concept has the potential to support sustainable spatial planning. This is recognized by the 2030 Agenda for Sustainable Development, which targets the integration of ecosystem and biodiversity values into national and local planning by 2020 (UN, 2015). It is also aligned with an increasing recognition of an ecosystem perspective as a key to effective spatial planning (TEEB, 2010a). The regional scale is particularly relevant for ES-

inclusive spatial planning (Balfors et al., 2016; Fürst et al., 2010) since it is the scale at which many development policies are established and coordinated (articulating national and local policies) and that the appropriate management of natural resources, interconnectivity between cities, economic growth and cultural identity are set in motion (Mascarenhas et al., 2012b). Hence, it is a beneficial governance level in terms of planning, coordinating and assessing actions towards sustainable development (Mascarenhas et al., 2010).

A coherent and integrated approach for practical application of the ES concept in planning and decision-making is needed, as are appropriate methods for identification and quantification of individual services, suitable models, indicators and the integration of system components (Burkhard et al., 2010; de Groot et al., 2010a). Integrating ES in spatial planning requires an in-depth understanding of how are ES manifested and how are they affected by human activities, like urban development (Balfors et al., 2016). Stakeholder engagement is also crucial and inherently linked to the ES agenda (Fish et al., 2016). Approaches and tools for assessing the effects of different spatial planning alternatives on biodiversity and ES are needed to find the best solutions during the planning process (Kopperoinen et al., 2016). Here it makes sense to explore synergies with already existing instruments or processes that support planning. Strategic Environmental Assessment (SEA) is particularly suited to this purpose and can be a good entry point for integrating ES in spatial planning (Geneletti, 2011), as it is already established as a widespread (often mandatory) process to assess effects of policies, programmes and plans.

Despite the attention that research on ES has attracted in recent years (Fisher et al., 2007; Potschin and Haines-Young, 2011), it has been regarded as a fragmented field (Abson et al., 2014; Seppelt et al., 2011) with an incomplete scientific basis (Bull et al., 2016) and many challenges still remain to fully integrate the concept of ES into everyday planning, management and decision-making (de Groot et al., 2010a). Challenges include finding meaningful and robust indicators to quantify ES, measuring changes in supply and demand and predicting future direction (Balvanera et al., 2017). Additionally, for most ES there is little incentive for decision makers, whether they are government officials, business managers, or local landowners, to account for the continued provision of ES in their decision making (Tallis and Polasky, 2009). The added value of taking an ES perspective remains tentative and fragile with respect to many salient areas of science and policy (Potschin et al., 2016). So the use of ES concepts to support real-life decision-making processes is still limited (Geneletti, 2011; Ruckelshaus et al., 2013).

The main aim of this research is to expand current knowledge on the integration of ES in spatial planning, with an underlying goal of supporting such integration. To achieve that aim, a mixed methods approach was developed and allowed a) drawing a profile of ES integration at European, national (Portugal) and regional level; b) identifying which ES and drivers of change are most relevant for a case study region (Lisbon Metropolitan Area), based on stakeholders' inputs; c) assessing the consequences of alternative regional development scenarios on LULC and ES. The methods supporting the approach included questionnaire surveys, document analysis, focus groups, participatory workshops, scenario analysis and spatial modelling and analysis. Based on the insights gained through the application of the approach, a conceptual framework for ES integration in spatial planning is proposed. The framework can be used in SEAs and by planning teams or authorities to support planning processes at several scales.

1.2 Ecosystem services and spatial planning

The notion that natural ecosystems play an important role supporting society probably traces back to the time of Plato, who understood that the deforestation of Attica led to soil erosion and the drying of springs (Mooney and Ehrlich, 1997). But one might consider the origins of modern concern for ES to trace to George Perkins Marsh's publication of *Man and Nature* in 1864 (Marsh, 1864). The book is described as being the first to attack the idea that the world's resources were infinite (Mooney and Ehrlich, 1997). For other authors there are even earlier precursory notions of natural capital and ecosystem services from the Classical economic period (Gómez-Baggethun et al., 2010). More contemporary landmark publications have helped raise worldwide awareness of the important connections between humans and their environment, including *Silent Spring* (Carson, 1962) or *The Limits to Growth* (Meadows et al., 1972). The origins of the modern history of ES are to be found in the late 1970s. This involves the utilitarian framing of those ecosystem functions that are deemed beneficial to society, as economic services in order to increase public interest in biodiversity conservation (Braat and de Groot, 2012). The paper by Westman (1977) is considered a landmark in that period. Westman argued that it is appropriate to separate the task of measuring and predicting the extent of physical damage accruing from the use of resources from the task of evaluating the worth of losses and equivalent gains, which he labelled "nature's services". The concept was further developed and the term "ecosystem services" would later be coined

by Ehrlich and Ehrlich (1981). Further landmark publications can be found in the 90's, somehow linked with a broader debate on sustainable development (WCED, 1987). These include the papers by Costanza and Daly (1992) arguing for the maintenance of natural capital as minimum necessary condition for sustainability and Costanza et al. (1997) putting forward an estimation of the value of the world's ES and natural capital, as well as the edited book by Daily (1997) bringing together the contributions of a broad, interdisciplinary group of natural and social scientists to better understand societal dependence on natural ecosystems. Syntheses of the history of the ES concept can be found in Mooney and Ehrlich (1997), Braat and de Groot (2010), Gómez-Baggethun et al. (2010) or Costanza et al. (2017).

A broad discussion on the concept of ES, with both supportive and critical viewpoints, was triggered by the works mentioned above, in particular the ones by Costanza et al. (1997) and Daily (1997). Several definitions of ES were also put forward as the concept evolved, with varying attention for the ecological basis or the economic use (Braat and de Groot, 2012; Costanza et al., 2017). This growing interest in ES led to a global initiative promoted by the United Nations Environment Program (UNEP) to understand the links between ecosystems and human well-being: the Millennium Ecosystem Assessment (MA, 2003). The MA defined ES very straightforwardly as the benefits people obtain from ecosystems, allowing a wide use of the definition, although with some critique that its simplicity also leaves room for confusion and different interpretations (Haines-Young and Potschin, 2010a). More recently, Costanza and colleagues presented a definition combining the MA one with the one by Costanza et al. (1997): ES are “the ecological characteristics, functions, or processes that directly or indirectly contribute to human wellbeing; that is, the benefits that people derive from functioning ecosystems” (Costanza et al., 2017, p.3).

The MA placed ecosystems firmly at the core of environmental science-policy discussions and, while drawing on earlier work, it provided a more explicit conceptual framing (Figure 1.1) from which later analytical methods could develop, fostering also more interdisciplinary and transdisciplinary approaches (Mace, 2016). It classified ES as a) provisioning services that are the products people obtain from ecosystems, such as food and water; b) regulating services that are the benefits people obtain from the regulation of ecosystem processes, such as flood and disease control; c) cultural services that are the non-material benefits from ecosystems through spiritual enrichment, cognitive development, reflection, recreation and aesthetic experiences; and d) supporting services that maintain the conditions for life on Earth and that are necessary for the produc-

tion of all other ES, including primary production, soil formation and nutrient cycling (MA, 2003).

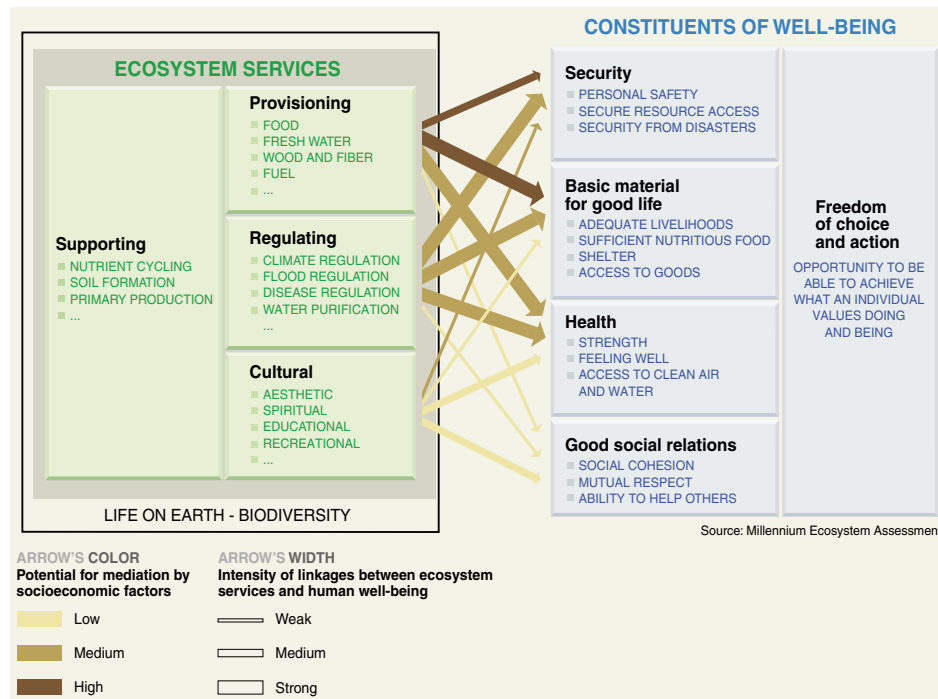


Figure 1.1 – Millennium Ecosystem Assessment’s conceptual framework. Source: MA (2005a).

Other subsequent frameworks were developed, including most notably: the ES cascade model (Haines-Young and Potschin, 2010) that was adapted for the TEEB initiative – The Economics of Ecosystems and Biodiversity (de Groot et al., 2010b); the EU framework for ecosystem assessments (Maes et al., 2013b); or more recently the one by IPBES, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (Díaz et al., 2015). Despite differences, all of these frameworks convey the notion that ES result from the interactions between ecosystems and societies, which together form a socio-ecological system (Balvanera et al., 2017). The ES cascade model has particularly sparked interest, since it has broken down into elements the flow going from ecological structures and processes to human well-being (see Figure 1.2 for a recent version). That interest included wide adoption or adaptations of the framework (see for example Baró et al., 2016; Kopperoinen et al., 2016; Maes et al., 2012a; Müller and Burkhard, 2012) and critiques, for example that the model is at the same time an oversimplification of a complex reality and an unnecessary complication of what is essentially a very straightforward definition (Costanza et al., 2017).

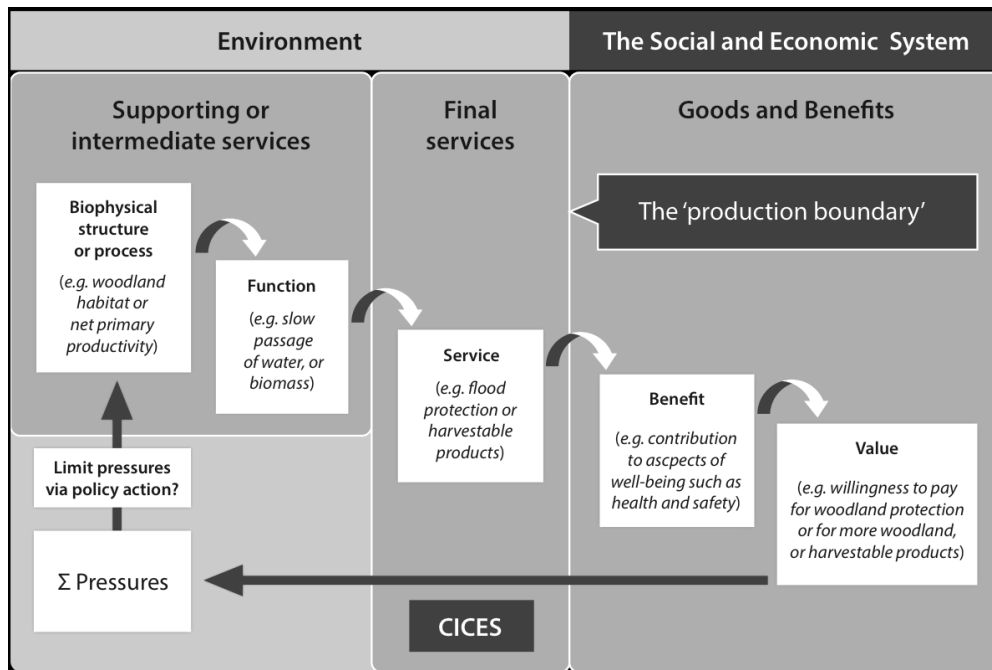


Figure 1.2 – The ES cascade model. CICES refers to the Common International Classification of Ecosystem Services. Source: Potschin and Haines-Young (2017).

Following the ES classification system defined by the MA, two other widely used international classification systems were developed: the one by the TEEB initiative (TEEB, 2010b) and the Common International Classification of Ecosystem Services (Haines-Young and Potschin, 2010). Table 1.1 presents a correspondence between the three classification systems, following Maes et al. (2013b). Although the three classification systems are related (they all include provisioning, regulating and cultural services), there are some main differences. The TEEB classification, which was developed building on the MA classification, omits supporting services such as nutrient cycling or primary production, which are seen in TEEB as a subset of ecological processes. Instead, habitat has been identified as a separate category to highlight the importance of ecosystems to provide habitat for migratory species and gene-pool “protectors” (de Groot et al., 2010b). CICES was developed aiming at compatibility with the framework of the UN System of Environmental-Economic Accounts, hence adopting a detailed hierarchical system that nests with the accounting system. Similarly with the TEEB classification, supporting services were omitted to avoid double counting (relevant for economic valuation and accounting purposes), since they are assumed to be embedded within each of the CICES categories (Haines-Young and Potschin, 2010). It should be noted that each classification has its

own advantages and disadvantages due to the specific context within which they were developed (Maes et al., 2013b).

Table 1.1 – Main international ES classification systems: Millennium Ecosystem Assessment (MA, 2003), The Economics of Ecosystems and Biodiversity (TEEB, 2010b) and CICES – Common International Classification of Ecosystem Services Services (R. Haines-Young and Potschin, 2010). Source: Maes et al. (2013).

MA categories	TEEB categories		CICES (v4.3) groups ¹
Food (fodder)	Food	Provisioning services	Biomass [nutrition]
			Biomass (materials from plants, algae and animals for agricultural use)
Fresh water	Water		Water (for drinking purposes) [nutrition]
			Water (for non-drinking purposes) [materials]
Fibre, timber	Raw materials		Biomass (fibres and other materials from plants, algae and animals for direct use and processing)
Genetic resources	Genetic resources		Biomass (genetic materials from all biota)
Biochemicals	Medicinal resources		Biomass (fibres and other materials from plants, algae and animals for direct use and processing)
Ornamental resources	Ornamental resources		Biomass (fibres and other materials from plants, algae and animals for direct use and processing)
			Biomass-based energy sources
			Mechanical energy (animal based)
		Other cultural outputs (existence, bequest)	

Table 1.1 (continued).

MA categories	TEEB categories		CICES (v4.3) groups ¹	
Air quality regulation	Air quality regulation	Regulating services (TEEB)	[Mediation of] gaseous/ air flows	
Water purification and water treatment	Waste treatment (water purification)		Mediation [of waste, toxics and other nuisances] by biota	
			Mediation [of waste, toxics and other nuisances] by ecosystems	
Water regulation	Regulation of water flows		Regulating and supporting services (MA)	[Mediation of] liquid flows
	Moderation of extreme events			
Erosion regulation	Erosion prevention		Regulating and maintenance services (CICES)	[Mediation of] mass flows
Climate regulation	Climate regulation			Atmospheric composition and climate regulation
Soil formation	Maintenance of soil fertility			Soil formation and composition
Pollination	Pollination			Lifecycle maintenance, habitat and gene pool protection
Pest regulation	Biological control			Pest and disease control
Disease regulation				
Primary production nutrient cycling (supporting services)	Maintenance of life cycles of migratory species (including nursery service)	Life cycle maintenance, habitat and gene pool protection		
		Soil formation and composition		
	Maintenance of genetic diversity (especially in gene pool protection)	[Maintenance of] water conditions		
		Life cycle maintenance, habitat and gene pool protection		

Table 1.1 (continued).

MA categories	TEEB categories		CICES (v4.3) groups ¹
Spiritual and religious values	Spiritual experience	Cultural services	Spiritual and/or emblematic
Aesthetic values	Aesthetic information		Intellectual and representational interactions
Cultural diversity	Inspiration for culture, art and design		Intellectual and representational interactions
			Spiritual and/or emblematic
Recreation and ecotourism	Recreation and tourism		Physical and experiential interactions
Knowledge systems and educational values	Information for cognitive development		Intellectual and representational interactions

¹Explanatory information from CICES division level [between squared brackets] and from CICES class level (between parentheses).

The relationship between biodiversity and ES has also been subject of scientific interest (Cardinale et al., 2012; Mace et al., 2012; Reyers et al., 2012). There is strong evidence that biodiversity loss has an impact on the functioning of ecosystems. That impact is non-linear and saturating, so change accelerates as biodiversity loss increases. However, understanding the consequences for ES is challenging since ES are often regulated by multiple ecosystem functions, which do not necessarily respond to changes in biodiversity in the same way (Cardinale et al., 2012). So our understanding of the physical and biological processes underpinning ES is still poor (Mace et al., 2012), with mixed evidence for effects of biodiversity on ES and data often lacking (Cardinale et al., 2012). Hence monitoring biodiversity alone is not sufficient to understand the status and trends of the services it provides (Balvanera et al., 2017). Nevertheless, biodiversity itself might be regarded as an ES with intrinsic or non-tangible value (e.g. for psychological health), while components of biodiversity are also directly harvested to meet human’s material needs (Balvanera et al., 2017; Mace et al., 2012). For planning and management, it is important to keep in mind that biodiversity and ES can respond differently to particular actions, including win-

win or mutually beneficial relationships, win-lose or trade-offs and win-neutral relationships (Reyers et al., 2012).

The ES framework is holistic in outlook and in principle it covers a very wide breadth of concerns. The field of ES research is developing a set of concepts and methodologies for understanding the environmental basis of human well-being. But it is also important to understand how these concepts and methodologies might serve to link and inform wider agendas across science and policy (Potschin et al., 2016). ES can be an effective tool for informing decisions about the use and management of natural resources, especially when trade-offs and synergies need to be taken into account (Balvanera et al., 2017). A commitment to applying and animating knowledge in a practical context is inherent to the ES perspective (Potschin et al., 2016). Spatial planning represents such a practical decision-making context.

Spatial planning has a growing importance for sustainability since it deals with land-use, a key human activity to promote social and economic development (Helming et al., 2008), but also LULC changes that are a main driver of anthropogenic ecosystem change (Burkhard et al., 2010). In comparison with the prescriptive nature of land use planning, where areas are just designated for development or protection (zoning), spatial planning is seen as more strategic, defining an overall (strategic) planning framework and setting spatial goals (Albrechts et al., 2003; Faludi, 2010; Kopperoinen et al., 2016). A major advantage of spatial planning is the ability to consider the cumulative impacts of incremental decisions on ecosystems, by taking a long-term view on the outcomes of different planning options. An effective planning framework can also make the policy and planning process more transparent and inclusive, by assessing who benefits from which ES (TEEB, 2010a). However, spatial planning is a complex process characterized by a plethora of biophysical, social, economic, political and institutional factors, most of which are beyond the decision makers' control. Those factors do not act independently and form a network of interactions and feedback loops on different temporal and spatial scales (Nidumolu et al., 2006; Partidário and Arts, 2005; Roberts, 2006).

Having to conciliate various interests and needs with potential different spatial impacts, spatial planning can lead to spatial changes, like changes in the composition and pattern of the landscape, with consequences on ecosystems and ES (Balfors et al., 2016; Kopperoinen et al., 2016). Figure 1.3 shows how those consequences can unfold, as conceptualized by Kopperoinen et al. (2016). The interests, problems and targets that spatial planning has to coordinate, combined with assets provided by ecosystem structure and biodiversity frame

the possible diversity of actions. Such actions can in turn impact on ecosystem structure, triggering further impacts on ecosystem processes, ecosystem services, benefits derived from the services and the value of those benefits for society. In some spatial planning contexts, like in Germany or the Netherlands, the concept of landscape functions is used in landscape planning. The concepts of landscape functions and ES have similarities and authors like Bastian et al. (2012) have argued that bringing both concepts together under a common framework can help better integrating the ES concept into spatial planning. Such a framework, linking ecosystem properties, potentials, and services can be found in Bastian et al. (2012).

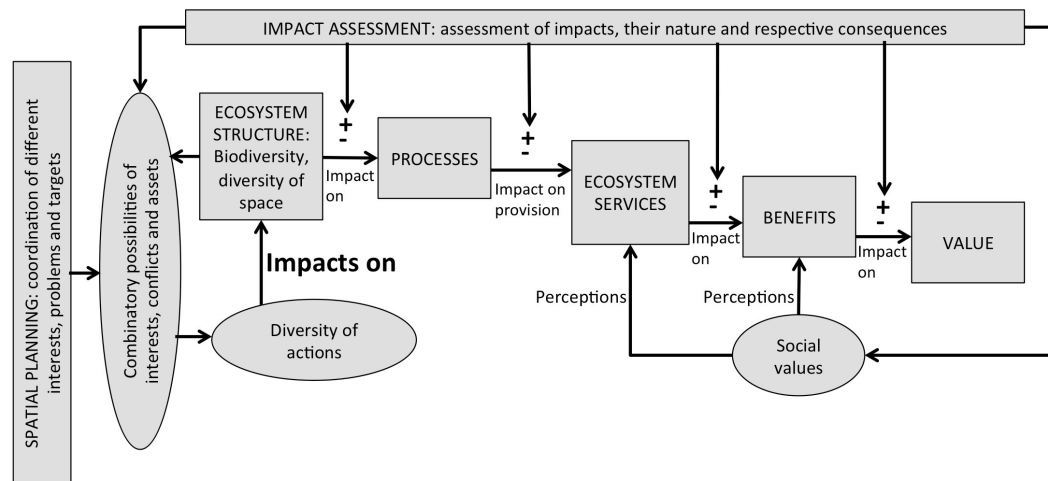


Figure 1.3 – Relationship between spatial planning, impact assessment and the ES cascade model (de Groot et al., 2010b; Haines-Young and Potschin, 2010). Source: Kopperoinen et al. (2016).

Figure 1.3 also shows what can be the role of impact assessment to assess the consequences or effects of spatial planning. That process has been formalized as Strategic Environmental Assessment (SEA), aiming to integrate environmental and sustainability considerations in strategic decision-making (Therivel, 2004). SEA is in place in some 60 countries (Fundingsland Tetlow and Hanusch, 2012), for example in Europe, with the adoption of Directive 2001/42/CE (known as SEA Directive), SEA has become a parallel and integrated process of plans and programmes. This provides a window of opportunity to formally mainstream ES into decisions at the strategic level (Geneletti, 2011). An ES-focused SEA can be a powerful tool to take effects of spatial plans into consideration, which can remain unnoticed under traditional assessment

techniques (Barral and Oscar, 2012). Additionally, synergies can be identified, for example the scenario-analysis approach used by several studies on ES is consistent with the typical framework adopted in impact assessment, and hence can be easily applied in SEA (Geneletti, 2011). But despite the growth in SEA practice and scientific literature, understandings of SEA still vary considerably (Noble and Nwanekezie, 2017). The recent interest in integrating ES in SEA has also shown the need for specific guidance, concerning theoretical and methodological approaches and empirical applications (Geneletti, 2013; Slootweg and van Beukering, 2008).

Approaches to integrate ES in SEA (and consequently in spatial planning) vary and some typologies have been identified. For example TEEB (2010a) contrasts a “sustainability-oriented spatial planning with pro-active SEA” with a “spatial planning with reactive SEA”. In the former, SEA facilitates the planning process in a pro-active and strategic way. It identifies ES and their respective stakeholders in a defined geographic area and maps sensitivities. Both the status of biodiversity as well as direct and indirect drivers of change are assessed. In the latter, SEA can be used to assess consequences of proposed plans and developments in a defined spatial area. Proposed activities and the planning area are known, and an inventory of ecosystems and their sensitivity to identified drivers of change can be made. In consultation with stakeholders, potential impacts on ecosystems can be translated into impacts on ES, expressed as opportunities or risks to social and economic well-being. Similarly, Baker et al. (2013) identified two main approaches: one is a comprehensive approach, where the assessment framework is entirely guided by ES; the other is a philosophical approach that applies a lighter ecosystems-thinking mind-set, helping to frame the assessment methodology rather than fundamentally defining it. There has also been some debate on whether the integration of ES in SEA can be beneficial for the SEA process itself. In general, there is the notion that such integration enhances the quality of SEA processes (Geneletti, 2011; Slootweg and van Beukering, 2008). But some authors warn that, although ES provide a potentially valuable framing for environmental assessment, there is the need for a pragmatic, context specific consideration of how they can improve it (Baker et al., 2013).

Any policy or planning intervention is likely to have environmental consequences that bear differentially on different groups and individuals, and on society as a whole (Grimble and Wellard, 1997). On the other hand, environmental problems are typically complex, uncertain, multi-scale and affect multiple stakeholders (Reed, 2008). These challenges require scientific approaches

that acknowledge unpredictability, incomplete control and a plurality of legitimate perspectives (Funtowicz and Ravetz, 1994). They also demand transparent decision-making that embraces a diversity of knowledge and values (Reed, 2008). These observations underlie arguments often put forward to make the case for stakeholder involvement in environmental decision-making, which can be typified as: normative-based arguments that participation is important in its own right, process-based arguments that participation is a better way of achieving particular ends and outcome-based arguments that participation leads to better ends (Fish et al., 2016).

Collaboration and public participation at different planning levels are fundamental to spatial planning and therefore particularly relevant for ES integration (Balfors et al., 2016; Hein et al., 2006; Kopperoinen et al., 2016). The ES concept itself and its framing by the Convention on Biological Diversity beg for stakeholder engagement, while at the same time ES thinking creates new needs, concerns and opportunities regarding participation in decision-making (Fish et al., 2016). Stakeholders can be generally defined as any group or individual who can affect or is affected by the achievement of an organization's objectives (Freeman, 1984) or by a decision (Reed, 2008). They can be individuals, communities, social groups or institutions of any size, aggregation or level in society (Grimble and Wellard 1997). Assessing ES with a stakeholder driven agenda has several potential advantages, most notably (Balvanera et al., 2017):

- the identification of key or priority services recognised and preferred by societal groups;
- the identification of indicators that are most meaningful for them;
- stakeholder involvement in community-based or citizen science-based ES monitoring, along with the collection of local ecological knowledge (Balfors et al., 2016);
- ES approaches themselves are most effective in leading to policy change and generating action (Rosenthal et al., 2014; Ruckelshaus et al., 2013), with easier adoption of ES framework and data, when decision-makers are successfully integrated (Balvanera et al., 2017).

Although it is generally understood that stakeholder participation can enhance the quality of environmental decisions, with many benefits being claimed for participation, few of the claims that are made have been tested (Reed, 2008). In the case of ES, while assessment methodologies are constantly improving, evidence exists that stakeholder engagement is often ineffective (Menzel and

Teng, 2010). Moreover, ES thinking creates new needs, concerns and opportunities regarding participation in decision-making. A major challenge for ES mainstreaming is that the ES discourse presents itself as a holistic world view, hence inclusive, but on the other hand describes the natural world in a highly specific way, with the risk of remaining a private expert discourse (Fish et al., 2016). The question of “how can analytical and participatory methods be combined to enable effective participatory policy and decision making dialogues?” (de Groot et al., 2010a) remains a challenge for ES integration.

The ES concept has already started to be mainstreamed in some important global policy processes (ten Brink and Kettunen, 2016), like the Strategic Plan for Biodiversity 2011-2020, under the UN Convention for Biological Diversity (UNEP/CBD/COP/DEC/X/2, 2010), or the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (Perrings et al., 2011), established in 2012, which is in itself an example of such mainstreaming. This is partially reflected on a lower governance level, for example in Europe, target 2 of the European Biodiversity Strategy to 2020 states that “by 2020, ecosystems and their services are maintained and enhanced by establishing green infrastructure and restoring at least 15% of degraded ecosystems” (European Commission, 2011a). Despite this mainstreaming of the ES concept in biodiversity policy, it still needs to be integrated more widely and coherently into other environmental, sectoral and horizontal policies, as well as vertically across governance levels, which represents both a major challenge and opportunity for the concept (Bouwma et al., 2016; Schleyer et al., 2015; ten Brink and Kettunen, 2016). This entails a series of requirements, for example common methods for monitoring and evaluation of ES, or better tools to help policy makers exploit cross-sectoral synergies and manage trade-offs between ES (Bouwma et al., 2016). Research is needed in the field of applicable assessment methods, in order to better integrate ES in spatial planning processes (Galler et al., 2016). More knowledge is demanded since the promise that ES assessments will contribute to better decision-making is not yet proven (Saarikoski et al., 2017).

This section summarized the main issues surrounding ES integration in spatial planning, which are covered in this research. In the next sections, the specific research questions and the methodological approach to address them are presented.

1.3 Research questions

Based on the motivation and background presented in the previous sections, this research aims at addressing the following main research question: How can the integration of ES in spatial planning be improved? This question unfolds into the following sub-questions:

- a) How is the concept of ES and its integration in spatial planning perceived by planning decision-makers and practitioners?
- b) How are ES integrated in the spatial planning policy framework?
- c) How can the effects of planning options on ES be assessed?

The methodological approach to address these questions is presented in the next section.

1.4 Methodological approach

To address the research questions presented in the previous section, a mixed methods approach was adopted. Mixed methods research can be generally described as an approach to knowledge (theory and practice) that attempts to consider multiple viewpoints, perspectives, positions, and standpoints, including always the standpoints of qualitative and quantitative research (Johnson et al., 2007). Although there is no one definition of mixed methods research, it can be defined as the type of research that combines elements of qualitative and quantitative research approaches for the broad purposes of breadth and depth of understanding and corroboration (Johnson et al., 2007), to more thoroughly investigate a phenomenon of interest (Teddlie and Tashakkori, 2010). It is particularly useful when the nexus of situational contingencies (e.g. given limited resources, what is the best combination to maximize usefulness of information and evidence?), in relation to the research question(s), suggests that a mixed methods approach is likely to provide superior research findings and outcomes (Johnson et al., 2007). This research approach often focuses on research questions that call for real-life contextual understandings, multi-level perspectives and cultural influences (Creswell et al., 2011). Mixed methods research focuses on both convergent and divergent results. The latter can provide greater insight into complex aspects of a phenomenon, leading to more in-depth investigation of previously unexplored aspects of that phenomenon (Teddlie and Tashakkori, 2010).

Mixed methods can play a relevant role in addressing wicked problems that are characterized by being urgent, having no certainty about their nature or the solutions, and requiring multiple interacting systems to make progress (Fetters and Molina-Azorin, 2017). One of the key features of spatial planning is precisely to identify and address wicked problems (Alden, 2006; Rae and Wong, 2012), while using the ES concept can also enable integrated, transdisciplinary approaches to solve such problems (Schröter et al., 2014). Moreover, research both on ES and spatial planning has to deal with uncertainty, complexity, multiple perspectives and take contextual conditions into account, characteristic of an issue-driven post-normal science (Davies et al., 2015; Funtowicz and Ravetz, 1994; Hattam et al., 2015; Jacobs et al., 2016). Although scarce, the use of mixed methods for ES research found in literature suggests that it can highlight complexities relating to management outcomes, identify areas where mismatches may occur between ES supply and demand in the future, as well as revealing potentially contentious issues requiring careful consideration if societal demands are to be balanced with conservation needs (Hattam et al., 2015). Considering these points and the features of mixed methods research described above, I argue that a mixed methods approach is adequate and can be beneficial to meet the purpose of this research and address its research questions.

In mixed methods approaches, the research question determines the specific methods to be used. Preferably, an overarching question may be broken down into sub-questions, each requiring a different approach (qualitative or quantitative) to answer (Teddlie and Tashakkori, 2010). This is the case in the present research. In what follows, the methods adopted for each sub-question are introduced. Figure 1.4 presents a schematic overview of how the methods are combined in an overall methodological approach.

Generally, the research draws insights from the ES and planning literature, as well as from the European spatial planning context, with a stronger focus on regional planning in Portugal. In order to move forward with knowledge on the integration of ES in spatial planning, it is essential to know what is the baseline or starting point. So, besides the usual literature review, summarized in Section 1.2 and included throughout Chapters 2 to 5, a profile of the regional planning context was drawn, based on a survey of planning stakeholders (Chapter 2) and a content analysis of policy and guidance documents (Chapter 3). The survey was operationalized through an online questionnaire and included mostly closed-ended questions with pre-coded response options, as well as an open question. It was targeted at practitioners and decision-makers from all regional spatial planning authorities in Portugal. It focused on

issues such as the level of awareness and knowledge of the ES concept among planners, the perceived level of current ES integration in regional spatial plans and corresponding strategic environmental assessments, the main factors that either facilitate or obstruct that integration, or the level of importance given to ES integration in the planning process. Data was analysed through descriptive statistics and content analysis in the case of open responses.

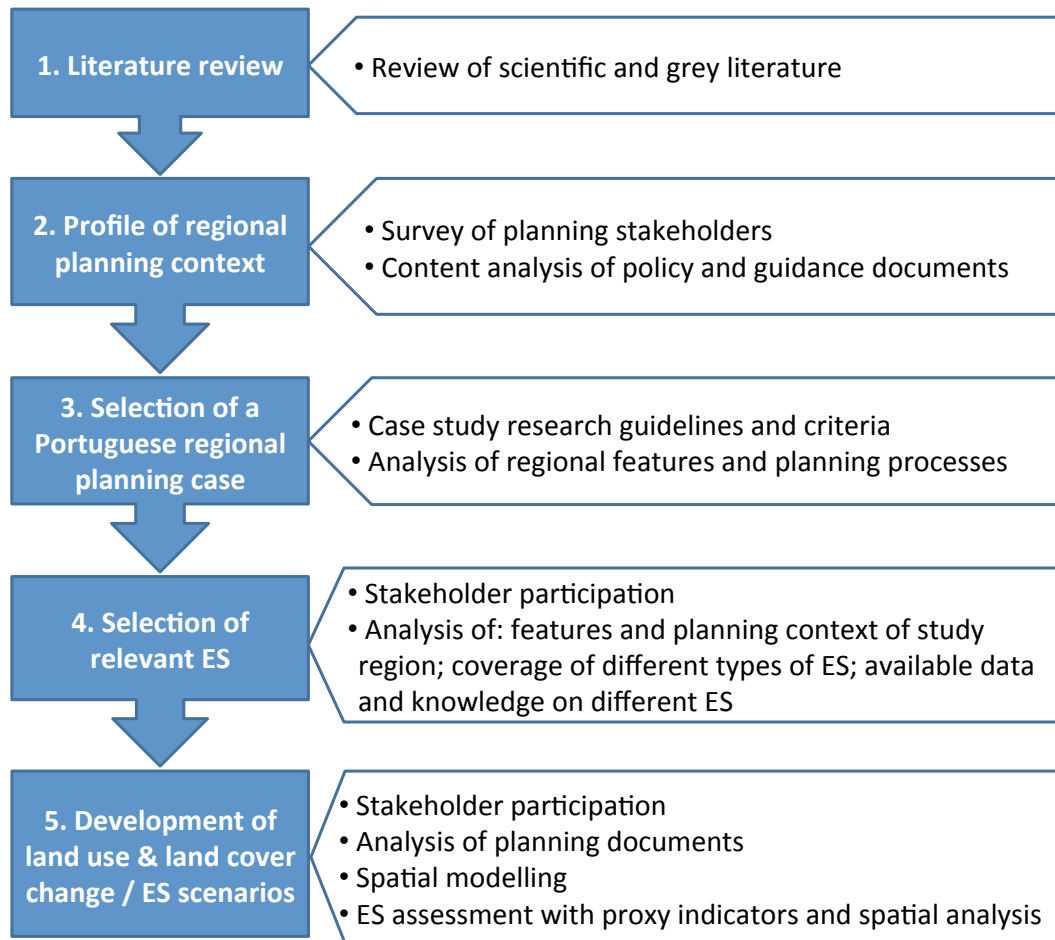


Figure 1.4 – Methodological approach followed in this research. The left side of the figure shows the main methodological steps, while the right side shows the specific methods or inputs supporting each step.

The content analysis of policy and guidance documents covered the European policy and guidance framework for spatial planning and SEA, as well as the national and regional levels of governance, using Portugal as example. Quantitative and qualitative content analysis were combined (Berg, 2001) and a set of key terms was developed to support the analysis, based on key selected ES literature (Costanza et al., 1997; Costanza and Daly, 1992; Daily, 1997; de

Groot, 1992; Ehrlich and Ehrlich, 1981; Haines-Young and Potschin, 2010b; MA, 2003; Mooney and Ehrlich, 1997; Pereira et al., 2009; TEEB, 2010b; Westman, 1977).

Taking into account case study research guidelines and criteria (Gerring, 2007; Yin, 2003), the Lisbon Metropolitan Area (LMA) was selected as a case study for the subsequent methodological steps. Home to the capital city of Lisbon, this region is the main urban agglomeration of Portugal and has been undergoing a suburbanization process, with urban sprawl taking place. On the other hand, there is also a relevant amount of agricultural, as well as natural and semi-natural areas. About 15% of the region is covered by areas protected for nature conservation. So this is a region with high demand for ES, but also relevant areas of ES provisioning, while nature conservation concerns and important drivers of ecosystem change, like urbanization, have to be considered in the spatial planning process. Moreover, the regional spatial plan (RSP) defined a Metropolitan Ecological Network (MEN) and is considered to be among the most representative examples of measures on green infrastructure in Europe (Losarcos and Romero, n.d.; Mazza et al., 2011). For these reasons, the LMA was considered a suitable and pertinent case study for the purpose of this research. More information on the LMA is provided in Chapters 4 and 5.

Relevant ES on which to focus further analysis were selected through a participatory approach (Chapter 4), complemented with an analysis of the features and planning context of the LMA, coverage of different types of ES and available data and knowledge. The selection of stakeholders to be involved in the participatory approach was guided by a) a review of existing policies and practices and of relevant documents related with spatial planning in Portugal and in LMA, similarly to Namaalwa et al. (2013), and b) author's knowledge on the region and on the planning context. An interest-influence matrix (Reed et al., 2009) was developed for stakeholder mapping. Two kinds of participatory techniques were adopted: (i) a focus group with technical staff from the regional planning authority; (ii) a participatory workshop with stakeholders from local authorities, the national environmental authority and academia. For each participatory moment, specific tools for systematic data collection were designed, as can be done to collect qualitative data (Yin, 2011). A pre-workshop questionnaire was also designed to collect participants' contextual information, perceptions of and knowledge on ES and individual opinion on the most important ES in the region. The participatory approach was designed to identify not only the priority ES in the LMA, but also the potential effects of drivers of

change or planning goals and objectives on LULC and ES. In this way, this methodological step provides crucial support for the next one.

Scenarios of LULC change and their effects on ES were developed (Chapter 5). To structure the scenario exercise, a scenario matrix (Rounsevell and Metzger, 2010) was developed around two axes of uncertainty regarding demographic and urban development patterns. These axes were chosen since: (i) land use change is strongly driven by population growth and urbanization processes, which result in increasing demand for natural resources, as well as space for housing and economic activities (Lauf et al., 2016); (ii) regional planning guidelines for the LMA aim at tackling urban sprawl while attracting residents; (iii) stakeholders consider urban regeneration, as opposed to new urban developments on non-urban land, a highly relevant planning goal (Chapter 4). The analysis placed particular emphasis on land take, given that it is an important global sustainability issue for spatial planning and ES (Ahern et al., 2014; Foley et al., 2005; Seto et al., 2011), and considering the suburbanization and urban sprawl observed in the region. A time horizon until 2030 was adopted, coincident with the 2030 Agenda for Sustainable Development (UN, 2015), with which the New Urban Agenda (HABITAT III, 2016) is closely aligned. Storylines (Rounsevell and Metzger, 2010) were developed for each scenario and translated into quantitative assumptions, covering a set of determinants commonly used to explain LULC change (Nuissl and Siedentop, 2013). Residential development was taken as main driver of change, together with household features, which are crucial for assessing future land consumption in urban areas (Haase et al., 2013). LULC changes were translated into changes in ES potential supply – the ecosystem biophysical capacity to supply services (Bastian et al., 2012). The ES focused were “maintenance of atmospheric composition and climate regulation”, “physical and experiential interactions” and “cultivated crops” (following the Common International Classification of Ecosystem Services; (Haines-Young and Potschin, 2010a)). These were considered most important for the LMA in the previous participatory exercise and cover regulation, cultural and provisioning ES. Proxy indicators to assess ES were developed, following common practice in ES studies (Maes et al., 2016).

As a whole, the methodological approach allows drawing and integrating insights into critical issues for ES integration in spatial planning, hence addressing the main research question presented in Section 1.3. A critical analysis of the approach was conducted and is presented in Chapter 6. In the next section, the structure of the dissertation is presented.

1.5 Structure of the dissertation

The core of this dissertation is composed of four main chapters (Chapters 2 to 5), each representing an original research paper and relating to the methodological approach presented in the previous section. The research papers included in Chapters 2 to 4 were published in international peer-reviewed scientific journals, while the paper in Chapter 5 was submitted for publication at the time of dissertation submission. The main chapters are preceded by the present introductory chapter and followed by a concluding chapter (Chapter 6). The next chapters can be summarized as follows:

- Chapter 2 presents the results of a questionnaire survey aimed at gaining insights on the views and perceptions of Portuguese regional spatial planners (practitioners and decision-makers), regarding the ES concept and its integration in spatial plans and SEA processes. This chapter was published as original research article in the journal *Landscape Ecology* in March 2014;
- Chapter 3 draws a profile on ES integration in the policy and guidance framework for spatial planning and SEA. The profile is supported by a content analysis of policy and guidance documents, covering the European, national (Portugal) and regional (Portuguese regions) governance levels. This chapter was published as original research article in the journal *Land Use Policy* in November 2015;
- Chapter 4 presents a participatory approach to select priority ES. The approach combines different participatory techniques and was applied with different types of stakeholders, using the Lisbon Metropolitan Area in Portugal as case study. The approach also allows linking ES with drivers of change and spatial planning goals that entail potential effects (positive or negative) on ES. Strengths and weaknesses of the approach are discussed. This chapter was published as original research article in the journal *Ecosystem Services* in April 2016;
- Chapter 5 explores how different scenarios of demographic and urban development patterns translate into LULC changes (particularly land take) and what are the consequences for ES supply. Four contrasting scenarios for the LMA in 2030 were developed, covering major determinants of land take (with a focus on residential development) and priority ES of climate regulation, recreation and food production. The chapter discusses the effects of a “compact city” versus an “urban sprawl” pat-

tern of urban development under contrasting demographic trends. Implications for debates around the “compact city” ideal and how land take is defined are also discussed. This chapter was submitted as original research article to an international peer-reviewed scientific journal;

- Chapter 6 synthesizes and integrates all the previous chapters, presenting the main overall research findings. A conceptual framework for ES integration in spatial planning is proposed. Recommendations for further research and planning practice are presented.

Integration of ecosystem services in spatial planning: a survey on regional planners' views¹

Abstract

Spatial plans shape land-use changes, which in turn are main drivers of anthropogenic ecosystem alterations, therefore influencing the ecosystem services (ES) delivered by a given territory. However, integration of the ES concept in policies and plans is reported as poor in literature. The main goal of this research is to gain insight on the views and perceptions of Portuguese regional spatial planners regarding the ES concept and its integration in spatial plans. For that we designed and administered a questionnaire survey aimed at practitioners and decision-makers from Portuguese regional spatial planning authorities. The survey focused on issues such as the level of awareness and knowledge of the ES concept among planners, the perceived level of current ES integration in regional spatial plans and corresponding strategic environmental assessments, the main factors that either facilitate or obstruct that integration, or the level of importance given to ES integration in the planning process. Findings show that planners know the ES concept, they consider it as important to be integrated in spatial planning and, interestingly, that it is already rather in-

¹ Mascarenhas, A., Ramos, T., Haase, D., Santos, R., 2014. Integration of ecosystem services in spatial planning: a survey on regional planners' views. *Landscape Ecology* 29, 1287–1300. doi:10.1007/s10980-014-0012-4 (reproduced with authorization of the publisher and subject to copyright restrictions imposed by them).

tegrated in existing plans. They believe that planning teams and authorities have skilled human resources for ES integration. However, they revealed a low knowledge on the main initiatives intended to push ecosystem services into the political agenda, like for example the Millennium Ecosystem Assessment. The questionnaire used can be easily transferred into other spatial planning contexts to draw e.g. a broader European picture on ES integration in spatial planning.

Keywords: ecosystem services, spatial planning, strategic environmental assessment, governance, stakeholder survey.

2.1 Introduction

The exponential growth of human activities is raising concern that further pressure on the Earth System could destabilize critical biophysical systems and trigger abrupt or irreversible environmental changes that would be deleterious or even catastrophic for human well-being (Rockstrom et al., 2009). This concern is largely motivated by an increasing awareness of the dependence of human beings upon the services provided by ecosystems, known as ecosystem services (ES). ES are generally defined as the benefits people obtain from ecosystems (MA, 2003) representing flows of value to human societies as a result of the state and quantity of natural capital (TEEB, 2010b).

Spatial plans have the capacity to induce changes in quality or quantity of ES, by determining development options and how those options translate in a given territory. This is related to the fact that one of the main drivers of anthropogenic ecosystem changes is land-use change (Burkhard et al., 2010; Reyers et al., 2009). Land-use change has the potential to produce severe ecological, economic and political problems or even hazards (Haase and Nuissl, 2010). So, it is for spatial and land-use planning that the effects of plans on ES provision and use are perhaps more evident and straightforward (Geneletti, 2011). Application of the ES concept at the level of land-use public policies will allow such effects to be considered and evaluated while making land-use proposals, and choices on future developments (Partidário and Gomes, 2013). Additionally, the regional scale is particularly important for sustainable spatial development, since it is at that scale that many development policies are established

and coordinated (articulating national and local policies) and that the appropriate management of natural resources, interconnectivity between cities, economic growth and cultural identity are set in motion (Birkmann, 2003; Mascarenhas et al., 2012b).

Despite the attention that research on ES has attracted in recent years (see Fisher et al. 2009), it is still a fragmented field (Seppelt et al., 2011) and many issues still remain unresolved to better integrate the ES concept into everyday planning, management and decision-making (de Groot et al., 2010a). For example, several different definitions of ES exist (Fisher et al., 2009). With increasing scientific disciplines referring to the ES concept and its mainstreaming in political and corporate discourse, the concept is seen as becoming multiform, harder to grasp and being applied in directions that diverge significantly from its original purpose (Gómez-Baggethun et al., 2010; Lamarque et al., 2011). Terminology associated with ES studies is often inconsistently used and does not directly relate to the terminology used by decision-makers, stakeholders or the public (Glaves et al., 2010; Müller et al., 2010). According to Lamarque et al. (2011), the coexistence of different terminologies and definitions can impede the on-the-ground use of the concept because of the difficulties in translating it into tangible, manageable, “things” to measure, count, qualify or map. In face of these and other issues, the use of ES concepts to support real-life decision-making processes and the integration of ES in policies and plans has been reported as poor or limited (Bennet et al., 2008; de Groot et al., 2010a; Geneletti, 2011; Koschke et al., 2012).

The integration of ES concerns into spatial planning can best be achieved by taking advantage of existing procedures to support plan making, such as strategic environmental assessment (SEA) (Geneletti, 2011). As a strategic decision support instrument, SEA can play a significant role in ensuring ES consideration (Partidário and Gomes, 2013) and provide better guarantees that ES are taken into account in planning and related decision-making processes (Slootweg and van Beukering, 2008). However, the integration of ES in SEA was, until recently, essentially covered by technical reports and guidelines (see for example Hobbs et al., 2010; Slootweg and van Beukering, 2008). It has been

poorly covered in scientific literature, with some recent exceptions (see Geneletti, 2011; Partidário and Gomes, 2013).

Awareness, knowledge, organizational and institutional capacity are essential prerequisites for mainstreaming ES in planning processes (Cowling et al., 2008). Governance of ES requires engaging those actors who understand, manage and benefit from the services. The way that existing policies and the institutional context condition the feasibility of new ES approaches should also be identified (Primmer and Furman, 2012). This is related to the importance of considering the different values that inform decision-making, of recognizing the complex and context-specific nature of environmental decisions, and the centrality of institutional arrangements for the implementation of these decisions (Adger et al., 2003). However, current ES approaches do not take existing administrative and governance structures and practices as a starting point (Primmer and Furman, 2012). Most of the research does not include (at least explicitly) the views and knowledge of the practitioners and decision-makers who are ultimately the main actors in each specific spatial planning context. This is important since ES integration is unlikely to happen if spatial planners are unaware for example of what ES are, what are the benefits of ES integration in the spatial planning process and what tools can be used to achieve such integration. With few exceptions of similar studies, such as the technical report by Glaves et al. (2010) or the articles by Lamarque et al. (2011) and Hauck et al. (2013a), to our knowledge, a survey of regional spatial planning practitioners and decision-makers, focused on those issues, is practically absent in literature.

Set against this background, the main goal of this research is to gain insight on the views and perceptions of Portuguese regional spatial planners regarding the ES concept and its integration in spatial plans. The following research questions were of particular interest:

- What is the level of awareness and knowledge that planners have about ES?
- What is the perceived level of current ES integration in the planning process?
- What are the main factors that either facilitate or obstruct that integration?

- What is the level of importance given to ES integration in the planning process and which stages are seen as the most relevant for such integration?

This is achieved by a questionnaire survey designed and administered by the research team, aimed at practitioners and decision-makers from regional spatial planning authorities. We present an exploratory research that builds on previous work that analysed Portuguese regional spatial plans (RSPs) and corresponding strategic environmental assessment (SEA) reports, as well as the national guidelines for spatial planning and SEA. That analysis revealed a low level of integration of the ES concept in RSPs, discrepant levels of integration between regional spatial plans (RSPs) and SEA reports – as a rule lower in the RSPs than in the SEA reports – as well as practically inexistent references to ES in the national guidelines (Mascarenhas et al., 2012a). Those findings partly motivated this research as a way to improve the knowledge on the factors that might influence ES integration in spatial planning. In that sense, this research allows going beyond the main outputs of the planning or SEA process – the plan or the SEA report themselves – investigating other aspects of the process, through the views and perceptions of planners, as important actors in that context. This research is also relevant for the case of Portugal, considering that there was a MA sub-global assessment done for the whole country (including five case studies at different sub-national levels as well), involving not only researchers but also practitioners (Pereira et al., 2009). This initiative should play a role in mainstreaming ES, at least by making the concept more popular and providing lessons from case studies. In fact, after its publication, some conferences and workshops on ES, mainly associated with forest ecosystems, were promoted by different organizations (private and public, including the national government's institute for nature and biodiversity conservation, national forest association and environmental agency). A few studies on ES were also carried out (e.g. a study on Hotspot Areas for Biodiversity and Ecosystem Services in *Montados* by the WWF Mediterranean Programme in Portugal) and more recently, in the business sector, the Portuguese branch of the World Business Council for Sustainable Development published a brochure on ES (BCSD Portugal, 2013). Still, national promotion of the ES concept is not yet an object of

other incentives like major funding programs or strong national policy guidelines.

2.2 The Portuguese regional spatial planning context

The main goals of Portuguese RSPs are: (i) to define guidelines for land-use, in a framework of strategic options defined at the regional level; (ii) to promote the integration and coordination of sectoral and environmental policies in regional spatial planning; and (iii) to provide guidance for municipal spatial plans (at the level of Local Administrative Units) (MAOTDR, 2006). In a given region, there are areas under several other plans that articulate with RSPs within the Portuguese spatial planning framework (e.g. for nature protection areas), which are not focused by this research. Nowadays, RSPs in Portugal are less prescriptive, they have a more strategic and integrated scope and coordinate different territorial and sectoral plans, following more a spatial than a land-use planning approach (Ferrão, 2011; Nadin, 2007). This means Portuguese RSPs are very broad in scope, covering themes like economic development, competitiveness, energy, transportation, nature protection, among others. Generically, RSPs define a territorial strategy anchored on a long-term vision for the region and broad planning goals that can be very diverse (e.g. “to qualify and diversify the tourism cluster”, “a region with high levels of energetic self-sufficiency and safety”). These broader goals are translated in more specific goals, usually called territorial strategic options, which are clustered in strategic axis and are essential components of RSPs. Territorial strategic options are spatially translated in a territorial model, which constitutes the spatial reference for RSPs. The territorial model is one of the main cartographic elements; these also include the urban system, the environmental protection and enhancement system, the accessibility and mobility system, heritage values, risks and territorial units. RSPs also include a set of guiding standards for how territorial strategic options are to be achieved and an execution program for the major public actions or investments.

Portuguese RSPs ideally operate at NUTS II level² (GSEOTC, 2005), although currently three of them are not aligned with NUTS II regions, but with agglomerations of NUTS III units. For each planning region, there is a spatial planning authority. These can be regional bodies of the central government (in

² According to the European Common Classification of Territorial Units for Statistics.

the mainland of Portugal, with five authorities) or regional governments (in the autonomous regions of Madeira and Azores archipelagos, with two authorities). These authorities are officially responsible for conceiving³ and enforcing the RSPs, as well as for approving and integrating into the plans the results of SEA. However the responsibilities of these authorities go beyond spatial planning; they include designing and implementing regional development strategies within EU Regional Development Fund policies. The hierarchy of authorities in the mainland can be simply described (considering what is relevant for this research) as comprising one president and one to two vice-presidents and several directorates, which can include divisions, then departments and even further disaggregation. One of the directorates is the spatial planning directorate, which deals mainly with the RSPs. A similar body exists within the regional governments of the archipelago islands. The planning process leading to the RSP involves practitioners and decision-makers from different directorates, departments and divisions of regional spatial planning authorities. A broad number of national, regional and local organizations are also involved in the planning process. Usually, topics are first technically developed on a sectoral basis (e.g. nature and biodiversity, risks, urban development) by specialized departments of the planning team, and then integrated in the RSP following discussion with such external organizations.

Currently there are eight RSPs covering all of Portugal's territory (Figure 2.1). Additional information for each RSP is shown in Table 1. Under national SEA legislation, SEA is required for RSPs. In Portugal the SEA directive (Directive 2001/42/EC) was transposed into national legislation in 2007 (Decree-Law No. 232/2007, of 15 of June). Only two of the eight RSPs did not have a SEA process, for the remaining, SEA reports are publicly available. The relationship between nature and humans, as conveyed by RSPs, is predominantly focused on a conservationist approach to nature and biodiversity. The natural system is also frequently regarded as a support for tourism and recreational activities. It is less frequent to observe a discourse focused on ES (see Mascarenhas et al., 2012a).

³ Regional spatial plans can be conceived by third party organizations, other than the regional spatial planning authorities (for example private companies, universities or consortiums). However the authorities are responsible for accompanying plan elaboration and they are the ultimate legal responsible for the plans.

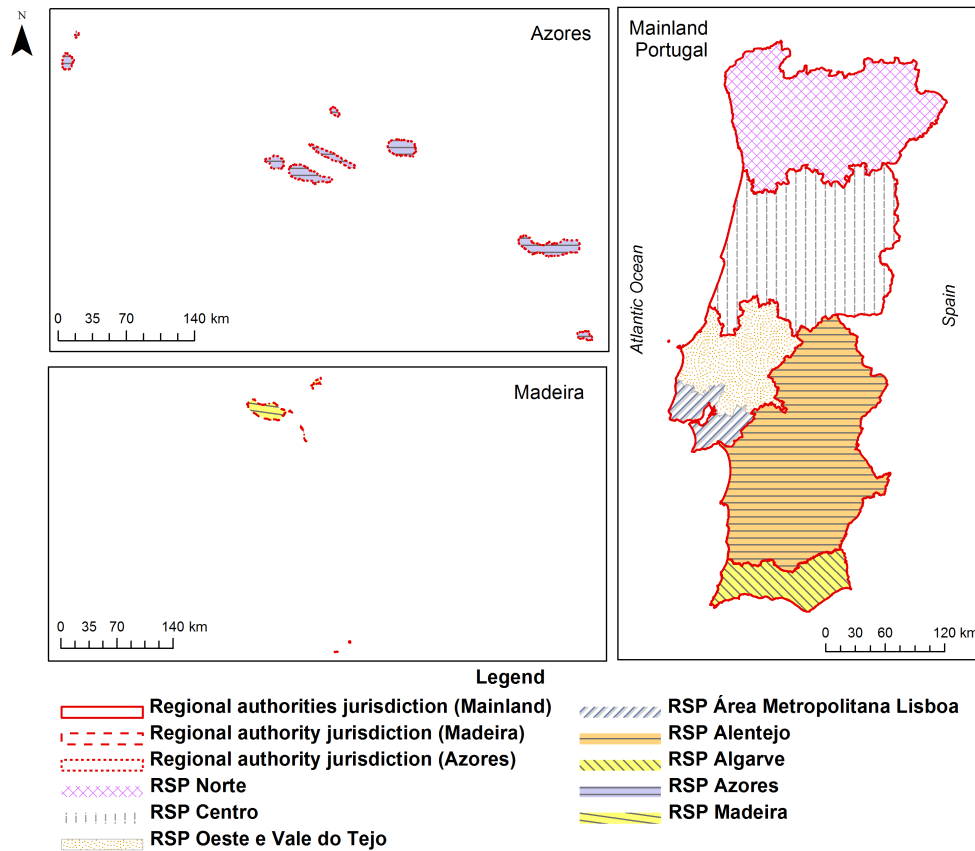


Figure 2.1 – Jurisdiction areas of the regional spatial planning authorities and areas of each RSP. Source of official administrative boundaries: Instituto Geográfico Português.

Table 2.1 – Regional spatial plans in Portugal. Data as provided in each plan.

RSP	Year of publication	Population (inhabitants)	Area (km ²)	SEA
Norte	2009*	3 689 682	21 286	Yes
Centro	2011*	1 744 554	23 659	Yes
Oeste e Vale do Tejo	2009	830 654	8 792	Yes
Área Metropolitana de Lisboa	2010*	2 821 876	2 944	Yes
Alentejo	2010	509 849	27 000	Yes
Algarve	2007	451 006	4 996	No
Azores	2008*	246 772	2 322	Yes
Madeira	1995	267 785	801	No

* Technical proposal awaiting legal publication.

2.3 Methodology

A questionnaire survey was designed and administered by the research team to gain insight on the views and perceptions of Portuguese regional spatial planners regarding ES and its integration in spatial plans (Appendix 1). A questionnaire was chosen as the data collection tool for the survey given that: (i) regional spatial planning authorities face work overload and increasingly insufficient human resources, having very limited or no time at all to spare for interviews; (ii) due to their unobtrusive nature and the ability to respond at one's convenience, some potential respondents prefer questionnaire surveys (Bhattacharjee, 2012). Given these features, we considered that using a questionnaire would increase response rates and outweigh possible advantages of conducting interviews.

The target population was composed of practitioners and decision-makers from Portuguese regional spatial planning authorities. We consider as practitioners, people who work in such authorities but who do not make decisions. They usually work as decision supporters and policy analysts but they do not take direct responsibility for decision-making. Decision-makers are considered to be people working in the same authorities but who take direct responsibility for decision-making. They occupy the higher hierarchical positions within the authorities. For simplicity, hereafter we refer to them together as planners.

Questions were numbered and clearly grouped by subject (Kelley et al., 2003) in four sections, as follows:

Framing

This section included questions to identify in which regional spatial planning authority and regional spatial plan(s) planners worked, as well as in which phase(s) of the regional spatial planning process did they work or follow.

Ecosystem services

This section asked about how well did planners know the ES concept and how would they define it. An open question was used for the latter since possible replies were unknown or too numerous to pre-code (Kelley et al., 2003). Planners were also asked how well did they know some concepts normally associated with the ES concept (environmental services, natural capital, ecosystem functions, landscape functions, green economy), as well as some major initia-

tives related with ES (MA, *Ecosistemas e Bem-Estar Humano*⁴, TEEB – The Economics of Ecosystems and Biodiversity). For a discussion on the concepts associated with the ES concept see for example Lamarque et al. (2011). It should be noted that until this point of the questionnaire no definition of ES was given. In the beginning of this section, an introductory text was included, stating that it was important that planners responded without purposely consulting information on ES. It was also asked that, in case receiving the questionnaire had already triggered such consultation, respondents would answer without using its results.

Ecosystem services and regional spatial planning

To answer the questions in this section, it was important to establish a minimum common knowledge of the ES concept among respondents, therefore in the beginning of the section the popular ES definition by MA (2005a) was presented. Then, in this section planners were asked to rate the degree of integration of the ES concept in the RSP they were involved with, as well as in the corresponding SEA, when existent. Associated with this, they were also asked to rate the contribution of a series of factors for the integration of the ES concept in the RSP: (i) generalized knowledge, within the institution, of the concept of ecosystem services; (ii) guidance from higher hierarchical bodies of the institution; (iii) technical skills of the staff; (iv) financial resources; (v) proposals from the external team or consultants in plan design; (vi) proposals from the Mixed Coordination Commission; (vii) guidelines from the national scale to the regional scale; (viii) recommendations from the SEA; (ix) outcomes of public consultation; (x) availability of baseline data; (xi) availability of studies (e.g. academic, technical reports); (xii) others.

These factors were identified based on knowledge by the research team about generic planning processes, on literature analysis and on suggestions by people involved in the pre-testing of the questionnaire. For example, different professionals and stakeholders will likely be involved in a planning process, demanding horizontal (on the same level of government) or vertical (on other levels) coordination (Faludi, 2000; Perdicoulis, 2011). In Portugal this translates in a body called a mixed coordination commission, which accompanies the regional planning process and can influence its outcomes (factor vi). Additionally, planners might not have the means to carry out the planning process (Faludi,

⁴ Sub-global assessment of the Millennium Ecosystem Assessment for Portugal (Pereira et al., 2009).

2000), so it is possible that a spatial plan is technically designed and developed by an external team under supervision of a planning authority, as was the case of some RSPs in Portugal (factor v, see also Section 2.2). Those needed means also relate to factors iii, iv, x and xi. Perdicoúlis (2011) also stresses the role of spatial planners' skills and information challenges in a planning process (factors iii and x). Related with the latter, availability of baseline data (factor x) and of studies (factor xi) plays an important role in the growing evidence-based approach to spatial planning. Evidence can be used to identify issues where attention is required (Morphet, 2011), like declining ES for example. As for SEA, Geneletti (2011) argues that, as an existing process to support planning, it can be advantageous to internalize ES concerns into spatial planning (factor viii). Along with SEA, legislation like Directive 2003/35/CE in the EU, or even good practice alone, call for public consultation (factor ix) in planning processes. This is a chance for all of those who were not involved in a more active participatory process to express their views. Some of these individuals or organized groups might draw attention to issues related with ES that were previously not identified. Planners could additionally suggest other factors that they considered relevant for ES integration. Section 3 also included questions about how important planners considered integrating the ES concept in regional spatial planning and which stages of the planning process were more or less important for that integration.

Additional information and follow-up of results

This section of the questionnaire was designed to collect more information on the respondents, such as what kind of position did they hold in the hierarchy of the authority (and in which division/department), their academic background and professional experience. Lietz (2010) recommends that this type of questions come in the end of a questionnaire rather than at the beginning in order to avoid negative feelings about the provision of more personal information impacting on the answering behaviour or participation. This section also included a comments question where respondents could provide overall comment on the questionnaire (recommended for example by Boynton and Greenhalgh, 2004), as well as two questions on their willingness to receive the aggregated results of the questionnaire and to participate in future initiatives of the research project.

Most questions were closed-ended with pre-coded response options, since they are quick to administer and can be easily coded and analysed (Kelley et al., 2003). For the majority of these questions, a Likert-type response scale length of five was adopted, including a middle option, following the recommendations

by Lietz (2010). Question 2.2 (asking planners to define ES) was open-ended so a content analysis was performed, according to Weber (1990); Neuendorf (2002); Hsieh and Shannon (2005); Elo and Kyngäs (2008). A directed content analysis (Hsieh and Shannon, 2005) was performed, based on existing definitions of ES by Costanza et al. (1997), Daily et al. (1997) and MA (2003). The following separate indicators or variables (Neuendorf, 2002) were identified for coding: (A) a relationship is established between ecosystems/nature and humans; (B) ecosystems are described as sustaining human life; (C) the word "benefits" (that people derive from ecosystems/nature) is explicitly mentioned; (D) ecosystem "functions", "conditions" or "processes" are explicitly mentioned; (E) "biodiversity" is explicitly mentioned; (F) examples of specific ES are mentioned. A structured categorization matrix was developed (Elo and Kyngäs, 2008) and variables were measured with nominal categories (present / absent / unable to determine). The unit of analysis was the entire response entered by respondents, given that responses were short and referred to a single definition (Neuendorf, 2002; Weber, 1990). When mentioned, examples of specific ES were categorized according to the ES categories defined by MA (2003).

The online questionnaire incorporated some logic rules to keep it simpler and more fluid for respondents. This also allowed that, if respondents had worked with more than one plan, some of the questions (in Section 3) would be repeated to get responses for each plan. This means that one respondent could give his/her opinion on ES integration for more than one plan, if he/she had that experience. A pre-test was conducted to assess critical factors of the questionnaire such as its clarity, comprehensiveness and acceptability (Rea and Parker, 1997). The pre-test involved eleven people working with spatial planning issues in different types of organization (e.g. local and regional authorities, universities), which filled-in the questionnaire accompanied by one member of the research team. The pre-test allowed adjusting some questions, adding or modifying some response options and estimating that fifteen minutes would be the average expected time to complete the questionnaire.

The invitation to participate in the survey included a brief text presenting the aims of the research, the target population, the scope of the research, the organizations conducting it, the general structure of the questionnaire, the estimated time needed to complete it, a statement of anonymity and of exclusive use of results for scientific research ends, as well as contact details of one of the researchers, following recommendations by Kelley et al. (2003) and Rea and Parker (1997). Seven regional authorities were asked to participate, covering the whole national territory. Five of these authorities are regional bodies of the cen-

tral government and two are regional governments from the autonomous regions of Madeira and Azores archipelagos. The request to fill in the online questionnaire was sent to the presidents of the regional spatial planning authorities. This is the formal and normal procedure for presenting requests to these authorities. For most of them, only the presidency's e-mail address is available in their website. Normally the request is then distributed further down the hierarchy of the authority. This means that the sampling method resembles a snowball sampling (Atkinson and Flint, 2001; Biernacki and Waldorf, 1981; Noy, 2008). In snowball sampling usually the researcher accesses informants through contact information that is provided by other informants (Noy, 2008). Potential respondents contacted on a first stage (top decision-makers), were responsible for distributing the questionnaire to other potential respondents, following a hierarchical top-down process. As a complement, respondents who voluntarily provided their contact were asked to further distribute the questionnaire to potential respondents. Responses were collected between the end of February and mid-May 2013. Responses were anonymous but respondents could voluntarily provide their e-mail address.

2.4 Results

A total of fifteen usable responses were returned. Given the number of responses, these results should not be interpreted as statistically representative of the entire population. Nevertheless, the main goal of this study was to conduct a descriptive exploratory data analysis with pilot character. The population size could not be calculated, due to several factors. Given the broad, strategic scope of RSPs, the planning process involves practitioners and decision-makers from different departments and divisions of regional spatial planning authorities (and even from several external organizations, as pointed out in Section 2.2). The competences of these authorities go beyond the RSPs, which means that some individuals might have worked only for a short period of time and for very specific tasks within the planning process. Some others were involved in the planning process (even as presidents or vice-presidents of the authorities) but are now not working with the planning authorities, or have assumed other tasks less related with the RSP. So information on exactly who has been involved in the planning process is not readily available. However, from the knowledge that the research team has on the authorities, a number that should

not surpass ten planners working more full-time on RSPs is considered reasonable, which means that the number of responses could represent around 21 percent of the total target population. For comparison, a response rate of 15-20% is typical for a mail survey (Bhattacharjee, 2012; Kelley et al., 2003). A similar number of responses was observed in a comparable study by Hauck et al. (2013a) who conducted a regional questionnaire survey in Satakunta (Finland, 29 responses), Saxony (Germany, 16 responses) and Silesia (Poland, 7 responses).

All regional spatial planning authorities are represented by at least one respondent and the maximum number of respondents per authority is three. None of the respondents has worked with a plan outside of the jurisdiction area of the planning authority where he/she currently works. Despite that, two respondents work with two plans (one of the plans is PROT Oeste e Vale do Tejo, whose responsibility is shared by two authorities). Generally, respondents worked or followed the main stages of the planning process. Most of them work either in a spatial planning directorate or in a regional development directorate, within the hierarchy of the authorities. The majority works as technician but there are five respondents occupying middle decision-making levels (for example service director, division chief) and one top decision-maker (regional director). Respondents are quite heterogeneous in terms of academic background and years of work experience. For example, graduation year ranges from 1978 to 2004 and post-graduation year ranges from 1986 to 2010, with variability also in terms of degree subjects. Total years of work experience vary between 8 and 32; years of work experience in regional spatial planning vary between 4 and 28. So, overall, respondents represent a heterogeneous group, which means that responses should not be biased due to similarity in these characteristics (see Appendix 2).

Eleven planners responded they know the concept of “ecosystem services” either fairly well or quite well. When asked how would they define the concept (open response) the following was observed: most respondents establish a relationship between ecosystems / nature and humans (variable A). An example of such a response is “the way in which ecosystems interact to sustain our daily life”. Almost half of the respondents explicitly mention ecosystem

“functions”, “conditions” or “processes” (variable D). Fewer of them described ecosystems as sustaining human life (variable B; see also example above) or explicitly mentioned the word “benefits” (variable C). Only three respondents explicitly referred to biodiversity (variable E). On the other hand, only one response had none of the variables present. This response (“Protection areas to be safeguarded”) conveys the notion of zoning areas for nature protection and therefore is not aligned with the main notions underlying the ES concept. Five respondents also mentioned examples of specific ES when defining what ES are. Examples were categorized according to the ES categories defined by MA (2003), as shown in Figure 2.2. Regulating services were more frequently mentioned, mainly related with water regulation, water purification and climate regulation. Examples of supporting services were related with soil formation, nutrient cycling and primary production. Provisioning services were related with fresh water, food and fuel wood. Cultural services were the least mentioned and were related with aesthetic, recreation and tourism. On the other hand, several examples could not be categorized, these included “risk protection” or “physical support to human activities” among others.

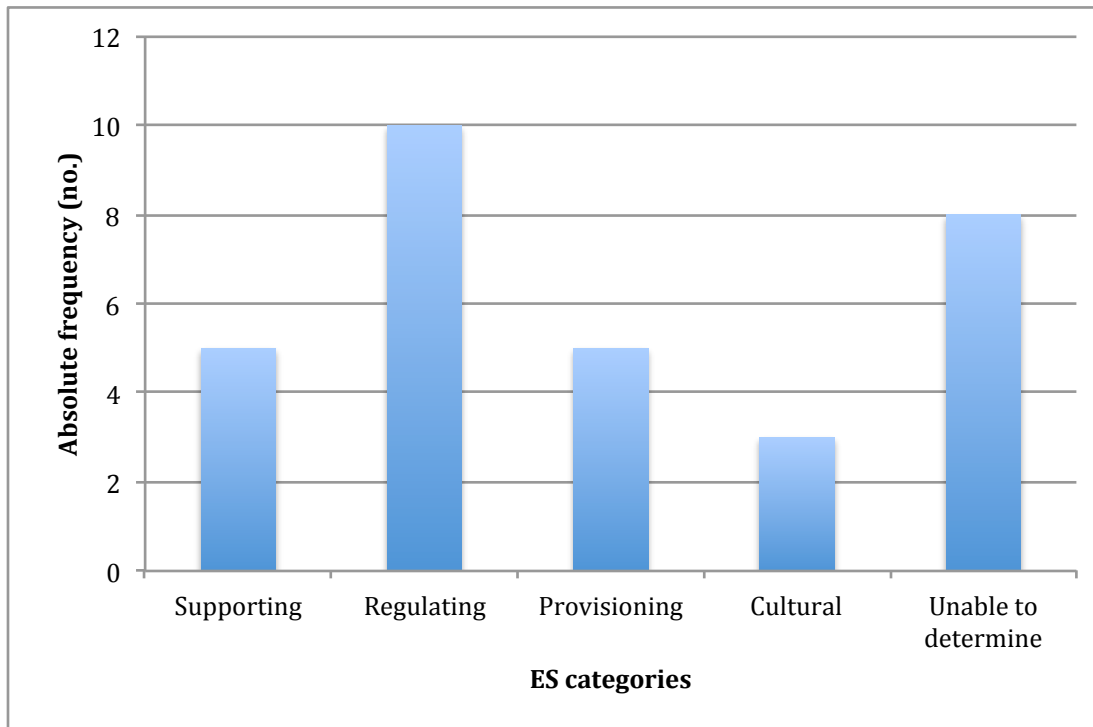


Figure 2.2 – Categorization of ES examples given by respondents, according to the ES categories defined by MA (2003).

In terms of concepts related with ES (environmental services, natural capital, ecosystem functions, landscape functions, green economy), all of them are at least fairly known by most planners. Despite that, only “functions” was spontaneously mentioned when planners were asked to define the ES concept. There is also a general low knowledge of respondents about some of the main initiatives related with ES (Millennium Ecosystem Assessment, its Portuguese sub-global assessment and The Economics of Ecosystems and Biodiversity).

Most planners rated the degree of integration of the ES concept in the plan they were involved as fair or high. A similar pattern of responses was observed for the degree of integration of the ES concept in SEAs of plans.

In terms of the contribution of a given set of factors for such integration, an analysis of results across all factors shows that overall, they are considered to have a positive contribution for ES integration, since the “positive” response category concentrated most responses. Factors considered to have more positive contributions (more responses for very positive and positive contribution) are “Proposals from the external team or consultants in plan design” and “Technical skills of the staff”, followed by “Generalized knowledge, within the institution, of the concept of ecosystem services”. “Recommendations from the SEA”

was one of the factors that got more responses for a very positive contribution. Most respondents regarded factor "Outcomes of public consultation" as having a null contribution for ES integration and factor "Financial resources" as either having a null contribution for ES integration or considered that this factor was "not applicable" for ES integration (Figure 2.3).

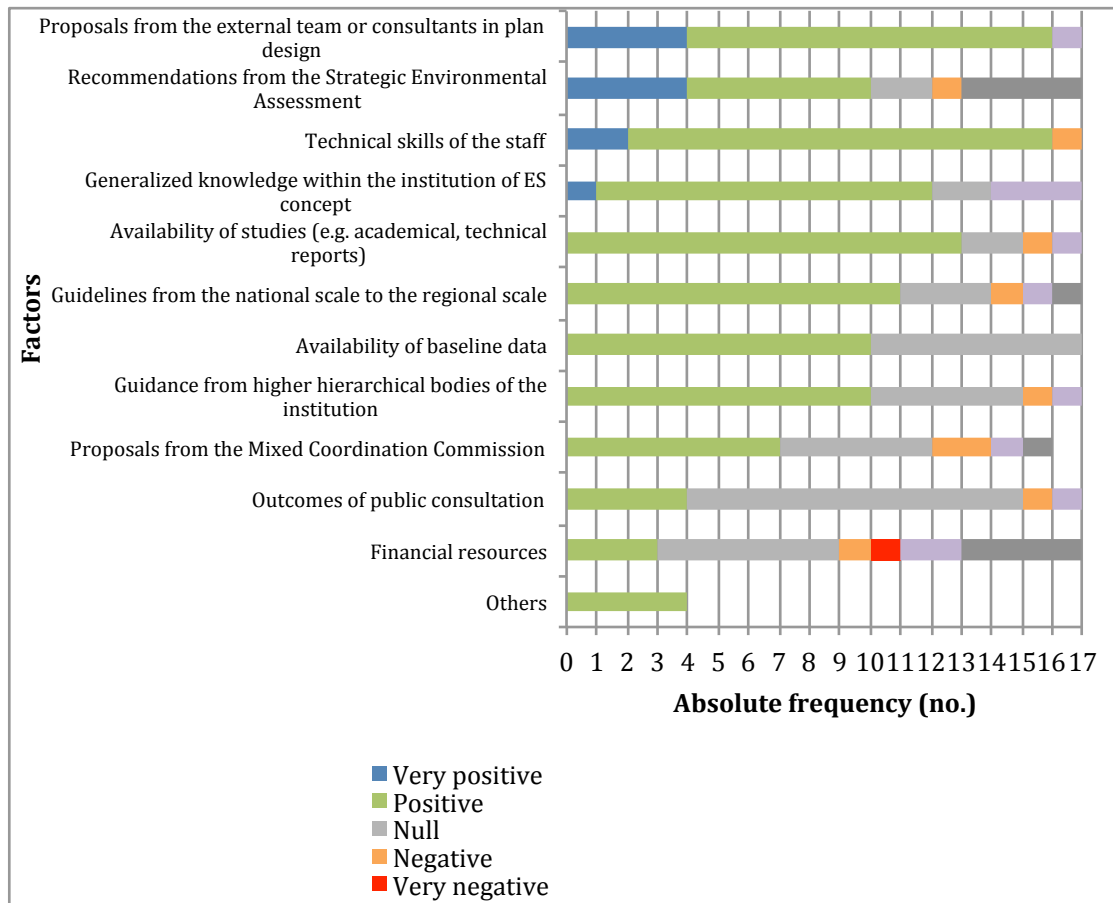


Figure 2.3 – How planners rate the contribution of different factors, for the integration of the ES concept in RSPs.

All of the planners responded that it is either very important or quite important to integrate the ES concept in regional spatial planning. Globally, planners responded it is important to integrate the concept along all the major planning process stages (Figure 2.4). Planning stages considered less important for ES integration are "Elaboration of terms of reference" and "Definition of the vision and main strategic goals of the plan".

Finally, almost all responding planners showed their willingness to receive results of the questionnaire and of future research, as well as to participate

in future initiatives of the research project (see Appendix 2 for results' figures not included in the article).

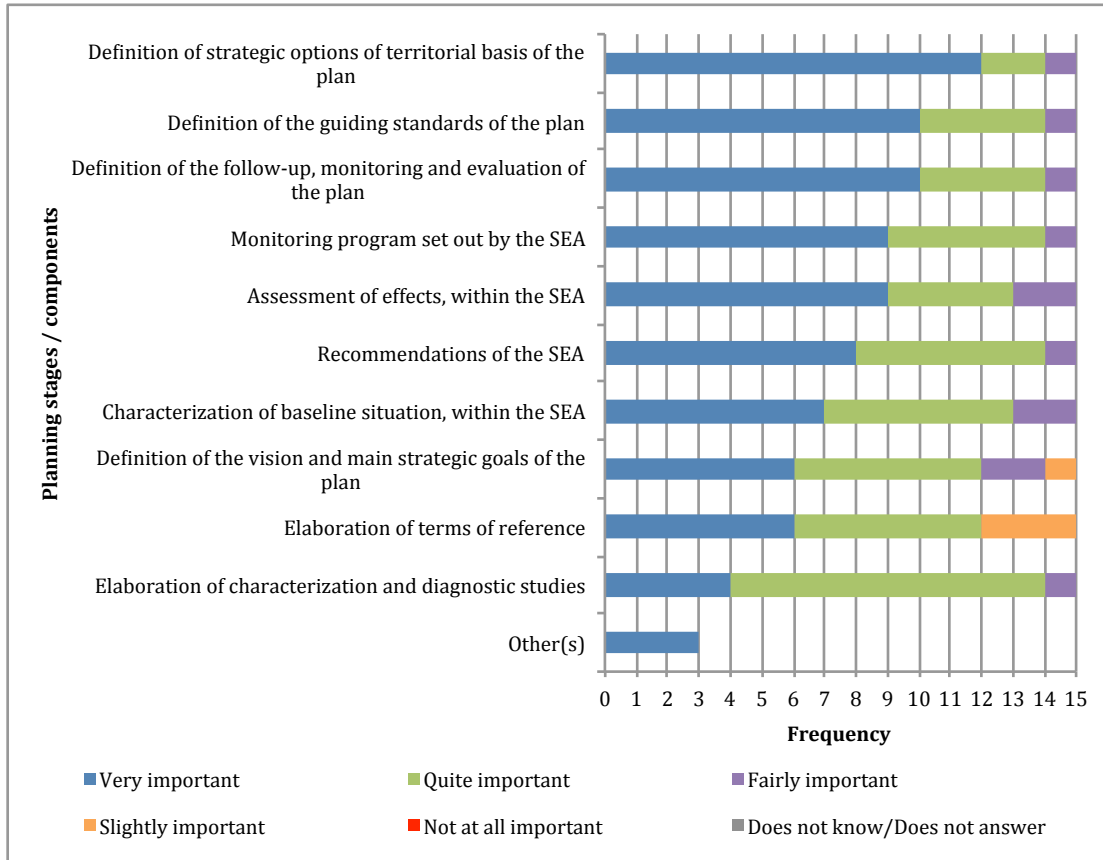


Figure 2.4 – How important planners consider different stages / components of the planning process to integrate the ES concept in regional spatial planning.

2.5 Discussion

The fact that the ES concept, as well as associated concepts, is generally known among responding planners opens good perspectives for ES integration in regional spatial planning in Portugal. However, one must consider the risk of getting socially desirable responses, which can occur when respondents think that they should be informed about certain issues and give responses conveying this impression instead of admitting ignorance. This can lead to answers that inaccurately reflect respondents' actual behaviours or in this case knowledge (Lietz, 2010). It is also not possible to know if respondents ignored the warning not to consult information on ES to answer the first sections of the questionnaire. Nevertheless, the definitions of the ES concept given by the planners are

consistent with their declared level of knowledge of the concept. Generally their definitions convey the same basic ideas as the definitions found in literature, such as the frequently cited ones by Costanza et al. (1997), Daily (1997) and MA (2005a). Similarly to these three examples, many planners explicitly mentioned the relationship between ecosystems or ES with humans. Other planners presented definitions closer to the ones by Costanza et al. (1997) and MA (2005a) by explicitly mentioning “benefits”. Some others explicitly mentioned ecosystems or ES as the basis for life on Earth, which is somewhat similar to the definition by Daily (1997), although Daily refers to sustaining and fulfilling specifically human life, not all life on Earth. Regulating services were the most frequently mentioned by planners when referring to ES examples. In Portugal, Honrado et al. (2013) found that, although implicitly, provisioning services are by far the most considered in environmental impact assessment (EIA) reports, followed by cultural services. For SEA reports, the same authors did not observe a predominance of any of the ES categories. In general terms, the preferences of human societies for the services provided by ecosystems seem to focus first on provisioning services, followed by regulating, cultural, and supporting services, in that order. This is related with the sequence of events that take place after human colonization of a new unsettled area, which is also linked to the short-term needs of humans (Rodríguez et al., 2006). One should acknowledge that there are several other ES definitions found in literature (see for example Boyd and Banzhaf, 2007; Fisher et al., 2009), however we do not aim here at doing an exhaustive comparison with all of them. In a similar study, Hauck et al. (2013a) found that familiarity with the ES concept varied widely among respondents from three regions in Finland, Germany and Poland. However, different groups of stakeholders were targeted (e.g. agriculture, recreation and tourism) which might explain such a high variability. In another similar study by Lamarque et al. (2011) involving professionals from different backgrounds and organizations and working at regional level, only half of the professionals had heard about the concept, and half of those defined it correctly. These findings from Hauck et al. (2013a) and Lamarque et al. (2011) contrast with our results, but could be explained by the different target audience and territorial characteristics.

The general knowledge of the ES concept among responding planners contrasts with the low knowledge on initiatives that helped bring the concept forward to the political agenda, such as the MA and the TEEB study at the global scale, or the Portuguese sub-global MA at national scale. This means that these initiatives did not play a significant role in communicating the concept to the planners. It also supports the observation by Burkhard et al. (2010) that the

MA remained on a rather conceptual level and political application of outcomes is lacking so far. These results can also mean that the term “ecosystem services” is successful by itself in conveying the basic ideas underlying the concept. This would contradict arguments made by several authors (see Fisher et al., 2009; Glaves et al., 2010; Lamarque et al., 2011; Müller et al., 2010) that the ES concept is still perceived as vague, limited or difficult to grasp. However, initiatives and sources of information other than the ones presented in the questionnaire, like conferences, workshops, studies and publications (see Section 2.1), may have played a role in communicating the concept.

The degree of integration of the ES concept in RSPs as declared by responding planners (fair to high) was somewhat surprising, considering a content analysis of Portuguese RSPs by Mascarenhas et al. (2012a), which found the degree of integration of the ES concept to be rather low. However, that content analysis focused on explicit mentioning of key terms related with ES. Combining the results of both researches might indicate that the ES concept is implicitly integrated in Portuguese RSPs. This would be aligned with findings by Honrado et al. (2013), which analysed selected Portuguese environmental impact assessment (EIA) and SEA reports, and observed a predominantly implicit coverage of ES against an almost inexistent explicit one. Hauck et al. (2013a) also report an implicit coverage of ES in EU policy documents. It could also indicate that the planners do not have an accurate perception of the degree of ES integration in the RSPs or that they misunderstood the ES concept, as can happen with broad concepts such as landscape or with concepts subject to different understandings depending on the application context, like “ecosystem functions”, which have different understandings in the ES approach and in landscape planning in Germany for example (von Haaren and Albert, 2011). However, the results of our content analysis of ES definitions by planners seem to exclude this possibility. The low degree of ES integration found by Mascarenhas et al. (2012a) also contrasts with the general level of knowledge of the ES concept declared by planners. Besides the influencing factors presented in Figure 2.3, there are several other possible reasons for this mismatch. One of them is related with the timing of initiatives that promote the ES concept in relation with the stage of development of planning processes leading to RSPs.

Factors considered to have a more positive contribution for ES integration are related with the capacities of human resources, either within the planning authorities (technical skills of the staff and generalized knowledge of the ES concept) or within external teams or consultants in plan design. This also means that respondents make a positive overall self-assessment of the regional spatial

planning authorities in terms of their internal capacities to integrate ES in spatial planning. On the other hand, outcomes of public consultation processes are mainly regarded as having no contribution for ES integration. This might imply that the ES concept is still not present in the minds of the general public (or even some organized groups) or they do not consider it important for regional spatial planning. It might however translate poor knowledge of the results of public consultation, poor perception on its benefits, or low trust on the importance and value of stakeholders' inputs for planning processes, by the planners. Further insight on this could be gained by a content analysis of the public consultation reports to find out to what extent is the ES concept covered and how does the importance given to it vary across different stakeholders. Extending the target population of the survey to other stakeholders involved in the planning process could also provide important insights. This is relevant considering that communication between plan-makers and those to whom they address their messages is always and necessarily distorted. Consequently, meaning assigned to a plan and its messages is never the same as intended (Faludi, 2000). Interestingly, financial resources was the factor with more "not applicable" responses in terms of its contribution for ES integration, which can be interpreted as planners thinking ES integration has little to do with how much financial resources are allocated to it.

The degree of importance given to ES integration in the planning process was high, echoing the increasing call for ES integration in literature (see for example Geneletti, 2011; Koschke et al., 2012). This was somewhat expected and it should be acknowledged that these results could suffer from socially desirable responses as previously discussed. There can also be significant gaps between the importance or usefulness attributed to a given concept or tool and its actual use, as was found by Rosenström (2006) in the case of sustainability indicators' usage by decision-makers in Finland. It is positive that planners considered important to integrate the ES concept across the whole planning process. Still, stages "Elaboration of terms of reference" and "Definition of the vision and main strategic goals of the plan" were considered the least important. We argue that these stages can be very important for ES integration, because they influence the whole process from its beginning. The terms of reference are particularly important when plans are commissioned to third party organizations (e.g. a consultancy firm). This is in line with the mainstream SEA thinking, for which SEA should be integrated into the strategic decision process preferably at the earliest possible (Cherp et al., 2007).

Questionnaires developed in different time periods, countries or cultural contexts may not be applicable in other contexts (Boynton and Greenhalgh, 2004). The questionnaire designed in this research can be administered in planning contexts other than the Portuguese one. However, in spatial planning, different contexts mean different political, institutional and societal conditions prevalent in the countries (or even regions) where planning systems develop (Ferrão, 2011; Nadin and Stead, 2008). Therefore, response options that are specific to the Portuguese context should be adapted (e.g. names of RSPs or of authorities). Some items might also need to be adapted (but not necessarily) to accommodate context specificity, namely the closed response options pertaining to the factors that contribute to ES integration and to the planning stages / components important for ES integration.

2.6 Conclusions

The ES concept is generally known among regional spatial planners who participated in the questionnaire survey. This was surprising in light of previous research and contrasts with findings from similar studies. It seems that major initiatives on ES (like the MA) did not have a major role in mainstreaming the ES concept among planners. Further research would be needed on other drivers of ES discourse into spatial planning, like inputs from stakeholders involved in public participation or from organizations with a saying in planning processes, demands or guidelines from recent regulations (e.g. EU directives) within the planning legal framework, contributions from academia (e.g. organization of scientific or training events), awareness-raising initiatives by NGOs, media coverage on ES-related issues, or major events that shape the political agenda (e.g. natural catastrophes). Most planners also considered that the ES concept is well integrated in RSPs and SEAs. Based on previous research we are lead to conclude that if the ES concept is already integrated in plans, it is implicitly so in the planning documents, or there is a gap between planners' perceptions and the real level of integration. These contrasting findings suggest that further research is needed to understand the nature of such gaps. They also highlight the importance of a mixed methods approach to research ES integration in spatial planning. Future research could be extended to include: (i) a deeper content analysis of planning documents including implicit ES integration; (ii) a content analysis of planning documents from different components / stages of the planning process, for example reports of the public consultation; (iii) surveying techniques that could complement questionnaire results (e.g. in-

interviews); (iv) a broader target population including other stakeholders involved in the process, in order to compare different views and perceptions.

The Portuguese institutional planning context influenced our sampling method. We did not have a sampling frame (list of the population members to be surveyed), which makes it difficult to discuss potential differences between respondents and non-respondents. For future similar studies, we recommend that an effort should be made to overcome such institutional restraints to characterize the target population. Taking into account this and other recommendations presented in this article, the questionnaire developed in this research can be adapted and administered in other spatial planning contexts different from the Portuguese, to draw a broader picture on ES integration in regional spatial planning.

Ecosystem services in spatial planning and strategic environmental assessment – A European and Portuguese profile⁵

Abstract

Despite the growing interest on ecosystem services (ES) in research, significant knowledge gaps on ES integration in decision making subsist. Particularly, ES-focused profiles of governance frameworks for different policy areas, like spatial planning, are scarce. The goal of this research is to draw a profile on ES integration in the European policy and guidance framework for spatial planning and strategic environmental assessment (SEA). To investigate how this framework might be translated in a particular country of the EU and across different levels of governance, the Portuguese spatial planning and SEA framework is also analysed. To achieve these goals, a content analysis of policy and guidance documents was conducted. We have found a general low level of explicit ES integration, but some notions associated with ES are present in the documents, although more indirectly. Results highlight the potential role of

⁵ Mascarenhas, A., Ramos, T.B., Haase, D., Santos, R., 2015. Ecosystem services in spatial planning and strategic environmental assessment—A European and Portuguese profile. *Land Use Policy* 48, 158–169. doi: 10.1016/j.landusepol.2015.05.012 (reproduced with authorization of the publisher and subject to copyright restrictions imposed by them).

SEA for ES integration. However, in the Portuguese context, the contribution of SEA in practice is currently limited and for the coming years ES will not be specifically targeted or integrated in regional spatial planning practice. Recent changes in the wider European governance framework contribute to potentially higher degrees of ES integration in the future. Nevertheless, bottom-up demand for improved ES integration in plans and policies will be an important driver. Our approach contributes to identify which policies, plans and guiding documents need improved ES integration.

3.1 Introduction

The concepts of ecosystem services (ES) flows and natural capital stocks are increasingly useful ways to highlight, measure, and value the degree of interdependence between humans and the rest of nature (Costanza et al., 2014). ES are commonly defined as the benefits people obtain from ecosystems (MA, 2003). They can be seen as a metaphor useful for raising public awareness about the crucial role ecosystems and their biodiversity play in maintaining the quality of our everyday life (Spangenberg, 2013).

Since the introduction of the concept of nature's services (Westman, 1977) and later of ES (Ehrlich and Ehrlich, 1981) in the academic literature, there has been a rapidly growing body of peer-reviewed literature on the subject of ES (Abson et al., 2014; Fisher et al., 2009; D. Haase et al., 2014). Furthermore, several authors stress that major initiatives on ES, like the Millennium Ecosystem Assessment (MA, 2005a) or TEEB – The Economics of Ecosystems and Biodiversity (TEEB, 2010b) have brought the ES concept into the international policy agenda (Braat and de Groot, 2012; Costanza et al., 2014; Gómez-Baggethun et al., 2010). Other initiatives contributing to this include for example the Urban Biosphere Initiative (URBIS) by ICLEI – Local Governments for Sustainability (www.urbis.iclei.org) and the Cities and Biodiversity Outlook project (CBO, www.cbobook.org), both concerned with the local/city level, or the Ecosystem Services Partnership, a global network that aims to enhance communication, coordination and cooperation in the conceptualization and application of ecosystem services (www.fsd.nl/esp). Accordingly, others mention that the ES concept is already being integrated in different policy contexts and is becoming an explicit decision and policy tool (Abson et al., 2014; Jacobs et al., 2014; Shapiro and Báldi, 2014). In fact, some recent international policy initiatives highlight ES, most notably the EU Biodiversity Strategy 2020 (European Commission, 2011a), or the Intergovernmental Platform on Biodiversity and

Ecosystem Services (IPBES) (Perrings et al., 2011). Also the global strategic plan for biodiversity for the period 2011–2020 of the Convention of Biological Diversity complements previous conservation based biodiversity targets with the addition of ES (Maes et al., 2013). However, Hauck et al. (2013b) stress that the implementation of the ES concept into European policy-making via the EU Biodiversity Strategy to 2020 needs its use at both national and regional levels.

At the same time, ES integration has been reported as poor and limited in general decision making and more specifically in spatial planning (Geneletti, 2011), development planning (Bennet et al., 2008), the US environmental law and policy (Ruhl, 2011; Ruhl et al., 2007), or landscape planning and management (Albert et al., 2014b; de Groot et al., 2010a; Hauck et al., 2013b). Authors like Daily et al. (2009) see a need for an explicit and systematic ES integration into decision making by individuals, corporations, and governments, supported by a rapid advancement of the ES science. This need is related with poor incentives for decision makers to account for ES (Sitas et al., 2014; Tallis and Polasky, 2009), although they might already use knowledge on ES but using different terminologies (von Haaren and Albert, 2011). There are also evidences that a majority of citizens embraces calculating the benefits that nature provides to people, and explicitly acknowledging it as part of decisions about how natural resources are managed and used (Bastian et al., 2012; Metz et al., 2010). In the context of EU policies, for Maes et al. (2013a) the alignment of the objectives of the EU water policy, the EU common agricultural policy and even the EU regional and cohesion policy, with Europe 2020 Strategy's resource efficiency guiding principle for other EU policies, is considered as a step towards the inclusion of ES in those policies and an important one towards a more sustainable economy, considering that both agriculture and regional development contribute to over 80% of the annual EU budget. Nevertheless, a knowledge gap concerning the actual dissemination of the ES concept into national environmental policies, beyond supranational programs and agreements, has been underlined by Matzdorf and Meyer (2014).

In this context, spatial planning is a particularly relevant decision making process, since one of the main drivers of anthropogenic ecosystem changes is land use change (Burkhard et al., 2010), for example linked with urbanization processes (D. Haase et al., 2014). It is for spatial and land-use planning that the effects of decisions upon ES provision and use are perhaps more evident and straightforward (Geneletti, 2011). Spatial plans or strategies have an important role in relating public policies to particular places and demonstrating that policies do not play out uniformly across a territory. Therefore they can help policy

makers understand the interaction of a given policy with the particular qualities and characteristics of the territory where it is applied, which is a key factor for policies' outcomes and effectiveness (Adams et al., 2006). Still some authors, like von Haaren and Albert (2011), are of the opinion that spatial planning science has failed to connect with the international ES discussion.

As a strategic decision support instrument, strategic environmental assessment (SEA) can play a significant role in ensuring ES consideration (Partidário and Gomes, 2013) and provide better guarantees that ES are taken into account in planning and related decision-making processes (Slootweg and van Beukering, 2008). In a SEA context, ES that are not explicitly identified may be overlooked, and even overridden by the strategy development, leading to negative consequences on services, as well as on human well-being (Honrado et al., 2013). Although ES integration in SEA has been discussed by some authors (see for example Geneletti, 2011; Partidário and Gomes, 2013) and analysis of SEA reports focused on that issue, even though scarce, exist (e.g., Honrado et al., 2013), a systematic analysis of relevant SEA documents in light of a coherent spatial planning framework, crossing different governance scales, is to our knowledge yet to be conducted.

The goal of this research is to draw a profile on ES integration in the European policy and guidance framework for spatial planning and SEA. To investigate how this framework might be translated to national and sub-national level in a particular country, across different levels of governance, the corresponding Portuguese framework is also analysed.

It is particularly important to consider ES in the European context, since some ES are crucial for Europe's economy and society. For example, Europe is likely to become more dependent on its own ability to produce food as the global price of food increases and imports from outside the EU become less affordable. Another example is that Europe's communities place a high value on nature and on the possibility of enjoying natural places for leisure activities (EASAC, 2009). Moreover, the European case is relevant for analysis across different governance levels, since it has a common supra-national governance framework that is internalized by member states and its effects can often be traced down to the local level. As noted by Matzdorf and Meyer (2014), the EU law is increasingly relevant in the member states, and it is difficult to find fields of environmental law that are not influenced by it. Additionally, the "resource-efficient Europe" flagship initiative, under the Europe 2020 Strategy (European Commission, 2011b), is influential for several other EU policies, as previously mentioned. Within the wide scope of this long-term framework, Europe is in

the forefront of political commitment to ES, most notably through its EU Biodiversity Strategy 2020 (European Commission, 2011a). The Natura 2000 network and the European Landscape Convention are also important EU-wide initiatives for safeguarding biodiversity and ES, with considerable benefits in terms of tourism, recreation and employment (EEA, 2012). Additionally, a multi-level analysis is relevant in light of evidence that vertical integration of SD policies within the European Union (EU) Member States is rather weak (ESDN, n.d.).

The choice of the Portuguese case has to do with the fact that Portugal was one of the few national level assessments, out of the eighteen approved MA sub-global assessments; actually it was the only one at national level in Europe. The MA assessment for Portugal was itself a multi-scale assessment, including case studies at lower levels (Pereira et al., 2009). This was similar to the aim of covering different governance levels in this research. Moreover, Portugal possesses a very diverse natural heritage thanks to its geographical location and geophysical conditions (CBD Secretariat, n.d.) – located in Southwestern Europe, it is predominantly a Mediterranean bio-geographical region in the mainland territory and a Macaronesian region in the archipelagos of Azores and Madeira. Hence it has high potential for ES provisioning, for example of pollination services (Maes et al., 2012b). These conditions also mean that Portugal is very vulnerable to global environmental changes, like climate change, with potential impacts including decreased precipitation, burnt area by forest fires and loss of species (e.g., typical tree species that contribute to the sense of place and cultural identity of the inhabitants, traditional forms of land use, and the tourism sector), among others (Metzger et al., 2006).

3.2 Context of spatial planning and strategic environmental assessment

3.2.1 Spatial planning

The EU does not have formal competences on spatial planning, because of the risk of a EU-wide planning framework going against the logic of national sovereignty of Member States (Faludi, 2009). However, several initiatives have been taking place, which are important for a European convergence in spatial planning policies. The complex puzzle formed by such initiatives and its influence on European spatial planning were thoroughly discussed by other authors (see for example Böhme, n.d.; Faludi, 2009; Ferrão, 2011; Philippe et al., 2014;

Salez, 2009). We briefly highlight the most relevant ones, considering the scope and aims of this research.

The European Spatial Planning Charter (CEMAT, 1983) provided both for the elaboration of a European structure for spatial planning and the need to organise sectoral policies on a territorial basis (Salez, 2009). Nevertheless, the European Spatial Development Perspective (ESDP; Committee on Spatial Development and Commission, 1999) was the first European policy document on spatial planning. Despite having no operational content that might commit the Member States (Salez, 2009), it established for the first time a strategic frame of reference for spatial development and so affirmed the involvement of the EU in this field.

The ESDP was followed by the guiding principles for Sustainable Spatial Development of the European Continent (CEMAT, 2000) and the European Landscape Convention, the latter aiming at the promotion of landscape protection, management and planning, and organisation of European co-operation on landscape issues. It is a relevant policy document given the conceptual links between ES and landscape (see for example de Groot et al., 2010b; Lamarque et al., 2011; Termorshuizen and Opdam, 2009).

The more recent Green Paper on Territorial Cohesion (CEC, 2008) is regarded as another push for European spatial planning (Faludi, 2010) and stimulated the mobilization of different institutions and stakeholders in the spatial planning domain (Ferrão, 2011). Despite that, there is no commonly agreed definition for territorial cohesion (Böhme et al., 2011; Philippe et al., 2014). The revised Territorial Agenda of the European Union (TAEU 2020) from 2011 aims at providing strategic orientations for territorial development, fostering integration of a territorial dimension within different policies at all governance levels and ensuring implementation of the Europe 2020 Strategy according to territorial cohesion principles. It also stresses that the Leipzig Charter on Sustainable European Cities and the Marseille and Toledo Declarations on Urban Development should be taken into account in territorial policy making at all levels.

In Portugal, Law 48/98 sets the fundamental policy basis for spatial planning, including its overall goals and general principles. It defines a Territorial Management System, organized in three levels (national, regional and local) and further regulated by Decree-Law 46/2009 that defines its juridical regime. The national level of spatial planning policy defines an overall strategic framework and sets guidelines for regional and local (municipal) spatial planning. It includes the National Program for Spatial Planning Policy (PNPOT), as well as

sectoral plans (for sectoral policies with spatial expression) and special plans (e.g. for nature protection areas), all of which are the responsibility of central government. The regional level sets the strategic framework for regional spatial planning, articulating itself with the national level and defining guidelines for spatial planning at local level. It is materialized in regional spatial plans (RSPs) that are under the responsibility of five decentralized authorities working at regional level (in mainland Portugal) and of two regional authorities (in the Madeira and Azores autonomous regions). The municipal level defines, in accordance with the national and regional guidelines, strategic options and its programming for local land use.

Currently, every region in Portugal has a RSP, either already legally published or in the form of final technical versions (see also Mascarenhas et al., 2014 for more information on the Portuguese RSPs). Since 2005 the general guidelines for the design of RSPs (GSEOTC, 2005) are available to support the planning process.

3.2.2 Strategic environmental assessment

Directive 2001/42/CE, usually called SEA Directive, sets the legal basis for SEA. Its main objective is to ensure that an environmental assessment is carried out for certain plans and programmes (e.g. spatial plans) which are likely to have significant effects on the environment. The requirements of the SEA Directive are to be integrated into existing procedures in Member States for the adoption of plans and programmes or incorporated in procedures established to comply with the Directive. The fact that SEA has this legal basis provides a window of opportunity to formally mainstream ES into decisions at the strategic level (Geneletti, 2011). The commission's guidance on the implementation of the SEA Directive (European Commission, 2003), has been drawn up to help Member States to ensure from an early stage as consistent implementation and application of the SEA Directive as possible.

The United Nations Economic Commission for Europe (UNECE) Protocol on SEA also requires its parties to evaluate the environmental consequences of their official draft plans and programmes. Besides individual countries, the European Union is one of the 38 signatories of the Protocol. This Protocol introduces a non-mandatory application of SEA to policies and legislation (in addition to plans and programmes) and it emphasizes the consideration of health, alongside environmental concerns in assessments. It is accompanied by the Resource Manual to Support Application of the Protocol on Strategic Environmen-

tal Assessment. The manual highlights the main requirements of the SEA Protocol, it outlines the key issues for applying the Protocol in practice and it provides materials for training and capacity-development programmes supporting application of the Protocol (UNECE, 2012).

More recently the Guidance on Integrating Climate Change and Biodiversity into Strategic Environmental Assessment (European Commission, 2013a) was published. This non-binding guidance aims to help improving the consideration and assessment of climate change and biodiversity issues into SEAs carried out across the EU Member States, under the SEA Directive. It is intended to supplement rather than conflict with any national SEA guidance.

In Portugal, the SEA Directive was transposed into national legislation by Decree-Law 232/2007, taking also into consideration the UNECE Protocol on SEA. The law that defines the Portuguese territorial system already incorporates, specifically for its scope, the application of Decree-Law 232/2007. As noted by Partidário (2012), most SEAs in Portugal are done for spatial planning processes, similarly to what happens Europe-wide (Söderman and Saarela, 2010). A Guide for Best Practices in SEA (Partidário, 2012) is available, following the former Portuguese Guide for Good Practice in SEA (Partidário, 2007).

3.3 Methods

This exploratory research draws a profile on ES integration in the European policy and guidance framework for spatial planning and SEA. A profile is understood here as a characterization of a governance framework across several levels, focusing on specific thematic areas (in this case spatial planning and SEA) and main features of interest (in this case related with ES). The profile is operationalized by a content analysis of policy and guidance documents pertaining to spatial planning and SEA in Europe and in Portugal. The following subsections present the scope of the content analysis and how it was performed.

3.3.1 Scope of the analysis

The content analysis covers the European and Portuguese policy and guidance framework for spatial planning and SEA (see Section 3.2). At sub-national level, our interest was on the regional level of spatial planning. This provides a cross-scale analysis and allows drawing insights about the top-down influence on ES integration. Within that context, we have considered docu-

ments that: (i) are legally mandatory; (ii) were published by Portuguese governmental institutions; (iii) were published by European governmental institutions and officially subscribed by national governments (especially Portugal) or by Ministers of those governments (e.g. Ministers responsible for spatial planning); (iii) serve as direct guidance to any of the previous types of documents. In terms of temporal scope, we have included documents published between 1983 (when the European Spatial Planning Charter was published) until the end of the year 2013.

The documents we have included in the content analysis are presented in Table 3.1. The RSPs analysed cover the whole of Portugal's territory (six of them correspond to NUTS II units and two of them to agglomerations of NUTS III units). Some are still waiting for their legal publication. In those cases, the most recent technical proposal available for the RSP was used for analysis. Little changes are expected between those proposals and the legal versions of RSPs. We also analysed six SEA reports for all the RSPs subject to SEA.

We have limited the lowest scale of our scope on the regional level, mainly because: (i) regional level is directly related with EU policies through the regional development and territorial cohesion policy. It is further emphasised by the 2009 review of the EU Strategy for Sustainable Development Strategy (CEC, 2009), which underlines the fact that sustainable development goals and principles should be further integrated into regional development. (ii) Like Fürst et al. (2010), we argue that the regional scale is particularly adequate for ES integration, since regions frequently have territorial delimitations that follow more closely natural features (e.g. distinct landscapes), than municipal administrative borders – this is the case in Portugal. Additionally, services provided by ecosystems can be both on-and off-site. Although many ES may be appropriated locally, beneficiaries also receive manifold services at a wider geographical scale (Liekens and De Nocker, 2013); (iii) we are interested in ES integration at a strategic level of spatial planning. At local level, spatial plans are often more of a regulatory/prescriptive nature (as observed in Portugal with the Municipal Master Plans). On the other hand, spatial planning is said to be particularly focused and pertinent at regional scale. Therefore, the region remains a meaningful concept for both analysis and research, as well as for policy intervention (Adams et al., 2006). The regional scale is also the one at which many development policies are established and coordinated (articulating national and local policies) and that the appropriate management of natural resources, interconnectivity between cities, economic growth and cultural identity are set in motion (Birkmann, 2003; Mascarenhas et al., 2012b).

Table 3.1 – Documents included in the content analysis.

Scope	Document	Publication date¹
Spatial planning		
Europe	European Spatial Planning Charter	1983
	European Spatial Development Perspective	1999
	Guiding Principles for Sustainable Spatial Development of the European Continent	2000
	European Landscape Convention	2000
	Leipzig Charter on Sustainable European Cities	2007
	Green Paper on Territorial Cohesion	2008
	Marseille Declaration on Urban Development	2008
	Toledo Declaration on Urban Development	2010
	Territorial Agenda of the European Union 2020	2011
Portugal	Madeira Regional Spatial Plan	1995
	Law 48/98	1998
	General Guidelines for the Design of Regional Spatial Plans	2005
	National Program of Spatial Planning Policy	2007
	Algarve Regional Spatial Plan	2007
	Açores Regional Spatial Plan	2008
	Decree-Law 46/2009	2009
	Norte Regional Spatial Plan	2009
	Oeste e Vale do Tejo Regional Spatial Plan	2009
	Alentejo Regional Spatial Plan	2010
	Área Metropolitana de Lisboa Regional Spatial Plan	2010
Centro Regional Spatial Plan	2011	

Table 3.1 (continued)

Scope	Document	Publication date ¹
SEA		
Europe	Directive 2001/42/CE (SEA Directive)	2001
	Commission's Guidance on the implementation of the SEA Directive	2003
	UNECE Protocol on SEA	2003
	Resource Manual to Support Application of the Protocol on SEA	2011
	EC's Guidance on Integrating Climate Change and Biodiversity into Strategic Environmental Assessment	2013
Portugal	Decree-Law 232/2007	2007
	SEA report of Oeste e Vale do Tejo Regional Spatial Plan	2008
	SEA report of Açores Regional Spatial Plan	2008
	SEA report of Alentejo Regional Spatial Plan	2008
	SEA report of Norte Regional Spatial Plan	2009
	SEA report of Área Metropolitana de Lisboa Regional Spatial Plan	2010
	SEA report of Centro Regional Spatial Plan	2011
	Guide for Best Practices in SEA	2012

¹ Considering the goals of the present research, publication date refers to the date when a final version of a given document was made publicly available, even though in some cases it was adopted later.

3.3.2 Content analysis

Content analysis can be broadly defined as “any technique for making inferences by systematically and objectively identifying special characteristics of messages” (Holsti, 1968, p. 608). In this research, a content analysis of European and Portuguese policy and guidance documents on spatial planning and SEA was conducted.

We combine quantitative and qualitative content analysis. This is in agreement with Berg (2001), who notes that counts of textual elements (typical of quantitative content analysis) provide a means for identifying, organizing,

indexing and retrieving data. Berg adds that the “analysis of the data once organized according to certain content elements should involve consideration of the literal words in the text being analysed, including the manner in which these words have been offered” (Berg, 2001, p. 242).

Key terms associated with the concept of ES were defined based on literature, including the notions of nature’s services (Daily, 1997; Westman, 1977), natural capital (Costanza and Daly, 1992), environmental services (Mooney and Ehrlich, 1997), ecosystem functions (de Groot, 1992), biodiversity as linked with ES (Haines-Young and Potschin, 2010b; TEEB, 2010b) and of course the concept of ES itself (Costanza et al., 1997; Ehrlich and Ehrlich, 1981; MA, 2003). As noted by Egoh et al. (2007), terms such as ecosystem functions or environmental services are sometimes used interchangeably with the term ecosystem services. Since several documents under analysis are written in Portuguese, literature in that language was also used for identification of key terms, namely Pereira et al. (2009). The term “ecosystemic” was included since it can be used in Portuguese language. We have also searched for combinations between elements of those concepts and their definitions. Individual terms can appear separated in the same sentence or paragraph, but still be directly related to each other in the message conveyed by the documents under analysis. Each key term or combination of terms was coded accordingly (Table 3.2).

Our content analysis is supported by the explicit occurrence of terms related with the ES concept. As Bauler and Pipart (2014) state, a first layer of adoption of ES, like the conceptual adoption, can be approached empirically by raising questions such as: How much has the concept been referred to in policy making documents? For Matzdorf and Meyer (2014) the strengths of the ES framework, in terms of influence for future environmental policy, are mainly at the conceptual level. They observe that in the EU, the ES framework is mainly used to enhance the holistic tendencies within environmental policies and as a communication tool. An analysis of explicit ES integration is also less prone to subjective interpretations.

Table 3.2 – Key terms used for qualitative analysis of policy and guidance documents.

Key term	Associated key term	Code
ecosystem	goods / services	A1
	benefits	A2
	human well-being	A3
ecosystemic	goods / services	B1
	benefits	B2
	human well-being	B3
biodiversity	goods / services	C1
	benefits	C2
	human well-being	C3
nature	goods / services	D1
	benefits	D2
	human well-being	D3
natural capital	-	E
ecosystem functions	-	F
environmental services	-	G

In the case of international documents (e.g. EU policy documents), a Portuguese version was analysed, when available, to increase coherence with the content analysis of the national documents and the key terms used. The index and references sections of each document were not considered in the content analysis. The location of key terms' occurrences within the structure of each document was also recorded for further analysis. The rationale for this is that recognition of ES higher up or lower down the hierarchy of policy documents can be interpreted as the degree of importance given to the concept. At a more operational level e.g. in the case of SEA reports, it is also different if ES are acknowledged for example only in the description of the baseline situation, or also in the assessment of effects or in the recommendations and monitoring.

While analysing key terms that are used in association with others (e.g. ecosystem, which can be associated with goods/services, benefits or human well-being in our coding system), a qualitative analysis was done on the kind of message being communicated and on usage of other terms, which might also relate to ES. Each of the terms used in combination were searched individually (for example, in the case of "ecosystem services", not only the term "ecosystem" was searched to find connections with the term "services", but also "services" was searched to figure out what it was related to). As stressed by Flyvbjerg

(2006), more often than not, a combination of qualitative and quantitative methods helps best to answer the research questions at hand for a given issue.

3.4 Results and discussion

3.4.1 European level

In all of the analysed documents that set the European spatial planning framework, only one occurrence of key terms was found in the European Spatial Development Perspective, relating nature and services: “Apart from this, new approaches should be taken to harmonise nature protection and spatial development. In the preservation of natural heritage protected areas and other ecologically valuable areas, an important service for the whole of society is provided” (p. 31). This reveals a practically inexistent ES integration in the European spatial planning policy framework, even though some of the documents (e.g. the TAEU 2020) were published after the MA or the TEEB initiative, which are frequently pointed out as having brought the ES concept into the international agenda (see for example Bastian et al., 2012; Costanza et al., 2014).

There are however some references to notions that are related with the ES concept in those documents. For example, the ESDP states: “In terms of their biological value and their natural cleaning and regulating functions, wetlands are a valuable resource.” (p. 33). It also states: “(. . .) ecological resources should be costed in economic terms – for instance through adapted fiscal solutions. Through earnings produced in this way, each region could open up appropriate new development opportunities, at the same time preserving the natural heritage.” (p. 31). On another part, it stresses the considerable value of cultural landscapes, for instance as tourist attractions. It draws attention to the fact that “The preservation of these landscapes is of great importance, but must not make economic use impossible or hinder it excessively.” (p. 33). The European Spatial Planning Charter calls for “(. . .) paying special attention to areas of natural beauty and to the cultural and architectural heritage (. . .)” (p. 14). It also highlights the specific functions of coastal areas and of rural areas, asking in particular for the conservation and management of the natural landscape. For mountain areas it stresses their importance for the ecological, economic, social, cultural and agricultural functions they fulfil and their value as depositories of natural resources. As for the Guiding Principles for Sustainable Spatial Development of the European Continent, in the document it is stated that the guiding principles “(. . .) aim in particular at bringing the economic and social require-

ments to be met by the territory into harmony with its ecological and cultural functions and therefore contributing to long-term, large-scale and balanced spatial development.” (p. 2). It refers for example to flood protection (commonly classified as regulating ES) by stating that flood plains and water meadows possess a high economic and ecological potential and that economic damage could be reduced through proper spatial planning of the whole catchment area of the rivers. In the Territorial Agenda of the European Union 2020 it is possible to find terms more directly related with the ES discourse, like “green economy” and “territorial capital”, most probably because it is the most recent document we included in our analysis, for the European spatial planning policy and guidance framework. Similarly to the European Spatial Planning Charter, at some point it stresses the importance of rural areas and explicitly refers to the services they provide: “Some rural areas tend to be vulnerable territories rich in cultural and natural values. We support the safeguarding and sustainable utilization of this territorial capital, the ecological functions and services it provides.” (p. 6). So it is possible to observe a common concern in these documents about harmonizing economic development, social well-being and nature protection. It might be argued that a basis for an ES approach already existed in the European policy and guidance framework for spatial planning, although expressed in a more implicit manner. Despite that, across the documents that set the European spatial planning framework, references to the protection of the environment, of nature or of natural resources are globally more common, conveying a more “traditional” approach to the environment and biodiversity. Natural and cultural heritage are also frequently mentioned, linked to aesthetics and recreational uses (commonly classified as cultural ES) and often associated with tourism.

For the documents of the European SEA framework, with the noteworthy exception of the EC’s Guidance on Integrating Climate Change and Biodiversity into Strategic Environmental Assessment (European Commission, 2013a), also no occurrences of key terms were found. The EC guidance document is a response to the commitments set out in the EU Strategy on Adaptation to Climate Change and in the TEEB study, so it would be expected to cover ES. Indeed this document is by far the one that integrates more the ES concept, in comparison with the other documents analysed in this research (both European-level and Portuguese). The ES concept is conveyed using several of the key terms defined for the content analysis (77 occurrences were found just for “ecosystem services”). It includes “ecosystem services” in its glossary of terms and explicitly refers to the MA. In its main points on how to identify climate change and biodiversity issues in SEAs, it recommends to “use ecosystem services to provide a

framework for assessing the interactions between biodiversity and climate change". It also suggests "degradation of ecosystem services" as one example of headline climate change and biodiversity issues to consider as part of SEAs. Furthermore it discusses the links between climate change and ES. It refers to the ideas conveyed by the ES concept using terms other than the key terms used for our content analysis. For example, "services" or "benefits" are sometimes associated with green infrastructure. This is probably related to the fact that the ES concept is well covered in the document, so the subject is treated in greater depth, using a richer vocabulary. Nevertheless, several of the occurrences of key terms (e.g. "ecosystem services") are actually used when referring to other documents, for example the new EU 2020 Biodiversity Strategy. Also a considerable number of occurrences appear in the document's annexes (e.g. 23 out of 77 total occurrences for "ecosystem services" appear in annex 3). Still, many occurrences are found in the main body of text, so the ES concept is conveyed across the whole document (Figure 3.1). Besides, the annexes of this document are important for the reader, considering it is a guidance document. Particularly annex 3, which contains a relevant proportion of occurrences for key terms in the whole document, is about "Tools for assessing climate change and biodiversity within SEA", therefore of very practical use for readers interested in applying the guidance for any given situation. However, the document is only available in English, which might hinder its use by planning authorities in European countries, especially at sub-national level.

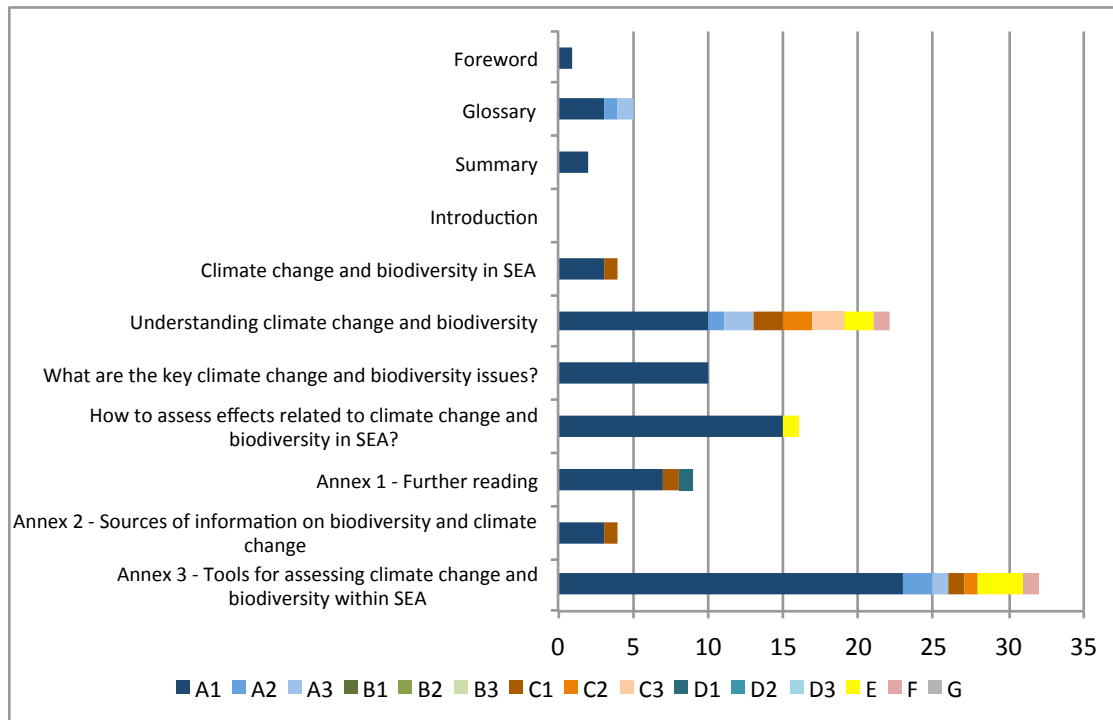


Figure 3.1 – Occurrences of key terms in the EC’s Guidance on Integrating Climate Change and Biodiversity into Strategic Environmental Assessment, by section of the document.

3.4.2 National and regional level – Portugal

For the national spatial planning policy and guidance framework in Portugal – Law 48/98; Decree-Law 46/2009; PNPOT; General Guidelines for the Design of Regional Spatial Plans – only two occurrences of key terms were found in PNPOT (C1 – “biodiversity” \wedge “goods/services”; G – “environmental services”). However they were located in a section of the document regarding the description of the territorial organization, trends and performance. That section is descriptive of the Portuguese land use reality. No occurrences were recorded in the Action Programme section, which lays down the national guidelines for spatial planning.

As for the Portuguese SEA policy and guidance framework – Decree-Law 232/2007 and best practice guidance for SEA – only the guidance document includes some occurrences of key terms (2x A1 – “ecosystem” \wedge “goods/services”; A3 – “ecosystem” \wedge “human well-being”; B1 – “ecosystemic” \wedge “goods/services”; C3 – “biodiversity” \wedge “human well-being”)⁶. With the excep-

⁶ The symbol \wedge denotes the operator AND, meaning a combination of two key terms as in Table 3.2 (e.g. “ecosystem” AND “human well-being”).

tion of the reference to “ecosystemic services” (B1), located in the section called “SEA in practice”, all occurrences are located in an introductory section called “What is SEA?”. One should add that this is the recently revised version of a previous guidance document (Partidário, 2007), which did not mention any of the key terms.

To organize the results of key terms’ occurrences in Portuguese RSPs, we followed a generic RSP structure defined by the General Guidelines for the Design of Regional Spatial Plans, issued by the Office of the Secretary of State for Spatial Planning and Cities (GSEOTC, 2005). Despite differences in structure among Portuguese RSPs, it is possible to fit the structure of each RSP in that generic structure (Mascarenhas et al., 2012b). Table 3.3 shows that, with the exception of RSP Madeira (the oldest RSP analysed), all of the RSPs include at least one occurrence of key terms, although the majority of plans have one or two occurrences. RSP Norte is the plan with the higher number of occurrences. Globally, the most frequent term is “environmental services” (G) and diversity of terms within each RSP is low. In terms of RSP documents’ structure, no occurrence was found at the highest strategic level of the “Vision for the region” and the section with the higher number of occurrences was the “Territorial model” of the plans. The “Territorial model” is essentially the spatial translation of the “Territorial Strategic Options”. RSP Açores is the only one that includes a reference to one of the key terms (E – “natural capital”) in the section “Monitoring and evaluation system”. The key term is included in a monitoring objective: “To promote the region’s competitiveness factors and to enhance the multiplying effect of public investment (with interventions of institutional or infrastructural nature), respecting and/or valuing the aspects of environmental nature and the natural capital of the archipelago”. Then it presents a couple of examples for possible associated indicators, dealing with the “Development of economic activities aligned with environmental goals”, namely the “number of companies that promote nature tourism” and “production of organic farming”. Thus, these are the only examples we found on explicit proposals for how ES are to be monitored during RSP implementation.

In the case of Portuguese SEA reports, although the specific location of key terms’ occurrences in each SEA report was recorded, a generic report structure was assumed for presentation of results (Table 3.4), taking into consideration the European Directive on SEA (Directive 2001/42/CE), the Portuguese guide for good practice in SEA that was available when SEAs were conducted (Partidário, 2007), as well as the SEA reports themselves, as they do not follow exactly the two previous documents in terms of content organization. At least

one occurrence of a key term was observed for all SEA reports, however no clear pattern was observed in terms of total number of occurrences and distribution of occurrences along each SEA report's structure. Nevertheless, with the exception of the SEA report for RSP Alentejo, all analysed reports include occurrences of key terms in three or more sections within their structures (including in the section where effects are more thoroughly assessed – “Strategic impacts assessment/opportunities and risks”).

Table 3.3 – Occurrences of key terms in Portuguese RSPs (different key terms within the same idea – same paragraph – are separated by “/”. Multiple occurrences of key terms in the same section of the generic RSP structure are separated by “;”).

Generic structure	Regional Spatial Plan (RSP)							
	Açores	Alentejo	Algarve	Área Metropolitana de Lisboa	Centro	Madeira	Norte	Oeste e Vale do Tejo
Vision for the region Ambition (long term goals)	-	-	-	-	-	-	-	-
Territorial Strategic Options 1. Strategic axis (overall guidelines for territorial intervention) 2. Territorial model 2.1. Overall scheme 2.2. Structuring systems 2.3. Territorial units	-	A1	-	-	-	-	-	-
	-	-	E	G; G	A1	-	A1/C1/G; C1/G; G	-
Interaction with sectoral policies	E	-	-	-	-	-	-	-
Guiding standards 1. General 2. Specific by intervention domain 3. Specific by territorial unit	-	-	-	G	-	-	G; G	G; G
Monitoring and evaluation system	E	-	-	-	-	-	-	-

Table 3.4 – Occurrences of key terms in SEA reports (different key terms within the same idea – same paragraph – are separated by “/”. Multiple occurrences of key terms in the same section of the generic RSP structure are separated by “;”. RSP Algarve and RSP Madeira did not have a SEA process).

Generic structure	SEA Report					
	Açores	Alentejo	Área Metropolitana de Lisboa	Centro	Norte	Oeste e Vale do Tejo
Executive summary	-	-	-	-	-	E
SEA goals and indicators	E	-	-	-	-	-
Identification of relevant/critical assessment factors	A1/ A3/ C1/ C3	-	A1	A1/ A3; E	-	-
Baseline description and evolution trends without RSP	A1/ A3; A1/ A3/ C1/ C3/ F; A1; A2/ C2	C2	A1; A1	A1/ A3/ C1/ C3/ F; A1/ A2/ F; A1/ C3; A1/ C1; A1/ C1; C2; E; F	A1/ C1; E	-
Strategic impacts assessment / Opportunities and risks	A1; A1; C2	-	A1; A1	A1/ C1; A1/ C1; A1; A1/ A3/ C1/ C3; A1/ C1; A1/ C1; A1/ C1; E	A1/ E/ G; E; E; G	E
Recommendations / Follow-up guidelines	E; E	-	-	A1/ C1	A1/ C1	G; G
Synthesis / Conclusions	E	-	A1; A1; A1	E	-	E
Appendices	-	-	-	-	-	A1; G

A joint analysis of Portuguese RSPs and SEA reports shows a varying degree of integration of the ES concept across them (Figure 3.2). It ranges from no occurrence of key terms at all to several occurrences of different key terms, showing a diversity of ways to refer to the concept of ES. Bauler and Pipart (2014) have also observed a somewhat differentiated adoption of the ES concept between the Belgian regions. For those authors, one possible reason for different levels of ES integration in policy making is the different level of knowledge and/or interpretation of the ES concept by the policy actors themselves. In Por-

tugal, findings by Mascarenhas et al. (2014b) suggest that the ES concept is generally known by regional spatial planners from different regional planning authorities. Consequently, this would not help in justifying the varying degrees of ES integration in Portuguese RSPs found in the present research. Interestingly, this is aligned with findings by Bauler and Pipart (2014) in Belgium, where every policy actor they interviewed was easily able to give a short definition of ES. Those interviewees also had the perception that the concept was well known throughout their respective environmental administrations. However, this contrasts with results from a survey and interviews with planners in Germany, where the ES concept was unknown by the majority of respondents, although they already use information related with many types of ES in their activities (Albert et al., 2014b). Another relevant finding by Albert et al. (2014b) was that planners with prior knowledge of the ES concept did not evaluate the usefulness of ES information more optimistically than ones without prior knowledge, and for some purposes they were even more pessimistic. The contrasting findings by these different authors (mostly coming from small samples of respondents) do not allow defining a clear relationship between degree of ES knowledge and of ES integration.

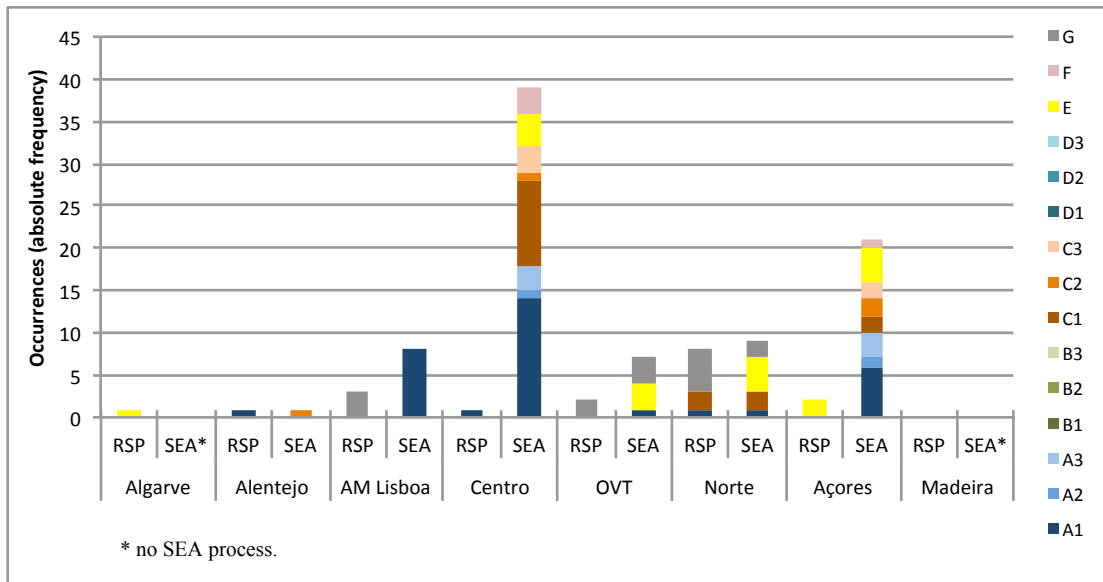


Figure 3.2 – Occurrences of key terms in Portuguese RSPs and corresponding SEA reports, per region.

In five of the six regions where RSPs had a SEA process, ES-related terms are more abundant in SEA reports than in RSPs, which would be expected giv-

en the nature and aims of SEA. However, apparently there is no link between the degree of ES consideration in SEA reports and in corresponding RSPs. This can be illustrated with RSP Centro, which has only one reference to “ecosystem services” (A1), when its SEA report is the one with more references to ES-related terms across many sections of the document. The reason why the SEA report of RSP Centro is richer than the remaining SEA reports in considering ES, might be related with the profile of the technical team that has conducted the SEA. The technical team includes researchers with a strong background in ecological economics, therefore more aware and knowledgeable of the ES concept. The same technical team conducted the SEA for RSP Açores, which ranks second in terms of richness of the ES concept among the SEA reports.

A qualitative analysis of the occurrences in the RSPs shows that, although ES are acknowledged by the plans, rarely there are goals or objectives explicitly relating to ES. In the case of SEA reports, only one of them (for the RSP Centro) explicitly calls for a need to assess the ES of the region under analysis, to support development strategies. A few of these documents explicitly refer to specific categories of ES, like supporting functions of ecosystems for example. Globally, the Portuguese RSPs and SEA reports, associate “nature” most often with “nature conservation”. It is also common among them that “nature tourism” is given importance. This means that, similarly to what was observed for European-level documents, nature is treated in a more traditional conservationist approach, or non-utilitarian conservation approach (Maes et al., 2013), and is essentially seen as providing the cultural ES of recreation. Considering that the majority of RSPs in Portugal came recently into force or are about to, our results suggest that high ES integration is not expected in the near future, similarly to what Albert et al. (2014b) observed in Germany. Albert et al. (2014b) suggest that the mainstreaming of ES information into formal, long-term, comprehensive planning processes will need to be requested and legitimized by regulatory frameworks provided by superior levels, such as the national or EU level.

According to Partidário (2012) despite the existing legal framework and the existence of some guideline standards, current practice in plan design and development depends on planning teams’ experience. Consequently, plans can be oriented towards problem resolution or towards strategic goals; they can adopt a more deterministic approach, heavily based on an extensive baseline description or a more strategic approach, concerned with long-term priority and dynamic choices. This factor can also justify different degrees of ES integration in different plans. However it is complex to conduct a deeper analysis on the composition of planning teams to examine this, since planning teams are

usually consortia, involving many people from different public and private organizations, and are sub-divided according to technical subjects (e.g. tourism, nature protection). This means that teams can have different degrees of similarity or overlapping in their composition.

3.4.3 Integrated analysis

The profile on ES integration coming out of our overall results, including all documents under analysis, shows that for spatial planning policy and guidance, integration of the ES concept is still very incipient. This observation does not support a clear notion (at least for spatial planning policy and guidance) that the ES concept is gaining increasing recognition in politics, has percolated in many policy documents, or that decision-makers are beginning to integrate knowledge about ES into policy-making processes, management and planning, as suggested by Hauck et al. (2013b), Jacobs et al. (2014) or Shapiro and Báldi (2014). However, as presented in Section 3.1, there are apparently contrasting perceptions on ES integration. The article by Hauck et al. (2013b) illustrates this. These authors state that the concept of ES is gaining increasing recognition in politics, and decision-makers are beginning to integrate knowledge about ES into policy-making processes, management and planning. However they also recognize that “while research has produced a vast amount of knowledge about ES, in many cases this knowledge has not yet been put to use in decision-making regarding ecosystem services”. In the United States context, Ruhl (2011) observes that many of the environmental laws Congress passed in the 1970s have undergone little more than superficial reforms, if any, in the past twenty years, meaning new scientific concepts such as ES often find no clear home in existing statutes. In an earlier publication, Ruhl draws attention to the fact that “wicked” issues that challenge law and policy, for example climate change or poverty, have found the attention of policymakers and have been addressed, with varying success, in tangible ways through law and policy, whereas ES have been largely ignored (Ruhl et al., 2007).

Nevertheless, still considering all the documents included in our content analysis, it was possible to find some implicit coverage of ES, as already presented. This is consistent with previous similar studies. For example, Matzdorf and Meyer (2014) developed criteria for an “ideal” ES-driven policy and used them to analyse the main water and biodiversity acts, current policy developments and future trends within the US and the EU. They found that the main laws in force cannot be considered ES-driven, but some terms and ideas therein

correspond to parts of the ES framework. However, they only cover the EU Habitats Directive, the EU Birds Directive and the EU Water Framework Directive in terms of EU policy. Also Hauck et al. (2013a), through analysis of EU policy documents, discussions in focus groups and interviews, found that many ES are both targeted and impacted by existing policies, even if ES were not mentioned explicitly as such (with the exception of a few conservation-related documents). However, that study takes into account the perceptions of decision makers, public officers or experts. Within the Belgian environmental policy domain, Bauler and Pipart (2014) conducted a document analysis to detect the factual occurrence of the ES concept as a sign for its institutional adoption. They have found only a few factual occurrences of the term “service(s)” and even fewer occurrences of “ecosystem services(s)”. Where the terms did occur, they were used mainly for descriptive purposes and less to motivate a shift in the underlying conceptual basis as such. They also found cases where several linked terms (e.g. ecosystem services, environmental services) are used. At local level, Piwowarczyk et al. (2013) have found that several ES were included in local strategic documents even though the term “ecosystem services” was never explicitly mentioned. However, they considered the mentioning of tourism and recreation or fisheries and seaways as referring to ES. We consider that such a relationship is too vague, given that a strategic policy document can cover those issues without taking ES into consideration. Implicit reference to ES was also found in Portuguese SEA practice by Honrado et al. (2013). They analysed SEA reports of different types of plans at different scales in Portugal (e.g. river basin management plans) and observed that only eight out of 60 reviewed cases explicitly mentioned ES, but generally in a very broad way and using different approaches to consider ES. In the implicit cases, ES were normally associated to their ecological values, and there was not a specific analysis related to ES benefits, values and links to human well-being. For those authors this was not surprising, given that SEA will consider the biological and ecological components of the environment. However they stress that the problem with implicit assessments is the way information is presented and understood by those who will use and explore it. Evident and explicit mention of problems enables quicker understanding, and unless the preoccupation is also explicit, there are great chances that the implicit issue will pass unnoticed.

According to Piwowarczyk et al. (2013), the fact that the strategic documents refer to many ES without mentioning the term “ecosystem services” specifically indicates that this concept might be relatively easy to understand by decision makers. It also opens up many possibilities to demonstrate to authorities that they have already been partially using this approach in their strategic

documents (see also Albert et al., 2014). In fact, several policy actors in Belgium interviewed by Bauler and Pipart (2014) stated they felt that the ES concept has in reality underpinned environmental policy making for a long time, even if unconsciously or indirectly using equivalent anthropocentric approaches. Similarly, Honey-Rosés and Pendleton (2013) state that decision makers often need information about ES even if they do not use this language to describe their policy agenda. These observations can be important because practitioners and decision makers might not be “scared” with yet another new term, which can become out of fashion, like it has happened with other terms in the past (see for example Bauler and Pipart, 2014). This relates with results of discussions with experts reported by Matzdorf and Meyer (2014), where experts stressed that the ES framework is currently a “buzz approach” but that nobody really knows how to use it. Those authors use this finding to stress that policy-relevant discussions are needed, on how the ES framework could help improve the implementation of environmental goals in countries with pre-existing environmental policies.

The high level of ES integration in the EC’s Guidance on Integrating Climate Change and Biodiversity into Strategic Environmental Assessment, as well as the higher level of ES integration in the Portuguese SEA reports when compared with the RSPs, suggest that SEA can play a key role as an entry point for ES integration, not only in spatial planning but also in other policies, as noted by Geneletti (2011) and Partidário and Gomes (2013). For Baker et al. (2013), two key characteristics of ES can be driving their inclusion in environmental assessment: (i) using ES presents a more complete, holistic and integrated consideration of the socio-ecological system; (ii) the ES concept is an effective framing of the environment in terms of communicating with and influencing stakeholders and decision makers. Those authors explore the benefits and challenges of ES integration in environmental assessment and conclude that such integration is probably more of a help than a hindrance and may help address some current problems with environmental assessment practice. But it needs to be context specific – including in some situations taking a more integrated approach and in others taking a lighter touch – and it will not be appropriate in all cases (Baker et al., 2013). This is in agreement with recent reviews of SEA effectiveness that show mixed results. Some studies provide evidence of SEA delivering both direct and indirect benefits. In contrast, other studies report that SEA has little direct or measurable influence on the contents of policies, plans and programmes (Fundingsland Tetlow and Hanusch, 2012). In the Portuguese SEA context, Honrado et al. (2013) observed that ES are not properly addressed in strategic approaches and they identified as a consequence, that it is difficult to

clearly understand how the consideration of ES may improve future strategic development. The role of guidance is highlighted by Baker et al. (2013) who state that practitioners are currently highly reliant on guidance and it appears that some guidance documents are supporting a more comprehensive ES approach to assessment. This may help its integration, but only if decision makers demand it and only if it is seen to make a difference without additional burden. For Baker et al. (2013), the above mentioned EC's guidance takes a lighter ecosystems-thinking approach to encourage practitioners to think about ES early on, but not in a prescriptive way. We also acknowledge the existence of other guidance/best practice documents like Slootweg and van Beukering (2008), Hobbs et al. (2010), or more recently UNEP (2014) that can as well be used by decision makers and practitioners.

There were no major differences in results obtained from the content analysis of documents published before and after the Millennium Ecosystem Assessment (MA, 2005a) and the TEEB study (TEEB, 2010b). These results support the notion that the publication of these two major initiatives on ES had little influence on the spatial planning and SEA policy and guidance framework, as well as on a more practical level (regional spatial plans and SEA reports). It relates with the observation by Burkhard et al. (2010) who state that the Millennium Ecosystem Assessment remained on a rather conceptual level and political application of outcomes is lacking so far. The exception to our observation is the EC's Guidance on Integrating Climate Change and Biodiversity into Strategic Environmental Assessment, which is actually the most recently published document included in our content analysis. In the specific case of Portugal, also no differences were found in documents published before and after the publication of the MA sub-global assessment that was conducted for the whole country (Pereira et al., 2009). Additionally, no clear trend in number of occurrences over time was observed.

At European, national and regional levels, policies or strategic documents other than the ones included in our analysis, can influence spatial planning and therefore play a role in ES integration, although more indirectly. At EU level the Common Agricultural Policy or Natura 2000 are examples of this. At national level this includes, for example in Portugal, the national strategy for nature conservation and biodiversity. As noted by Böhme (n.d.), the exact way and the degree of impact of those other policies differ greatly throughout the EU, due to the great variety of spatial conditions, governance systems and the ways in which Member States transpose EU sector policies into national legislation. Spatial planning systems are deeply embedded in their socio-economic, political

and cultural context, which can potentially constrain the scope for mutual learning (Nadin and Stead, 2008). In the case of Portugal for example, Pires (2005) stated that the influence of the ESDP on planning practice in the country was, until then, very weak if not negligible. He observed that the evidence available seemed to reflect an implicit but widespread assumption that the ESDP was neither relevant to inform current planning practice nor a useful reference framework for guiding future changes in planning. Nevertheless, doing a broader analysis to include other documents could constitute potential further research, for an extended profile of environmental and spatial planning policies in terms of ES integration.

Regarding the question about other factors that might help explaining a low level of ES integration, another tentative explanation can be drawn from literature. Abson et al. (2014) present findings suggesting that a shared conceptual vocabulary has not yet emerged within the field of ES research. Within a sustainability context, they suggest three critical challenges for the future development of the ES concept as it moves from being primarily a heuristic model towards becoming an explicit management tool: better interdisciplinary knowledge integration, greater focus on normative knowledge, and improved recognition of the ES concept as a potential transformative tool. Accordingly, Spangenberg (2013) states that there are many schools of thought and strands of discussion in the field of ES, showing how new (and not yet consolidated) it is. It should also be noted that specific services can only be properly integrated with policy and planning after additional research on biodiversity and ecosystem functioning relationships and links between ecosystem functions and services are understood, as stressed by Haase et al. (2014). Additionally, Honey-Rosés and Pendleton (2013) draw attention to the potential divorce from the needs of decision makers, since current research on ES disproportionately focuses on supplying ever more information about the value of ES and less on a systematic, scientific understanding of the demand by decision makers for such information. In any case, there is evidence that an effective ES integration in planning is also dependent on the context, objectives and capacities of a specific planning process (Albert et al., 2014a).

The qualitative analysis of documents shows a commonly stated need to harmonise economic development, social well-being and environmental protection. The integration of these three dimensions, together with the institutional/governance dimension, is part of the sustainable development discourse (Spangenberg, 2002; WCED, 1987). As noted by Abson et al. (2014), the ES concept can be a bridge for the sustainability discourse and for Jacobs et al. (2014) it

is rooted in sustainability thinking. In this line of thought, an evolution towards an ES discourse in policy and guiding documents can probably happen in the future. For Matzdorf and Meyer (2014), new laws will incorporate the ES framework into one or two environmental fields, but an overall law completely encompassing ES is not expected in the future, at least in the EU and the US. Thus, policy frameworks like for spatial planning can be very relevant to mainstream the ES framework into decision-making. Although, in principle, strategic documents do not provide management details, they define a framework for more operational management plans. Thus, as argued by Piwowarczyk et al. (2013), if the question of ES is not evident at the strategic level, it will not likely appear at the level of operational programs. This is valid for a planning framework that cascades along scales, for example from European to national, regional and local scales. The planning framework can therefore play an important role as driver for on-the-ground action on ES.

In this research, our content analysis focused on explicit key terms in a first stage. This has the advantage of diminishing subjectivity and increasing reproducibility. However, it might not reveal additional insights, like a deeper analysis probably would. Supplementing the analysis of explicit terms with a qualitative analysis was deemed useful in this research, since it unveiled a more implicit ES integration, or at least a call for it, as previously discussed. Also, a supervised semi-automatic search for the key terms allowed a quality check that could hardly be done through a fully automated process. To register each occurrence, it was not enough for example that “biodiversity” and “services” appeared in the same sentence or paragraph, if a relationship was not established, conveying the message of biodiversity somehow delivering services to society.

3.5 Conclusions

The profile drawn in this research shows a general low level of explicit ES integration in the spatial planning and SEA policy and guidance framework, both at European level and national level in the case of Portugal. Additionally, our results for Portuguese RSPs and SEA reports suggest that, in practical terms, for the coming years ES will not be specifically targeted or integrated in regional spatial planning practice. This is considering that most of the RSPs analysed are recent or in the process of legally coming into force. However, despite the low number of explicit references to ES in many of the documents analysed, some notions associated with ES, although more indirectly, are already

present in the policy and guidance documents. Considering the influence that other important and more recent policies can have on the whole European governance framework and on nature/natural capital (e.g. EU Biodiversity Strategy to 2020), one might expect a higher degree of ES integration in the future for spatial planning at European level.

Conducting the analysis presented in this paper for a wider scope of European policies could allow drawing insights on the horizontal integration of the ES concept across different sectoral policies. This horizontal integration is relevant given the potential of the ES concept to integrate social, economic and ecological aspects. On the other hand, expanding the profile to include other European countries would allow understanding how vertical integration differs across various spatial planning contexts, cultures and political realities. The same analysis could also be conducted to compare the European context with others. These applications could help identifying common factors that enable or hinder ES integration in spatial planning, within and across governance levels. This could also be applied to other sectoral policies, for that matter.

Our findings do not provide direct evidence that the MA and TEEB placed the ES concept in the international political agenda. Nevertheless, at international level, several initiatives already exist to facilitate policy integration of ES. From the documents analysed in our profile, the EC's Guidance on Integrating Climate Change and Biodiversity into Strategic Environmental Assessment can be regarded as the best guiding document for an ES approach to spatial planning. However, based on this research, it seems that the major challenge lies at national and particularly sub-national levels, where landscape and land-use changes are most often negotiated and decided. This highlights the importance of bottom-up demand from different groups of stakeholders for considering ES in decision making, as well as of increased levels of awareness and training by decision makers and public officers at those governance levels. In order to achieve this, successful local initiatives that clearly show the benefits of integrating ES in decision making, improved tools for ES assessments that are easy to grasp by practitioners and whose results are meaningful for decision makers and general public, as well as improved media coverage on the importance of ES for society, are all important factors. The role of applied research, involving society, is crucial for this endeavour.

Participatory selection of ecosystem services for spatial planning: Insights from the Lisbon Metropolitan Area, Portugal⁷

Abstract

Ecosystem services (ES) assessments have been undergoing rapid developments. Despite considerable advancements it is still difficult to comprehensively assess a large suite of ES, often requiring a selection of the most relevant ones. However, documented and tested procedures to select ES, particularly through participatory processes, are scarce. The aim of this research is to explore the participatory selection of ES, illustrated with the case of the Lisbon Metropolitan Area in Portugal, southwestern Europe. Drawing from a spatial planning context, different types of stakeholders were involved through a combination of participatory techniques. It was possible to identify differences in stakeholders' ES selection, while at the same time arriving at a set of priority ES

⁷ Mascarenhas, A., Ramos, T.B., Haase, D., Santos, R., 2016. Participatory selection of ecosystem services for spatial planning: Insights from the Lisbon Metropolitan Area, Portugal. *Ecosystem Services* 18, 87–99. doi:10.1016/j.ecoser.2016.02.011 (reproduced with authorization of the publisher and subject to copyright restrictions imposed by them).

and linking them with spatial planning goals that entail potential effects on ES. The strengths of the approach include the use of different participatory techniques, of drivers that help translating plans and of an existing ES classification system to support it. On the other hand, the exploratory nature of the research meant that a limited range of types of stakeholders was covered. The participatory approach developed in this research has the potential to be adapted for ES selection in other planning contexts or in strategic environmental assessments.

4.1 Introduction

Natural resources management is increasingly supported by the concept of ecosystem services (ES), generally defined as the benefits people obtain from ecosystems (MA, 2003), representing flows of value to human societies as a result of the state and quantity of natural capital (TEEB, 2010b). Given their abundance until fairly recently, the importance of ES is often widely appreciated only upon their loss (Daily, 2000). On the other hand, the integration of ES in policy and planning still faces many challenges. ES are therefore not well considered in current landscape planning and environmental governance (de Groot et al., 2010a; Geneletti, 2011; Kaczorowska et al., 2015; Koschke et al., 2012; Liu and Opdam, 2014).

Using the ES concept can enable a comprehensive evaluation of policy and planning impacts, highlighting trade-offs and synergies between different strategic options, as stressed by Hauck et al. (2013a). A focus on ES in participatory decision-making processes can provide a common language that facilitates comparisons of management alternatives. This can foster dialogue among groups with different interests and beliefs and increase the likelihood that plans are mutually acceptable (Granek et al., 2010).

ES approaches themselves are most effective in leading to policy change and generating action when embedded within a participatory decision process (Rosenthal et al., 2014; Ruckelshaus et al., 2013). A stronger focus on stakeholder processes is thus a key element for implementing ES into planning and management practice, representing a means to increase the relevance and impact of study results in decision-making (Koschke et al., 2014).

ES assessments usually start by an identification of ES based on biophysical data (Menzel and Teng, 2010) and/or by a selection dependent on the availability of modeling tools (e.g. Schröter et al., 2005), of data on the site of interest (e.g. Larondelle and Haase, 2012), of data from other sites (e.g. for benefit trans-

fer as in Liu et al., 2010) or on other limiting factors. Afterwards, the contribution of ES to human well-being is generally assessed through valuation processes (Gómez-Baggethun and de Groot, 2010) which are heavily dependent on social, cultural and economic contexts (Pascual et al., 2010). The opinions, knowledge, interests, perceptions, needs, ideological predilections and values of societal individuals, which support ES valuation, are likely to differ widely (Fontaine et al., 2013; Hauck et al., 2013a; Hein et al., 2006; Spangenberg et al., 2014; Spangenberg and Settele, 2010). Planners have to take that diversity into account when making or facilitating relevant decisions (Hubacek and Kronenberg, 2013). Considering also that quantitative valuation is generally restricted to a small set of selected ES, engaging stakeholders to identify what matters avoids unsubstantiated assumptions about priority services, values, or benefits (Chan et al., 2012).

Separating the identification of ES from their valuation, as currently practiced, suggests that ES can be defined without reference to values and thus that ES can be understood as a purely scientific concept (Menzel and Teng, 2010). This suggestion is unlikely (see for example Sagoff, 2011) and can lead to policy-irrelevant ES assessments (Menzel and Teng, 2010) or to ES becoming a technocratic discourse (Abson et al., 2014). By dealing with complex socio-ecological systems, ES research requires choices, which are normative by definition (Jacobs et al., 2014). In this article it is argued that if people's opinions, knowledge, perceptions and values are used for ES valuation in assessments or planning processes, then it is reasonable to incorporate them also earlier in the process, namely when a selection of ES to focus on is done. However, documented and tested procedures to select ES, particularly through participatory processes, are scarce. This fits within the broader notion that non-economic social approaches to ES assessment are still poorly covered (Orenstein and Groner, 2014).

The goal of this research was to develop and explore a participatory approach for selecting priority ES in a spatial planning context. The approach, which targets different types of stakeholders using different participatory techniques, was tested in a Portuguese regional planning context and lessons were drawn about its application.

4.2 Participatory selection of ecosystem services in spatial planning

Early stakeholder engagement has been recommended by some authors for ES assessments in the context of spatial planning or natural resource management, for example in marine protected areas (Cárcamo et al., 2014), urban regions (Söderman et al., 2012), coastal ecosystems (Granek et al., 2010), or data-poor regions (Paudyal et al., 2015; Ramirez-Gomez et al., 2015). Stakeholders are any group or individual who can affect or is affected by the achievement of an organization's objectives (Freeman, 1984) or by a decision (Reed, 2008). They can be individuals, communities, social groups or institutions of any size, aggregation or level in society (Grimble and Wellard, 1997). Although it is generally understood that stakeholder participation can enhance the quality of environmental decisions, with many benefits being claimed for participation, few of the claims that are made have been tested (Reed, 2008).

While methodologies for assessing ES are constantly improving, stakeholder engagement is often ineffective (Menzel and Teng, 2010) and only little attention has been given to the identification of which ES to assess (Malinga et al., 2013). More specifically, there is a dearth of participatory methods for identifying priority services (Chan et al., 2012). For example in the context of planning marine protected areas, Granek et al. (2010) observe that stakeholders' perceptions and identification of ES and conservation goals are absent from the scientific literature. Existing reviews of ES studies also show that stakeholders are most often not involved in ES assessments (D. Haase et al., 2014; Luederitz et al., 2015; Nieto-Romero et al., 2014), so there is a lack of explicit inclusion of people's values and needs (Menzel and Teng, 2010). When stakeholders are involved, this is limited to one scale, one type of stakeholder, aiming at one type (mostly cultural) of ES (D. Haase et al., 2014), and stakeholders' inputs are primarily to evaluate parameters and outcomes of simulations (Seppelt et al., 2011), in a later stage of ES assessment. These findings contrast with evidence that the identification of relevant ES are among the most demanded information items from stakeholders, as reported by Koschke et al. (2014). Another issue observed by Koschke et al. (2014) is that usually only scarce information on participatory processes is provided in ES studies, which often renders the process itself non-transparent. They identify a lack of practical experience described in scientific literature and that difficulties, failures or mistakes are not mentioned or discussed. This kind of information is important to draw lessons and improve participatory processes. Therefore there is clear potential for improving stakeholder processes in the context of operationalizing the ES concept,

with relevancy of ES for stakeholders being one of the problems to tackle (Koschke et al., 2014).

Nevertheless it is possible to find in the literature examples of participatory approaches for ES selection in a spatial planning context, most notably the studies by Bryan et al. (2010), Koschke et al. (2012), Hauck et al. (2013a), Malinga et al. (2013), Namaalwa et al. (2013) or Liu and Opdam (2014). In these works, ES selection can be included as a part of more general approaches like multi-criteria assessments (Koschke et al., 2012) or participatory scenario planning (Malinga et al., 2013). Different participatory techniques are used, frequently in combination, and include regional surveys (Hauck et al., 2013a), interviews (Bryan et al., 2010; Malinga et al., 2013), workshops (Koschke et al., 2012; Malinga et al., 2013; Namaalwa et al., 2013), small group discussions, voting processes or even valuation exercises themselves (Liu and Opdam, 2014). The types of stakeholders involved vary with the planning context, scale and aims of the studies. They include planning and environmental authorities, NGOs, planning associations, economic agents (e.g. farmers), resources user groups, or academia. Although stakeholders at the same scale of the scope of each study are preferentially targeted (mainly regional or local), involvement of stakeholders at different scales can also occur (see, for example, Namaalwa et al., 2013). In some cases a checklist of services is presented to stakeholders to support ES selection. These lists can be developed based on existing ES classification systems (for example from the TEEB project, see Hauck et al., 2013a), on existing information on the study area or even from stakeholders' inputs in early stages of the process (Koschke et al., 2012; Namaalwa et al., 2013). The use of existing ES classification systems, like the ones from MA or TEEB, usually demands their adaptation according to stakeholder needs and the context of each study (see Bryan et al., 2010, Koschke et al., 2012, Hauck et al., 2013a). It is noteworthy that practically in all of these studies, the process of ES selection by stakeholders is not done in direct connection with planning goals. The exception is the work by Liu and Opdam (2014) that links ES prioritization with building common planning visions, although the approach remains on a conceptual level. Other authors link ES selection with potential drivers of change (see Malinga et al., 2013; Namaalwa et al., 2013). It should also be stressed that most articles are not focused specifically on the participatory selection of ES in policy and planning processes, which is only partially covered and discussed.

4.3 Methods

4.3.1 Lisbon Metropolitan Area and its planning context

Situated in the Atlantic coast of Portugal, the Lisbon Metropolitan Area (LMA) is the third largest urban region in the Iberian Peninsula, after Madrid and Barcelona. This urban region represents, in terms of its population and economic production, a provincial capital of similar dimensions, in the European context, to Athens, Barcelona, Bratislava, Dublin, Edinburgh, Helsinki, Ljubljana, Sofia and Stockholm (Campo, 2009). It is Portugal's main urban area, where the capital city of Lisbon is located. In 2011 it held over 2.8 million residents, representing close to 27% of Portugal's total population, although it covers around 3.3% of the country's total area. Covering an area of 2944 km² on the northern and southern riverbanks of the Tagus estuary, the LMA is a NUTS II⁸ region including 18 municipalities. Population density in the northern sub-unit of the LMA (NUTS III – Greater Lisbon) is more than three times higher than in the southern sub-unit (NUTS III – Setúbal Peninsula). Despite the presence of major urban areas, the LMA has also considerable agricultural and natural areas, including five areas of nature protection that are part of the Natura 2000 network, as well as a large river and seafront, including along the two estuaries of Tagus and Sado rivers (Figure 4.1).

⁸ Nomenclature of Units for Territorial Statistics, a European Union classification.

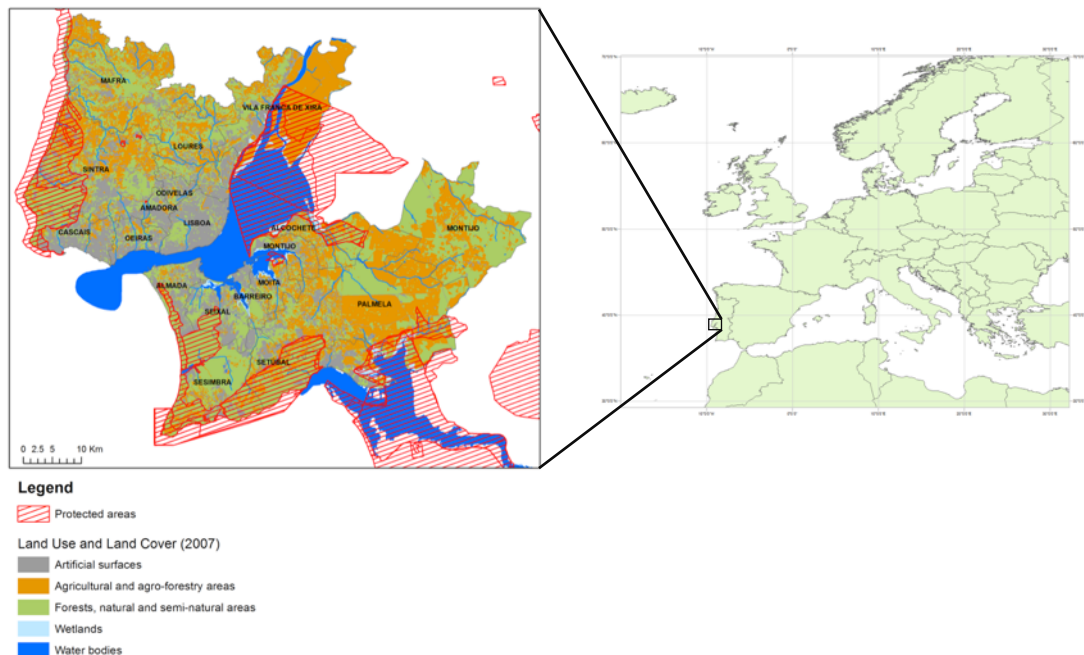


Figure 4.1 – Location and major land use / land cover of the Lisbon Metropolitan Area. Source: Instituto Geográfico Português.

The absence of spatial planning regulations in the LMA, which only started to be systematically implemented in the beginning of the 1990s, influenced the development of the region by increasing the negative side effects of a rapid metropolitan growth (e.g. unsustainable mobility patterns) (Campo, 2009). The region has been subject to a constant opening of new areas of urbanization (Costa et al., 2009). Between 2001 and 2011 housing units increased about 15% while population increased less than 6%. Population grew 13.8% between 1981 and 2011 in the whole LMA, while it decreased 32.2% in the Lisbon municipality, which suggests a pattern of suburbanization.

The regional spatial plan (RSP) legally in force for the LMA was approved in 2002. Greatly driven by political options taken at the national level to implement new major infrastructures in the region, a revision of the RSP was initiated and a technical proposal was finalized in 2010, accompanied by a strategic environmental assessment (SEA) and subject to public consultation. The fundamental structure of the revised RSP proposal is shown in Figure 4.2. The five Domains for Vision Implementation develop in 20 Lines of Action, with Key-objectives, Targets and Guiding Norms for its implementation. For example for domain “C. Sustainability and Harmony with Nature”, one of the Lines of Action is “C1. To ensure the functioning of the Metropolitan Ecological Network” that includes two key-objectives: (i) to preserve biodiversity and (ii) to increase

urban green space. Targets include “Maintaining or increasing the area of the Regional Environmental Protection and Enhancement Structure with land cover/land use that promotes nature conservation and biodiversity”. Specific Guiding Norms for each Line of Action provide detailed orientations, directives and measures for planning and implementation on the ground, which are compiled and organized in individual sheets. For Line of Action C1 for example there is a sheet with Guiding Norms for “C1.1. Implementing/materializing the Metropolitan Ecological Network”. The strategic goals are materialized in a spatial reference – the Territorial Model. The new plan proposal also revises the Metropolitan Ecological Network defined in the 2002 RSP, which congregates different existing land use classifications for conservation (like designated areas for nature conservation, or areas included in the national agricultural reserve), aiming at their interconnectedness and coherence in the metropolitan region.

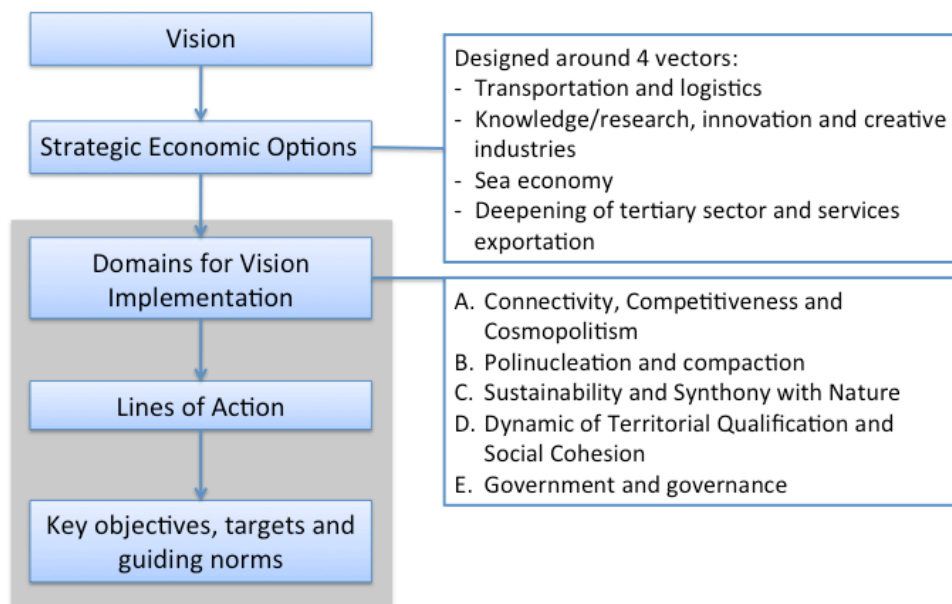


Figure 4.2 – Fundamental structure of the technical proposal of the regional spatial plan for the Lisbon Metropolitan Area.

4.3.2 Participatory selection of ES

To develop and explore a participatory approach for ES selection, relevant stakeholders were initially selected. This was supported by a review of existing policies and practices and of relevant documents related with spatial planning in Portugal and in LMA, similar to what Namaalwa et al. (2013) did to assess an institutional setup. Also, one of the universities conducting this research is lo-

cated in the LMA and holds accumulated knowledge on the region and on the planning context, which helps contextualizing that information.

The selection of stakeholders took into consideration how planning processes take place in Portugal and other places. In such processes a technical team from a planning authority usually prepares a technical proposal for a spatial plan, incorporating afterwards views from other stakeholders through public participation and/or consultation. Even in the cases where consultants are hired by the planning authority to prepare the technical proposal, the authority supervises plan design and is the ultimate legal responsible for the plan. By setting the regional planning goals, it has high influence on potential planning effects on ES and high interest that the planning outcomes are achieved, relative to the other stakeholders. In its turn, local authorities are responsible for implementing regional planning goals on the ground. Therefore they have higher practical influence on effects upon ES, although their interest on achieving regional planning outcomes is lower. Including local authorities is important since perceptions relating to sustainability at the regional scale may mask local differences (Mascarenhas et al., 2014a; O'Toole et al., 2006). The Portuguese environmental authority and selected universities from the region are also involved in the formal RSP consultation process. The interest-influence matrix (see Reed et al., 2009) of all these stakeholders is depicted in Figure 4.3.

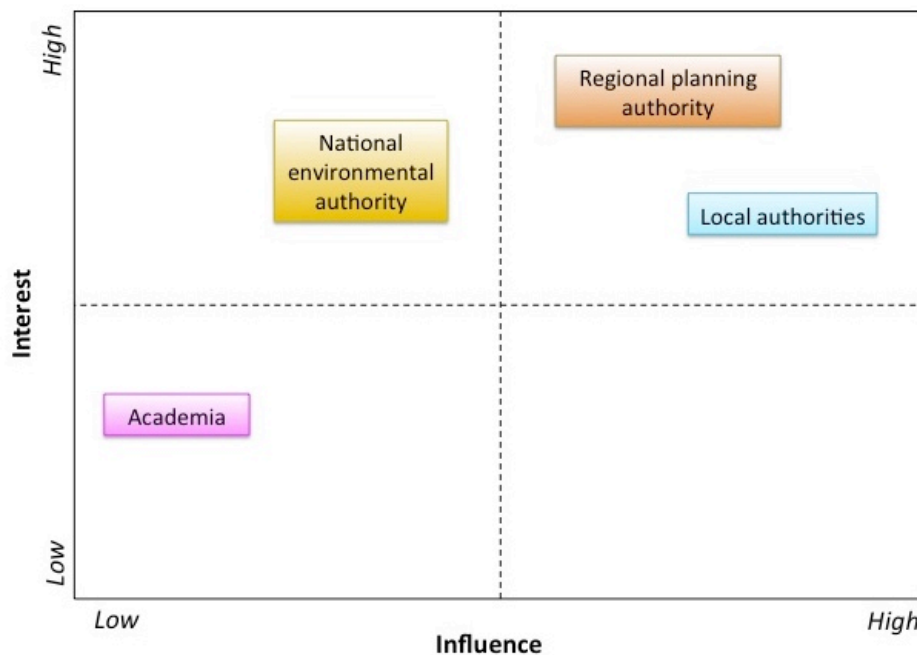


Figure 4.3 – Interest-influence matrix for the stakeholder groups involved in the participatory approach.

Considering the features of the above described planning process and the roles of different stakeholders therein, the participatory selection of ES was supported by two kinds of participatory techniques: (i) focus group with technical staff from the regional planning authority; (ii) participatory workshop with stakeholders from local authorities, national environmental authorities and academia. For each participatory moment, specific tools for systematic data collection were designed, as can be done to collect qualitative data (Yin, 2011). The participatory approach developed and explored in this research is depicted in Figure 4.4 and further detailed in Sections 4.3.2.1 and 4.3.2.2.

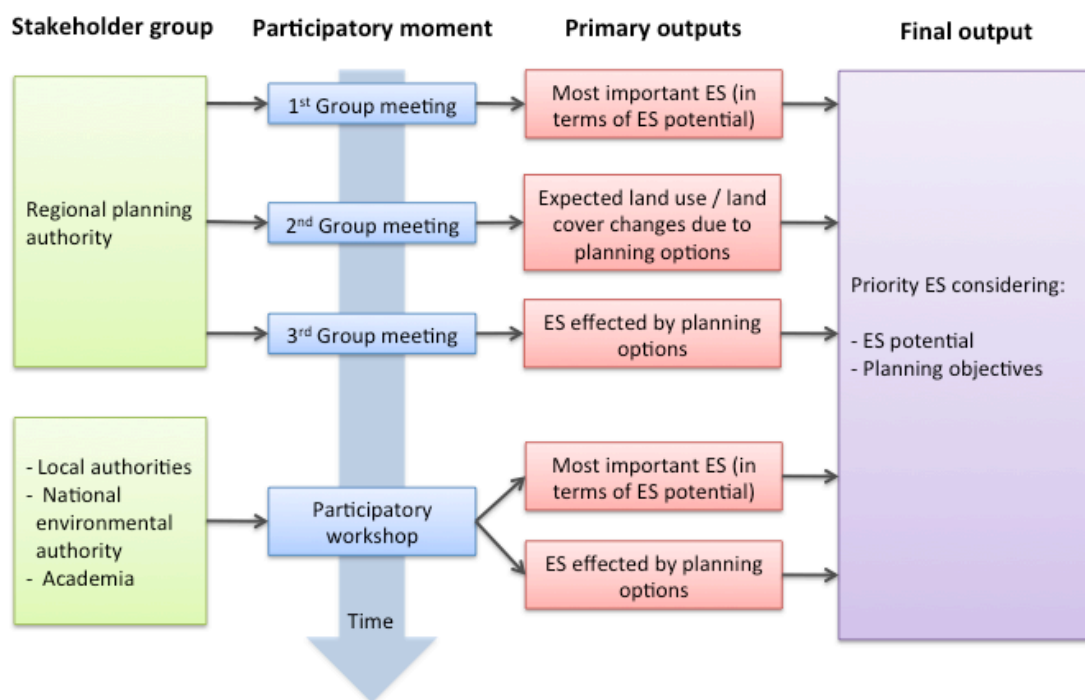


Figure 4.4 – Schematic overview of the participatory approach developed and explored in this research.

4.3.2.1 Focus group meetings with the regional planning authority

Three focus group meetings were held with a small group of technical staff from the regional spatial planning authority. The goal was to engage them in an increasingly complex exercise of ES selection. In a focus group, multiple perspectives can be represented and there is an opportunity to witness discourse between participants (Weber and Ringold, 2015). The research literature considers focus groups as the main type of moderately sized groups. The groups are “focused” because they include individuals who previously have

had some common experience or presumably share some common views. When conversing with such groups, the researcher serves as a moderator and tries to induce all the members of a group to express their opinions but with minimum, if any, direction (Yin, 2011). Observation was also a way of data collection in the meetings. Observing can be an invaluable way of collecting data because what the researcher observes and perceives is not filtered by what others might have (self-)reported. In this sense, these observations are a form of primary data (Yin, 2011). The selection of individual participants from the regional authority was not entirely under the control of the research team. Similar to what happens for most field settings, and especially those with readily acknowledged organizational or social networks (Yin, 2011), access to participants came from an official of the institution.

The focus group meetings were moderated by one researcher, involved five to seven participants and lasted between 2.5 and 3 h. The first goal of the first meeting was to briefly introduce the research's goals and team, as well as the subject of ES, including concepts, approaches and initiatives. A second goal was to allow participants to select the ES they considered more important in the region, having in mind the features of the region, regardless of existing planning goals. Thus this exercise tried to capture something similar to ecosystem or landscape potentials (Bastian et al., 2012) to distinguish between the potential, or capacity (MA, 2005b) to supply services and the actual or demanded use of these services by humans (see also Castro et al., 2014). For this, a matrix was designed, translating to Portuguese the CICES – Common International Classification of Ecosystem Services (Haines-Young and Potschin, 2010a) and including a column to identify ES considered more important. The CICES was chosen as a basis for ES selection, since it is already used at high-level decision-making. It was developed from the work on environmental accounting undertaken by the European Environment Agency (EEA, 2011). It supports their contribution to the revision of the System of Environmental-Economic Accounting, which is currently being led by the United Nations Statistical Division. The use of an existing ES classification system instead of collecting open answers has the advantage of avoiding confusion or overlapping in the identification of ES by participants. It helps overcoming situations where different people have different understandings of what ES are. By encouraging participants to think about and express final outcomes rather than intermediate factors, it promotes clarity on what is ultimately relevant to them and eliminates double counting of potentially interdependent features (Weber and Ringold, 2015). Participants were asked to select few ES (five was suggested as a maximum), in order to clearly identify the ones considered more important. This is the most common number

of services in ES assessments (Seppelt et al., 2011) and is in accordance with similar approaches (for example Granek et al., 2010 and Paudyal et al., 2015).

The goal of the second meeting was to identify effects of RSP's strategic goals and objectives on land use/land cover (LULC) in the region (in terms of gain or loss of area). This exercise was deemed useful since participants worked in spatial planning, therefore were expected to be more used to think about LULC than ES. Malinga et al. (2013) present similar arguments to work with LULC instead of ES when involving stakeholders. This also took into account the existence of correspondence between Corine Land Cover (CLC) classes and ecosystem types proposed by (Maes et al., 2013), as well as the ability to support spatially explicit ES assessments that can be done at subsequent stages. The time horizon used was the same as the RSP (until the year 2020). A matrix was designed for this exercise, including the different levels of strategic goals, objectives and targets of the RSP, one column to insert potentially affected CLC classes and another to insert comments (Table A3.1, Appendix 3). A Portuguese version of the CLC 2006 nomenclature (Caetano et al., 2009) was distributed to participants for consulting the codes to insert in the matrix. Each of the three levels of the CLC nomenclature could be inserted whenever participants considered that planning goals and objectives would affect entire groups of CLC classes (e.g. level 2 class "11 – Urban fabric" that includes the level 3 classes "111 – Continuous urban fabric" and "112 – Discontinuous urban fabric"). In the comments column, participants could for example identify specific areas of the region where LULC changes were expected, or elaborate a little bit further on the causes of expected LULC changes.

The goal of the third meeting was to identify effects (positive or negative) of RSP's strategic goals and objectives on ES in the region. The time horizon was again 2020. A matrix similar to the one used in the second meeting was designed, including the strategic goals, objectives and targets laid down by the plan, one column to insert potentially affected ES and another to insert comments (Table A3.2, Appendix 3). A table with a coded version of CICES in Portuguese was designed to assist participants when filling-in the matrix. The nomenclature of codes follows the same rationale as the one in CLC (Table A3.3, Appendix 3). Participants could identify aggregated levels of ES affected by the plan, for example they could identify the group '1.1.1. Biomass', if they thought that all the classes contained therein (1.1.1.1. until 1.1.1.6.) would be affected. However, they were asked to try identifying ES at the most disaggregated level whenever possible.

4.3.2.2 Participatory workshop

A participatory workshop was designed to collect the views and opinions of other groups of stakeholders in the region, in addition to the regional planning authority (see Section 4.3.2). A pre-workshop questionnaire was designed to collect contextual information for each participant, their perceptions of and knowledge on ES and their individual opinion on the most important ES in the region, having in mind the existing characteristics of the region, regardless of existing planning goals. This was similar to the exercise conducted in the first meeting with the regional planning authority. Accordingly, the same matrix was used for data collection. A pre-test of the questionnaire was conducted to assess critical factors such as its clarity, comprehensiveness and acceptability (Rea and Parker, 1997). The pre-test was done with a group of people from academia and practitioners, working on the fields of sustainability strategy development and assessment, public participation, SEA and education for sustainable development.

The workshop was divided in two halves. The first half consisted of presentations by researchers on the topic of ES. The goal was to familiarize participants with the concept of ES, its links with spatial planning and some related issues (e.g. valuation). This was considered useful to set a minimum common knowledge basis among participants and improve the productivity of the interactive exercise that would follow. The exercise was conducted in the second half of the workshop. Participants were divided in smaller groups. Each group was comprised of people belonging to the same stakeholder typology (e.g. a group including only people from local authorities). In this way, comparison of groups' results can more clearly reveal different views and opinions from different types of stakeholder. Also, data collection through observation of each group's discussion was not the main aim of the exercise. Each group was asked to go through a list of drivers (or driving forces) and identify the corresponding ES that could be affected (positively or negatively) in the region (Table A3.4, Appendix 3).

A driver is any natural or human-induced factor that directly or indirectly causes a change in an ecosystem (Nelson et al., 2005). Achieving the objectives of a plan may trigger such drivers that alter the quality, quantity, and/or spatial distribution of ES (Geneletti, 2011). Drivers were used instead of the plan itself (like it was in the focus group) since the plan was a technical proposal, not legally enforced, which had two main consequences: (i) participants were not necessarily familiarized with the plan; (ii) local authorities were not willing to use it for the participatory exercise, because it was not clear if it would be legal-

ly approved, due to a changing political context, and some local authorities opposed several planning options throughout the planning process. Moreover, RSPs assume a more strategic character and are less prescriptive than local spatial plans, which means that it is not always so clear how they will translate in practice. Drivers can be therefore used to translate planning goals and objectives in order to facilitate participation. The identification of drivers was based on the review work by Anastasopoulou et al. (n.d.) and the study by Namaalwa et al. (2013), as well as on the RSP itself. Participants could also add drivers that they considered relevant in the region.

The same CICES coded table designed for the focus group (see Section 4.3.2.1.) was distributed to participants for them to link ES codes with drivers. Participants were as well asked to preferably identify the most disaggregated level of ES ("Class" in CICES), although they could identify aggregated levels. After identifying the ES affected by each driver, each working group was asked to identify the three drivers exerting greater effects on ES and the three ES that would be more affected, positively or negatively.

The resulting ES from each group were compiled, together with the most selected ES in the individual pre-workshop questionnaire, duplicates were merged and the resulting set of ES was hanged on a large pin board. Each participant was given three sticker votes that could be distributed as they wished across the ES they considered having higher priority.

4.4 Results and discussion

4.4.1 Focus group meetings with the regional planning authority

Participants of the focus group meetings had a diverse academic background (geography, architecture, environmental and civil engineering), held different positions within the authority and performed different tasks, including compliance analysis of local spatial plans, working on regional observatories/RSPs monitoring or on SEA. Most participants had around 20 years of experience working in spatial planning. The knowledge of the ES concept was evenly distributed among those who knew it slightly well, fairly well, or quite well.

In the beginning of the first meeting there was the need to clarify that in the ES concept, "ecosystem" is not necessarily a larger, consolidated area with recognized nature conservation value. Other areas provide ES, for example parks, avenues, gardens and yards or green roofs and facades (D. Haase et al.,

2014). There was also the need to explain better the goal of the exercise. This was successfully achieved by posing the question: in a scenario of potential loss of all ES in the region, if you could choose five ES to keep, which ones would you choose? Before filling in the matrix, participants wanted to express by their own words what they considered to be the most important features of the region associated with the supply of ES. They mentioned the notable landscapes (cultural service), the historical heritage (cultural service), the aquifer system of the Setúbal Peninsula – the biggest one in the Iberian Peninsula (water provisioning service), and finally the Tagus estuary (associated with several services, including recreation, aesthetic value). Participants also made several references to the Metropolitan Ecological Network, defined by the RSP, as an important planning mechanism to ensure the continued provision of ES.

The ES considered most important by the majority of participants include cultivated crops, groundwater for drinking and non-drinking purposes, mediation of mass and liquid flows, micro and regional climate regulation, as well as intellectual and representative interactions related with cultural heritage and entertainment (Table A.3.5, Appendix 3). The three CICES sections of ES, which are commonly used to classify ES in other classification schemes (provisioning, regulation and maintenance, cultural), are represented by the ES considered most important. The most important ES identified by participants using the matrix were coherent with the most notable features of the region associated with the supply of ES, which they had previously identified.

In the second meeting it was possible to identify the LULC classes that would be more impacted by the RSP (Table A.3.6, Appendix 3). Most of the identified LULC classes are artificial surfaces, like urban fabric or industrial, commercial and transport units, corresponding to urban ecosystem types according to Maes et al. (2013b). It was also possible to identify LULC classes that might change in different directions depending on planning objectives, for example some objectives would tend to stabilize agricultural areas, while others would decrease them. Although participants were invited to think about expected changes for the region as a whole, it was difficult for them (especially the ones involved in planning at lower scales) not to think about specific areas within the region, where changes could occur. This highlights the important role of spatial translation of LULC changes, to identify where changes will occur and spatial trade-offs (Haase and Nuissl, 2010). If one translates the LULC classes into ecosystem types (following Maes et al. 2013b), it is also possible to observe that the expected effects of the RSP would be focused on urban, cropland, grassland and marine inlets and transitional waters types of ecosys-

tems. On the other hand, participants did not identify any effects on forests and semi-natural areas. These areas relate with ecosystem types including woodland and forest, (natural) grassland, heathland and shrub, and sparsely vegetated land (Maes et al., 2013b). LULC classes/ecosystem types can then be related with different ES that they can provide (see for example Larondelle et al., 2014 and Zorrilla-Miras et al., 2014), although that exercise is not further explored in this article. Including other stakeholders with different backgrounds (e.g. working in nature conservation or forestry) in this exercise could result in different LULC being identified, which stresses the relevance of stakeholder representativeness in the planning process in terms of ES prioritization and trade-off analysis.

In the third meeting, all responses collected identified a positive effect of the RSP's key objectives on ES (Table A.3.7, Appendix 3). This was not surprising since the overall goal of the RSP is to promote sustainable regional development, which translates in its key objectives. These results support the notion that participants have recognized a concern with sustainability across the RSP. On the other hand, this could indicate that assessing the effects of spatial plans with a more strategic nature (less prescriptive) will need a deeper analysis of the plan and a discussion on probable ways through which the plan will unfold in the territory. From the point of view of the participatory process, this will demand more resources (e.g. time). The kind of results obtained could be used to identify potential trade-offs between ES, associated with planning objectives. However since only positive effects on ES were identified, it is possible to trace planning objectives with synergistic (positive) effects on ES. For example, objective 'To diminish pressure on maritime and estuarine margins' has expected effects on mass stabilisation and control of erosion rates, as well as on flood protection. In this kind of analysis, one must consider and look into more detail at the possible causality links between ES. In this example, mass stabilisation and control of erosion rates would very probably contribute to flood protection. Some of the effects identified actually refer more to effects on services provided by human systems than by natural systems. For example the objective to eliminate houses with no basic infrastructure were expected to have a positive effect on disease control and aesthetic value. This is a reasonable assumption, although the effect will be mainly due to infrastructure construction, so it is much more related with manufactured capital than with natural capital. This stresses the potential need of revisiting the concept of ES during the participatory exercise and also highlights the pertinence of bringing together ES and built space in urban regions. There is evidence that people can actually attribute more so-

cial value to man-made services than to ES in similar participatory exercises (see Bryan et al., 2010).

Participants briefly discussed among themselves the territorial expression of each planning objective and consulted the plan document when needed, as they were individually filling in the matrix. This provided an opportunity for them to exchange knowledge and experiences regarding the implementation of planning objectives “on the ground”. They particularly stressed the planning objective ‘To invest in urban rehabilitation instead of new construction for housing’ as crucial to regional sustainability, since urban growth accompanied with loss of population from the inner city areas of Lisbon was regarded as an important issue that has not been appropriately addressed in the past (see Section 4.3.1). Planning objective ‘To re-orient urban demand to rehabilitation of existing urban areas’ also addresses this issue. Re-urbanization and urban renewal associated with population decline is a pressing sustainability challenge across several cities in Europe and other parts of the world, which has been discussed in more detail for example for Makiivka in Ukraine, Halle and Leipzig in Germany, or Liverpool in England (A. Haase et al., 2014; Nuisl et al., 2008). It is an issue in need of further research that demands a careful analysis of the particular planning context to avoid an ill-founded transfer of ‘best practices’ (A. Haase et al., 2014). Participants could not indicate which ES would be affected by the strategic objective “To preserve biodiversity”. This is in line with the debate found in literature regarding the relationship between ES and biodiversity (e.g. Mace et al., 2012). A short discussion took place and several participants expressed that biodiversity would support all ES, which is aligned with a substantial amount of literature.

In this research, access to the regional planning authority was achieved through one of its officials. According to Yin (2011), this way of gaining access, through a “gatekeeper”, can affect the reception of the researcher by other officials, if they believe that the research study represents the interests of the gatekeeper. However, a welcoming reception by participants was observed and there was no apparent reason to believe that such a limiting situation took place. Nevertheless, detecting such situations is not always possible through observation during the limited available time for interaction with participants. Another known source of bias in focus groups is the phenomenon of ‘group-think’ due to dominant participants (Janis, 1972). The use of tools for systematic data collection from individual participants, as was done in this research, helps minimizing this phenomenon.

4.4.2 Participatory workshop

The participatory workshop involved 26 participants, the majority of them from local authorities (15 participants from 9 of the 18 municipalities in AML), followed by six participants from the national environmental authority and five participants from academia. All had higher education and worked on average for seven years in spatial planning (though some with no previous experience). Six participants had a poor knowledge of the ES concept, seven had a reasonable knowledge, eleven knew the concept well and two knew the concept very well. The majority of participants knew reasonably or well the concepts of environmental services, natural capital, ecosystem functions, landscape functions and green economy. On the other hand, the majority of participants were completely unaware or knew poorly the Millennium Ecosystem Assessment (MA), the Portuguese MA sub-global assessment or the TEEB initiative. All participants considered either very important or important to integrate the ES concept in regional and municipal spatial planning. The majority of participants did not know how to rate the degree of integration of the ES concept in the existing regional spatial plan and in the SEA process of the new plan proposal (most of these did not know the results of the SEA at all). In terms of the degree of ES integration in municipal spatial plans, responses were more distributed and there was no observed majority for any response category. The majority of participants did not know how to rate the contribution that SEA processes had been giving to the integration of the ES concept in municipal spatial plans of the region. Responses to the same question but related to the municipality in which participants worked were more distributed, still with 12 participants that did not know how to rate it.

Either provisioning or regulating services were the main ES identified as the most relevant in LMA, individually through the pre-workshop questionnaire and considering ES supply (regardless of planning goals). Water was a very relevant provisioning ES and mediation of flows, together with climate regulation were very relevant regulating ES (Table A.3.8, Appendix 3).

‘Water consumption’ was the driver that most groups (5 out of 6) identified as bearing potentially greater effects on ES. Three groups, all from local authorities, identified ‘expansion of urban green space’ also as an important driver (with potential positive effects on ES). Water consumption and urban green space are related to the demand of essential ES in urban contexts and there are evidences that current demand could be substantially optimized for an enhanced human wellbeing, at least in Europe (Rodríguez-Rodríguez et al., 2015). Urban green space also fits within the concept of green infrastructure, which is

considered to play a major role in ES provision (Maes et al., 2015), as recognized by the EU-wide strategy on Green Infrastructure (European Commission, 2013b). Drivers selected by two groups include 'urbanization of coastal, estuarine and fluvial margins', 'territorial fragmentation', 'total energy consumption' and 'passenger transport in own transportation'. In these cases, the two groups were either a local authority and the national authority or a local authority and academics.

With the exception of ES 'hydrological cycle and water flow maintenance', there was no convergence in the ES identified as most relevant by each group (Table A.3.9, Appendix 3). However, the final voting by all participants of the results of each group and of the pre-workshop questionnaire clearly converged on the services of superficial and ground water for drinking (with groundwater gathering more votes), followed by mediation of liquid flows (Table A.3.10, Appendix 3). The ES class 'hydrological cycle and water flow maintenance' (included in ES group mediation of liquid flows) was actually the only item to get votes from all types of stakeholder, which is coherent with the previous results of each working group. These results stress the important role of water as an issue for the management of ES in the region. They are also consistent with the most relevant driver identified by most of the groups. The CICES division 'Maintenance of physical, chemical, biological conditions', especially focusing on the group 'Atmospheric composition and climate regulation' and the class 'Global climate regulation by reduction of greenhouse gas concentrations' also concentrated many votes.

4.4.3 Integrated analysis

The regional ES considered more relevant by the focus group and by participants of the workshop, considering the existing features of the region regardless of planning goals, showed high similarity. In both cases, services related with 'water', 'mediation of flows' and 'maintenance of atmospheric composition and climate regulation' were considered important. This shows an agreement at general level on the main ES provided in the region, which was not necessarily expected at start, given the different interests and influences of the stakeholder groups (see Section 4.3.2, see also García-Nieto et al., 2015). Still there were more subtle differences. Regarding water, the regional planning authority focused more on groundwater and workshop participants on surface water. Within the ES group 'atmospheric composition and climate regulation', workshop participants included the 'global climate regulation by reduction of

greenhouse gas concentrations' as an important ES class, while the regional planning authority focused on the 'micro and regional climate regulation'. Additionally, the regional planning authority identified 'intellectual and representative interactions' (related to cultural heritage and entertainment) as important cultural ES in the region, whereas workshop participants did not include any cultural ES in the most important ones. As pointed out by Chan et al. (2012), cultural ES have been under-represented in existing ES efforts, mainly due to the focus on economic valuation and the fact that some ES are especially difficult and contentious to value in monetary terms. Also 'cultivated crops' was consensually considered important by participants from the regional planning authority but was not identified by workshop participants. These results show a higher preference for provisioning and regulating services than for cultural services, which is aligned with the preferences of human societies for ES according to Rodríguez et al. (2006). Figure 4.5 illustrates the different priorities of each stakeholder group, which can be best identified through the results of the first focus group meeting with the regional authority and of the working groups in the participatory workshop (detailed results in Appendix 3). It was also possible to identify the ES deemed to have higher priority both by focus group and workshop participants, as well as the associated planning objectives or drivers that participants highlighted (Table 4.1).

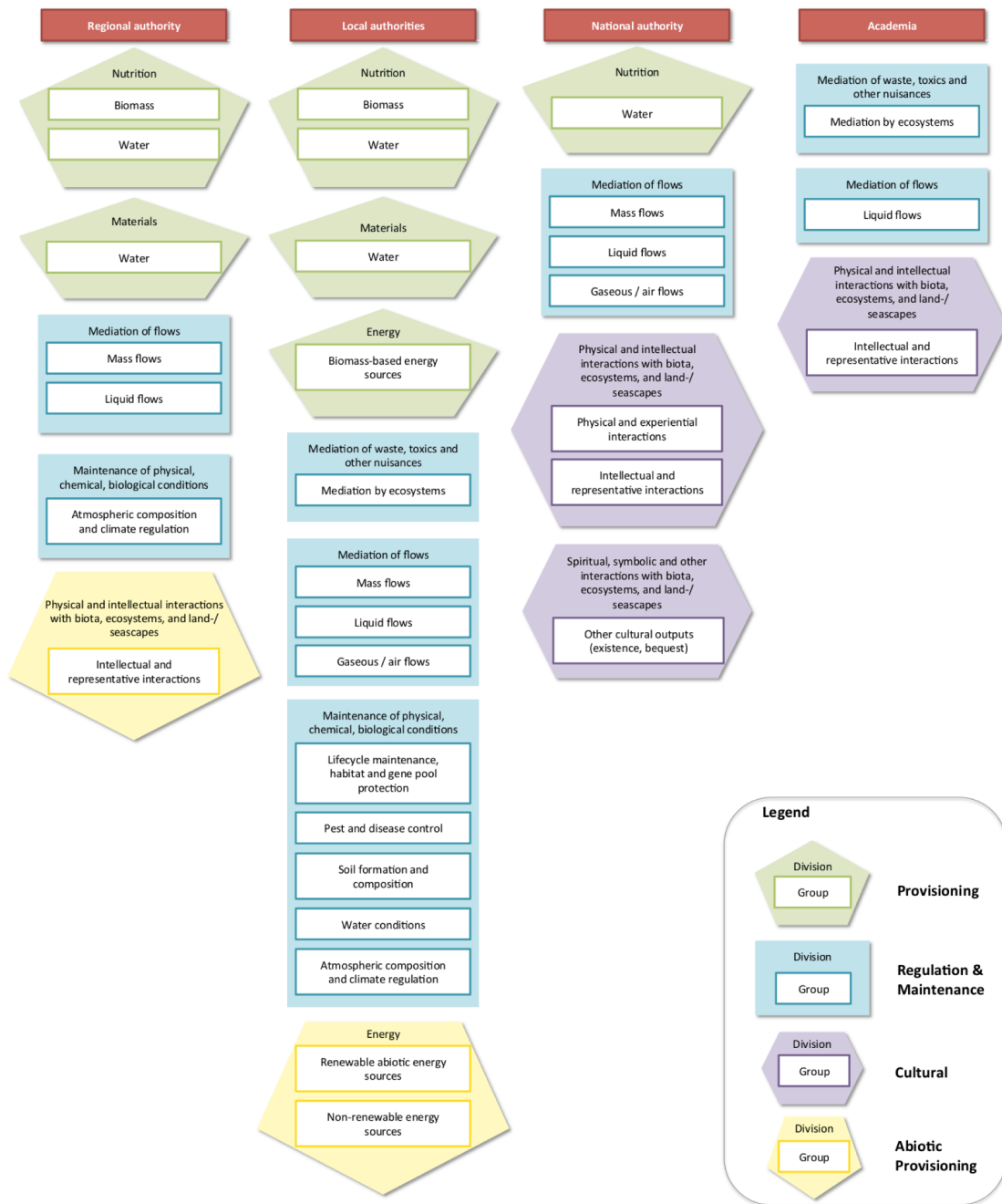


Figure 4.5 – Most important ES for each stakeholder group, referring to results from the first focus group meeting with the regional authority and from the working groups in the participatory workshop. CICES levels of Section, Division and Group are shown.

Table 4.1 – Relationships between priority ecosystem services, planning objectives and drivers.

Ecosystem service	Planning objectives (P) / Drivers (D)	Effect
Water provisioning	(P) To ensure the quality of the Tejo/Sado aquifer	+
	(P) To preserve water quality and improve supply efficiency	+
	(P) To improve efficiency in water consumption	+
	(D) Water consumption	-
Mediation of flows	(P) To diminish pressure on maritime and estuarine margins	+
	(P) To reduce population exposure to natural, technological and environmental risks	+
	(P) Environmental reclaiming of contaminated soils	+
	(D) Urbanization of coastal, estuarine and fluvial margins	-
Maintenance of atmospheric composition and climate regulation	(P) To improve the articulation of policies, planning and management of mobility	+
	(P) To support intra-regional mobility	+
	(P) To increase collective use and green spaces	+
	(P) To preserve soils with more agricultural and forest value	+
	(P) To reduce emission of atmospheric pollutants	+
	(P) To increase energy efficiency of transport	+
	(P) To integrate soft modes in trips	+
	(D) Expansion of urban green space	+

Observation of, and feedback from participants, especially in the workshop, pointed to difficulties in working with the CICES table, since it can be too technical. As stressed by Maes et al. (2013b) and Koschke et al. (2014), each classification has its own advantages and disadvantages due to the specific context within which they were developed, so there is no ES classification system that is totally consistent and can be commonly applied, revealing the distinct need for refinements in practical applications. For the context of this research it can be argued that the use of ES classification systems that are not so technical as CICES could facilitate the participatory process. An example could be the MA classification system, although in a study by Koschke et al. (2012), ES based on the MA were not fully understood by regional planning actors and had to be adapted. This issue will be even more crucial for processes involving other types of stakeholders, for example not working with environmental issues or with lower education levels than the ones who participated in this research. On the other hand, the CICES table allows flexibility in the sense that stakeholders can refer to very specific ES (at the class level) or to more general ES. This can potentially provide a good common basis for participation by stakeholders holding different types and levels of knowledge. However, it increases the complexity of data analysis. On a more abstract level, observation of and feedback from participants suggest that the ES concept, which was explicitly explained to stakeholders before the participatory exercises, was mostly accepted and understood, similar to the findings by Koschke et al. (2014), although as they stress, understanding of the concept also varies between stakeholder groups and educational level.

In this research the participatory approach was tested mainly for demonstration and exploratory purposes. The choice of a more restricted group of stakeholder types for participation also took into account that stakeholders are included when there are good and prudent reasons to do so, but not when their involvement is impractical, unnecessary or imprudent (Bryson, 2004). Still, it showed differences according to stakeholder groups (e.g. regarding the importance given to cultural ES) and can be useful to identify stakeholders' interests related with ES. These results contrast with findings from a similar study by Cárcamo et al. (2014), who observed few significant differences among different stakeholder groups when prioritizing ES and associated threats. We acknowledge that involving different people or types of stakeholders in the process could yield different results, with other ES being selected or not being possible to clearly identify preferences of certain ES over others (see Hauck et al., 2013a). For example, the results of this research represent a group of people with higher educational level and therefore do not reflect the views and opin-

ions of people with other educational levels. Although the participatory approach can limit manipulation of the public process by single-interest groups, it cannot eliminate that possibility without careful attention to the composition of the participant group and strong public engagement in the process, as Granek et al. (2010) stress. Therefore an implementation of the approach in a real planning context would benefit from a broader representativeness of the stakeholders involved. This is in line with Chan et al. (2012) who recommend an approach of iteratively involving local experts and then other stakeholders while gradually defining the study on the basis of researcher and stakeholder needs or limitations. The stakeholder analysis for this can be conducted with the active participation of the stakeholders themselves (Reed et al., 2009). The goal however would not be statistical representation considering that, in a frame of deliberative democratic theory, citizens are viewed as deeply embedded in society, hence the approach does not require (and is in most cases not suitable for) statistical representation (Lienhoop et al., 2015). A related topic in need of further research is the potential weighting of stakeholder responses to deal with sample representativeness and non-response bias of participatory processes (Brown et al., 2015).

On the other hand, results of such a participatory process will benefit from a cross-analysis of the contents of the spatial plan and the specific features of the region under study. This is in agreement with Menzel and Teng (2010) who recommend that first stakeholders are asked to identify important ES and then that information is merged with biophysical data, as the basis for identification of ES. But it goes one step further by including also the dispositions of spatial plans so that results are relevant for the planning context. It should be noted that gaps and tensions between subjective stakeholder information and more objective information can occur (see Aretano et al., 2013; Castro et al., 2014; Faehnle et al., 2014; Fitzsimons et al., 2012). Regional planners are faced with the challenge to integrate and institutionalize the consideration of social values together with more traditional biophysical and economic information in planning (Bryan et al., 2010; Ryan, 2011). The interplay between those different types of information constitutes a topic in need of further research, especially in a planning context.

The approach developed in this research has several benefits. It allows deciding which features (ES) to focus on in resource management, which according to Weber and Ringold (2015) is a significant accomplishment given the numerous possibilities. The transdisciplinary nature of the approach also helped improve the knowledge on the research needs of different stakeholders from

the LMA, namely in identifying ES that research can primarily target. In any given ES assessment, the approach helps framing appropriate scientific questions, improve the quality of analytical outputs and increase the likelihood that results are salient and accessible to stakeholders and policymakers (Rosenthal et al., 2014). Other benefits included increasing stakeholders' awareness and drawing upon the insights and expertise of different actors, which are tangible benefits identified by Podestá et al. (2013) from a collaborative research perspective.

Deliberative methods are usually faced with problems, for example of representativeness or communication (see Spash, 2007). Time was a limiting factor for the quality of the results of this research. Having more time available seems to be a major asset to deal with the challenges of stakeholder engagement in ES studies, which have more to do with such practical aspects than with ES related ones (Koschke et al., 2014). To expand the lessons one can take from the participatory approach, further work could be developed to collect feedback from participants on the participatory process itself in a structured way. As Koschke et al. (2014) stress, this should be a focal aspect in ES studies to better assess their success. For that matter, another exercise could be comparing the results of the participatory process with monitoring data on how plan implementation and regional ES are developing over time.

Table 4.2 summarizes the main strengths and weaknesses of the approach, previously discussed. The approach presented here can be adapted for application in different natural resource management and planning contexts (not only spatial planning), whenever ES have to be considered in decision making. This is provided that minimum governance conditions exist, like freedom of speech. Acknowledging that context plays a major role, to apply the approach generically it is important to be able to: (i) identify different viewpoints and perceptions on the situation at stake; (ii) identify different interests and influence power, as well as power relations of and between stakeholders (see Figure 4.3); (iii) identify the links with relevant policies or plans and processes of making them; (iv) assess features that influence the suitability of participatory techniques and ways of applying them (e.g. self-completion questionnaire versus face to face interview according to stakeholders' literacy levels). In Europe, there are several common values and views, or even guidelines for given policies (e.g. environmental), that are shared by the different countries. Many initiatives have contributed and still contribute to this (e.g. the INTERREG program). In this sense, the European context is probably one good case where more similar conditions exist to apply the approach. However, many other initiatives

aiming at promoting sustainability and enhancing governance take place worldwide (e.g. nrg4SD – Network of Regional Governments for Sustainable Development or ICLEI – Local Governments for Sustainability). Such initiatives show that it is possible to pursue common goals or to use similar approaches in very different contexts, including developed and developing countries. Incorporating general best practice guidelines for stakeholder participation (see for example Reed, 2008) can support a successful application of the approach presented in this article in other contexts, thereby fostering cross-contextual and cross-cultural learning.

Table 4.2 – Main strengths and weaknesses of the participatory approach explored in this research.

Strengths	Weaknesses
<ul style="list-style-type: none"> - Combination of participatory techniques - Link to drivers of change and planning/conservation goals - ES concept explicitly explained by research team and a common understanding accepted by all stakeholders - Use of a flexible ES classification (CICES) 	<ul style="list-style-type: none"> - Limited number of stakeholder types/responsibilities - Lack of experience of the involved stakeholders in dealing with the ES concept complexities - Lack of previous experiences/cases that could be used as a starting point - Technical complexity of CICES (for stakeholder participation and for data analysis) - Feedback on the process itself not collected in structured way

4.5 Conclusions

ES are usually selected based on availability of data, relevance to a study area, interests of the team conducting the assessment, or abundance of information in other ES assessments. A selection of ES driven by decision-making needs and especially by stakeholders’ opinions, perceptions, values and needs is much scarcer.

In this research, a participatory approach was developed and explored to identify priority ES in a spatial planning context of the Lisbon Metropolitan Area. The approach allows working with stakeholders holding different levels of knowledge on the spatial plan and on ES. This was mainly achieved by using

different stakeholder engagement techniques, by translating the plan's dispositions into drivers of potential ES change and by using the CICES classification system as a support to engage in a dialogue with stakeholders. The approach can be used as a guiding framework for stakeholder engagement in ES-focused planning processes. It can also be used for a scoping process, within a SEA, or for an initial/rapid ES assessment, where the goal could be to conduct a 'quick and dirty' assessment that can be further expanded. Nevertheless, this might not always be the goal, so it depends on the scope and goals of any given process or initiative. Through the approach one can identify potential mismatches between which ES are considered more important and which ES will likely be more affected by spatial plans (according to stakeholders). This information can support the definition of planning priorities.

Although the approach was tested mainly for demonstration and exploratory purposes, it was possible to identify differences in ES prioritization across different stakeholder groups, while at the same time identifying a group of regional ES that the majority of participants considered as priority. Water provisioning, mediation of flows and maintenance of atmospheric composition and climate regulation were the ES considered to have higher priority. For participants from the regional planning authority, intellectual and representative interactions related to cultural heritage and entertainment, as well as cultivated crops were also important ES in the region. It was also possible to establish links between planning goals/drivers and possible effects on regional ES, highlighting the potential of the approach to be used in a spatial planning process. Additionally, a series of advantages and drawbacks of the approach were identified. For a practical implementation of the approach in a real planning context, it is recommended that a broad range of types of stakeholders are involved, representing the different values, interests, opinions and perceptions in relation with ES in a given territory. It is also recommended that the outcomes of the participatory approach are complemented with an analysis of the spatial plans themselves (or existing planning proposals) and of biophysical features of the planning area, to support a more informed selection of ES. Adequate resources should be in place to implement these recommendations. Further research is needed on the way information from these different sources can be combined to inform planning. Another related research challenge is to identify which participatory techniques (e.g. participatory mapping) work best, considering for example the needs of different kinds of stakeholders or the planning stages, as well as how to integrate the resulting data.

Participatory processes are context-specific, particularly in spatial planning. Therefore it is not linear to define approaches or conceptual frameworks that will work everywhere and in different planning contexts. However, it is possible to draw lessons from a case-specific empirical experience that can help in other situations and can build-up a sufficient body of evidence to advance the development of such approaches and conceptual frameworks. This research attempted to provide such a contribution.



Pathways of demographic and urban development and their effects on land take and ecosystem services: The case of Lisbon Metropolitan Area, Portugal⁹

Abstract

Land use and land cover (LULC) changes, particularly land take by urbanization, can jeopardize ecosystems and their capacity to provide humans with numerous benefits, known as ecosystem services (ES). A better understanding of the connections between land take, changes in complex LULC patterns and ES is still needed, especially forward-looking analyses that can support spatial planning, in face of targets like “no net land take” as set in Europe. The aim of this research is to explore how different scenarios of demographic and urban development patterns translate into land take and what are the consequences for ES supply. Using the Lisbon Metropolitan Area (LMA) in Portugal as case study, four contrasting scenarios for 2030 were developed, covering major determinants of land take (with a focus on residential development) and priority ES for the LMA, dealing with climate regulation, recreation and food production. Our findings suggest that the effects of urban development on land take

⁹ Mascarenhas, A., Haase, D., Ramos, T.B., Santos, R. Pathways of demographic and urban development and their effects on land take and ecosystem services: The case of Lisbon Metropolitan Area, Portugal (submitted).

are positive for a “compact city” and negative for an “urban sprawl” pattern, even for opposite demographic developments. However, each pattern can have both positive and negative effects on ES supply. We discuss the findings’ implications for debates around the “compact city” ideal. We argue that the way land take is defined, together with the features of the LULC data used, has an impact on this kind of assessments. For further research, we suggest exploring the approach with different stakeholders to gather their insights, adopting more extreme scenario assumptions.

5.1 Introduction

Human activities are transforming the terrestrial environment at unparalleled rates and scales, with the conversion of land to urban uses being one of the most irreversible human impacts on the global biosphere (Seto et al., 2011). These changes can undermine ecosystems’ capacity to provide people with benefits – known as ecosystem services (MA, 2005a) – like sustaining food production, maintaining freshwater and forest resources, regulating climate and air quality, or ameliorating infectious diseases (Foley et al., 2005). With worldwide population and urban areas growing, future urbanization is unprecedented (Ahern et al., 2014).

The concept of land take underlies such global challenges (Valerio et al., 2015). It can be defined generally as the loss of undeveloped land to human-developed land, or more specifically as the loss of agricultural, forest and other semi-natural and natural land to urban and other artificial land development (UWE Bristol, 2016), similarly to the definition of land consumption (Nuisl and Siedentop, 2013). This includes areas sealed by construction and urban infrastructure, as well as urban green areas and sports and leisure facilities (EEA and JRC, 2006). Urban land expansion is generally growing at faster rates than urban population, suggesting that urban growth is becoming more dispersed than compact (Decoville and Schneider, 2015; Seto et al., 2011). Hence, a much faster relative increase in land take than that of demographic growth has been observed in different regions of the world, like in Europe (BIO by Deloitte, 2014; Decoville and Schneider, 2015) where land take can even occur under declining population (Haase et al., 2013; Kasanko et al., 2006). These mismatches have been associated with decreasing household size and increasing residential land take per capita (Haase et al., 2013; UWE Bristol, 2016). However, forecasting future land take remains a scientific challenge, since there is no grand theory of

urban development, from which an explanatory model of land consumption can be deduced (Nuissl and Siedentop, 2013).

At the same time, the interactions between urban development patterns and ecosystem dynamics, are still poorly understood (Alberti, 2005; Gómez-Baggethun et al., 2013). This has motivated research linking ES with “urbanization” or “land consumption”, terms often used to express the same phenomenon as land take. Different urban development patterns have been found to carry different consequences for ES supply and demand in Britain (Eigenbrod et al., 2011). However, a cross-analysis of four European cities found no uniform urban spatial pattern of ES provisioning that can serve as a generic model for cities (Larondelle and Haase, 2013). Future scenarios implying less soil sealing for the Stockholm metropolitan area were associated with higher supply of some, but not all ES, with inconclusive results for others (Kain et al., 2016). The impact of land take on ES can vary depending not only on the magnitude of land take, but also on the type of areas taken (Sallustio et al., 2015). Considerable gaps still need to be addressed to better understand the connections between land take, changes in complex LULC patterns and ES, especially forward-looking analyses that can support spatial planning (Kain et al., 2016).

The aim of this research is to explore how different scenarios of demographic and urban development patterns translate into land take and what are the consequences for ES supply. The Lisbon Metropolitan Area (LMA) in Portugal, southwestern Europe, is used as case study to support the analysis conducted (Section 5.2.1). Through a newly designed methodological approach covering major determinants of land take and priority ES for the LMA (Section 5.2.2), we show the consequences of each scenario for land take and ES supply (Section 5.3). The implications of our findings, strengths and limitations of the approach, as well as recommendations for further research, are discussed in Section 5.4. Main findings, summarized in Section 5.5, underline the positive effects that a “compact city” pattern of urban development can have on land take, in contrast with the negative effects of an “urban sprawl” pattern, even for opposite demographic developments. However, each urban development pattern can have both positive and negative effects on ES supply.

5.2 Methods

5.2.1 Study area – Lisbon Metropolitan Area

The LMA is located in Portugal (Figure 5.1), integrated in the overarching policy framework of the European Union (EU), which has the policy goal of: "By 2020, EU policies take into account their direct and indirect impact on land use in the EU and globally, and the rate of land take is on track with an aim to achieve no net land take by 2050" (European Commission, 2011c). The term "net land take" remains, however, a relatively new concept at EU level, emerging in the context of the "no net loss" approach advocated by the EU Biodiversity Strategy to 2020 (BIO by Deloitte, 2014). Six countries of the EU have already set quantitative objectives for limiting land take, but in very different ways (Decoville and Schneider, 2015) illustrating the challenges of putting the land take concept into practice. An overall land take target also needs regionally specific policy options for dealing with demographic and land use change (UWE Bristol, 2016). Additionally, it has been suggested to complement the net land take indicator in order to aim at no net loss of ecosystem services (ES) due to land take by 2050 (BIO by Deloitte, 2014). Hence this is a complex policy issue demanding more evidence to support spatial planning. The LMA provides a relevant case study considering that a) in Europe most coastal regions and almost all large urban agglomerations are affected by soil sealing, and b) the Portuguese coast is among the very few regions in Europe affected by both rapid land take and high sealing rates (Prokop et al., 2011), which has higher potential to compromise ES supply.

The LMA has an area of 3,015 km², a maximum length of 73 km North-South and 88 km East-West, with a coastline stretching 320 km and the maximum altitude reaching 528 m (INE, 2016a). It encompasses 18 municipalities including the country's capital Lisbon and is the third largest urban region in the Iberian Peninsula, after Madrid and Barcelona. Although representing ca. 3% of the total area of Portugal, it hosts over a fourth of the country's population (about 2.8 million inhabitants) and it concentrates 40% of the national GDP (Campo, 2009). The LULC of the LMA (Figure 5.1) reveals a mosaic of urban areas (mainly concentrated around the Tagus estuary and the city of Lisbon), agricultural, as well as natural and semi-natural areas. About 15% of the region is covered by areas protected for nature conservation, which are the main components of a Metropolitan Ecological Network (MEN), established by the regional spatial plan (CCDR-LVT, 2004).

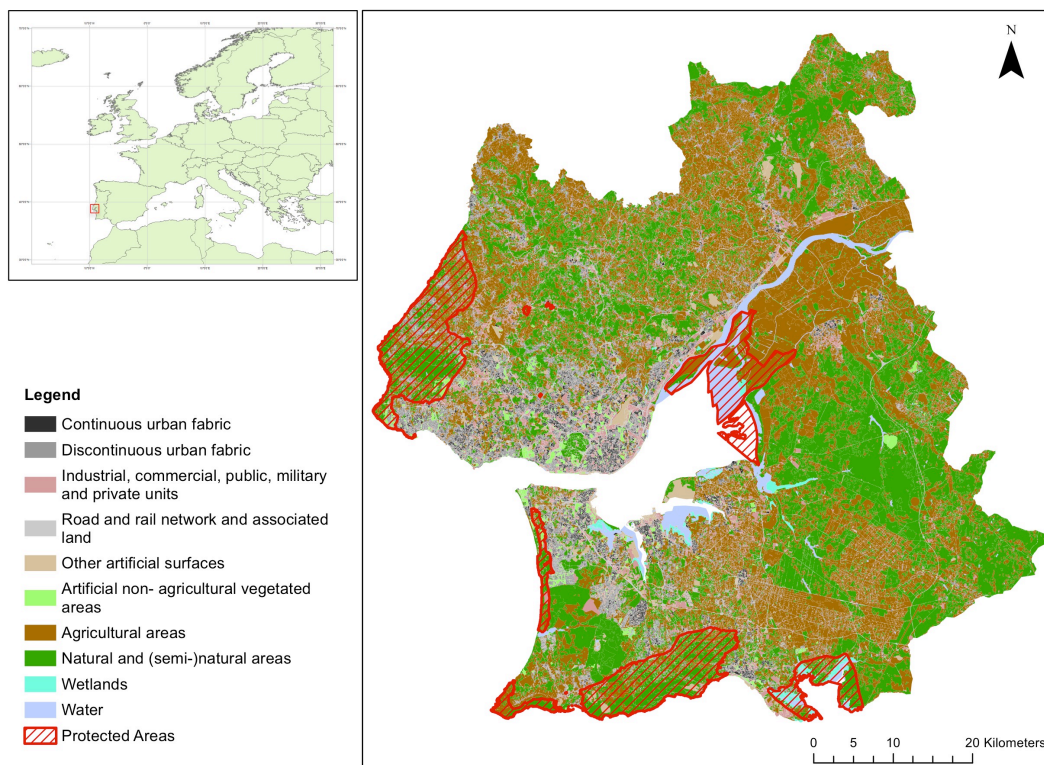


Figure 5.1 – Lisbon Metropolitan Area’s location in the European context, land use / land cover in 2012 and nature conservation areas (Sources: Natural Earth; Urban Atlas; ICNF).

Over the last four decades the LMA transitioned from a radial concentric metropolis (1960s-1980s), with Lisbon as major employment centre, to a poly-centric metropolis (1990s-2000s) characterized by the fragmentation of its economic, urban, natural and social dimensions. Urban sprawl has taken place in association with transportation infrastructure development (Campo, 2009). The region has been undergoing a suburbanization process and households have been growing at considerably higher rates than population, with associated growth in the number of empty houses. In the last few decades, housing policies in Portugal have pulled away investment in rehabilitation of older buildings (IHRU, 2015). While population growth can be a strong predictor of land-use evolution (Padeiro, 2016), social and demographic changes and recent economic dynamics are believed to be changing the patterns of housing demand and families’ residential strategies, for example decreasing average household size and home ownership (Pinto, 2012). A considerable amount of urban development has been achieved in transgression of municipal spatial plans, often inside protected areas (Padeiro, 2016). These plans are the ones with direct influ-

ence on urban development, but they should follow strategic guidelines laid down by regional spatial plans. The LMA might also be the only Portuguese region with decreasing forest area in the future (Santos et al., 2015).

The demographic and urban development observed in the region, as well as the variety of LULC, ranging from major urban areas to natural areas worthy of conservation status, reveal the relevance of land take and ES for regional planning in the LMA.

5.2.2 Methodological approach

To answer the exploratory question of how could land take occur in the future and what are the consequences for ES supply, scenarios were developed, structured around two axes of uncertainty, reflecting possible demographic and urban pattern development pathways (Figure 5.2). This is the most commonly used method for the construction of scenario logics in environmental change assessment (Rounsevell and Metzger, 2010). One axis represents a continuum between population decline and population growth, while the other axis represents a continuum between a sprawled and a compact pattern of urban development. These axes were chosen since: (i) land use change is strongly driven by population growth and urbanization processes, which result in increasing demand for natural resources, as well as space for housing and economic activities (Lauf et al., 2016); (ii) regional planning guidelines for the LMA aim at tackling urban sprawl while attracting residents; (iii) stakeholders consider urban regeneration, as opposed to new urban developments on non-urban land, a highly relevant planning goal (Mascarenhas et al., 2016). A time horizon until 2030 was adopted, coincident with the 2030 Agenda for Sustainable Development, with which the New Urban Agenda (HABITAT III, 2016) is closely aligned.

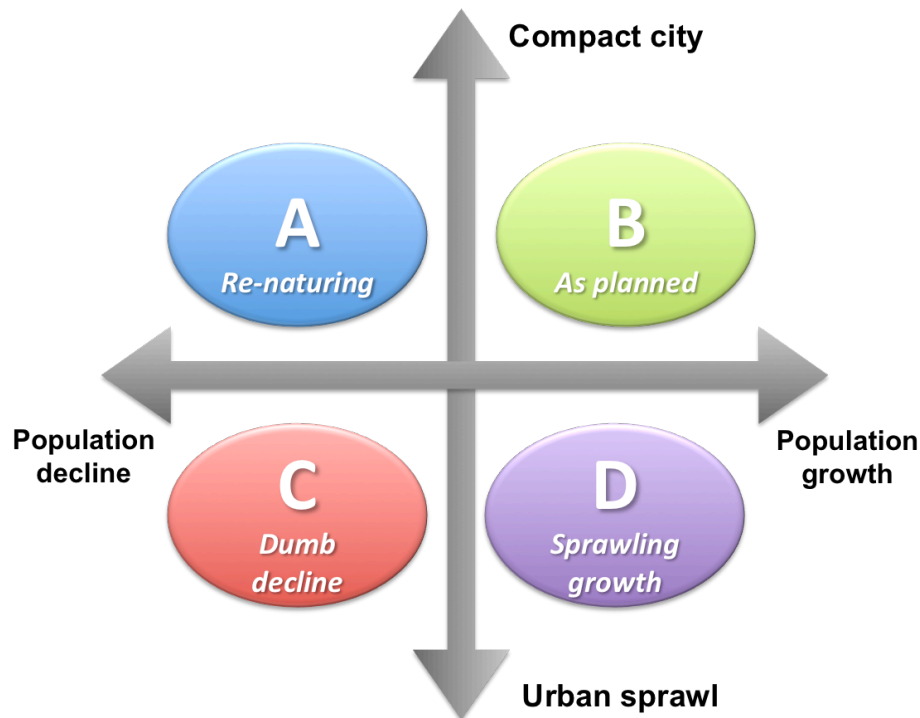


Figure 5.2 – Scenario matrix structured around two axes of uncertainty reflecting possible demographic and urban pattern development pathways.

For each quadrant in Figure 5.2 a storyline (Rounsevell and Metzger, 2010) was developed (Appendix 4) and translated into quantitative assumptions. A set of determinants commonly used to explain land use change (Nuissl and Siedentop, 2013) was considered (Table 5.1). Future population change was estimated through simple forecasts for 2030, by adjusting a regression model to decadal census data from 1960 to 2011. The observed trend (increasing population) was assumed for scenarios B and D; the opposite was assumed for scenarios A and C. No limit was imposed for population change. For LULC changes the focus was on artificial areas, taking residential development as main driver of change, together with household features, which are crucial for assessing future land consumption in urban areas (Haase et al., 2013). Urban Atlas 2012 (European Commission, 2016) for the functional urban areas of Lisbon and Setúbal (together making up the LMA) was used as baseline spatial dataset. In scenarios A and B, housing supply is demand-dependent, being a function of the change in population and household features. In scenario C, housing supply is demand-independent assuming a reduction in household size, increasing floor space area and real estate speculation. In scenario D, housing supply is partially demand-dependent, combining the other scenarios' assumptions. Changes in artificial areas dependent on population change were calculated as:

$$\Delta A = \Delta P \times HS^{-1} \times FS \times F^{-1} \times (1 - R) \times \alpha$$

Equation 1

Where:

ΔA – Change in artificial areas

ΔP – Change in population

HS – Household size

FS – Floor-space area

F – Number of floors

R – Rehabilitation rate

α – Empirical factor

Values for household size (HS) and average floor-space area (FS) were derived from observed values in 2011 or in the previous two decades, depending on the scenario. The number of floors per building (F) was kept constant as in 2011 for the sake of results' interpretation. For rehabilitation rate (R) – the proportion of rehabilitated relative to new dwellings – the 33% target for 2031 set out by the Portuguese Housing Strategy (IHRU, 2015) was assumed. Given that other urban land uses (e.g. commercial units) change along with residential areas (Kasanko et al., 2006), an empirical factor (α) was derived from the LMA-specific relationship between the Urban Atlas class “urban fabric” and the remaining artificial areas.

Table 5.1 – Description / quantification of scenario assumptions.

Determinants [units]	Scenario A "Re-naturing"	Scenario B "As planned"	Scenario C "Dumb decline"	Scenario D "Sprawling growth"
Aspatial				
Population change (ΔP) [%; inhabitants]	-7.5% (-211,534)	+7.5% (+211,534)	-7.5% (-211,534)	+7.5% (+211,534)
Housing supply [%]	Demand-dependent		Demand-independent (+6% per decade ¹)	Partially demand-dependent (+6% per decade + new demand)
Average household size (HS) [inhabitants/household]	3		Not applicable	2
Average floor-space area (FS) [m ²]	96.33		107.4	
Average floors per building (F) [floors]	2.46			
Rehabilitation (R) [dimensionless]	Not applicable	0.33	0	
Empirical factor (α) [dimensionless]	1.5			
Spatial				
Distance to main roads [m]	No effect		Changes allowed in 500 m buffer	
Distance to already existing urban areas [km]	Re-naturing outside 2 km buffer has 2 nd highest priority	New artificial surfaces allowed in 2 km buffer		No effect
Land use regulations	Re-naturing in MEN has highest priority	No new artificial surfaces allowed in MEN		New artificial surfaces allowed in MEN

Table 5.1 (continued).

Determinants [units]	Scenario A "Re-naturing"	Scenario B "As planned"	Scenario C "Dumb decline"	Scenario D "Sprawling growth"
Conversion rules	Re-naturing (conversion to "Forest") occurs preferably: 1 st in "Land without current use" 2 nd in "Discontinuous urban fabric" with increasing sealing rate	New artificial surfaces are built on existing "Discontinuous urban fabric" by conversion to "Continuous urban fabric (S.L. > 80%)" with decreasing sealing rate preference	New artificial surfaces take the form of "Discontinuous medium density urban fabric (S.L. 30% - 50%)"	

¹ Extrapolation of past four decades' trend.

For distance to main roads, the LMA's road network was extracted from Urban Atlas. After testing different distances, a 250-meter buffer was considered to plausibly reflect urban sprawl along roads (covering 99.7% of existing discontinuous urban fabric), while leaving space for land take (covering 90.4% of greenfield areas). A buffer of 2 km was adopted for distance to already existing urban areas, recommended as the horizon of perception, a concept used to analyse urban sprawl (EEA and FOEN, 2016). In scenario A, re-naturing (conversion to forest) in "Land without current use" had the highest preference, reflecting a common rational planning option, as those areas have lower opportunity costs than many others in urban areas (McDonald, 2015). Areas of "discontinuous urban fabric" with increasing sealing rate (S.L.) follow in the conversion rules' hierarchy, translating a "compact city" paradigm where the most dispersed areas are tackled first. Conversely, in scenario B new artificial areas are built on existing "discontinuous urban fabric" with a decreasing sealing rate preference, to maximize densification opportunities. For scenarios C and D, it was assumed that land take would occur through conversion to discontinuous medium density urban fabric.

Observing spatial and conversion rules, the spatial allocation of LULC changes for each scenario followed the technical approach by Larondelle et al.

(2016), which allocates spatial transitions randomly to polygons of given LULC classes, while considering zoning rules, using statistics and GIS software (in this research, Microsoft Excel 2011 and ArcGIS 10.3). Given that whole polygons change, the changed area can be higher than the one calculated in previous steps. For scenarios B, C and D, the average sealing rates of discontinuous urban fabric were taken into consideration when calculating the final areas to be converted (e.g. if average sealing rate for new artificial areas is 40%, the area resulting from Eq. 1 is multiplied by 1.6 to account for the remaining 60% of area needed for land take).

The LULC changes of each scenario were translated into changes in ES potential supply, defined as the ecosystem biophysical capacity to supply services (Bastian et al., 2012). The analysis focused on “maintenance of atmospheric composition and climate regulation” (henceforth “climate regulation”), “physical and experiential interactions” and “cultivated crops”, considered most important for the LMA in a previous participatory exercise (Mascarenhas et al., 2016) and covering regulation, cultural and provisioning ES. We follow the Common International Classification of Ecosystem Services (CICES; Haines-Young and Potschin, 2010a). Proxy indicators to assess ES were developed as it is common in ES studies (Maes et al., 2016).

“Climate regulation” was estimated through:

- Surface emissivity and f -evapotranspiration, calculated according to Schwarz et al. (2011). To derive a case study-specific lookup table, for emissivity CORINE Land Cover 2000 and Landsat 7 ETM+ data (band 6 low gain, spatial resolution of 60 x 60 m, from a scene retrieved on 24 June 2000, within the retrieval period of satellite images to derive CLC 2000), both covering the study area, were used. For f -evapotranspiration, data were used for available water capacity (Ballabio et al., 2016) and age stand (national data for period 1997-1998; European Commission, 1997). A mean value of 0.077 (expressed as volume fraction) for available water capacity and 26 years for age stand were calculated and used as assumptions for the LMA.
- Above-ground carbon storage, based on values from an empirical study carried out by Chaparro and Terradas (2009) for Barcelona, one of the few existing studies of that kind in Europe, with the most similar climate to the LMA – Mediterranean warm temperate with dry summer (Strohbach and Haase, 2012). For LULC classes not

covered by that study, values by Gibbs (2006) were used. Appendix 5 shows the lookup table for the three indicators.

Recreation potential (amount of natural recreational areas and their proximity to urban areas) was used as indicator of “Physical and experiential interactions”. The Urban Atlas classes considered natural recreational areas were “natural and semi-natural areas”, “wetlands” and “water”. “Artificial non-agricultural vegetated areas” (comprising “green urban areas” and “sports and leisure facilities”) were not included (see land take definition in Section 5.1). We assumed that potential recreation provision is inversely proportional to proximity of recreational areas to urban areas (Paracchini et al., 2014), to reflect the negative effect of human pressure. Proximity was assessed through the percentage of artificial areas within a 500-meter buffer around natural recreational areas. The features of the LMA guided the choice of that distance, although it is the same distance used in similar studies and by cities like Berlin or across the Netherlands to set targets on access to urban green space (Kabisch et al., 2016). The amount of artificial areas within protected areas was also analysed, since high potential recreation provision is mostly typical of protected areas (Paracchini et al., 2014).

“Cultivated crops” was assessed through a food production potential indicator: the amount of areas suitable for food production (LULC class “agricultural areas”, comprising “arable land / annual crops”, “permanent crops”, “pastures”, “complex and mixed cultivation” and “orchards”). Agricultural land is an important proxy for mapping food provision (Egoh et al., 2012) and urbanization can imply considerable loss of agricultural areas (Kasanko et al., 2006).

5.3 Results

The main results obtained show the effects of demographic and urban pattern development pathways on land take and ES. They first reveal how demand-dependency of housing supply, household features and urban rehabilitation policies effect changes in residential land area, linked to demographic changes. Although in scenarios A and C population declines by 211,534 inhabitants, scenario A resulted in 276 ha of residential land area no longer needed, while in scenario C, 23 ha of residential land area are needed. Similarly, scenarios B and D assume the same population increase but scenario D requires 300

ha more residential land area than scenario B (Figure 5.3). This is because in scenarios A and B housing supply is strictly dependent on demand, average household size is bigger, average floor space is smaller and some urban rehabilitation takes place to accommodate more inhabitants, while in scenarios C and D housing supply is completely or partially dependent on demand (accounting for example for real estate speculation), average household size is smaller, average floor space is bigger and no urban rehabilitation takes place.

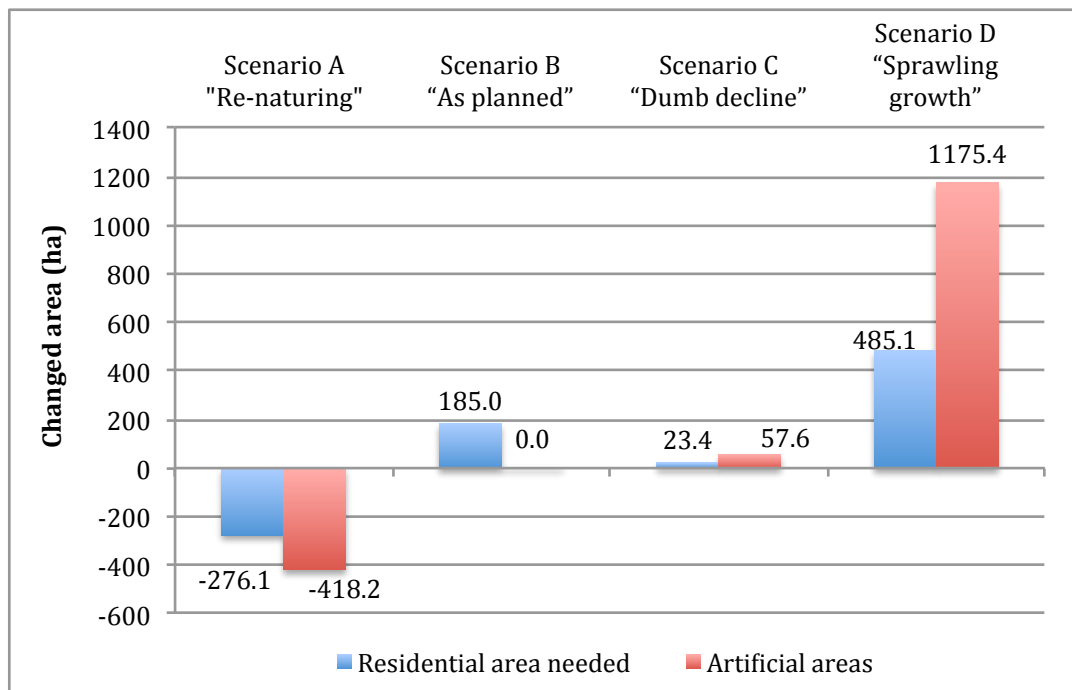


Figure 5.3 – Changes in residential and artificial areas (land take) per scenario, relative to baseline year.

Differences were observed in land take associated with different urban pattern development pathways. For example, in scenario B, although 185 ha of new residential land area were needed, this did not translate into land take, as already existing discontinuous urban fabric was densified to accommodate that need. In contrast, scenario C with considerably less new residential land area needed (23.4 ha), translated into 57.6 ha of land take relative to the baseline year. Results also show which areas are converted (and by how much) within spatial rules for each scenario. In scenario A, all re-naturing can take place in the protected areas and all “land without current use” in 2012 (48.8 ha), as well as about 33% of “discontinuous very low density urban fabric (S.L. < 10%)” (369.4 ha), can be re-natured (Figure 5.4). In scenario B, the 185 ha of new resi-

dential land area needed were met without land take due to densification of 795.6 ha of “discontinuous dense urban fabric (S.L. 50% - 80%)” in a 2 km buffer around already existing urban areas and outside protected areas (Figure 5.5). For scenarios C and D, Figure 5.6 illustrates the land take of agricultural, natural and semi-natural areas in a 500 m buffer around main roads, including in protected areas, clearly higher in scenario D due to growing population.

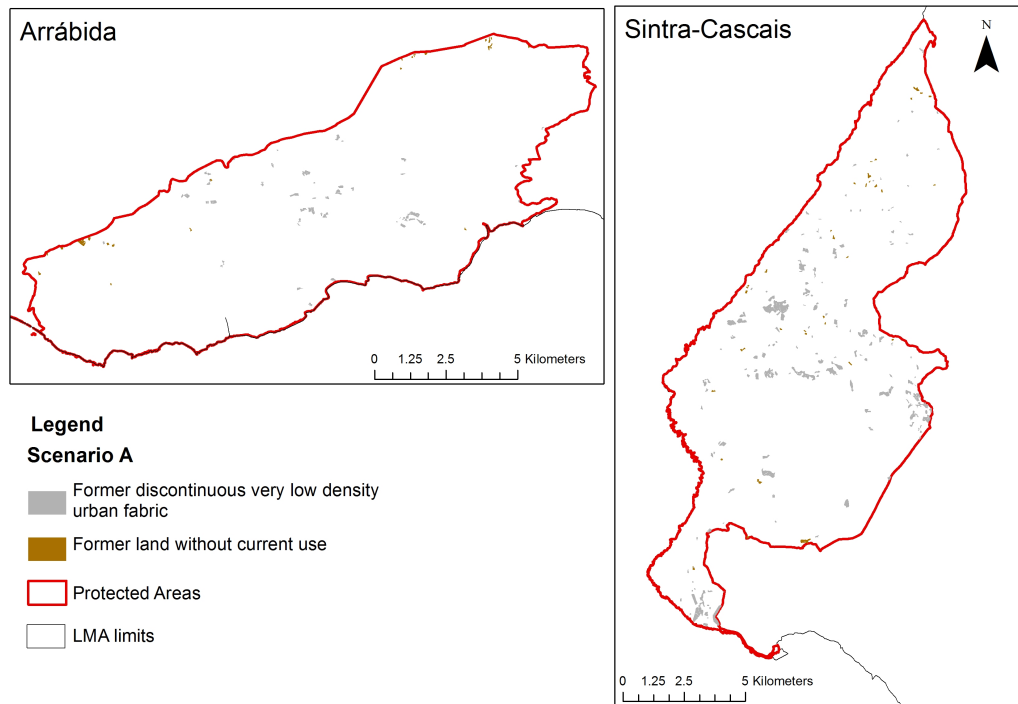


Figure 5.4 – Re-natured areas under Scenario A. Results zoomed-in for two protected areas to enhance visualisation.

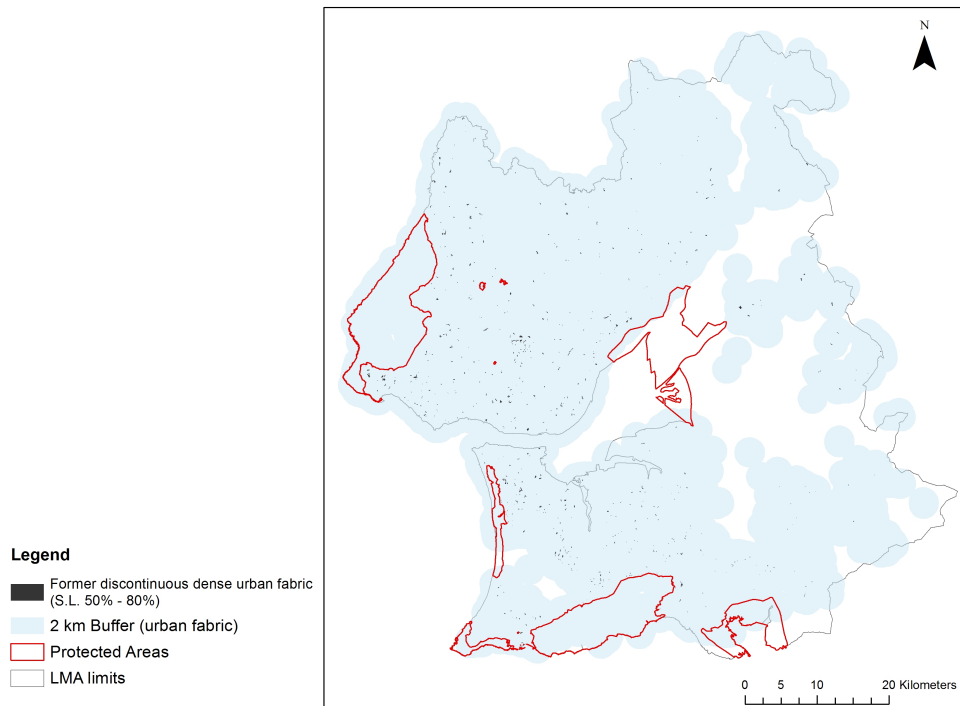


Figure 5.5 – Areas of discontinuous dense urban fabric densified under scenario B (conversion to continuous urban fabric), in a 2 km buffer around already existing urban fabric and outside protected areas.

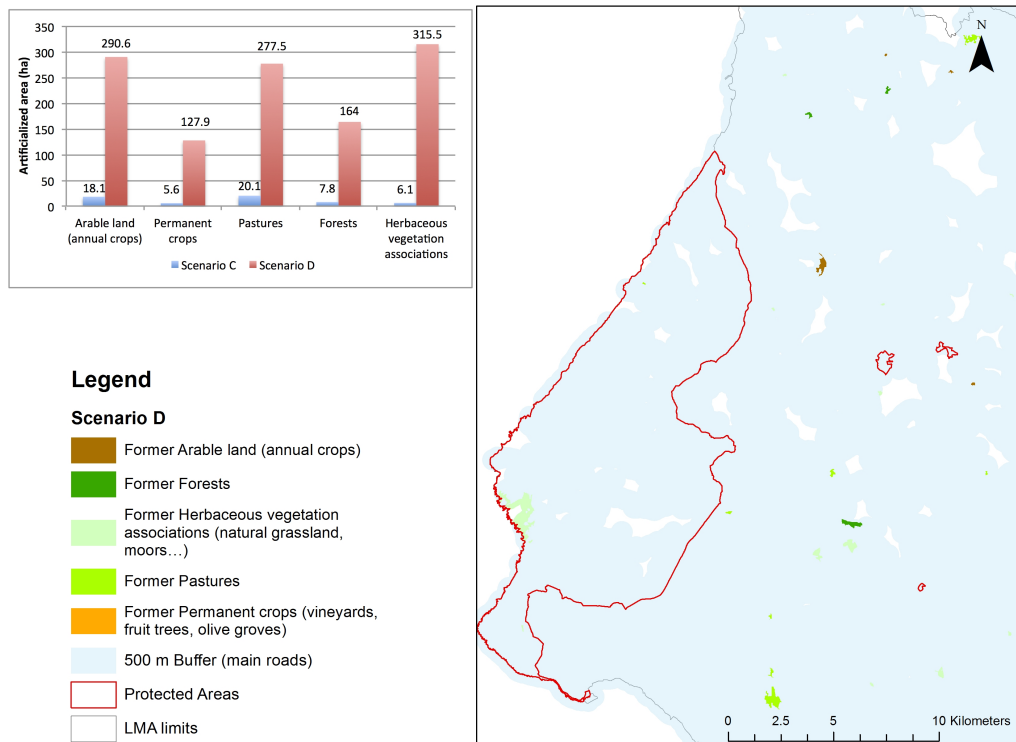


Figure 5.6 – Top left: Classes of agricultural, natural and semi-natural areas artificialized under scenarios C and D. Right: Zoomed-in view of scenario D illustrating how land take occurs in a 500 m buffer around main roads, in- and outside protected areas.

Changes in mean f -evapotranspiration and mean emissivity index (Figure 5.7.A) relative to the baseline observed at regional level for all scenarios were too low to be detected with the significant digits for both indicators. In scenarios A and B, total carbon stored decreased (by 2,635.3 and 7,689.5 Mg, respectively), while in scenarios C and D it increased (by 368 and 6,937.8 Mg, respectively, Figure 5.7.B).

The biggest change in natural recreational areas was a decrease of 479.4 ha in scenario D, while an increase was only observed in scenario A as a consequence of “re-naturing” conversion rules. A decrease of 13.9 ha was estimated for scenario C and no change was observed in scenario B (Figure 5.7.C). On the other hand, scenario A was the one with the biggest increase in percentage of artificial areas in a 500 m buffer of natural recreational areas. A change of 0.1 percentage points for scenario D and no changes for scenarios B and C were observed (Figure 5.7.D). Scenario A was nevertheless the only one with a decrease (418.2 ha) of artificial areas within protected areas, in contrast with scenario D, the only one with an increase (169.6 ha) (Figure 5.7.E).

Changes in the food production potential indicator (agricultural areas) only take place in scenarios C and D due to the conversion rules adopted. In both scenarios there is a loss of agricultural areas, of 696 and 43.7 ha, respectively (Figure 5.7.F).

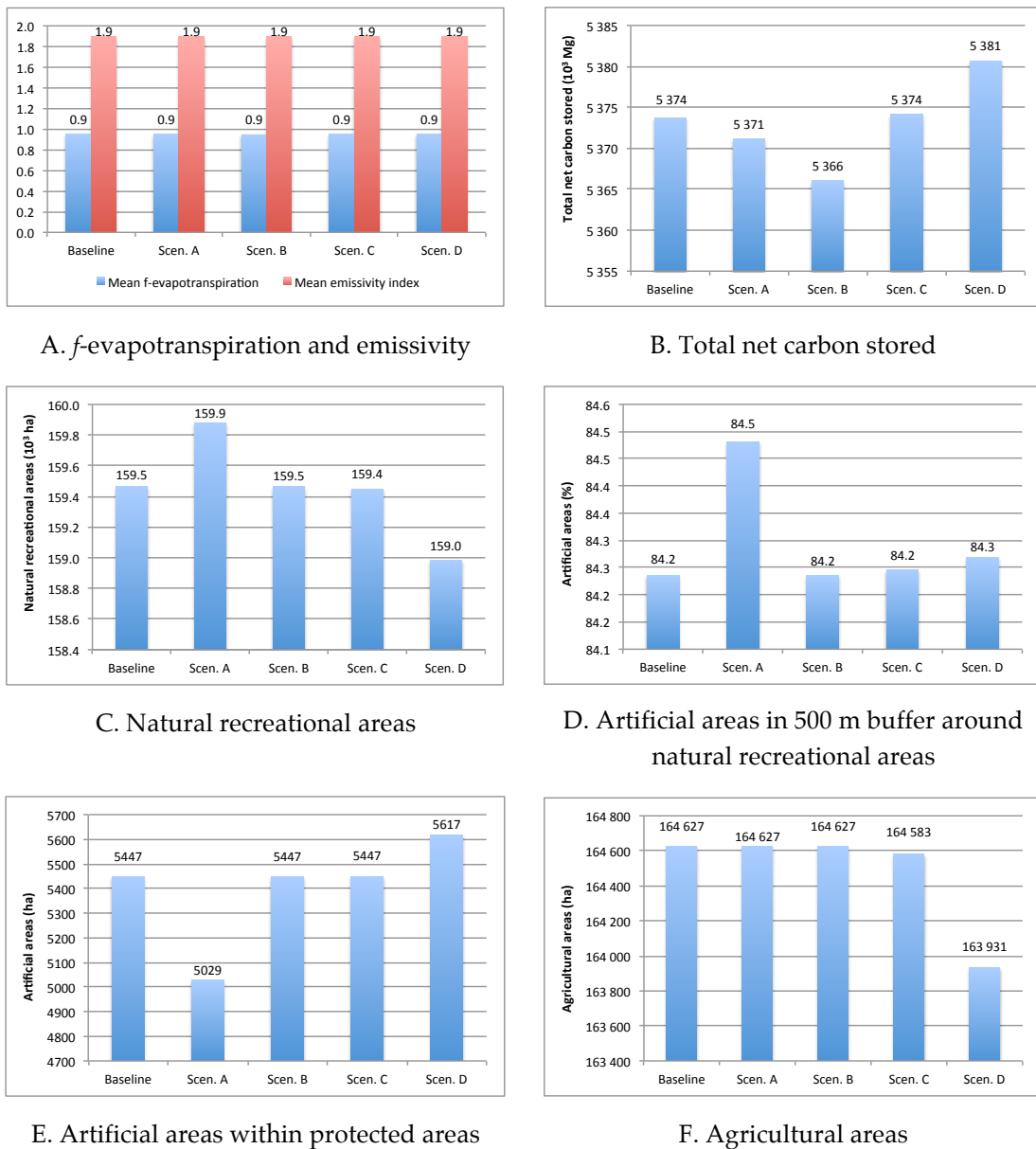


Figure 5.7 – Values of ES indicators for the baseline year 2012 and for each scenario (year 2030).

5.4 Discussion

Our results are aligned with the notion that alternative urban patterns generate differential ecological effects, with consequences on ES (Alberti, 2005). The scenarios can therefore inform discussions on urban growth management, a much-debated subject in the field of urban planning (Valerio et al., 2015)..

The four scenarios show how alternative demographic and urban pattern pathways would perform in relation to a “no net land take” target, as set for

Europe in 2050 (European Commission, 2011c). Similarly to Lavallo et al. (2013) we estimated that, to be on track towards a “no net land take” by 2050, the average annual land take in the LMA by 2030 would be 710 ha (with the average annual land take between 1990 and 2012 using CORINE Land Cover data as baseline). Scenarios A and B would automatically meet a “no net land take” target, since no land take occurs. Scenarios C and D result in considerably lower average annual land take by 2030 (3.2 and 65.3 ha, respectively), meaning that land take would in both cases still be converging with the 2050 target. The land take per day resulting from those scenarios (0.009 and 0.18 ha, respectively) is considerably lower than some national and regional land take targets in Europe (for example 30 ha/day in Germany, 1 ha/day in Luxembourg and 3.3 ha/day in Wallonia by 2020; Decoville and Schneider, 2015). Although direct comparisons cannot be made, given differences in scale and context (Decoville and Schneider, 2015), this means that the LMA could meet such targets, should they be used as reference, in any of the scenarios explored. Both cases suggest that the levels of land take estimated in this research can be considered conservative estimates. We recommend adopting more extreme scenario assumptions, to allow exploring both diverging and converging pathways of land take, relative to a “no net land take” target. For example in urban planning, build-out analyses are often conducted to assess effects on habitat, assuming that all land that could be taken would actually be taken (McDonald, 2015). However, decision-makers may prefer scenarios with marginal LULC change patterns over more radical scenarios, in cases where planning interventions are not expected to be disruptive, e.g. due to resource limitations (Larondelle et al., 2016).

Our “Sprawling growth” and “Dumb decline” scenarios reflect regional, national and international business-as-usual trends, since (a) the same trend of growth in artificial areas and loss of greenfield areas is expected in all Portuguese regions until 2040 (Santos et al., 2015), while urban sprawl is already experienced in different regions of the world, including Europe, North-America, China, India or in Africa (Kasanko et al., 2006; Valerio et al., 2015); (b) the existence of land take even under declining or stable population has been observed across European cities (Haase et al., 2013; Valerio et al., 2015). For scenarios affecting areas of land without current use (like scenario A), it should be noted that although those areas have the potential to promote sustainability through regeneration and greening, they can also be hard-spots for sustainability transition, with conflicting visions for its future development (Larondelle et al., 2016).

The scenario exercise revealed mixed messages regarding changes in ES potential supply, similarly to Kain et al. (2016). No differences were found

across scenarios for the indicators of mean f -evapotranspiration and mean emissivity index, for the LMA as a whole, which results from too low LULC changes. This does not necessarily mean that no effects at local level take place. For example, the area lost to land take in scenario D is almost half the size of one of LMA's municipalities (Amadora) hosting more than 175,000 residents, giving an idea of the potential scale of impacts at that level, as Local climate regulation through cooling effect is important for human well-being (Schwarz et al., 2011). For spatial planning, an analysis at a more detailed scale (e.g. municipal level) could guide regional planning (e.g. where to focus re-naturing measures), supporting multi-level territorial governance. Our approach can support such analyses, since it produces spatially explicit results.

Land take resulted in higher net carbon storage, which was rather surprising, although inconclusive differences in above-ground carbon storage have been found in similar research (Kain et al., 2016). This results from the lookup values adapted for this research, which reflect a case where urban forest has (i) higher percentage of tree cover relative to shrub cover than natural forest; (ii) generally excellent or good condition, higher trunk diameter or leaf area density of trees, in contrast with a higher proportion of trees in poor or critical condition in natural forest (Chaparro and Terradas, 2009); (iii) lower decomposition carbon emissions due to healthier vegetation (Baró et al., 2014). This bears intriguing implications for sustainability analysis of land take: from a carbon storage point of view, it could be more sustainable to convert natural forest into urban green space. However this is context-dependent, as carbon storage of vegetation depends on even more factors than the ones just described. To support a real planning setting, further research is needed to derive LMA-specific values.

The "Re-naturing" scenario is particularly beneficial for recreation potential, since natural recreational areas increase, while artificial areas decrease within protected areas, which typically have high recreation potential (Paracchini et al., 2014). Re-naturing to forest areas is advantageous since forests are generally considered as attractive sites (Paracchini et al., 2014). Oppositely, scenarios where land take occurs decrease recreation potential. Results for the percentage of artificial areas in the proximity of natural recreational areas were inconclusive, demanding further research. In scenario B there is no change in recreation potential from the baseline year, because new artificial areas are built in already existing discontinuous urban fabric. However, where densification takes place, the pressure put on proximate natural recreational areas is higher. On the other hand, this means that more people can potentially benefit from proximate natural recreational areas. This highlights the im-

portance of considering spatial aspects in ES assessments, which are commonly overlooked in urban planning, particularly the proximity between natural habitat and ES beneficiaries (McDonald, 2015). It also reveals an inherent tension between recreation ES supply and demand. Potential recreation provision is inversely proportional to the proximity of recreational areas to urban areas (Paracchini et al., 2014), as natural areas surrounded by urban areas are more readily ecologically degraded than are natural areas in rural settings (McDonald, 2015; McDonald et al., 2009). However, accessibility also determines the potential flow of the service to visitors, since it is necessary that people reach recreational areas in order to benefit from it (Paracchini et al., 2014). Spatial planners have to deal with such tensions to balance ES supply, demand and flows for ES-based planning, together with conservation goals for areas of high natural value.

The loss of agricultural areas in scenarios C and D are aligned with projections of future LULC for Portugal, which point to a significant decrease in agricultural areas in the next couple of decades (Santos et al., 2015). In terms of food production potential, considering the productivity of the three most produced crops in LMA in 2015 (INE, 2016b), differences in agricultural areas for scenarios C and D could translate into a loss of about (scenario C / scenario D) 4,162 tons / 66,280 tons of tomato, 1,579 tons / 25,152 tons of potato or 2,588 tons / 41,210 tons of green maize, relative to the baseline scenario (assuming that all agricultural area lost would be used to grow each crop). This is a simple but effective way to communicate potential scenario consequences to stakeholders. Similarly, Gardi et al. (2015) demonstrated that Europe's intense urbanisation has a direct impact on its capability to produce food. In scenarios of increasing population, the potential policy impact of even small losses in agricultural production increases, since production will need to increase to maintain current levels of self-sufficiency (Eigenbrod et al., 2011). Although cities, metropolitan areas, regions or even countries, most often rely on imports to satisfy their food demands, some degree of self-sufficiency is important for their sustainability and resilience in face of events like the unexpected rapid rise in food prices observed in mid-2008 (Godfray et al., 2010). When no land take occurs but urban densification takes place, like in scenario B, although no agricultural area is lost (so no change in food production potential would be expected), opportunities for urban farming might diminish (Artmann et al., 2017).

Potential trade-offs between ES were identified. In scenario A, while natural recreational areas increased, total net carbon stored decreased, relative to the baseline year. An opposite relation was found in scenarios C and D. At the

same time, for these scenarios an increase in total net carbon stored is accompanied by a decrease in food production potential. Assessing such trade-offs, as well as synergies, is crucial to support planning processes (Grêt-Regamey et al., 2017).

This research reveals possible tensions between the “compact city” model of urban development and the provision of ES to urban dwellers. Although a compact urban development safeguards more greenfield areas from land take by urbanization than a dispersed one, it might translate into poor contact with nature and ES supply for urban dwellers (Tian et al., 2014; Tratalos et al., 2007), due to a high amount of built-up infrastructure and a low amount of natural elements. The size of the urban area influences this, as it affects the distance between the urban environment’s core and the surrounding greenfield areas. This can trigger a rebound effect, where city dwellers migrate to the suburbs because of decreasing quality of life in the city (BIO by Deloitte, 2014). These tensions can have implications for multi-level spatial planning governance, as regional planning authorities might prioritize a compact urban development to minimize land take and maximize ES supply by greenfield areas, whereas local planning authorities might prioritize a dispersed urban development to provide for contact with natural elements and ES supply within urban areas. More evidence is called for to re-consider the “compact city” as an ideal, since not only its direct economic benefits, but also its ecological effects should be taken into account (Artmann et al., 2017; Lauf et al., 2016; Tratalos et al., 2007). At any given density, there is substantial scope for maximising ecological performance (Tratalos et al., 2007) and concepts such as “smart-compact-green cities” (Artmann et al., 2017) are beginning to be explored. We recommend further research on the balance between land take and compactness of urban areas, regarding its effects on nature and people.

This research also points to possible limitations of applying the land take concept together with a given LULC classification scheme, like Urban Atlas, when analysing the effects of LULC changes on ES supply. This is most evident in the case of LULC class of green urban areas, which besides areas with vegetation planted and regularly worked by humans (e.g. gardens), includes also forests or green areas extending from the surroundings into urban areas, when at least two sides are bordered by urban areas and structures, and traces of recreational use are visible (European Commission, 2016). This means that some natural areas important for ES supply might be disregarded under a land take perspective. Recreational use, a common cultural ES, is even one of the criteria to classify those areas as artificial. Applying available recommendations on access

to green space, for example that everyone should have green space no further than 300 meters (5-minute walk) from their home (Natural England, 2010), often developed taking urban green space into consideration, becomes therefore challenging, although in principle it could be an alternative or complementary way to quantify the recreation potential indicator used in this research. This is linked with a more general discussion on the potential limits of the ES concept in urban environments, challenged by dependence on context and scale in practical ES assessment (Beichler et al., 2017).

Finally, we stress relevant methodological issues:

- The rather simple approaches used in this research to map ES have advantages, including lower data requirements, easiness of explanation and understanding, higher transparency (linked to trust among users), as well as the possibility to incorporate local data, models and stakeholder knowledge. However their accuracy and precision may be lower. On the other hand, more complex approaches, like mapping integrating process models, require more data and expertise, but may be more credible and accurate (Maes et al., 2016). In spatial planning practice, modeling has a limited role in assessing impacts on biodiversity and ES due to practical limitations, so relatively easy approaches are often used (Kopperoinen et al., 2016). Scale dependency of ES estimates, which can affect the use of lookup tables at scales different than the ones for which they were developed (Baveye, 2017), should be further researched.
- Analyses of the exact results for each scenario should take into account that they represent one among several possible futures, since the determination of which areas will ultimately change is subject to randomness. An alternative use of the approach to support planning discussions among stakeholders would be to analyse the possible ranges of results for each scenario.
- A limited set of ES was used to illustrate potential effects of land take. This might obscure important effects on other ES and consequently on potential synergies or trade-offs relevant for planning decisions. Similarly to Tratalos et al. (2007) we recommend further research to analyse the relationships between a wider range of ES and urban development patterns.

- Including indicators of ES demand and flow can improve ES assessment frameworks (Sutherland et al., 2017), providing a richer picture of the consequences of each scenario.

5.5 Conclusions

Alternative pathways of demographic and urban pattern development bear different effects on land take and ES supply. A “compact city” pattern can result in no land take under population growth or even in land gain for re-naturing under population decline, with improvements in recreation potential linked with habitat quality in protected areas, but with a decrease in total net carbon storage. On the other hand, an “urban sprawl” pattern can result in land take even when population declines, with negative consequences for recreation and food production potential, but with an increase in total net carbon storage. However, tensions might exist between the “compact city” model of urban development and the provision of ES to urban dwellers, especially across planning levels. How land take is defined, as well as what kind of LULC data is used, has an impact on assessments of land take on ES. Such assessments remain context-sensitive.

The approach presented in this paper offers a venue to explore possible futures and planning options. Hence, it can play an important role in participatory ES-based planning, acting as a tool to trigger and support discussion among a wide range of stakeholders. However, considerable challenges remain in order to assess ES in face of LULC change. We suggest that further research should explore the approach with different stakeholders to gather their insights. We recommend exploring more extreme scenario assumptions, to assess pathways of land take both converging with and diverging from a “no net land take” target. It is nonetheless important to be transparent about assumptions and limitations. Discussions around scenario assumptions can reveal the needs, aspirations, opinions and perceptions of planning stakeholders.



Conclusions and recommendations

This dissertation contributes to existing knowledge on the integration of ES in spatial planning, where important gaps and challenges exist (Albert et al., 2014a; de Groot et al., 2010a; Kopperoinen et al., 2016; see also Chapter 1). The research presented in Chapter 2 suggests that Portuguese regional spatial planners are knowledgeable of the ES concept, they consider important to integrate it in spatial planning and according to their perception, it is already rather integrated in existing plans. They also believe that planning teams and authorities have skilled human resources for ES integration. These findings suggest a positive institutional environment for ES integration. More recent studies have found a similar positive opinion by planning stakeholders on the ES concept and its usefulness for planning (Beery et al., 2016), but this does not automatically mean that knowledge on ES will be used as impartial arbiter between policy options, in face of other factors like established interests (Saarikoski et al., 2017). Interestingly, Portuguese planners revealed a low knowledge of the main initiatives intended to push ES into the political agenda, like the Millennium Ecosystem Assessment. This raises questions for further research on which pathways help explain the previous findings. Part of the explanation might be related to an already existing, even if implicit, ES integration in planning processes, as discussed in Chapter 3 and below. The number of respondents to the survey questionnaire was limited and its results are exploratory. To improve the insights gained from the research presented in Chapter 2, in a setting where more resources would be available to conduct the research, the target population could be broadened to include other stakeholders involved in planning

processes, or complementary surveying techniques could be used, like interviews, to gain more in-depth information.

As shown in Chapter 3, ES-related terminology is poorly integrated in the European and Portuguese policy and guidance framework for spatial planning. These findings are aligned with the notion that there is potential for greater conceptual and operational integration of the ES concept at regional, national and EU level, similarly to the study by Kettunen et al. (2014) of the EU policy framework. Some references to notions related with the ES concept could be found, so to a limited extent there is implicit ES integration, similarly to findings by other studies (Hauck et al., 2013a; Matzdorf and Meyer, 2014; Rall et al., 2015). Implicit use of the ES concept can take place not only in planning documents, but also in the daily work of planners, as reported by Beery et al. (2016). As those authors stress, the distinction between implicit and explicit conceptual use of ES is important to understand to what extent the explicit use is an indicator for the actual implementation of the ES concept, and when is the concept implemented without using explicit terminology. In turn, this information is relevant, considering that mismatches can occur between the use of the ES concept at strategic level and on the ground (Primmer and Furman, 2012). This might be the case in Portugal, since the integration of the ES concept in policy and guidance documents, as found in Chapter 3 (poor) and as perceived by planning stakeholders in Chapter 2 (rather integrated) are not well aligned, suggesting that stakeholders can be already applying an ES way of thinking, even if it is not explicitly included in documents, similarly to what Beery et al. (2016) found.

Still, the analysis in Chapter 3 found that the EC's Guidance on Integrating Climate Change and Biodiversity into Strategic Environmental Assessment (European Commission, 2013a) can provide good guidance for an ES approach to spatial planning. And as the ES concept gradually gains presence in EU policies (Bouwma et al., 2016), its integration in spatial planning might improve in the future. In Portugal, within the on-going revision process of the National Program for Spatial Planning Policy there are signs that ES integration is desired, for example meetings and public workshops dedicated to this issue were already held. However, the analysis of Portuguese RSPs and SEA reports conducted in Chapter 3 suggest that, in practical terms, for the coming years ES will not be specifically targeted or integrated in regional spatial planning, since most of the RSPs analysed were recent or in the process of legally coming into force. For further research, it would be interesting to analyse how does the ES concept get integrated into future spatial planning policies (through which pro-

cesses, with which stakeholders and how exactly in the policy documents). Such a longitudinal policy analysis is useful to improve the understanding of ES integration in spatial planning (Wilkinson et al., 2013). The findings of Chapter 3 support the notion that SEA can play an important role for ES integration. The chapter also recommends for further research to conduct a similar analysis a) for a wider scope of European policies and for other European countries, hence addressing the horizontal and vertical integration of the ES concept, respectively; b) comparing the European context with other regions of the world.

Through the participatory approach presented in Chapter 4, it was possible to identify differences in the ES considered most relevant by different types of stakeholders, while at the same time identifying a set of common priority ES for the LMA. These were related with water provisioning, mediation of flows and maintenance of atmospheric composition and climate regulation. Potential links between drivers of change or planning goals, changes in LULC and in ES were also established, based on stakeholders' inputs. Combining all that information, one can identify which ES are considered more important and which ones will potentially be more affected by spatial plans. This can support the definition of planning priorities.

The developed participatory approach can play an important role in improving ES integration in spatial planning, since so far ES have been usually selected based on availability of data, relevance to a study area, interests of the team conducting the assessment, or abundance of information in other ES assessments. Such selection criteria might not be aligned with stakeholders' priorities, which entails the risk of lowering the saliency and legitimacy (Cash et al., 2003) of ES assessments. By combining different participatory techniques, using drivers of change to help translating plan dispositions and adopting an established ES classification system, the approach allows working with stakeholders holding different levels of knowledge on the spatial plans and on ES. Similarly to the research reported in Chapter 2, due to the resources available, a limited range of stakeholders was covered, so further research could expand that range, in order to better represent the different values, interests, opinions and perceptions in relation with ES for a specific planning context. Gathering participants' feedback on the participatory process itself is also recommended. Two main challenges remain for the selection of ES: one is how to best combine information for different selection criteria and another is to identify which participatory techniques work best for the specific needs of different kinds of stakeholders or of different planning stages, as well as how to integrate data resulting from different participatory techniques.

Chapter 5 showed how alternative pathways of demographic and urban pattern development can bear different effects on land take and ES supply. “Compact city” and “urban sprawl” oriented planning strategies were analysed under different demographic development trends, through the development of four contrasting scenarios for the LMA in the year 2030. The scenario assessment covered major determinants of land take (with a focus on residential development) and priority ES for the LMA, dealing with climate regulation, recreation and food production (mainly guided by the results of the participatory process described in Chapter 4). The main findings suggest that the effects of urban development on land take can be positive for a “compact city” and negative for an “urban sprawl” pattern, even under opposite demographic trends. But each pattern can have both positive and negative effects on ES supply. It should be noted that the spatially explicit results obtained do not capture socio-cultural values, which are difficult or even impossible to map based on biophysical parameters only (Kopperoinen et al., 2016). For further research, changes in ES demand could be analysed, considering the beneficiaries of ES and who decides who receives what (Mace, 2016).

As discussed in Chapter 5, tensions might exist between the “compact city” model of urban development and the provision of ES to urban dwellers, especially across planning levels. Therefore, the findings in Chapter 5 are relevant for debates around the “compact city” ideal (see for example Artmann et al., 2017; Tratalos et al., 2007). Another critical issue discussed is that the way land take is defined, as well as what kind of LULC data is used, has an impact on assessments of land take on ES. Such assessments are also context-sensitive. Considerable challenges remain in order to assess ES in face of LULC change. Further research could explore the scenario approach with different stakeholders to gather their insights, while exploring more extreme scenario assumptions, to assess pathways of land take both converging with and diverging from a “no net land take” target and hence increasing policy relevance. A major potential of such a participatory exploration of the scenario approach is that it can provide critical support to participatory planning processes. Discussions around scenario assumptions can reveal the needs, aspirations, opinions and perceptions of stakeholders. It is nevertheless important to be transparent about assumptions and limitations.

This research followed a mixed methods approach. The methodological pluralism promoted by such an approach is appropriate to understand all the aspects of complex systems, which demands going beyond silo thinking (Norgaard, 1989). However, most ES assessments focus only on one approach

(ecological, socio-cultural or economic), or combine ecological assessments with some form of economic or non-monetary valuation, but rarely there is a synthesis of the findings arising from the different approaches (Hattam et al., 2015). Therefore, this research can provide a more comprehensive picture of the topic of ES integration in spatial planning than many existing ES studies found in scientific literature. Mixed methods approaches can generate mixed messages (Hattam et al., 2015; Hatton MacDonald et al., 2014), as integrating data and findings from different strands of a study remains challenging (Creswell et al., 2011; Fetters and Molina-Azorin, 2017; Johnson et al., 2007). But if those messages are interpreted as challenges or used to focus ecosystem management, then the full potential of mixed methods approaches can be utilised, outperforming single method approaches (Hattam et al., 2015).

Geographic information approaches, like the ones explored in Chapter 5, are uniquely positioned to facilitate integration of mixed methods, as several applications exist to integrate qualitative and quantitative data in GIS frameworks (Cheong et al., 2012). In that context, a scenario-based approach, as the one followed in Chapter 5, makes possible exchanges of stakeholder perspectives and expert opinions, contributing to mixed methods integration by linking qualitative socio-economic information from discussions with stakeholders with quantitative data and models and as a result providing quantitative, spatially explicit information on current and future patterns of LULC change (Cheong et al., 2012).

Drawing inspiration from the steps followed in this research, a conceptual framework for the integration of ES in spatial planning is proposed (Figure 6.1). The framework incorporates the principles of credibility (scientific adequacy of technical evidence and arguments), saliency (relevance to the needs of decision-makers) and legitimacy (respect for stakeholders' divergent values and beliefs), recommended for designing knowledge systems for sustainability (Cash et al., 2003). It is designed to allow for meaningful participation, scenario development and integration of local and traditional knowledge, which are important to support the use of ES knowledge in spatial planning (McKenzie et al., 2014). Through its focus on mixed methods and stakeholder participation, the conceptual framework incorporates a call for inter- and trans-disciplinarity.

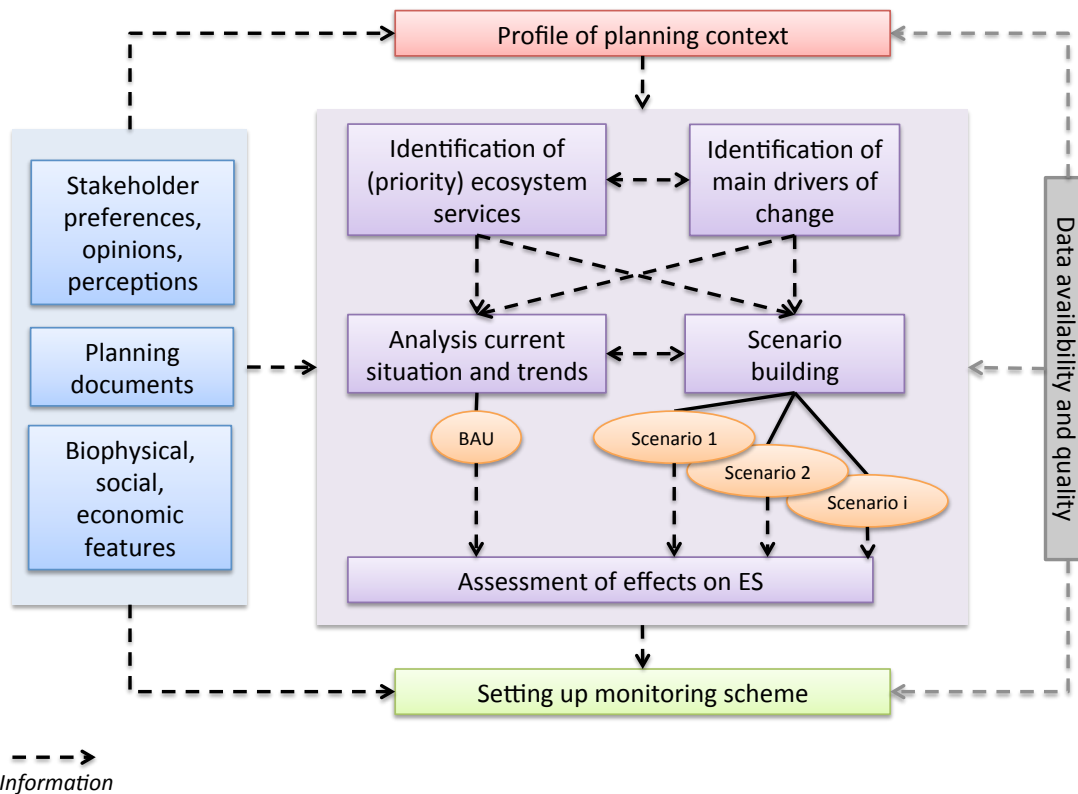


Figure 6.1 – Conceptual framework for the integration of ES in spatial planning.

In the proposed conceptual framework, a profile of the planning context sets a basis to inform the following steps, since effectively integrating ES in planning requires careful scoping of the context, objectives and capacities. It also allows knowing which information needs and requirements planners and decision-makers have, concerning the possible integration of ES information in existing administrative and decision-making structures (Albert et al., 2014a). This profile can be achieved through the approaches presented in Chapters 2 and 3. Priority ES and main drivers of change should be identified, to focus the analysis and optimize available resources. An approach to achieve this in a participatory way is presented in Chapter 4. Then, an analysis of plausible scenarios for future LULC changes can support assessments of the effects on ES of alternative planning options. Such an exercise is presented in Chapter 5. It is beneficial to develop scenarios and models in close interaction with stakeholders (Rounsevell and Metzger, 2010). However, this is often limited by available resources. Presenting stakeholders with preliminary or first-round scenario results to support discussions is a compromise strategy to overcome such limitations. It should also be noted that GIS-based methods to assess effects of spatial planning policies on ES have a strong visual capability that can be misleading if

the inherent uncertainties are not properly communicated (Balfors et al., 2016). A monitoring scheme should be set up. Monitoring ES is vital for informing decision-making to protect human well-being and the natural systems upon which it relies at different scales (Balvanera et al., 2017). The stage of setting up a monitoring scheme is not explored in-depth in this research. However, the proxy indicators used to assess ES in Chapter 5 could serve as a basis for such a scheme, covering of course only a restricted set of ES. The lessons learnt through the use of those proxy indicators (discussed in Chapter 5) could inform the process. The setting up of the monitoring scheme could be supported with existing literature on ES indicators (for example Albert et al., 2016; Guimarães et al., 2017; Müller and Burkhard, 2012), which was considered when developing the proxy indicators in Chapter 5. It could also be supported by community monitoring of ES (by local stakeholders), which could better incorporate traditional ecological knowledge and increase local interest and investment in the maintenance of ecosystems (Balvanera et al., 2017). As shown on the left side of the figure, stakeholder preferences, opinions and perceptions play an important role in the whole process, aligned with the current paradigm of collaborative planning, which means a shift from planning for the people to planning with the people (Kopperoinen et al., 2016). Planning documents and the biophysical, social and economic features of the specific territory under study are also important data and information sources. The right side of the figure illustrates how the process of ES integration in spatial planning is constrained by data availability and quality. The conceptual framework should be read as a cyclic, iterative process, which is in line with the characteristics of contemporary spatial planning (Mccall and Dunn, 2012; Nilsson et al., 2009; Opdam et al., 2001) mixed methods research (Teddlie and Tashakkori, 2010).

This dissertation showcases the application of the conceptual framework and has put forward approaches to achieve each one of the steps shown in the centre (although the “setting up monitoring scheme” requires further in-depth research). The knowledge generated by the application of the framework should be assessed, in collaboration with relevant stakeholders, to ascertain the various ways in which that knowledge is used by different groups at different stages of the planning process (McKenzie et al., 2014) and how does ES information enter the decision-making process (Hatton MacDonald et al., 2014). This underlies the cyclic, iterative nature of the conceptual approach and is crucial to advance ES integration in spatial planning. As stressed by ten Brink and Kettunen (2016), integrating the ES concept into policy development and implementation needs a good evidence base, a range of tools and instruments, en-

gagement by different stakeholders and mobilization of resources to facilitate the uptake. The conceptual framework addresses most of those needs, with the mobilization of resources being one of the next steps needed if the framework would be applied in a real planning context. Since context is crucial for spatial planning, applying the conceptual framework in other planning settings would be beneficial to gain more empirical insights and hence more knowledge on ES integration.

Figure 6.2 shows how the proposed conceptual framework for ES integration can support the planning process through synergies with the SEA process. Such synergies are important, considering that there is a risk that ES integration is simply seen as an additional burden on existing environmental assessment processes, being largely omitted for being too resource intensive. This risk is plausible, since practitioners and decision makers appear reluctant to diverge from well-established approaches to environmental assessment (Baker et al., 2013).

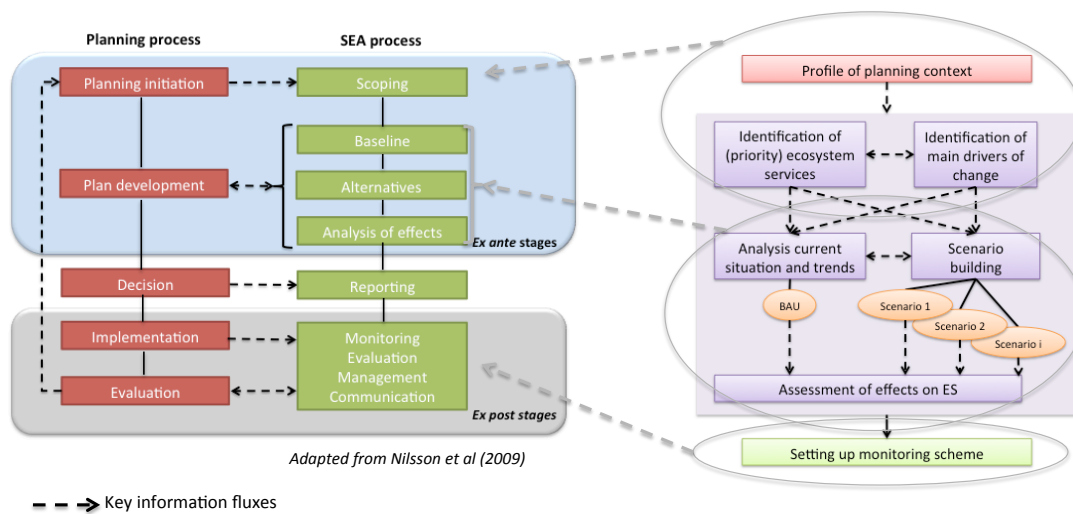


Figure 6.2 – Synergies between the proposed conceptual framework for ES integration and SEA, in support of the planning process.

It is possible to find some evidence of use of the research conducted. The survey questionnaire developed in Chapter 2 has been used as reference to analyse the current understanding and network relations in a multi-actor arrangement related to integration of ES in SEA and spatial planning in Chile (Rozas-Vásquez et al., 2017). The methodological approach developed to guide the content analysis of planning and guidance documents, presented in Chapter 3, has

been used as reference in a similar study, to analyse the role of ES within spatial planning and SEA procedures of municipal master plans and Natura 2000 management plans in Sardinia (Leone and Zoppi, 2016).

This chapter has synthesized and discussed the main overall findings of the conducted research, identifying also major points for further research. The research has brought new insights on the topic of ES integration in spatial planning. It was found that ES are poorly and mainly implicitly integrated in spatial planning policies at European, national and regional levels, but SEA can act as a good policy instrument for ES integration in the future. Despite poor integration in planning policies, regional planning stakeholders in Portugal are receptive to and seem to be ready for a spatial planning approach integrating ES. Through stakeholder engagement, priority ES could be identified for the LMA, mainly relating to water provisioning, mediation of flows and maintenance of atmospheric composition and climate regulation. The analysis of alternative scenarios for the future of the LMA has shown how a “compact city” development is more advantageous than an “urban sprawl” one, in terms of land take. But findings suggested that each of those patterns can have both positive and negative effects on ES supply, which has implications for debates around the “compact city” ideal. The richness of new insights brought about by this research, which is needed to address the complexity of the research topic, was greatly enhanced by adopting a mixed methods approach. A conceptual framework was proposed, which can support planning teams and authorities better integrating ES in spatial planning, including through SEA processes. Despite these advancements, the integration of ES in spatial planning remains a fruitful field of inquiry for future research.

7 References

- Abson, D.J., von Wehrden, H., Baumgärtner, S., Fischer, J., Hanspach, J., Härdtle, W., Heinrichs, H., Klein, A.M., Lang, D.J., Martens, P., Walmsley, D., 2014. Ecosystem services as a boundary object for sustainability. *Ecol. Econ.* 103, 29–37. doi:<http://dx.doi.org/10.1016/j.ecolecon.2014.04.012>
- Adams, N., Alden, J., Harris, N., 2006. Introduction: Regional Development and Spatial planning in an enlarged european union, in: Adams, N., Alden, J., Harris, N. (Eds.), *Regional Development and Spatial Planning in an Enlarged European Union*. Ashgate, Aldershot, UK, p. 283.
- Adger, W.N., Brown, K., Fairbrass, J., Jordan, A., Paavola, J., Rosendo, S., Seyfang, G., 2003. Governance for sustainability: towards a “thick” analysis of environmental decisionmaking. *Environ. Plan. A* 35, 1095–1110.
- Ahern, J., Cilliers, S., Niemelä, J., 2014. The concept of ecosystem services in adaptive urban planning and design: A framework for supporting innovation. *Landsc. Urban Plan.* 125, 254–259. doi:<http://dx.doi.org/10.1016/j.landurbplan.2014.01.020>
- Albert, C., Aronson, J., Fürst, C., Opdam, P., 2014a. Integrating ecosystem services in landscape planning: requirements, approaches, and impacts. *Landsc. Ecol.* 29, 1277–1285. doi:[10.1007/s10980-014-0085-0](https://doi.org/10.1007/s10980-014-0085-0)
- Albert, C., Bonn, A., Burkhard, B., Daube, S., Dietrich, K., Engels, B., Frommer, J., Götzl, M., Grêt-Regamey, A., Job-Hoben, B., Koellner, T., Marzelli, S., Moning, C., Müller, F., Rabe, S.-E., Ring, I., Schwaiger, E., Schweppe-Kraft, B., Wüstemann, H., 2016. Towards a national set of ecosystem service indicators: Insights from Germany. *Ecol. Indic.* 61, Part 1, 38–48. doi:<http://dx.doi.org/10.1016/j.ecolind.2015.08.050>
- Albert, C., Hauck, J., Buhr, N., von Haaren, C., 2014b. What ecosystem services information do users want? Investigating interests and requirements among landscape and regional planners in Germany. *Landsc. Ecol.* 29, 1301–1313. doi:[10.1007/s10980-014-9990-5](https://doi.org/10.1007/s10980-014-9990-5)
- Alberti, M., 2005. The Effects of Urban Patterns on Ecosystem Function. *Int. Reg. Sci. Rev.* 28, 168–192. doi:[10.1177/0160017605275160](https://doi.org/10.1177/0160017605275160)
- Albrechts, L., Healey, P., Kunzmann, K.R., 2003. Strategic Spatial Planning and Regional Governance in Europe. *J. Am. Plan. Assoc.* 69, 113–129. doi:[10.1080/01944360308976301](https://doi.org/10.1080/01944360308976301)
- Alden, J., 2006. Regional Development and Spatial Planning, in: Adams, N., Alden, J., Harris, N. (Eds.), *Regional Development and Spatial Planning in an Enlarged European Union*. Ashgate, Hampshire and Burlington, pp. 17–42.
- Anastasopoulou, S., Chobotova, V., Dawson, T., Kluvankova-Oravska, T., Rounsevell, M., n.d. Identifying and assessing socio-economic and environmental drivers that affect ecosystems and their services.
- Aretano, R., Petrosillo, I., Zaccarelli, N., Semeraro, T., Zurlini, G., 2013. People perception of landscape change effects on ecosystem services in small

- Mediterranean islands: A combination of subjective and objective assessments. *Landsc. Urban Plan.* 112, 63–73. doi:http://dx.doi.org/10.1016/j.landurbplan.2012.12.010
- Artmann, M., Kohler, M., Meinel, G., Gan, J., Ioja, I.-C., 2017. How smart growth and green infrastructure can mutually support each other — A conceptual framework for compact and green cities. *Ecol. Indic.* doi:10.1016/j.ecolind.2017.07.001
- Atkinson, R., Flint, J., 2001. Accessing Hidden and Hard-to-Reach Populations: Snowball Research Strategies . *Soc. Res. Updat.*
- Baker, J., Sheate, W.R., Phillips, P., Eales, R., 2013. Ecosystem services in environmental assessment — Help or hindrance? *Environ. Impact Assess. Rev.* 40, 3–13. doi:http://dx.doi.org/10.1016/j.eiar.2012.11.004
- Balfors, B., Azcárate, J., Mörtberg, U., Karlson, M., Gordon, S.O., 2016. Impacts of urban development on biodiversity and ecosystem services, in: *Handbook on Biodiversity and Ecosystem Services in Impact Assessment.* Edward Elgar Publishing, Inc., Cheltenham, UK, pp. 167–194.
- Ballabio, C., Panagos, P., Monatanarella, L., 2016. Mapping topsoil physical properties at European scale using the LUCAS database. *Geoderma* 261, 110–123. doi:10.1016/j.geoderma.2015.07.006
- Balvanera, P., Quijas, S., Karp, D.S., Ash, N., Bennett, E.M., Boumans, R., Brown, C., Chan, K.M.A., Chaplin-Kramer, R., Halpern, B.S., Honey-Rosés, J., Kim, C.-K., Cramer, W., Martínez-Harms, M.J., Mooney, H., Mwampamba, T., Nel, J., Polasky, S., Reyers, B., Roman, J., Turner, W., Scholes, R.J., Tallis, H., Thonicke, K., Villa, F., Walpole, M., Walz, A., 2017. Ecosystem Services, in: Walters, M., Scholes, R.J. (Eds.), *The GEO Handbook on Biodiversity Observation Networks.* Springer International Publishing, Cham, pp. 39–78. doi:10.1007/978-3-319-27288-7_3
- Baró, F., Chaparro, L., Gómez-Baggethun, E., Langemeyer, J., Nowak, D.J., Terradas, J., 2014. Contribution of Ecosystem Services to Air Quality and Climate Change Mitigation Policies: The Case of Urban Forests in Barcelona, Spain. *Ambio* 43, 466–479. doi:10.1007/s13280-014-0507-x
- Baró, F., Palomo, I., Zulian, G., Vizcaino, P., Haase, D., Gómez-Baggethun, E., 2016. Mapping ecosystem service capacity, flow and demand for landscape and urban planning: A case study in the Barcelona metropolitan region. *Land use policy* 57, 405–417. doi:10.1016/j.landusepol.2016.06.006
- Barral, M.P., Oscar, M.N., 2012. Land-use planning based on ecosystem service assessment: A case study in the Southeast Pampas of Argentina. *Agric. Ecosyst. Environ.* 154, 34–43. doi:10.1016/j.agee.2011.07.010
- Bastian, O., Haase, D., Grunewald, K., 2012. Ecosystem properties, potentials and services - The EPPS conceptual framework and an urban application example. *Ecol. Indic.* 21, 7–16. doi:10.1016/j.ecolind.2011.03.014
- Bauler, T., Pipart, N., 2014. Ecosystem Services in Belgian Environmental Policy Making: Expectations and Challenges Linked to the Conceptualization and Valuation of Ecosystem Services, in: Jacobs, S., Dendoncker, N., Keune, H. (Eds.), *Ecosystem Services - Global Issues, Local Practices.* Elsevier, San

- Diego, CA, pp. 121–133.
- Baveye, P.C., 2017. Quantification of ecosystem services: Beyond all the “guesstimates”, how do we get real data? *Ecosyst. Serv.* 24, 47–49. doi:10.1016/j.ecoser.2017.02.006
- BCSD Portugal, 2013. Integrar a Biodiversidade e os Serviços dos Ecossistemas na Estratégia Corporativa. Conselho Empresarial para o Desenvolvimento Sustentável, Lisboa.
- Beery, T., Stålhammar, S., Jönsson, K.I., Wamsler, C., Bramryd, T., Brink, E., Ekelund, N., Johansson, M., Palo, T., Schubert, P., 2016. Perceptions of the ecosystem services concept: Opportunities and challenges in the Swedish municipal context. *Ecosyst. Serv.* 17, 123–130. doi:10.1016/j.ecoser.2015.12.002
- Beichler, S.A., Bastian, O., Haase, D., Heiland, S., Kabisch, N., Müller, F., 2017. Does the Ecosystem Service Concept Reach its Limits in Urban Environments? *Landsc. Online* 51, 1–22. doi:10.3097/LO.201751
- Bennet, K., Ranganathan, J., West, P., Irwin, F., Perrings, C., Timmer, D., 2008. Introduction, in: Mlot, C. (Ed.), *Ecosystem Services: A Guide for Decision Makers*. World Resources Institute, p. 80.
- Berg, B.L., 2001. *Qualitative Research Methods for the Social Sciences*. Allyn & Bacon, Needham Heights, MA.
- Bhattacharjee, A., 2012. *Social Science Research: Principles, Methods, and Practices*, 2nd ed, USF Tampa Bay Open Access Textbooks Collection. University of South Florida, Tampa.
- Biernacki, P., Waldorf, D., 1981. Snowball Sampling: Problems and Techniques of Chain Referral Sampling. *Sociol. Methods Res.* 10, 141–163. doi:10.1177/004912418101000205
- BIO by Deloitte, 2014. Study supporting potential land and soil targets under the 2015 Land Communication.
- Birkmann, J., 2003. Measuring sustainable spatial planning in Germany: indicator- based monitoring at the regional level. *Built Environ.* 29, 296–305.
- Böhme, K., n.d. European Spatial Policy-Making, BSR INTERREG III B Project Report.
- Böhme, K., Doucet, P., Komornicki, T., Zaucha, J., Świątek, D., 2011. How to strengthen the territorial dimension of „Europe 2020“ and EU Cohesion Policy. Warsaw.
- Bouwma, I., Schleyer, C., Primmer, E., Winkler, K.J., Berry, P., Young, J., Carmen, E., Špulerová, J., Bezák, P., Preda, E., Vadineanu, A., 2016. Adoption of the ecosystem services concept in EU policies. *Ecosyst. Serv.* doi:10.1016/j.ecoser.2017.02.014
- Boyd, J., Banzhaf, S., 2007. What are ecosystem services? The need for standardized environmental accounting units. *Ecol. Econ.* 63, 616–626. doi:10.1016/j.ecolecon.2007.01.002

- Boynton, P.M., Greenhalgh, T., 2004. Selecting, designing, and developing your questionnaire. *Br. Med. J.* 328, 1312–1315.
- Braat, L.C., de Groot, R., 2012. The ecosystem services agenda: bridging the worlds of natural science and economics, conservation and development, and public and private policy. *Ecosyst. Serv.* 1, 4–15. doi:http://dx.doi.org/10.1016/j.ecoser.2012.07.011
- Brown, G., de Bie, K., Weber, D., 2015. Identifying public land stakeholder perspectives for implementing place-based land management. *Landsc. Urban Plan.* 139, 1–15. doi:http://dx.doi.org/10.1016/j.landurbplan.2015.03.003
- Bryan, B.A., Raymond, C.M., Crossman, N.D., Macdonald, D.H., 2010. Targeting the management of ecosystem services based on social values: Where, what, and how? *Landsc. Urban Plan.* 97, 111–122. doi:http://dx.doi.org/10.1016/j.landurbplan.2010.05.002
- Bryson, J.M., 2004. What to do when Stakeholders matter - Stakeholder Identification and Analysis Techniques. *Public Manag. Rev.* 6, 21–53. doi:10.1080/14719030410001675722
- Bull, J.W., Jobstvogt, N., Böhnke-Henrichs, A., Mascarenhas, A., Sitas, N., Baulcomb, C., Lambini, C.K., Rawlins, M., Baral, H., Zähringer, J., Carter-Silk, E., Balzan, M. V., Kenter, J.O., Häyhä, T., Petz, K., Koss, R., 2016. Strengths, Weaknesses, Opportunities and Threats: A SWOT analysis of the ecosystem services framework. *Ecosyst. Serv.* 17, 99–111. doi:http://dx.doi.org/10.1016/j.ecoser.2015.11.012
- Burkhard, B., Petrosillo, I., Costanza, R., 2010. Ecosystem services - Bridging ecology, economy and social sciences. *Ecol. Complex.* 7, 257–259. doi:10.1016/j.ecocom.2010.07.001
- Caetano, M., Nunes, V., Nunes, A., 2009. CORINE Land Cover 2006 for Continental Portugal. Technical Report. Instituto Geográfico Português.
- Campo, S., 2009. Sustainability assessment of urban policy scenarios: analysing the impacts of land use-transportation interaction in the Lisbon Metropolitan Area. *Rev. Int. Sostenibilidad, Tecnol. y Humanismo* 4, 125–149.
- Cárcamo, P.F., Garay-Flühmann, R., Squeo, F.A., Gaymer, C.F., 2014. Using stakeholders' perspective of ecosystem services and biodiversity features to plan a marine protected area. *Environ. Sci. Policy* 40, 116–131. doi:http://dx.doi.org/10.1016/j.envsci.2014.03.003
- Cardinale, B.J., Duffy, J.E., Gonzalez, A., Hooper, D.U., Perrings, C., Venail, P., Narwani, A., MacE, G.M., Tilman, D., Wardle, D.A., Kinzig, A.P., Daily, G.C., Loreau, M., Grace, J.B., Larigauderie, A., Srivastava, D.S., Naeem, S., 2012. Biodiversity loss and its impact on humanity. *Nature* 486, 59–67. doi:10.1038/nature11148
- Carson, R., 1962. *Silent Spring*. Houghton Mifflin Company, Boston.
- Cash, D.W., Clark, W.C., Alcock, F., Dickson, N.M., Eckley, N., Guston, D.H., Jäger, J., Mitchell, R.B., 2003. Knowledge systems for sustainable development. *Proc. Natl. Acad. Sci.* 100, 8086–8091.

doi:10.1073/pnas.1231332100

- Castro, A.J., Verburg, P.H., Martín-López, B., Garcia-Llorente, M., Cabello, J., Vaughn, C.C., López, E., 2014. Ecosystem service trade-offs from supply to social demand: A landscape-scale spatial analysis. *Landsc. Urban Plan.* 132, 102–110. doi:http://dx.doi.org/10.1016/j.landurbplan.2014.08.009
- CBD Secretariat, n.d. Convention on Biological Diversity - Country profiles: Portugal [WWW Document]. URL http://www.cbd.int/countries/?country=pt
- CCDR-LVT, 2004. PROT-AML: Plano Regional de Ordenamento do Território da Área Metropolitana de Lisboa. Lisboa.
- CEC, 2009. Mainstreaming sustainable development into EU policies: 2009 Review of the European Union Strategy for Sustainable Development.
- CEC, 2008. Communication from the Commission: Green paper on territorial cohesion: turning territorial diversity into strength, COM (2008) 616.
- CEMAT, 2000. Guiding Principles for Sustainable Spatial Development of the European Continent.
- CEMAT, 1983. European Regional/Spatial Planning Charter.
- Chan, K.M.A., Guerry, A.D., Balvanera, P., Klain, S., Satterfield, T., Basurto, X., Bostrom, A., Chuenpagdee, R., Gould, R., Halpern, B.S., Hannahs, N., Levine, J., Norton, B., Ruckelshaus, M., Russell, R., Tam, J., Woodside, U., 2012. Where are Cultural and Social in Ecosystem Services? A Framework for Constructive Engagement. *Bioscience* 62, 744–756. doi:10.1525/bio.2012.62.8.7
- Chaparro, L., Terradas, J., 2009. Report on Ecological services of urban forest in Barcelona. Barcelona.
- Cheong, S.-M., Brown, D.G., Kok, K., Lopez-Carr, D., 2012. Mixed methods in land change research: towards integration. *Trans. Inst. Br. Geogr.* 37, 8–12. doi:10.1111/j.1475-5661.2011.00482.x
- Cherp, A., Watt, A., Vinichenko, V., 2007. SEA and strategy formation theories: From three Ps to five Ps. *Environ. Impact Assess. Rev.* 27, 624–644. doi:http://dx.doi.org/10.1016/j.eiar.2007.05.008
- Committee on Spatial Development, Commission, E., 1999. ESDP - European Spatial Development Perspective. Towards Balanced and Sustainable Development of the Territory of the European Union. European Commission.
- Costa, E.M., Rocha, J., Rodrigues, M., 2009. Urban form analysis employing land cover and spatial metrics - The case of Lisbon Metropolitan Area. 5th Int. Conf. Virtual City Territ.
- Costanza, R., d'Arge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R. V., Paruelo, J., Raskin, R.G., Sutton, P., van den Belt, M., 1997. The value of the world's ecosystem services and natural capital. *Nature* 387, 253–260.
- Costanza, R., Daly, H.E., 1992. Natural Capital and Sustainable Development. *Conserv. Biol.* 6, 37–46. doi:10.1046/j.1523-1739.1992.610037.x

- Costanza, R., de Groot, R., Braat, L., Kubiszewski, I., Fioramonti, L., Sutton, P., Farber, S., Grasso, M., 2017. Twenty years of ecosystem services: How far have we come and how far do we still need to go? *Ecosyst. Serv.* 28, 1–16. doi:10.1016/j.ecoser.2017.09.008
- Costanza, R., de Groot, R., Sutton, P., van der Ploeg, S., Anderson, S.J., Kubiszewski, I., Farber, S., Turner, R.K., 2014. Changes in the global value of ecosystem services. *Glob. Environ. Chang.* 26, 152–158. doi:http://dx.doi.org/10.1016/j.gloenvcha.2014.04.002
- Cowling, R.M., Ego, B., Knight, A.T., O'Farrell, P.J., Reyers, B., Rouget, M., Roux, D.J., Welz, A., Wilhelm-Rechman, A., 2008. An operational model for mainstreaming ecosystem services for implementation. *Proc. Natl. Acad. Sci.* 105, 9483–9488. doi:10.1073/pnas.0706559105
- Creswell, J.W., Klassen, A.C., Plano Clark, V.L., Smith, K.C., 2011. Best practices for mixed methods research in the health sciences. Washington, DC.
- Daily, G.C., 2000. Management objectives for the protection of ecosystem services. *Environ. Sci. Policy* 3, 333–339. doi:10.1016/S1462-9011(00)00102-7
- Daily, G.C., 1997. Nature's services: societal dependence on natural ecosystems.
- Daily, G.C., Polasky, S., Goldstein, J., Kareiva, P.M., Mooney, H.A., Pejchar, L., Ricketts, T.H., Salzman, J., Shallenberger, R., 2009. Ecosystem services in decision making: time to deliver. *Front. Ecol. Environ.* 7, 21–28. doi:10.1890/080025
- Davies, K.K., Fisher, K.T., Dickson, M.E., Thrush, S.F., Le Heron, R., 2015. Improving ecosystem service frameworks to address wicked problems. *Ecol. Soc.* 20, 37. doi:10.5751/ES-07581-200237
- de Groot, R.S., 1992. Functions of Nature: Evaluation of Nature in Environmental Planning, Management and Decision Making. Wolters-Noordhoff, Groningen.
- de Groot, R.S., Alkemade, R., Braat, L., Hein, L., Willemsen, L., 2010a. Challenges in integrating the concept of ecosystem services and values in landscape planning, management and decision making. *Ecol. Complex.* 7, 260–272. doi:10.1016/j.ecocom.2009.10.006
- de Groot, R.S., Fisher, B., Christie, M., Aronson, J., Braat, L., Haines-Young, R., Gowdy, J., Maltby, E., Neuville, A., Polasky, S., Portela, R., Ring, I., 2010b. Integrating the ecological and economic dimensions in biodiversity and ecosystem service valuation, in: Kumar, P. (Ed.), *The Economics of Ecosystems and Biodiversity (TEEB): Ecological and Economic Foundations*. Earthscan, London.
- Decoville, A., Schneider, M., 2015. Can the 2050 zero land take objective of the EU be reliably monitored? A comparative study. *J. Land Use Sci.* 1–19. doi:10.1080/1747423X.2014.994567
- Díaz, S., Demissew, S., Carabias, J., Joly, C., Lonsdale, M., Ash, N., Larigauderie, A., Adhikari, J.R., Arico, S., Báldi, A., Bartuska, A., Baste, I.A., Bilgin, A., Brondizio, E., Chan, K.M.A., Figueroa, V.E., Duraiappah, A., Fischer, M., Hill, R., Koetz, T., Leadley, P., Lyver, P., Mace, G.M., Martin-Lopez, B., Okumura, M., Pacheco, D., Pascual, U., Pérez, E.S., Reyers, B., Roth, E.,

- Saito, O., Scholes, R.J., Sharma, N., Tallis, H., Thaman, R., Watson, R., Yahara, T., Hamid, Z.A., Akosim, C., Al-Hafedh, Y., Allahverdiyev, R., Amankwah, E., Asah, T.S., Asfaw, Z., Bartus, G., Brooks, A.L., Caillaux, J., Dalle, G., Darnaedi, D., Driver, A., Erpul, G., Escobar-Eyzaguirre, P., Failler, P., Fouda, A.M.M., Fu, B., Gundimeda, H., Hashimoto, S., Homer, F., Lavorel, S., Lichtenstein, G., Mala, W.A., Mandivenyi, W., Matczak, P., Mbizvo, C., Mehrdadi, M., Metzger, J.P., Mikissa, J.B., Moller, H., Mooney, H.A., Mumby, P., Nagendra, H., Nesshover, C., Oteng-Yeboah, A.A., Pataki, G., Roué, M., Rubis, J., Schultz, M., Smith, P., Sumaila, R., Takeuchi, K., Thomas, S., Verma, M., Yeo-Chang, Y., Zlatanova, D., 2015. The IPBES Conceptual Framework - connecting nature and people. *Curr. Opin. Environ. Sustain.* doi:10.1016/j.cosust.2014.11.002
- EASAC, 2009. Ecosystem services and biodiversity in Europe, EASAC policy report. European Academies Science Advisory Council.
- EEA, 2012. Protected areas in Europe - an overview. European Environment Agency, Copenhagen.
- EEA, 2011. An experimental framework for ecosystem capital accounting in Europe. European Environment Agency, Copenhagen.
- EEA, FOEN, 2016. Urban sprawl in Europe - Joint EEA-FOEN report. Luxembourg.
- EEA, JRC, 2006. Urban sprawl in Europe: the ignored challenge. Copenhagen.
- Egoh, B., Drakou, E.G., Dunbar, M.B., Maes, J., Willemsen, L., 2012. Indicators for mapping ecosystem services: a review. Luxembourg.
- Egoh, B., Rouget, M., Reyers, B., Knight, A.T., Cowling, R.M., van Jaarsveld, A.S., Welz, A., 2007. Integrating ecosystem services into conservation assessments: A review. *Ecol. Econ.* 63, 714–721. doi:10.1016/j.ecolecon.2007.04.007
- Ehrlich, P., Ehrlich, A., 1981. *Extinction: The causes and consequences of the disappearance of species.* Victor Gollancz Ltd, London.
- Eigenbrod, F., Bell, V.A., Davies, H.N., Heinemeyer, A., Armsworth, P.R., Gaston, K.J., 2011. The impact of projected increases in urbanization on ecosystem services. *Proc. R. Soc. B Biol. Sci.* 278, 3201–3208. doi:10.1098/rspb.2010.2754
- Elo, S., Kyngäs, H., 2008. The qualitative content analysis process. *J. Adv. Nurs.* 62, 107–115. doi:10.1111/j.1365-2648.2007.04569.x
- ESDN, n.d. Mechanisms of Vertical Integration [WWW Document]. URL http://www.sd-network.eu/?k=country_profiles&s=vertical_integration&country=all_countries
- European Commission, 2016. Mapping Guide for a European Urban Atlas.
- European Commission, 2013a. Guidance on integrating climate change and biodiversity into strategic environmental assessment. European Union, Brussels. doi:10.2779/11869
- European Commission, 2013b. Green Infrastructure (GI) — Enhancing Europe’s Natural Capital.

- European Commission, 2011a. Our life insurance, our natural capital: an EU biodiversity strategy to 2020.
- European Commission, 2011b. A resource-efficient Europe - Flagship initiative under the Europe 2020 Strategy.
- European Commission, 2011c. Roadmap to a Resource Efficient Europe (COM/2011/0571), Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of Regions.
- European Commission, 2003. Implementation of Directive 2001/42 on the Effects of Certain Plans and Programmes on the Environment.
- European Commission, 1997. Study on European Forestry Information and Communication System - Reports on forestry inventory and survey systems. Volume 2 - Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, Czech Republic, Hungary, Poland.
- Faehnle, M., Bäcklund, P., Tyrväinen, L., Niemelä, J., Yli-Pelkonen, V., 2014. How can residents' experiences inform planning of urban green infrastructure? Case Finland. *Landsc. Urban Plan.* 130, 171–183. doi:http://dx.doi.org/10.1016/j.landurbplan.2014.07.012
- Faludi, A., 2010. Centenary paper: European spatial planning: past, present and future. *Town Plan. Rev.* 81, 1–22. doi:10.3828/tpr.2009.21
- Faludi, A., 2009. A turning point in the development of European spatial planning? The "Territorial Agenda of the European Union" and the "First Action Programme." *Prog. Plann.* 71, 1–42. doi:http://dx.doi.org/10.1016/j.progress.2008.09.001
- Faludi, A., 2000. The Performance of Spatial Planning. *Plan. Pract. Res.* 15, 299–318. doi:10.1080/713691907
- Ferrão, J., 2011. *O Ordenamento do Território como Política Pública*. Fundação Calouste Gulbenkian, Lisboa.
- Fetters, M.D., Molina-Azorin, J.F., 2017. The Journal of Mixed Methods Research Starts a New Decade: Perspectives of Past Editors on the Current State of the Field and Future Directions. *J. Mix. Methods Res.* 11, 423–432. doi:10.1177/1558689817729476
- Fish, R., Saratsi, E., Reed, M., Keune, H., 2016. Stakeholder participation in ecosystem service decision making, in: Potschin, M., Haines-Young, R., Fish, R., Turner, K. (Eds.), *Routledge Handbook of Ecosystem Services*. Routledge, Abingdon and New York, pp. 256–270.
- Fisher, B., Costanza, R., Turner, K., Morling, P., 2007. Defining and Classifying Ecosystem Services for Decision Making, CSERGE Working Paper EDM 07-04.
- Fisher, B., Turner, R.K., Morling, P., 2009. Defining and classifying ecosystem services for decision making. *Ecol. Econ.* 68, 643–653. doi:10.1016/j.ecolecon.2008.09.014
- Fitzsimons, J., Pearson, C.J., Lawson, C., Hill, M.J., 2012. Evaluation of land-use planning in greenbelts based on intrinsic characteristics and stakeholder

- values. *Landsc. Urban Plan.* 106, 23–34.
doi:<http://dx.doi.org/10.1016/j.landurbplan.2012.01.012>
- Flyvbjerg, B., 2006. Five Misunderstandings About Case-Study Research. *Qual. Inq.* 12, 219–245. doi:10.1177/1077800405284363
- Foley, J.A., DeFries, R., Asner, G.P., Barford, C., Bonan, G., Carpenter, S.R., Chapin, F.S., Coe, M.T., Daily, G.C., Gibbs, H.K., Helkowski, J.H., Holloway, T., Howard, E.A., Kucharik, C.J., Monfreda, C., Patz, J.A., Prentice, I.C., Ramankutty, N., Snyder, P.K., 2005. Global Consequences of Land Use. *Science* (80-.). 309, 570–574. doi:10.1126/science.1111772
- Fontaine, C.M., Dendoncker, N., De Vreese, R., Jacquemin, I., Marek, A., Van Herzele, A., Devillet, G., Mortelmans, D., François, L., 2013. Towards participatory integrated valuation and modelling of ecosystem services under land-use change. *J. Land Use Sci.* 9, 278–303. doi:10.1080/1747423X.2013.786150
- Freeman, R.E., 1984. *Strategic Management: a Stakeholder Approach*. Pitman, Boston.
- Fundingsland Tetlow, M., Hanusch, M., 2012. Strategic environmental assessment: the state of the art. *Impact Assess. Proj. Apprais.* 30, 15–24. doi:10.1080/14615517.2012.666400
- Funtowicz, S.O., Ravetz, J.R., 1994. Uncertainty, complexity and post-normal science. *Environ. Toxicol. Chem.* 13, 1881–1885. doi:10.1002/etc.5620131203
- Fürst, C., Volk, M., Pietzsch, K., Makeschin, F., 2010. Pimp Your Landscape: A Tool for Qualitative Evaluation of the Effects of Regional Planning Measures on Ecosystem Services. *Environ. Manage.* 46, 953–968. doi:10.1007/s00267-010-9570-7
- Galler, C., Albert, C., von Haaren, C., 2016. From regional environmental planning to implementation: Paths and challenges of integrating ecosystem services. *Ecosyst. Serv.* 18, 118–129. doi:10.1016/j.ecoser.2016.02.031
- García-Nieto, A.P., Quintas-Soriano, C., García-Llorente, M., Palomo, I., Montes, C., Martín-López, B., 2015. Collaborative mapping of ecosystem services: The role of stakeholders' profiles. *Ecosyst. Serv.* 13, 141–152. doi:<http://dx.doi.org/10.1016/j.ecoser.2014.11.006>
- Gardi, C., Panagos, P., Liedekerke, M. Van, Bosco, C., Brogniez, D. De, 2015. Land take and food security: assessment of land take on the agricultural production in Europe. *J. Environ. Plan. Manag.* 58, 898–912. doi:10.1080/09640568.2014.899490
- Geneletti, D., 2013. Ecosystem services in environmental impact assessment and strategic environmental assessment. *Environ. Impact Assess. Rev.* 40, 1–2. doi:10.1016/j.eiar.2013.02.005
- Geneletti, D., 2011. Reasons and options for integrating ecosystem services in strategic environmental assessment of spatial planning. *Int. J. Biodivers. Sci. Ecosyst. Serv. Manag.* 7, 143–149. doi:10.1080/21513732.2011.617711
- Gerring, J., 2007. *Case Study Research: Principles and Practices*. Cambridge University Press, Cambridge.

- Gibbs, H.K., 2006. Olson's Major World Ecosystem Complexes Ranked by Carbon in Live Vegetation: An Updated Database Using the GLC2000 Land Cover Product. Oak Ridge, Tennessee.
- Glaves, P., Egan, D., Smith, S., Heaphy, D., Rowcroft, P., Fessey, M., East, S., 2010. Valuing Ecosystem Services in the East of England, Phase Two: Regional Pilot Technical Report. Sustainability East.
- Godfray, H.C.J., Beddington, J.R., Crute, I.R., Haddad, L., Lawrence, D., Muir, J.F., Pretty, J., Robinson, S., Thomas, S.M., Toulmin, C., 2010. Food Security: The Challenge of Feeding 9 Billion People. *Science* (80-). 327, 812 LP-818.
- Gómez-Baggethun, E., de Groot, R., 2010. Natural Capital and Ecosystem Services: The Ecological Foundation of Human Society, in: Hester, R.E., Harrison, R.M. (Eds.), *Ecosystem Services*. Royal Society of Chemistry, Cambridge, pp. 105–121.
- Gómez-Baggethun, E., de Groot, R., Lomas, P.L., Montes, C., 2010. The history of ecosystem services in economic theory and practice: From early notions to markets and payment schemes. *Ecol. Econ.* 69, 1209–1218. doi:10.1016/j.ecolecon.2009.11.007
- Gómez-Baggethun, E., Gren, Å., Barton, D.N., Langemeyer, J., McPhearson, T., O'Farrell, P., Andersson, E., Hamstead, Z., Kremer, P., 2013. Urban Ecosystem Services, in: Elmqvist, T., Fragkias, M., Goodness, J., Güneralp, B., Marcotullio, P.J., McDonald, R.I., Parnell, S., Schewenius, M., Sendstad, M., Seto, K.C., Wilkinson, C. (Eds.), *Urbanization, Biodiversity and Ecosystem Services: Challenges and Opportunities: A Global Assessment*. Springer Netherlands, Dordrecht, pp. 175–251. doi:10.1007/978-94-007-7088-1_11
- Granek, E.F., Polasky, S., Kappel, C. V, Reed, D.J., Stoms, D.M., Koch, E.W., Kennedy, C.J., Cramer, L.A., Hacker, S.D., Barbier, E.B., Aswani, S., Ruckelshaus, M., Perillo, G.M.E., Silliman, B.R., Muthiga, N., Bael, D., Wolanski, E., 2010. Ecosystem Services as a Common Language for Coastal Ecosystem-Based Management Los Servicios del Ecosistema como un Lenguaje Común para el Manejo de Costas Basado en Ecosistemas. *Conserv. Biol.* 24, 207–216. doi:10.1111/j.1523-1739.2009.01355.x
- Grêt-Regamey, A., Altwegg, J., Sirén, E.A., van Strien, M.J., Weibel, B., 2017. Integrating ecosystem services into spatial planning—A spatial decision support tool. *Landsc. Urban Plan.* 165, 206–219. doi:10.1016/j.landurbplan.2016.05.003
- Grimble, R., Wellard, K., 1997. Stakeholder methodologies in natural resource management: a review of principles, contexts, experiences and opportunities. *Agric. Syst.* 55, 173–193. doi:http://dx.doi.org/10.1016/S0308-521X(97)00006-1
- GSEOTC, 2005. Orientações Gerais para a Elaboração dos Planos Regionais de Ordenamento do Território.
- Guimarães, H., Braga, R., Mascarenhas, A., Ramos, T.B., 2017. Indicators of ecosystem services in a military Atlantic Forest area, Pernambuco—Brazil. *Ecol. Indic.* 80, 247–257. doi:10.1016/j.ecolind.2017.05.030

- Haase, A., Rink, D., Grossmann, K., Bernt, M., Mykhnenko, V., 2014. Conceptualizing urban shrinkage. *Environ. Plan. A* 46, 1519–1534.
- Haase, D., Kabisch, N., Haase, A., 2013. Endless Urban Growth? On the Mismatch of Population, Household and Urban Land Area Growth and Its Effects on the Urban Debate. *PLoS One* 8, e66531.
- Haase, D., Larondelle, N., Andersson, E., Artmann, M., Borgström, S., Breuste, J., Gomez-Baggethun, E., Gren, Å., Hamstead, Z., Hansen, R., Kabisch, N., Kremer, P., Langemeyer, J., Rall, E., McPhearson, T., Pauleit, S., Qureshi, S., Schwarz, N., Voigt, A., Wurster, D., Elmqvist, T., 2014. A Quantitative Review of Urban Ecosystem Service Assessments: Concepts, Models, and Implementation. *Ambio* 43, 413–433. doi:10.1007/s13280-014-0504-0
- Haase, D., Nuissl, H., 2010. Assessing the impacts of land use change on transforming regions. *J. Land Use Sci.* 5, 67–72. doi:10.1080/1747423x.2010.481074
- Haber, W., 2007. Energy, food, and land --- The ecological traps of humankind. *Environ. Sci. Pollut. Res. - Int.* 14, 359–365. doi:10.1065/espr2007.09.449
- HABITAT III, 2016. New Urban Agenda: Draft Outcome Document for Adoption in Quito, October 2016.
- Haines-Young, R., Potschin, M., 2010a. Proposal for a Common International Classification of Ecosystem Goods and Services (CICES) for Integrated Environmental and Economic Accounting. European Environment Agency, Nottingham.
- Haines-Young, R., Potschin, M., 2010b. The links between biodiversity, ecosystem services and human well-being, in: Raffaelli, D., Frid, C. (Eds.), *Ecosystem Ecology: A New Synthesis*. CUP, Cambridge.
- Haines-Young, R., Potschin, M.P., 2010c. The links between biodiversity, ecosystem services and human well-being, in: Raffaelli, D., Frid, C. (Eds.), *Ecosystem Ecology: A New Synthesis*. CUP, Cambridge.
- Hattam, C., Böhnke-Henrichs, A., Börger, T., Burdon, D., Hadjimichael, M., Delaney, A., Atkins, J.P., Garrard, S., Austen, M.C., 2015. Integrating methods for ecosystem service assessment and valuation: Mixed methods or mixed messages? *Ecol. Econ.* 120, 126–138. doi:10.1016/j.ecolecon.2015.10.011
- Hatton MacDonald, D., Bark, R.H., Coggan, A., 2014. Is ecosystem service research used by decision-makers? A case study of the Murray-Darling Basin, Australia. *Landsc. Ecol.* 29, 1447–1460. doi:10.1007/s10980-014-0021-3
- Hauck, J., Görg, C., Varjopuro, R., Ratamáki, O., Jax, K., 2013a. Benefits and limitations of the ecosystem services concept in environmental policy and decision making: Some stakeholder perspectives. *Environ. Sci. Policy* 25, 13–21. doi:10.1016/j.envsci.2012.08.001
- Hauck, J., Schweppe-Kraft, B., Albert, C., Görg, C., Jax, K., Jensen, R., Fürst, C., Maes, J., Ring, I., Höningová, I., Burkhard, B., Mehring, M., Tiefenbach, M., Grunewald, K., Schwarzer, M., Meurer, J., Sommerhäuser, M., Priess, J.A., Schmidt, J., Grêt-Regamey, A., 2013b. The Promise of the Ecosystem

- Services Concept for Planning and Decision-Making. *GAIA - Ecol. Perspect. Sci. Soc.* 22, 232–236.
- Hein, L., van Koppen, K., de Groot, R.S., van Ierland, E.C., 2006. Spatial scales, stakeholders and the valuation of ecosystem services. *Ecol. Econ.* 57, 209–228. doi:http://dx.doi.org/10.1016/j.ecolecon.2005.04.005
- Helming, K., Pérez-Soba, M., Tabbush, P., 2008. Sustainability impact assessment of land use changes.
- Hobbs, J., Ghanime, L., Paris, R., Levine, T., Wang, S., Dalal-Clayton, B., OECD, 2010. *Strategic Environmental Assessment and Ecosystem Services*.
- Holsti, O.R., 1968. Content analysis, in: Lindzey, G., Aaronson, E. (Eds.), *The Handbook of Social Psychology*. Addison-Wesley, Reading, MA.
- Honey-Rosés, J., Pendleton, L.H., 2013. A demand driven research agenda for ecosystem services. *Ecosyst. Serv.* 5, 160–162. doi:http://dx.doi.org/10.1016/j.ecoser.2013.04.007
- Honrado, J.P., Vieira, C., Soares, C., Monteiro, M.B., Marcos, B., Pereira, H.M., Partidário, M.R., 2013. Can we infer about ecosystem services from EIA and SEA practice? A framework for analysis and examples from Portugal. *Environ. Impact Assess. Rev.* 40, 14–24. doi:http://dx.doi.org/10.1016/j.eiar.2012.12.002
- Hsieh, H.-F., Shannon, S.E., 2005. Three Approaches to Qualitative Content Analysis. *Qual. Health Res.* 15, 1277–1288. doi:10.1177/1049732305276687
- Hubacek, K., Kronenberg, J., 2013. Synthesizing different perspectives on the value of urban ecosystem services. *Landsc. Urban Plan.* 109, 1–6. doi:http://dx.doi.org/10.1016/j.landurbplan.2012.10.010
- IHRU, 2015. *Estratégia Nacional para a Habitação: Desafios e Mudanças*. Lisbon.
- INE, 2016a. *Statistical Yearbook of Área Metropolitana de Lisboa 2015*. Lisbon.
- INE, 2016b. *Estatísticas Agrícolas 2015 (Agricultural Statistics 2015)*. Lisboa.
- Jacobs, S., Dendoncker, N., Keune, H., 2014. Editorial for *Ecosystem Services - Global Issues, Local Practices*, in: Jacobs, S., Dendoncker, N., Keune, H. (Eds.), *Ecosystem Services - Global Issues, Local Practices*. Elsevier, San Diego, CA, pp. xix–xxviii.
- Jacobs, S., Dendoncker, N., Martín-López, B., Barton, D.N., Gomez-Baggethun, E., Boeraeve, F., McGrath, F.L., Vierikko, K., Geneletti, D., Sevecke, K.J., Pipart, N., Primmer, E., Mederly, P., Schmidt, S., Aragão, A., Baral, H., Bark, R.H., Briceno, T., Brogna, D., Cabral, P., De Vreese, R., Liqueste, C., Mueller, H., Peh, K.S.-H., Phelan, A., Rincón, A.R., Rogers, S.H., Turkelboom, F., Van Reeth, W., van Zanten, B.T., Wam, H.K., Washbourn, C.L., 2016. A new valuation school: Integrating diverse values of nature in resource and land use decisions. *Ecosyst. Serv.* 22, 213–220. doi:10.1016/j.ecoser.2016.11.007
- Jaeger, J.A.G., Schwick, C., 2014. Improving the measurement of urban sprawl: Weighted Urban Proliferation (WUP) and its application to Switzerland. *Ecol. Indic.* 38, 294–308. doi:10.1016/j.ecolind.2013.11.022

- Janis, I.L., 1972. Victims of groupthink: A psychological study of foreign-policy decisions and fiascoes. Houghton Mifflin, Boston, MA.
- Johnson, R.B., Onwuegbuzie, A.J., Turner, L.A., 2007. Toward a Definition of Mixed Methods Research. *J. Mix. Methods Res.* 1, 112–133. doi:10.1177/1558689806298224
- Kabisch, N., Strohbach, M., Haase, D., Kronenberg, J., 2016. Urban green space availability in European cities. *Ecol. Indic.* 70, 586–596. doi:10.1016/j.ecolind.2016.02.029
- Kaczorowska, A., Kain, J.-H., Kronenberg, J., Haase, D., 2015. Ecosystem services in urban land use planning: Integration challenges in complex urban settings—Case of Stockholm. *Ecosyst. Serv.* doi:http://dx.doi.org/10.1016/j.ecoser.2015.04.006
- Kain, J.-H., Larondelle, N., Haase, D., Kaczorowska, A., 2016. Exploring local consequences of two land-use alternatives for the supply of urban ecosystem services in Stockholm year 2050. *Ecol. Indic.* 70, 615–629. doi:10.1016/j.ecolind.2016.02.062
- Kasanko, M., Barredo, J.I., Lavalle, C., McCormick, N., Demicheli, L., Sagris, V., Brezger, A., 2006. Are European cities becoming dispersed?: A comparative analysis of 15 European urban areas. *Landsc. Urban Plan.* 77, 111–130. doi:10.1016/j.landurbplan.2005.02.003
- Kelley, K., Clark, B., Brown, V., Sitzia, J., 2003. Good practice in the conduct and reporting of survey research. *Int. J. Qual. Heal. Care* 15, 261–266. doi:10.1093/intqhc/mzg031
- Kettunen, M., ten Brink, P., Underwood, E., Salomaa, A., 2014. Policy Needs and Opportunities for Operationalising the Concept of Ecosystem Services.
- Kopperoinen, L., Albert, C., Itkonen, P., 2016. Applications of biodiversity and ecosystem services impact assessment in spatial planning, in: Geneletti, D. (Ed.), *Handbook on Biodiversity and Ecosystem Services in Impact Assessment*. Edward Elgar Publishing Limited, Cheltenham, pp. 222–254.
- Koschke, L., Fürst, C., Frank, S., Makeschin, F., 2012. A multi-criteria approach for an integrated land-cover-based assessment of ecosystem services provision to support landscape planning. *Ecol. Indic.* 21, 54–66. doi:http://dx.doi.org/10.1016/j.ecolind.2011.12.010
- Koschke, L., Van der Meulen, S., Frank, S., Schneidergruber, A., Kruse, M., Fürst, C., Neubert, E., Schröder, C., Müller, F., Bastian, O., 2014. Do You Have 5 Minutes To Spare? – The Challenges Of Stakeholder Processes In Ecosystem Services Studies. *Landsc. Online* 37, 1–25.
- Lamarque, P., Quétier, F., Lavorel, S., 2011. The diversity of the ecosystem services concept and its implications for their assessment and management. *C. R. Biol.* 334, 441–449. doi:http://dx.doi.org/10.1016/j.crv.2010.11.007
- Larondelle, N., Frantzeskaki, N., Haase, D., 2016. Mapping transition potential with stakeholder- and policy-driven scenarios in Rotterdam City. *Ecol. Indic.* doi:10.1016/j.ecolind.2016.02.028
- Larondelle, N., Haase, D., 2013. Urban ecosystem services assessment along a

- rural–urban gradient: A cross-analysis of European cities. *Ecol. Indic.* 29, 179–190. doi:10.1016/j.ecolind.2012.12.022
- Larondelle, N., Haase, D., 2012. Valuing post-mining landscapes using an ecosystem services approach—An example from Germany. *Ecol. Indic.* 18, 567–574. doi:http://dx.doi.org/10.1016/j.ecolind.2012.01.008
- Larondelle, N., Haase, D., Kabisch, N., 2014. Mapping the diversity of regulating ecosystem services in European cities. *Glob. Environ. Chang.* 26, 119–129. doi:http://dx.doi.org/10.1016/j.gloenvcha.2014.04.008
- Lauf, S., Haase, D., Kleinschmit, B., 2016. The effects of growth, shrinkage, population aging and preference shifts on urban development—A spatial scenario analysis of Berlin, Germany. *Land use policy* 52, 240–254. doi:10.1016/j.landusepol.2015.12.017
- Lavalle, C., Barbosa, A.L., Mubareka, S., Jacobs-Crisioni, C., Baranzelli, C., Castillo, C.P., 2013. Land Use Related Indicators for Resource Efficiency - Part I Land Take Assessment. Luxembourg. doi:10.2788/94223
- Leone, F., Zoppi, C., 2016. Conservation Measures and Loss of Ecosystem Services: A Study Concerning the Sardinian Natura 2000 Network. *Sustain.* . doi:10.3390/su8101061
- Liekens, I., De Nocker, L., 2013. Valuation of ES: Challenges and Policy Use, in: Jacobs, S., Dendoncker, N., Keune, H. (Eds.), *Ecosystem Services - Global Issues, Local Practices*. Elsevier, San Diego, CA, pp. 107–119. doi:http://dx.doi.org/10.1016/B978-0-12-419964-4.00011-1
- Lienhoop, N., Bartkowski, B., Hansjürgens, B., 2015. Informing biodiversity policy: The role of economic valuation, deliberative institutions and deliberative monetary valuation. *Environ. Sci. Policy* 54, 522–532. doi:http://dx.doi.org/10.1016/j.envsci.2015.01.007
- Lietz, P., 2010. Research into questionnaire design. *Int. J. Mark. Res.* 52, 249–272. doi:citeulike-article-id:10634466
- Liu, J., Opdam, P., 2014. Valuing ecosystem services in community-based landscape planning: introducing a wellbeing-based approach. *Landsc. Ecol.* 29, 1347–1360. doi:10.1007/s10980-014-0045-8
- Liu, S., Costanza, R., Troy, A., D’Aagostino, J., Mates, W., 2010. Valuing New Jersey’s Ecosystem Services and Natural Capital: A Spatially Explicit Benefit Transfer Approach. *Environ. Manage.* 45, 1271–1285. doi:10.1007/s00267-010-9483-5
- Losarcos, L., Romero, L., n.d. Green Infrastructure In-Depth Case Analysis.
- Luederitz, C., Brink, E., Gralla, F., Hermelingmeier, V., Meyer, M., Niven, L., Panzer, L., Partelow, S., Rau, A.-L., Sasaki, R., Abson, D.J., Lang, D.J., Wamsler, C., von Wehrden, H., 2015. A review of urban ecosystem services: six key challenges for future research. *Ecosyst. Serv.* 14, 98–112. doi:http://dx.doi.org/10.1016/j.ecoser.2015.05.001
- MA, 2005a. *Ecosystems and Human Well-being: Synthesis*. Island Press, Washington, DC.
- MA, 2005b. *Ecosystems and Human Well-being:Scenarios*. Island Press,

Washington DC.

- MA, 2003. *Ecosystems and Human Well-being: A Framework for Assessment*. Island Press, Washington DC.
- Mace, G., 2016. Ecosystem services: Where is the discipline heading?, in: Potschin, M., Haines-Young, R., Fish, R., Turner, R.K. (Eds.), *Routledge Handbook of Ecosystem Services*. Routledge, Abingdon and New York, pp. 602–606.
- Mace, G.M., Norris, K., Fitter, A.H., 2012. Biodiversity and ecosystem services: a multilayered relationship. *Trends Ecol. & Evol.* 27, 19–26. doi:10.1016/j.tree.2011.08.006
- Maes, J., Barbosa, A., Baranzelli, C., Zulian, G., Batista e Silva, F., Vandecasteele, I., Hiederer, R., Liqueste, C., Paracchini, M., Mubareka, S., Jacobs-Crisioni, C., Castillo, C., Lavallo, C., 2015. More green infrastructure is required to maintain ecosystem services under current trends in land-use change in Europe. *Landsc. Ecol.* 30, 517–534. doi:10.1007/s10980-014-0083-2
- Maes, J., Crossman, N.D., Burkhard, B., 2016. Mapping ecosystem services, in: Potschin, M., Haines-Young, R., Fish, R., Turner, R.K. (Eds.), *Routledge Handbook of Ecosystem Services*. Routledge, Abingdon and New York, pp. 188–204.
- Maes, J., Egoh, B., Willemen, L., Liqueste, C., Vihervaara, P., Schägner, J.P., Grizzetti, B., Drakou, E.G., Notte, A. La, Zulian, G., Bouraoui, F., Luisa Paracchini, M., Braat, L., Bidoglio, G., 2012a. Mapping ecosystem services for policy support and decision making in the European Union. *Ecosyst. Serv.* 1, 31–39. doi:10.1016/j.ecoser.2012.06.004
- Maes, J., Hauck, J., Paracchini, M.L., Ratamäki, O., Hutchins, M., Termansen, M., Furman, E., Pérez-Soba, M., Braat, L., Bidoglio, G., 2013a. Mainstreaming ecosystem services into EU policy. *Curr. Opin. Environ. Sustain.* 5, 128–134. doi:http://dx.doi.org/10.1016/j.cosust.2013.01.002
- Maes, J., Hauck, J., Paracchini, M.L., Ratamäki, O., Termansen, M., Perez-Soba, M., Kopperoinen, L., Rankinen, K., Schägner, J.P., Henrys, P., Cisowska, I., Zandersen, M., Jax, K., La Notte, A., Leikola, N., Pouta, E., Smart, S., Hasler, B., Lankia, T., Andersen, H.E., Lavallo, C., Vermaas, T., Alemu, M.H., Scholefield, P., Batista, F., Pywell, R., Hutchins, M., Blemmer, M., Fonnesbech-Wulff, A., Vanbergen, A.J., Münier, B., Baranzelli, C., Roy, D., Thieu, V., Zulian, G., Kuussaari, M., Thodsen, H., Alanen, E.-L., Egoh, B., Sørensen, P.B., Braat, L., Bidoglio, G., Research, P. for E.E., 2012b. A spatial assessment of ecosystem services in Europe: methods, case studies and policy analysis - phase 2. Ispra.
- Maes, J., Teller, A., Erhard, M., Liqueste, C., Braat, L., Berry, P., Egoh, B., Puydarrieux, P., Fiorina, C., Santos, F., Paracchini, M.L., Keune, H., Wittmer, H., Hauck, J., Fiala, I., Verburg, P.H., Condé, S., Schägner, J.P., San Miguel, J., Estreguil, C., Ostermann, O., Barredo, J.I., Pereira, H.M., Stott, A., Laporte, V., Meiner, A., Olah, B., Royo Gelabert, E., Spyropoulou, R., Petersen, J.E., Maguire, C., Zal, N., Achilleos, E., Rubin, A., Ledoux, L., Brown, C., Raes, C., Jacobs, S., Vandewalle, M., Connor, D., Bidoglio, G., 2013b. Mapping and Assessment of Ecosystems and their Services. An

- analytical framework for ecosystem assessments under action 5 of the EU biodiversity strategy to 2020. Luxembourg.
- Malinga, R., Gordon, L.J., Lindborg, R., Jewitt, G., 2013. Using Participatory Scenario Planning to Identify Ecosystem Services in Changing Landscapes. *Ecol. Soc.* 18. doi:10.5751/ES-05494-180410
- MAOTDR, 2006. Programa Nacional da Política de Ordenamento do Território – Programa de Acção.
- Marsh, G.P., 1864. *Man and Nature; or, Physical Geography as Modified by Human Action*. Charles Scribner, New York.
- Mascarenhas, A., Coelho, P., Subtil, E., Ramos, T.B., 2010. The role of common local indicators in regional sustainability assessment. *Ecol. Indic.* 10, 646–656. doi:http://dx.doi.org/10.1016/j.ecolind.2009.11.003
- Mascarenhas, A., Nunes, L.M., Ramos, T.B., 2014a. Exploring the self-assessment of sustainability indicators by different stakeholders. *Ecol. Indic.* 39, 75–83. doi:http://dx.doi.org/10.1016/j.ecolind.2013.12.001
- Mascarenhas, A., Ramos, T., Haase, D., Santos, R., 2014b. Integration of ecosystem services in spatial planning: a survey on regional planners' views. *Landsc. Ecol.* 29, 1287–1300. doi:10.1007/s10980-014-0012-4
- Mascarenhas, A., Ramos, T.B., Haase, D., Santos, R., 2016. Participatory selection of ecosystem services for spatial planning: Insights from the Lisbon Metropolitan Area, Portugal. *Ecosyst. Serv.* 18, 87–99. doi:10.1016/j.ecoser.2016.02.011
- Mascarenhas, A., Ramos, T.B., Haase, D., Santos, R., 2012a. Ecosystem services in regional spatial plans and SEA. 32nd Annu. Meet. Int. Assoc. Impact Assess.
- Mascarenhas, A., Ramos, T.B., Nunes, L., 2012b. Developing an integrated approach for the strategic monitoring of regional spatial plans. *Land use policy* 29, 641–651. doi:http://dx.doi.org/10.1016/j.landusepol.2011.10.006
- Matzdorf, B., Meyer, C., 2014. The relevance of the ecosystem services framework for developed countries' environmental policies: A comparative case study of the US and EU. *Land use policy* 38, 509–521. doi:http://dx.doi.org/10.1016/j.landusepol.2013.12.011
- Mazza, L., Bennett, G., De Nocker, L., Gantioler, S., Losarcos, L., Margerison, C., Kaphengst, T., McConville, A., Rayment, M., ten Brink, P., Tucker, G., van Diggelen, R., 2011. *Green Infrastructure Implementation and Efficiency*. Final report for the European Commission, DG Environment on Contract ENV.B.2/SER/2010/0059. London and Brussels.
- Mccall, M.K., Dunn, C.E., 2012. Geo-information tools for participatory spatial planning: Fulfilling the criteria for “good” governance? *Geoforum* 43, 81–94. doi:10.1016/j.geoforum.2011.07.007
- McDonald, R.I., 2015. *Conservation for Cities: How to Plan and Build Natural Infrastructure*. Island Press, Washington D.C.
- McDonald, R.I., Forman, R.T.T., Kareiva, P., Neugarten, R., Salzer, D., Fisher, J., 2009. Urban effects, distance, and protected areas in an urbanizing world.

- Landsc. Urban Plan. 93, 63–75. doi:10.1016/j.landurbplan.2009.06.002
- McKenzie, E., Posner, S., Tillmann, P., Bernhardt, J.R., Howard, K., Rosenthal, A., 2014. Understanding the Use of Ecosystem Service Knowledge in Decision Making: Lessons from International Experiences of Spatial Planning. *Environ. Plan. C Gov. Policy* 32, 320–340. doi:10.1068/c12292j
- Meadows, D.H., Meadows, D.L., Randers, J., Behrens, W.W., 1972. *The limits to growth*. Universe Books, New York.
- Menzel, S., Teng, J., 2010. Ecosystem Services as a Stakeholder-Driven Concept for Conservation Science. *Conserv. Biol.* 24, 907–909. doi:10.1111/j.1523-1739.2009.01347.x
- Metz, D., Wiegel, L., Conservancy, T.N., 2010. Key Findings From Recent National Opinion Research on “Ecosystem Services.” The Nature Conservancy, Missoula MT.
- Metzger, M.J., Rounsevell, M.D.A., Acosta-Michlik, L., Leemans, R., Schröter, D., 2006. The vulnerability of ecosystem services to land use change. *Agric. Ecosyst. Environ.* 114, 69–85. doi:10.1016/j.agee.2005.11.025
- Mooney, H.A., Ehrlich, P.R., 1997. Ecosystem Services: a Fragmentary History, in: Daily, G. (Ed.), *Nature’s Services: Societal Dependence on Natural Ecosystems*. Island Press, Washington DC.
- Morphet, J., 2011. *Effective Practice in Spatial Planning*, The RTPI Library. Routledge, New York.
- Müller, F., Burkhard, B., 2012. The indicator side of ecosystem services. *Ecosyst. Serv.* 1, 26–30. doi:10.1016/j.ecoser.2012.06.001
- Müller, F., Groot, R.S. de, Willemen, L., 2010. Ecosystem Services at the Landscape Scale: the Need for Integrative Approaches. *Landsc. online Off. J. Int. Assoc. Landsc. Ecol.* 11.
- Nadin, V., 2007. The emergence of the spatial planning approach in England. *Plan. Pract. Res.* 22, 43–62. doi:10.1080/02697450701455934
- Nadin, V., Stead, D., 2008. European Spatial Planning Systems, Social Models and Learning. *disP - Plan. Rev.* 44, 35–47. doi:10.1080/02513625.2008.10557001
- Namaalwa, S., Van dam, A.A., Funk, A., Ajie, G.S., Kaggwa, R.C., 2013. A characterization of the drivers, pressures, ecosystem functions and services of Namatala wetland, Uganda. *Environ. Sci. Policy* 34, 44–57. doi:http://dx.doi.org/10.1016/j.envsci.2013.01.002
- Natural England, 2010. *Nature Nearby: Accessible Natural Greenspace*.
- Nelson, G.C., Janetos, A., Bennet, E., 2005. Drivers of change in ecosystem condition and services, in: Carpenter, S.R., Pingali, L.P., Bennett, M.E., Zurek, M.B. (Eds.), *Scenarios Assessment of the Millennium Ecosystem Assessment*. Island Press, London, pp. 174–222.
- Neuendorf, K.A., 2002. *The Content Analysis Guidebook*. Sage Publications, Thousand Oaks, CA.
- Nidumolu, U.B., de Bie, C., van Keulen, H., Skidmore, A.K., Harmsen, K., 2006.

- Review of a land use planning programme through the soft systems methodology. *Land use policy* 23, 187–203. doi:10.1016/j.landusepol.2004.08.003
- Nieto-Romero, M., Oteros-Rozas, E., González, J.A., Martín-López, B., 2014. Exploring the knowledge landscape of ecosystem services assessments in Mediterranean agroecosystems: Insights for future research. *Environ. Sci. Policy* 37, 121–133. doi:http://dx.doi.org/10.1016/j.envsci.2013.09.003
- Nilsson, M., Wiklund, H., Finnveden, G., Jonsson, D.K., Lundberg, K., Tyskeng, S., Wallgren, O., 2009. Analytical framework and tool kit for SEA follow-up. *Environ. Impact Assess. Rev.* 29, 186–199. doi:http://dx.doi.org/10.1016/j.eiar.2008.09.002
- Noble, B., Nwanekezie, K., 2017. Conceptualizing strategic environmental assessment: Principles, approaches and research directions. *Environ. Impact Assess. Rev.* 62, 165–173. doi:10.1016/j.eiar.2016.03.005
- Norgaard, R.B., 1989. The case for methodological pluralism. *Ecol. Econ.* 1, 37–57. doi:10.1016/0921-8009(89)90023-2
- Noy, C., 2008. Sampling Knowledge: The Hermeneutics of Snowball Sampling in Qualitative Research. *Int. J. Soc. Res. Methodol.* 11, 327–344. doi:10.1080/13645570701401305
- Nuissl, H., Rink, D., Couch, C., Karecha, C., 2008. Decline and Sprawl: Urban Sprawl is not Confined to Expanding City Regions, in: *Urban Sprawl in Europe*. Blackwell Publishing Ltd, pp. 136–162. doi:10.1002/9780470692066.ch5
- Nuissl, H., Siedentop, S., 2013. Landscape planning for minimizing land consumption, in: Meyers, R.A. (Ed.), *Encyclopedia of Sustainability Science and Technology*. Springer, New York, pp. 5785–5817.
- O'Toole, K., Wallis, A., Mitchell, B., 2006. Local perceptions of sustainability indicators: Issues of scale and implications for management. *Rural Soc.* 16, 25–46. doi:10.5172/rsj.351.16.1.25
- Opdam, P., Foppen, R., Vos, C., 2001. Bridging the gap between ecology and spatial planning in landscape ecology. *Landsc. Ecol.* 16, 767–779. doi:10.1023/A:1014475908949
- Orenstein, D.E., Groner, E., 2014. In the eye of the stakeholder: Changes in perceptions of ecosystem services across an international border. *Ecosyst. Serv.* 8, 185–196. doi:http://dx.doi.org/10.1016/j.ecoser.2014.04.004
- Padeiro, M., 2016. Conformance in land-use planning: The determinants of decision, conversion and transgression. *Land use policy* 55, 285–299. doi:10.1016/j.landusepol.2016.04.014
- Paracchini, M.L., Zulian, G., Kopperoinen, L., Maes, J., Schägner, J.P., Termansen, M., Zandersen, M., Perez-Soba, M., Scholefield, P.A., Bidoglio, G., 2014. Mapping cultural ecosystem services: A framework to assess the potential for outdoor recreation across the EU. *Ecol. Indic.* 45, 371–385. doi:10.1016/j.ecolind.2014.04.018
- Partidário, M.R., 2012. *Guia de melhores práticas para Avaliação Ambiental*

- Estratégica - orientações metodológicas para um pensamento estratégico em AAE. Agência Portuguesa do Ambiente, Lisboa.
- Partidário, M.R., 2007. Guia de boas práticas para Avaliação Ambiental Estratégica - orientações metodológicas. Agência Portuguesa do Ambiente, Amadora.
- Partidário, M.R., Arts, J., 2005. Exploring the concept of strategic environmental assessment follow-up. *Impact Assess. Proj. Apprais.* 23, 246–257. doi:10.3152/147154605781765481
- Partidário, M.R., Gomes, R.C., 2013. Ecosystem services inclusive strategic environmental assessment. *Environ. Impact Assess. Rev.* 40, 36–46. doi:http://dx.doi.org/10.1016/j.eiar.2013.01.001
- Pascual, U., Muradian, R., Brander, L., Gómez-Baggethun, E., Martín-López, B., Verma, M., Armsworth, P., Christie, M., Cornelissen, H., Eppink, F., Farley, J., Loomis, J., Pearson, L., Perrings, C., Polasky, S., 2010. The economics of valuing ecosystem services and biodiversity, in: Kumar, P. (Ed.), *The Economics of Ecosystems and Biodiversity (TEEB) Ecological and Economic Foundations*. Earthscan, London and Washington.
- Paudyal, K., Baral, H., Burkhard, B., Bhandari, S.P., Keenan, R.J., 2015. Participatory assessment and mapping of ecosystem services in a data-poor region: Case study of community-managed forests in central Nepal. *Ecosyst. Serv.* 13, 81–92. doi:http://dx.doi.org/10.1016/j.ecoser.2015.01.007
- Perdicoúlis, A., 2011. *Building Competences for Spatial Planners, The Natural and Built Environment*. Routledge, New York.
- Pereira, H.M., Domingos, T., Vicente, L., Proença, V., 2009. *Ecosistemas e Bem-Estar Humano - Avaliação para Portugal do Millenium Ecosystem Assessment*.
- Perrings, C., Duraiappah, A., Larigauderie, A., Mooney, H., 2011. The Biodiversity and Ecosystem Services Science-Policy Interface. *Science* (80-). 331, 1139–1140. doi:10.1126/science.1202400
- Philippe, D., Böhme, K., Zaucha, J., 2014. EU territory and policy-making: from words to deeds to promote policy integration. *Eur. J. Spat. Dev.*
- Pinto, T.C., 2012. Patterns of housing demand under uncertainty: a case study in Lisbon. *Cid. Comunidades e Territ.* 25, 21–35.
- Pires, A.D.R., 2005. The fragile foundations of european spatial planning in Portugal. *Eur. Plan. Stud.* 13, 237–252. doi:10.1080/0965431042000321802
- Piwowarczyk, J., Kronenberg, J., Dereniowska, M.A., 2013. Marine ecosystem services in urban areas: Do the strategic documents of Polish coastal municipalities reflect their importance? *Landsc. Urban Plan.* 109, 85–93. doi:http://dx.doi.org/10.1016/j.landurbplan.2012.10.009
- Podestá, G.P., Natenzon, C.E., Hidalgo, C., Ruiz Toranzo, F., 2013. Interdisciplinary production of knowledge with participation of stakeholders: A case study of a collaborative project on climate variability, human decisions and agricultural ecosystems in the Argentine Pampas. *Environ. Sci. Policy* 26, 40–48.

- doi:<http://dx.doi.org/10.1016/j.envsci.2012.07.008>
- Potschin, M., Haines-Young, R., 2017. Linking people and nature: Socio-ecological systems, in: Burkhard, B., Maes, J. (Eds.), *Ecosystem Services Mapping*. Pensoft Publishers, Sofia, pp. 41–43.
- Potschin, M., Haines-Young, R., Fish, R., Turner, R.K., 2016. Ecosystem services: Linking and informing agendas – introduction, in: Potschin, M., Roy, H.-Y., Fish, R., Turner, R.K. (Eds.), *Routledge Handbook of Ecosystem Services*. Routledge, Abingdon and New York, pp. 469–472.
- Potschin, M.B., Haines-Young, R.H., 2011. Ecosystem services: Exploring a geographical perspective. *Prog. Phys. Geogr.* 35, 575–594. doi:10.1177/0309133311423172
- Primmer, E., Furman, E., 2012. Operationalising ecosystem service approaches for governance: Do measuring, mapping and valuing integrate sector-specific knowledge systems? *Ecosyst. Serv.* 1, 85–92. doi:10.1016/j.ecoser.2012.07.008
- Prokop, G., Jobstmann, H., Schönbauer, A., 2011. Overview of best practices for limiting soil sealing or mitigating its effects in EU-27.
- Rae, A., Wong, C., 2012. Monitoring Spatial Planning Policies: Towards an Analytical, Adaptive, and Spatial Approach to a “Wicked Problem.” *Environ. Plan. B Plan. Des.* 39, 880–896. doi:10.1068/b37112
- Rall, E.L., Kabisch, N., Hansen, R., 2015. A comparative exploration of uptake and potential application of ecosystem services in urban planning. *Ecosyst. Serv.* 16, 230–242. doi:10.1016/j.ecoser.2015.10.005
- Ramirez-Gomez, S.O.I., Torres-Vitolas, C.A., Schreckenberg, K., Honzák, M., Cruz-Garcia, G.S., Willcock, S., Palacios, E., Pérez-Miñana, E., Verweij, P.A., Poppy, G.M., 2015. Analysis of ecosystem services provision in the Colombian Amazon using participatory research and mapping techniques. *Ecosyst. Serv.* 13, 93–107. doi:<http://dx.doi.org/10.1016/j.ecoser.2014.12.009>
- Rea, L.M., Parker, R.A., 1997. *Designing and Conducting Survey Research: A Comprehensive Guide*, 2nd ed. Jossey-Bass Publishers, San Francisco.
- Reed, M.S., 2008. Stakeholder participation for environmental management: A literature review. *Biol. Conserv.* 141, 2417–2431. doi:<http://dx.doi.org/10.1016/j.biocon.2008.07.014>
- Reed, M.S., Graves, A., Dandy, N., Posthumus, H., Hubacek, K., Morris, J., Prell, C., Quinn, C.H., Stringer, L.C., 2009. Who’s in and why? A typology of stakeholder analysis methods for natural resource management. *J. Environ. Manage.* 90, 1933–1949. doi:<http://dx.doi.org/10.1016/j.jenvman.2009.01.001>
- Reyers, B., O’Farrell, P.J., Cowling, R.M., Egoh, B.N., Le Maitre, D.C., Vlok, J.H.J., 2009. Ecosystem services, land-cover change, and stakeholders: finding a sustainable foothold for a semiarid biodiversity hotspot. *Ecol. Soc.* 14, 38.
- Reyers, B., Polasky, S., Tallis, H., Mooney, H.A., Larigauderie, A., 2012. Finding

- Common Ground for Biodiversity and Ecosystem Services. *Bioscience* 62, 503–507. doi:10.1525/bio.2012.62.5.12
- Roberts, P., 2006. Evaluating regional sustainable development: Approaches, methods and the politics of analysis. *J. Environ. Plan. Manag.* 49, 515–532. doi:10.1080/09640560600747786
- Rockstrom, J., Steffen, W., Noone, K., Persson, A., Chapin, F.S., Lambin, E., Lenton, T.M., Scheffer, M., Folke, C., Schellnhuber, H.J., Nykvist, B., de Wit, C.A., Hughes, T., van der Leeuw, S., Rodhe, H., Sörlin, S., Snyder, P.K., Costanza, R., Svedin, U., Falkenmark, M., Karlberg, L., Corell, R.W., Fabry, V.J., Hansen, J., Walker, B., Liverman, D., Richardson, K., Crutzen, P., Foley, J., 2009. Planetary Boundaries: Exploring the Safe Operating Space for Humanity. *Ecol Soc* 14:32.
- Rodríguez-Rodríguez, D., Kain, J.H., Haase, D., Baró, F., Kaczorowska, A., 2015. Urban self-sufficiency through optimised ecosystem service demand. A utopian perspective from European cities. *Futures* 70, 13–23. doi:http://dx.doi.org/10.1016/j.futures.2015.03.007
- Rodríguez, J.P., Beard, J.T.D., Bennett, E.M., Cumming, G.S., Cork, S.J., Agard, J., Dobson, A.P., Peterson, G.D., 2006. Trade-offs across Space, Time, and Ecosystem Services. *Ecol. Soc.* 11.
- Rosenström, U., 2006. Exploring the Policy Use of Sustainable Development Indicators: Interviews with Finnish Politicians. *J. Transdiscipl. Environ. Stud.* 5, 1–13.
- Rosenthal, A., Verutes, G., McKenzie, E., Arkema, K.K., Bhagabati, N., Bremer, L.L., Olwero, N., Vogl, A.L., 2014. Process matters: a framework for conducting decision-relevant assessments of ecosystem services. *Int. J. Biodivers. Sci. Ecosyst. Serv. Manag.* 1–15. doi:10.1080/21513732.2014.966149
- Rounsevell, M.D.A., Metzger, M.J., 2010. Developing qualitative scenario storylines for environmental change assessment. *Wiley Interdiscip. Rev. Clim. Chang.* 1, 606–619. doi:10.1002/wcc.63
- Rozas-Vásquez, D., Fürst, C., Geneletti, D., Muñoz, F., 2017. Multi-actor involvement for integrating ecosystem services in strategic environmental assessment of spatial plans. *Environ. Impact Assess. Rev.* 62, 135–146. doi:10.1016/j.eiar.2016.09.001
- Ruckelshaus, M., McKenzie, E., Tallis, H., Guerry, A., Daily, G., Kareiva, P., Polasky, S., Ricketts, T., Bhagabati, N., Wood, S.A., Bernhardt, J., 2013. Notes from the field: Lessons learned from using ecosystem service approaches to inform real-world decisions. *Ecol. Econ.* 115, 11–21. doi:http://dx.doi.org/10.1016/j.ecolecon.2013.07.009
- Ruhl, J.B., 2011. Ecosystem services and the Clean Water Act: strategies for fitting new science into old law. *Environ. Law* 40, 1381–1399.
- Ruhl, J.B., Kraft, S.E., Lant, C.L., 2007. *The Law and Policy of Ecosystem Services*. Island Press, Washington, DC.
- Ryan, R.L., 2011. The social landscape of planning: Integrating social and perceptual research with spatial planning information. *Landsc. Urban Plan.*

- 100, 361–363. doi:<http://dx.doi.org/10.1016/j.landurbplan.2011.01.015>
- Saarikoski, H., Primmer, E., Saarela, S.-R., Antunes, P., Aszalós, R., Baró, F., Berry, P., Blanco, G.G., Gómez-Baggethun, E., Carvalho, L., Dick, J., Dunford, R., Hanzu, M., Harrison, P.A., Izakovicova, Z., Kertész, M., Kopperoinen, L., Köhler, B., Langemeyer, J., Lapola, D., Liqueste, C., Luque, S., Mederly, P., Niemelä, J., Palomo, I., Pastur, G.M., Peri, P.L., Preda, E., Priess, J.A., Santos, R., Schleyer, C., Turkelboom, F., Vadineanu, A., Verheyden, W., Vikström, S., Young, J., 2017. Institutional challenges in putting ecosystem service knowledge in practice. *Ecosyst. Serv.* doi:10.1016/j.ecoser.2017.07.019
- Sagoff, M., 2011. The quantification and valuation of ecosystem services. *Ecol. Econ.* 70, 497–502. doi:10.1016/j.ecolecon.2010.10.006
- Salez, P., 2009. How Europe comes to spatial planning: from the birth of regional policy to the Green Paper on territorial cohesion, the emergence of the Community as a player over more than 20 years (translated from French), in: Yves, J., Baudelle, G. (Eds.), *L'Europe – Aménager Les Territoires*. Armand Colin, Paris, p. 424.
- Sallustio, L., Quatrini, V., Geneletti, D., Corona, P., Marchetti, M., 2015. Assessing land take by urban development and its impact on carbon storage: Findings from two case studies in Italy. *Environ. Impact Assess. Rev.* 54, 80–90. doi:10.1016/j.eiar.2015.05.006
- Santos, S., Cabral, P., Zamyatin, A., 2015. Scenarios and Modeling of Land Use and Cover Changes in Portugal from 1980 to 2040. *Int. J. Agric. Environ. Inf. Syst.* 4, 1–15. doi:10.4018/IJAEIS.2015100101
- Schleyer, C., Görg, C., Hauck, J., Winkler, K.J., 2015. Opportunities and challenges for mainstreaming the ecosystem services concept in the multi-level policy-making within the EU. *Ecosyst. Serv.* 16, 174–181. doi:10.1016/j.ecoser.2015.10.014
- Schröter, D., Cramer, W., Leemans, R., Prentice, I.C., Araújo, M.B., Arnell, N.W., Bondeau, A., Bugmann, H., Carter, T.R., Gracia, C.A., de la Vega-Leinert, A.C., Erhard, M., Ewert, F., Glendining, M., House, J.I., Kankaanpää, S., Klein, R.J.T., Lavorel, S., Lindner, M., Metzger, M.J., Meyer, J., Mitchell, T.D., Reginster, I., Rounsevell, M., Sabaté, S., Sitch, S., Smith, B., Smith, J., Smith, P., Sykes, M.T., Thonicke, K., Thuiller, W., Tuck, G., Zaehle, S., Zierl, B., 2005. Ecosystem Service Supply and Vulnerability to Global Change in Europe. *Science* (80-.). 310, 1333–1337. doi:10.1126/science.1115233
- Schröter, M., van der Zanden, E.H., van Oudenhoven, A.P.E., Remme, R.P., Serna-Chavez, H.M., de Groot, R.S., Opdam, P., 2014. Ecosystem Services as a Contested Concept: a Synthesis of Critique and Counter-Arguments. *Conserv. Lett.* 7, 514–523. doi:10.1111/conl.12091
- Schwarz, N., Bauer, A., Haase, D., 2011. Assessing climate impacts of planning policies—An estimation for the urban region of Leipzig (Germany). *Environ. Impact Assess. Rev.* 31, 97–111. doi:10.1016/j.eiar.2010.02.002
- Seppelt, R., Dormann, C.F., Eppink, F. V., Lautenbach, S., Schmidt, S., 2011. A quantitative review of ecosystem service studies: approaches, shortcomings and the road ahead. *J. Appl. Ecol.* 48, 630–636. doi:10.1111/j.1365-

2664.2010.01952.x

- Seto, K.C., Fragkias, M., Güneralp, B., Reilly, M.K., 2011. A Meta-Analysis of Global Urban Land Expansion. *PLoS One* 6, e23777.
- Shapiro, J., Báldi, A., 2014. Accurate accounting: How to balance ecosystem services and disservices. *Ecosyst. Serv.* 7, 201–202. doi:<http://dx.doi.org/10.1016/j.ecoser.2014.01.002>
- Sitas, N., Prozesky, H., Esler, K., Reyers, B., 2014. Opportunities and challenges for mainstreaming ecosystem services in development planning: perspectives from a landscape level. *Landsc. Ecol.* 29, 1315–1331. doi:[10.1007/s10980-013-9952-3](https://doi.org/10.1007/s10980-013-9952-3)
- Slootweg, R., van Beukering, P., 2008. *Valuation of Ecosystem Services and Strategic Environmental Assessment - Lessons from Influential Cases*. Utrecht.
- Söderman, T., Kopperoinen, L., Shemeikka, P., Yli-Pelkonen, V., 2012. Ecosystem Services Criteria for Sustainable Development in Urban Regions. *J. Environ. Assess. Policy Manag.* 14, 1250008. doi:[10.1142/S1464333212500081](https://doi.org/10.1142/S1464333212500081)
- Söderman, T., Saarela, S.-R., 2010. Biodiversity in strategic environmental assessment (SEA) of municipal spatial plans in Finland. *Impact Assess. Proj. Apprais.* 28, 117–133. doi:[10.3152/146155110X498834](https://doi.org/10.3152/146155110X498834)
- Spangenberg, J.H., 2013. Ecosystem Services in a Societal Context, in: Jacobs, S., Dendoncker, N., Keune, H. (Eds.), *Ecosystem Services - Global Issues, Local Practices*. Elsevier, San Diego, CA, pp. 91–95. doi:<http://dx.doi.org/10.1016/B978-0-12-419964-4.00009-3>
- Spangenberg, J.H., 2002. Environmental space and the prism of sustainability: frameworks for indicators measuring sustainable development. *Ecol. Indic.* 2, 295–309. doi:[http://dx.doi.org/10.1016/S1470-160X\(02\)00065-1](http://dx.doi.org/10.1016/S1470-160X(02)00065-1)
- Spangenberg, J.H., Görg, C., Truong, D.T., Tekken, V., Bustamante, J.V., Settele, J., 2014. Provision of ecosystem services is determined by human agency, not ecosystem functions. Four case studies. *Int. J. Biodivers. Sci. Ecosyst. Serv. Manag.* 10, 40–53. doi:[10.1080/21513732.2014.884166](https://doi.org/10.1080/21513732.2014.884166)
- Spangenberg, J.H., Settele, J., 2010. Precisely incorrect? Monetising the value of ecosystem services. *Ecol. Complex.* 7, 327–337. doi:<http://dx.doi.org/10.1016/j.ecocom.2010.04.007>
- Spash, C.L., 2007. Deliberative monetary valuation (DMV): Issues in combining economic and political processes to value environmental change. *Ecol. Econ.* 63, 690–699. doi:<http://dx.doi.org/10.1016/j.ecolecon.2007.02.014>
- Strohbach, M.W., Haase, D., 2012. Above-ground carbon storage by urban trees in Leipzig, Germany: Analysis of patterns in a European city. *Landsc. Urban Plan.* 104, 95–104. doi:[10.1016/j.landurbplan.2011.10.001](https://doi.org/10.1016/j.landurbplan.2011.10.001)
- Sutherland, I.J., Villamagna, A.M., Dallaire, C.O., Bennett, E.M., Chin, A.T.M., Yeung, A.C.Y., Lamothe, K.A., Tomscha, S.A., Cormier, R., 2017. Undervalued and under pressure: A plea for greater attention toward regulating ecosystem services. *Ecol. Indic.* doi:[10.1016/j.ecolind.2017.06.047](https://doi.org/10.1016/j.ecolind.2017.06.047)

- Tallis, H., Polasky, S., 2009. Mapping and Valuing Ecosystem Services as an Approach for Conservation and Natural-Resource Management. *Ann. N. Y. Acad. Sci.* 1162, 265–283. doi:10.1111/j.1749-6632.2009.04152.x
- Teddlie, C., Tashakkori, A., 2010. Overview of contemporary issues in mixed methods research, in: Teddlie, C., Tashakkori, A. (Eds.), *SAGE Handbook of Mixed Methods in Social & Behavioral Research*. SAGE Publications, Inc., Thousand Oaks, California, pp. 1–42. doi:10.4135/9781506335193
- TEEB, 2010a. *The Economics of Ecosystems and Biodiversity for Local and Regional Policy Makers*. UNEP.
- TEEB, 2010b. *The Economics of Ecosystems and Biodiversity: Mainstreaming the Economics of Nature: A synthesis of the approach, conclusions and recommendations of TEEB*.
- ten Brink, P., Kettunen, M., 2016. A policy perspective on mainstreaming ecosystem services: opportunities and risks, in: Potschin, M., Roy, H.-Y., Fish, R., Turner, R.K. (Eds.), *Routledge Handbook of Ecosystem Services*. Routledge, Abingdon and New York, pp. 473–480.
- Termorshuizen, J., Opdam, P., 2009. Landscape services as a bridge between landscape ecology and sustainable development. *Landsc. Ecol.* 24, 1037–1052. doi:10.1007/s10980-008-9314-8
- Therivel, R., 2004. *Strategic Environmental Assessment in Action*. Earthscan, London.
- Tian, Y., Jim, C.Y., Wang, H., 2014. Assessing the landscape and ecological quality of urban green spaces in a compact city. *Landsc. Urban Plan.* 121, 97–108. doi:10.1016/j.landurbplan.2013.10.001
- Tratalos, J., Fuller, R.A., Warren, P.H., Davies, R.G., Gaston, K.J., 2007. Urban form, biodiversity potential and ecosystem services. *Landsc. Urban Plan.* 83, 308–317. doi:10.1016/j.landurbplan.2007.05.003
- UN, 2015. *Transforming our world: the 2030 Agenda for Sustainable Development*. United Nations, New York.
- UNECE, 2012. *Resource Manual to Support Application of the Protocol on Strategic Environmental Assessment*.
- UNEP/CBD/COP/DEC/X/2, 2010. *The Strategic Plan for Biodiversity 2011–2020 and the Aichi Biodiversity Targets*. Conference of the Parties to the Convention on Biological Diversity, Nagoya.
- UNEP, Programme, U.N.E., 2014. *Integrating Ecosystem Services in Strategic Environmental Assessment: A guide for practitioners*. United Nations Environment Programme.
- UWE Bristol, 2016. *Future brief: No net land take by 2050?* Bristol.
- Valerio, Q., Anna, B., Francesco, C., Diego, G., Dalila, R., Piermaria, C., 2015. Monitoring land take by point sampling: Pace and dynamics of urban expansion in the Metropolitan City of Rome. *Landsc. Urban Plan.* 143, 126–133. doi:10.1016/j.landurbplan.2015.06.012
- von Haaren, C., Albert, C., 2011. Integrating ecosystem services and environmental planning: limitations and synergies. *Int. J. Biodivers. Sci.*

- Ecosyst. Serv. Manag. 7, 150–167. doi:10.1080/21513732.2011.616534
- WCED, 1987. *Our Common Future*. Oxford University Press, Oxford.
- Weber, M.A., Ringold, P.L., 2015. Priority river metrics for residents of an urbanized arid watershed. *Landsc. Urban Plan.* 133, 37–52. doi:http://dx.doi.org/10.1016/j.landurbplan.2014.09.006
- Weber, R.P., 1990. *Basic Content Analysis, 2nd ed, Quantitative Applications in the Social Sciences*. Sage Publications, Thousand Oaks, CA.
- Westman, W.E., 1977. How Much Are Nature's Services Worth? *Science* (80-.). 197, 960–964. doi:10.1126/science.197.4307.960
- Wilkinson, C., Saarne, T., Peterson, G.D., Colding, J., 2013. Strategic Spatial Planning and the Ecosystem Services Concept – an Historical Exploration. *Ecol. Soc.* 18, 37. doi:10.5751/ES-05368-180137
- Yin, R.K., 2011. *Qualitative Research from Start to Finish*. The Guilford Press, New York.
- Yin, R.K., 2003. *Case Study Research: Design and Methods*, 3rd ed. SAGE Publications Inc, Thousand Oaks, CA.
- Zorrilla-Miras, P., Palomo, I., Gómez-Baggethun, E., Martín-López, B., Lomas, P.L., Montes, C., 2014. Effects of land-use change on wetland ecosystem services: A case study in the Doñana marshes (SW Spain). *Landsc. Urban Plan.* 122, 160–174. doi:http://dx.doi.org/10.1016/j.landurbplan.2013.09.013

Appendices

Appendix 1 – Document version of the online questionnaire

Ecosystem services in regional spatial planning

Welcome!

The main goal of this questionnaire is to investigate what are the factors that influence the integration of the concept of ecosystem services in regional spatial planning processes.

This questionnaire is targeted at presidents, vice-presidents, service directors, division chiefs and practitioners of all regional spatial planning authorities, which are or have been involved in regional spatial planning processes.

The results of this questionnaire will provide a valuable contribution for an ongoing PhD research in CENSE – Center for Environmental and Sustainability Research (Universidade Nova de Lisboa) and the Lab of Landscape Ecology (Humboldt University in Berlin), entitled “Assessing the effects of spatial plans on ecosystem services at regional scale”.

Please read each question carefully. The questionnaire takes about 15 minutes to respond and is divided in four distinct sections:

Section 1 – Framing

Section 2 – Ecosystem services

Section 3 – Ecosystem services and regional spatial planning

Section 4 – Additional information and follow-up of results

Responses to this questionnaire are anonymous and will be exclusively used for scientific research ends.

Thank you for your cooperation!

If you find any difficulty in filling-in the questionnaire please contact André Mascarenhas through the address XXX or telephone number XXX.

1 – Framing

1.1. In which regional spatial planning authority do you work?

- CCDR Norte
- CCDR Centro
- CCDR Lisboa e Vale do Tejo
- CCDR Alentejo
- CCDR Algarve
- Secretaria Regional do Ambiente e dos Recursos Naturais (Região Autónoma da Madeira)
- Secretaria Regional do Ambiente e do Mar (Região Autónoma dos Açores)

1.2. In which regional spatial plan(s) are or were you involved?

- PROT Norte
- PROT Centro
- PROT Oeste e Vale do Tejo
- PROT Área Metropolitana de Lisboa
- PROT Alentejo
- PROT Algarve
- POTRAM (R.A. Madeira)
- PROT Açores

1.3. In which phase(s) of the regional spatial planning process do or did you work / follow?

- Elaboration of terms of reference
- Elaboration of characterization and diagnostic studies
- Elaboration of plan proposal (e.g. definition of strategic goals and options, guiding standards, territorial model)
- Following of the strategic environmental assessment process
- Plan implementation after approval
- Participation in follow-up, monitoring and evaluation body
- Other(s). Which ones: _____

2 – Ecosystem services

In this section of the questionnaire you will be asked some questions about ecosystem services. It is important that you respond without purposely consulting information on ecosystem services. In case receiving this questionnaire has already triggered such consultation, please answer without using its results.

2.1. How well do you know the concept of “ecosystem services”?

- Very well
- Quite well
- Fairly well
- Slightly well
- Not at all

2.2. If you did not respond “Not at all” to the previous question, how would you define what ecosystem services are?

Open response

2.3. How well do you know the following concepts?

	Very well	Quite well	Fairly well	Slightly well	Not at all
Environmental services					
Natural capital					
Ecosystem functions					
Landscape functions					
Green economy					

2.4. How well do you know the following initiatives?:

	Very well	Quite well	Fairly well	Slightly well	Not at all
Millenium Ecosystem Assessment					
Ecosistemas e Bem-Estar Humano					
The Economics of Ecosystems and Biodiversity (TEEB)					

3 – Ecosystem services and regional spatial planning

For this section of the questionnaire, the most popular definition of ecosystem services is presented, following the *Millenium Ecosystem Assessment*¹⁰:

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.

¹⁰ The Millennium Ecosystem Assessment (MA) was called for by the United Nations Secretary-General Kofi Annan in 2000. Initiated in 2001, the objective of the MA was to assess the consequences of ecosystem change for human well-being and the scientific basis for action needed to enhance the conservation and sustainable use of those systems and their contribution to human well-being. The MA has involved the work of more than 1,360 experts worldwide. Their findings provide a state-of-the-art scientific appraisal of the condition and trends in the world’s ecosystems and the services they provide (such as clean water, food, forest products, flood control, and natural resources) and the options to restore, conserve or enhance the sustainable use of ecosystems.

3.1. How do you rate the degree of integration of the concept of ecosystem services in the regional spatial plan you are or were involved?

- Very high
- High
- Fair
- Low
- Very low / Inexistent
- Do not know / Do not answer

3.2. How do you rate the degree of integration of the concept of ecosystem services in the strategic environmental assessment of the above mentioned regional spatial plan?

- Very high
- High
- Fair
- Low
- Very low / Inexistent
- Do not know / Do not answer

3.3. How do you rate the contribution of each of the following factors, for the integration of the concept of ecosystem services in the above mentioned regional spatial plan?

Factors	Very positive	Positive	Null	Negative	Very negative	Do not know / Do not answer	Not applicable
Generalized knowledge, within the institution, of the concept of ecosystem services							
Guidance from higher hierarchical bodies of the institution							
Technical skills of the staff							
Financial resources							

Proposals from the external team or consultants in plan design							
Proposals from the Mixed Coordination Commission							
Guidelines from the national scale to the regional scale							
Recommendations from the Strategic Environmental Assessment							
Outcomes of public consultation							
Availability of baseline data							
Availability of studies (e.g. academic, technical reports)							
Others. Which ones?							

3.4. Do you consider important to integrate the concept of ecosystem services in regional spatial planning?

- Very important
- Quite important
- Fairly important
- Slightly important
- Not at all important
- Do not know / Do not answer

3.5. If you did not respond “Not at all important” or “Do not know / Do not answer” to the previous question, in which stages / components of the planning process do you consider important to integrate the concept of ecosystem services in regional spatial planning?

	Very important	Quite important	Fairly important	Slightly important	Not at all important	Do not know / Do not answer
Elaboration of terms of reference						
Definition of the vision and main strategic goals of the plan						
Elaboration of characterization and diagnostic studies						
Definition of strategic options of territorial basis of the plan						
Definition of the guiding standards of the plan						
Definition of the follow-up, monitoring and evaluation of the plan						
Characterization of baseline situation, within the Strategic Environmental Assessment						
Assessment of effects, within the Strategic Environmental Assessment						
Recommendations of the Strategic Environmental Assessment						
Monitoring program set out by the Strategic Environmental Assessment						
Other(s). Which one(s)?						

4 – Additional information and follow-up of results

4.1. In which division / department do you work?

Open response

4.2. What position do you hold?

Open response

4.3. What is your academic background?

Degree	Degree designation	Conclusion date
<i>Open response</i>	<i>Open response</i>	<i>Open response</i>
<i>Open response</i>	<i>Open response</i>	<i>Open response</i>
<i>Open response</i>	<i>Open response</i>	<i>Open response</i>
<i>Open response</i>	<i>Open response</i>	<i>Open response</i>

4.4. How many years of professional experience do you have:

4.4.1. In total?

Open response

4.4.2. Working in regional spatial planning?

Open response

4.5. Additional observations / comments about the questionnaire (optional):

Open response

4.6. Do you wish to receive updates on the aggregated results of this questionnaire and other project results?

- Yes
- No

4.7. Do you wish to participate in eventual future initiatives of the project?

- Yes
- No

4.8. In case you responded “Yes” to questions 4.6. or 4.7. please provide an e-mail address

Open response

Thank you very much for your cooperation!

Would you like to know more about ecosystem services?

[Click here to access an informative brochure by the European Commission](#)

Appendix 2 – Additional results of the online questionnaire

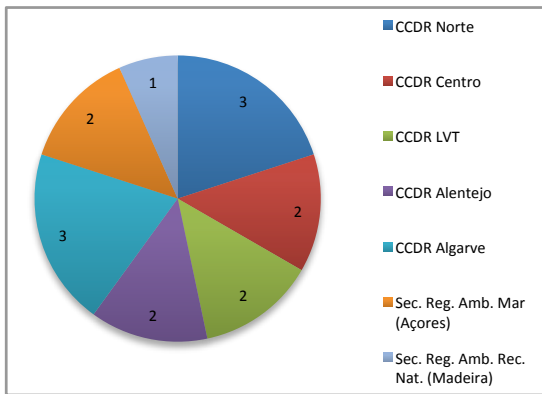


Figure 1 – Responses to “In which regional spatial planning authority do you work?”.

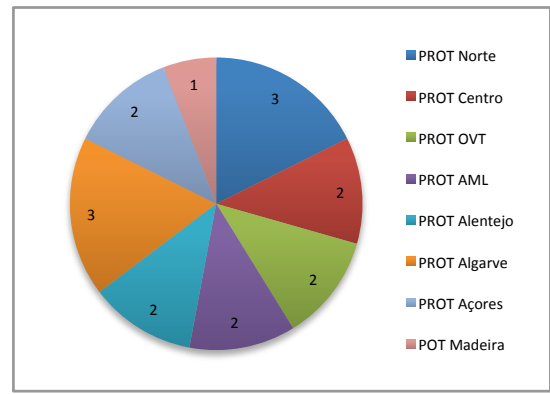


Figure 2 – Responses to “In which regional spatial plan(s) are or were you involved?”.

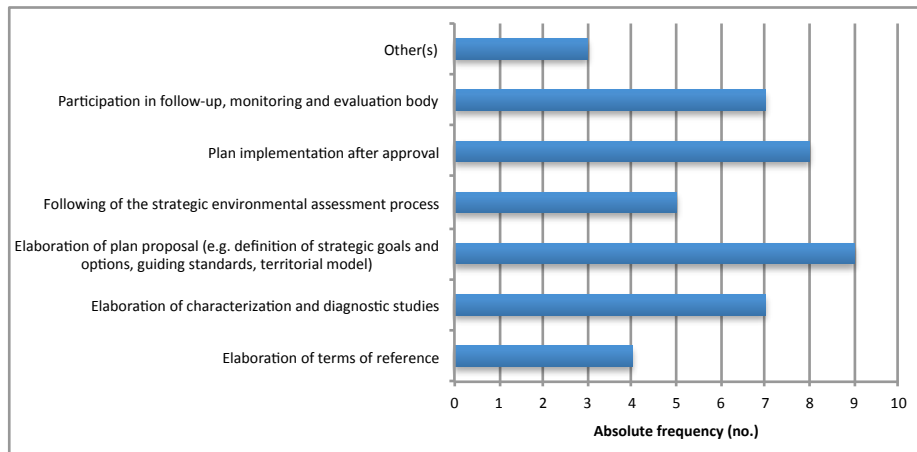


Figure 3 – Responses to “In which phase(s) of the regional spatial planning process do or did you work / follow?”.

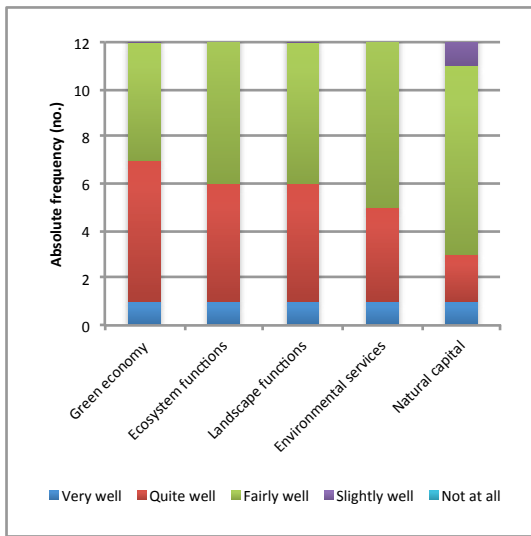


Figure 4 – Responses to “How well do you know the following concepts?”.

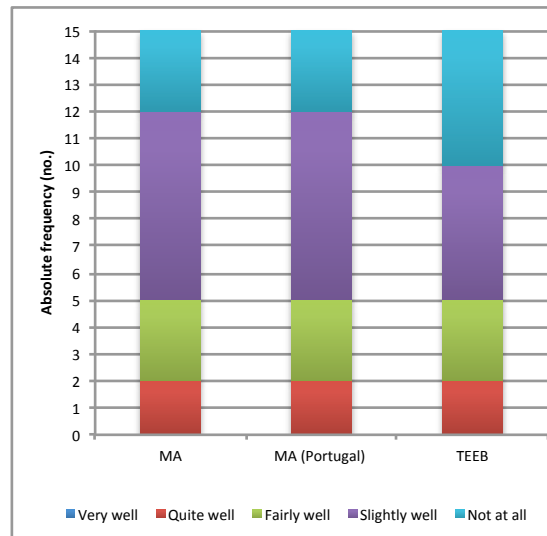


Figure 5 – Responses to “How well do you know the following initiatives?”. MA – Millennium Ecosystem Assessment; MA (Portugal) – Portuguese sub-global assessment of MA; TEEB – The Economics of Ecosystems and Biodiversity.

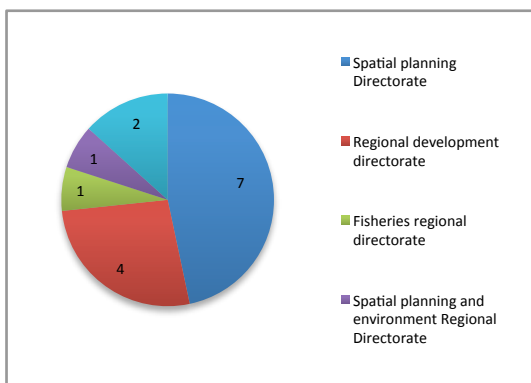


Figure 6 – Responses to “In which division / department do you work?”.

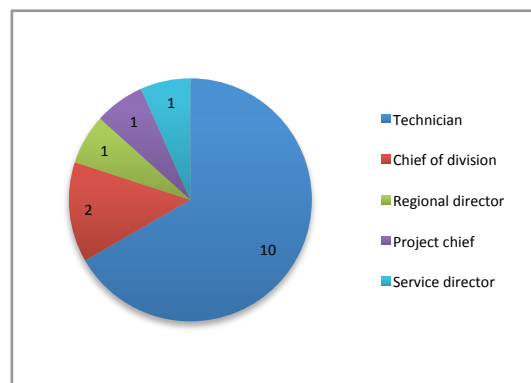


Figure 7 – Responses to “What position do you hold?”.

Table 1 – Responses to “What is your academic background?”.

Field of study	Frequency
Graduation	
Geography and Regional Planning	4
Architecture	4
Public relations	1
Biology	1
Forestry Engineering	1
Sociology and Planning	1
Aquatic Environment Sciences	1
Economy	1
Engineering	1
Post-graduation	
Territorial management	1
Business management	1
Coastal management	1
Regional Development	1
Natural resource planning and management	1
Public management	1
Building rehabilitation	1
Spatial and environmental planning	1

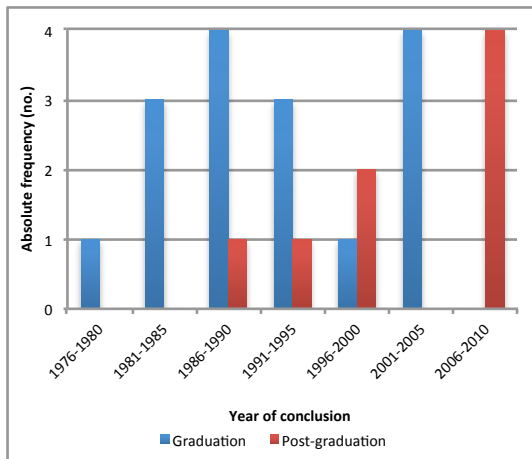


Figure 8 – Responses to “What is your academic background?” (continued).

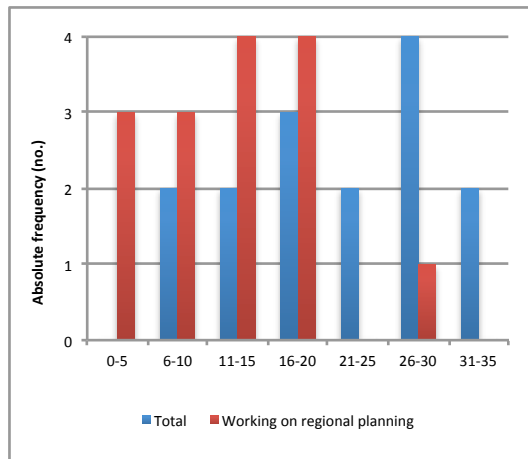


Figure 9 – Responses to “How many years of professional experience do you have: (i) in total; (ii) working regional spatial planning?”

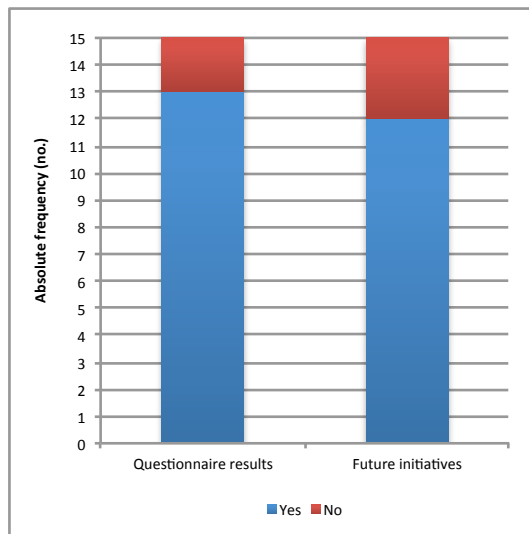


Figure 10 – Responses to “Do you wish to receive updates on the aggregated results of this questionnaire and other project results?” and “Do you wish to participate in eventual future initiatives of the project?”.

Appendix 3 – Supplementary material for Chapter 4

Table A.3.1 – Sample of the matrix used in the second group meeting with technical staff from the regional spatial planning authority. Note: the plan does not set targets with direct correspondence to Lines of Action or Key Objectives.

Domains for Vision Implementation (and targets)	Lines of Action	Key Objectives	CLC class (Code; ↑ / ↓ / = / ?) ^a	Comments
<p>C. Sustainability and Synthyony with Nature</p> <p>Targets:</p> <p># Maintenance or increase of ERPVA area with land-use that favors nature and biodiversity conservation</p> <p># 80% of quarry areas with exhausted geological resources with Landscape and Environmental Recovery Plan</p> <p># Decrease in the population living in risk areas (flash flooding and landsliding)</p> <p># Final energy intensity less than 137,4 tep/M€</p> <p># 31% share of renewables in total final energy consumption</p> <p># More efficient mobility in terms of GHG</p> <p># Complying with legal limits</p>	C1. To ensure the functioning of the Metropolitan Ecological Network	To preserve biodiversity		
		To increase public use green spaces		
	C2. To ensure the functioning of the natural systems	To ensure the quality of the Tejo/Sado aquifer		
		Environmental reclaiming of contaminated soils		
		To diminish pressure on maritime and estuarine fronts		
	C3. To use and enhance resources in a logic of sustainability	To preserve soils with more agricultural and forest value		
		To enhance tourism in the rural space, ensuring synergies with the agricultural activity		
		To know, conserve and enhance the geological heritage		
	C4. To avoid and mitigate risks	To reduce population exposure to natural, technological and environmental risks		
	C5. To invest in energetic sustainability as a lever for innovation and competitiveness	To reduce dependence in fossil fuel sources		
		To reduce energetic dependence from the exterior, increasing supply security		
		To increase energy efficiency and the exporting capacity of high techno-		

Appendices

for air quality # 100% increase in the selective waste collection # Decrease of water losses to less than 20% # Increase of 35% in the reuse of treated wastewater # Decrease in exposure to noise and compliance with legal limits		logical intensity based on renewable energies and energy efficiency		
	C6. To promote a more sustainable mobility	To reduce emission of atmospheric pollutants		
		To increase energy efficiency of transport		
		To integrate soft modes in trips		
	C7. To improve sanitation of the region	To preserve water quality and improve supply efficiency		
		To improve efficiency in water consumption		
	C1. To ensure the functioning of the Metropolitan Ecological Network	To reduce the volume of waste going to landfills		

Table A.3.2 – Sample of the matrix used in the third group meeting with technical staff from the regional spatial planning authority.

Domains for Vision Implementation (and targets)	Lines of Action	Key Objectives	Ecosystem services (CICES code; + / - / ?) ^a	Comments
C. Sustainability and Synthony with Nature Targets: # Maintenance or increase of ERPVA area with land-use that favors nature and biodiversity conservation # 80% of quarry areas with exhausted geological resources with	C1. To ensure the functioning of the Metropolitan Ecological Network	To preserve biodiversity		
		To increase public use green spaces		
	C2. To ensure the functioning of the natural systems	To ensure the quality of the Tejo/Sado aquifer		
		Environmental reclaiming of contaminated soils		
		To diminish pressure on maritime and estuarine fronts		
	C3. To use and enhance resources in a logic of sustainability	To preserve soils with more agricultural and forest value		
		To enhance tourism in		

<p>Landscape and Environmental Recovery Plan</p> <p># Decrease in the population living in risk areas (flash flooding and landsliding)</p> <p># Final energy intensity less than 137,4 tep/M€</p> <p># 31% share of renewables in total final energy consumption</p> <p># More efficient mobility in terms of GHG</p> <p># Complying with legal limits for air quality</p> <p># 100% increase in the selective waste collection</p> <p># Decrease of water losses to less than 20%</p> <p># Increase of 35% in the reuse of treated wastewater</p> <p># Decrease in exposure to noise and compliance with legal limits</p>		the rural space, ensuring synergies with the agricultural activity		
		To know, conserve and enhance the geological heritage		
	C4. To avoid and mitigate risks	To reduce population exposure to natural, technological and environmental risks		
	C5. To invest in energetic sustainability as a lever for innovation and competitiveness	To reduce dependence in fossil fuel sources		
		To reduce energetic dependence from the exterior, increasing supply security		
		To increase energy efficiency and the exporting capacity of high technological intensity based on renewable energies and energy efficiency		
	C6. To promote a more sustainable mobility	To reduce emission of atmospheric pollutants		
		To increase energy efficiency of transport		
		To integrate soft modes in trips		
	C7. To improve sanitation of the region	To preserve water quality and improve supply efficiency		
		To improve efficiency in water consumption		
	C1. To ensure the functioning of the Metropolitan Ecological Network	To reduce the volume of waste going to landfills		

^a Legend: (CICES code) – according to the nomenclature presented in Table 3; (+) – positive effect on the identified ES; (-) – negative effect on the identified ES; (?) – Possible effects worthy of further investigation.

Table A.3.3 – Sample of CICES table with codes for the different aggregation levels of ES. Adapted from Haines-Young and Potschin (2010).

Section	Division	Group	Class	Examples
1. Provisioning	1.1. Nutrition	1.1.1. Bio-mass	1.1.1.1. Cultivated crops	Cereals (e.g. wheat, rye, barely), vegetables, fruits etc.
			1.1.1.2. Reared animals and their outputs	Meat, dairy products (milk, cheese, yoghurt), honey etc.
			1.1.1.3. Wild plants, algae and their outputs	Wild berries, fruits, mushrooms, water cress, salicornia (saltwort or samphire); seaweed (e.g. <i>Palmaria palmata</i> = dulse, dillisk) for food
			1.1.1.4. Wild animals and their outputs	Game, freshwater fish (trout, eel etc.), marine fish (plaice, sea bass etc.) and shellfish (i.e. crustaceans, molluscs), as well as equinoderms or honey harvested from wild populations; Includes commercial and subsistence fishing and hunting for food
			1.1.1.5. Plants and algae from in-situ aquaculture	In situ seaweed farming
			1.1.1.6. Animals from in-situ aquaculture	In-situ farming of freshwater (e.g. trout) and marine fish (e.g. salmon, tuna) also in floating cages; shellfish aquaculture (e.g. oysters or crustaceans) in e.g. poles
		1.1.2. Water	1.1.2.1. Surface water for drinking	Collected precipitation, abstracted surface water from rivers, lakes and other open water bodies for drinking
			1.1.2.2. Ground water for drinking	Freshwater abstracted from (non-fossil) ground-water layers or via ground water desalination for

Section	Division	Group	Class	Examples
				drinking

Table A.3.4 – Sample of the matrix used to identify ES affected by driving forces.

Driving forces	Affected ecosystem services (CICES code; + / - / ?)
Expansion of agricultural area	
Decrease of forest area	
Expansion of industrial area	
Urbanization of non-urban areas	
Implementation of new transportation infrastructure (e.g. roads, railways)	
Dispersed settlements	
Expansion of green urban space	
Urbanization of river, estuarine and coastal margins	

^a Legend: (CICES code) – according to the nomenclature presented in Table 3; (+) – positive effect on the identified ES; (-) – negative effect on the identified ES; (?) – Possible effects worthy of further investigation.

Table A.3.5 – Most important ES selected by participants in the first focus group meeting with the regional authority. Results presented only for the ES considered important by four or more participants (same for aggregation).

Section	Division	Group	Class	Number of votes	Aggregation (no. of participants)
Provisioning	Nutrition	Biomass	Cultivated crops	7	-
		Water	Ground water for drinking	5	-
	Materials	Water	Ground water for non-drinking purposes	4	-
Regulation and maintenance	Mediation of flows	Mass flows	Mass stabilisation and control of erosion rates	6	A (4)
			Buffering and attenuation of mass flows	4	A (4)

		Liquid flows	Hydrological cycle and water flow maintenance	7	B (6)
			Flood protection	6	B (6)
	Maintenance of physical, chemical, biological conditions	Atmospheric composition and climate regulation	Micro and regional climate regulation	5	-
Cultural	Physical and intellectual interactions with biota, ecosystems, and land-/seascapes [environmental settings]	Intellectual and representative interactions	Heritage, cultural	7	C (5)
			Entertainment	5	C (5)

Table A.3.6 – Effects of planning objectives on land use / land cover in the region, as identified by participants in the second focus group meeting with the regional authority.

CLC class	Expected change	Planning objective	Ecosystem types (level 2)
11. Urban fabric	↓	To diminish pressure on maritime and estuarine margins	Urban
	=	To regenerate in an integrated fashion the social housing neighbourhoods To invest in urban rehabilitation instead of new construction for housing	
12. Industrial, commercial and transport units	↓	To diminish pressure on maritime and estuarine margins	Urban
121. Industrial or commercial units	↑	To invest in transformation logistics	
		To reinforce and diversify the supply of infrastructured areas for economic activities	
123. Port areas	↑	To enhance the international touristic attractiveness of the region in a sustainability	

		logic	
132. Dump sites	↓	Environmental reclaiming of contaminated soils To reduce the volume of waste going to landfills	
14. Artificial, non-agricultural vegetated areas	↑	To increase green and collective use spaces	
141. Green urban areas	↑	To diminish pressure on maritime and estuarine margins Environmental reclaiming of contaminated soils	
142. Sport and leisure facilities	↑ / =	To attract creative and artistic talents from the whole world	
	↑	To reinforce the region as privileged destination for business, cultural sports and nature tourism To increase the international attractiveness of Lisbon To promote the offering of proximity equipments and services and equity in its access	
2. Agricultural areas	=	To consolidate and improve agricultural and forestry areas To counter disperse edification To promote a nucleated and structured rural settlement	Cropland (and grassland in the case of pastures)
	↓	To reinforce and diversify the supply of infrastructured areas for economic activities	
422. Salines	↑	To increment in a sustainable way fishing and aquaculture activities	Marine inlets and transitional waters

Table A.3.7 – Main ecosystem services affected by planning objectives, as identified by participants from the regional planning authority.

Ecosystem services	Effect	Planning objectives
1. Production	+	<p>To consolidate and improve agricultural and forestry areas</p> <p>To re-orient urban demand to rehabilitation of existing urban areas</p> <p>To reinforce and diversify the supply of infrastructured areas for economic activities</p> <p>To invest in urban rehabilitation instead of new construction for housing</p>
111. Biomass	+	To enhance tourism in the rural space, ensuring synergies with the agricultural activity
1111. Cultivated crops	+	Environmental reclaiming of contaminated soils
1115. Plants and algae from in-situ aquaculture	+	To transform AML in a pole of Sea research and exploitation
1116. Animals from in-situ aquaculture	+	<p>To transform AML in a pole of Sea research and exploitation</p> <p>To increment in a sustainable way fishing and aquaculture activities</p>
112. Water	+	<p>To ensure the quality of the Tejo/Sado aquifer</p> <p>To preserve water quality and improve supply efficiency</p> <p>To improve efficiency in water consumption</p>
121. Biomass	+	To preserve soils with more agricultural and forest value
122. Water	+	<p>To ensure the quality of the Tejo/Sado aquifer</p> <p>To preserve water quality and improve supply efficiency</p>

13. Energy	+	<p>To reduce dependency in fossil fuel sources</p> <p>To reduce energetic dependence from the exterior, increasing supply security</p> <p>To increase energy efficiency and the exporting capacity of high technological intensity based on renewable energies and energy efficiency</p>
2. Regulation and maintenance	+	<p>To re-orient urban demand to rehabilitation of existing urban areas</p> <p>To reinforce and diversify the supply of infrastructured areas for economic activities</p> <p>To invest in urban rehabilitation instead of new construction for housing</p>
21. Mediation of waste, toxics and other nuisances	+	<p>Environmental reclaiming of contaminated soils</p> <p>To reduce the volume of waste going to landfills</p>
2211. Mass stabilisation and control of erosion rates	+	<p>To diminish pressure on maritime and estuarine margins</p> <p>To reduce population exposure to natural, technological and environmental risks</p>
2221. Hydrological cycle and water flow maintenance	+	<p>Environmental reclaiming of contaminated soils</p>
2222. Flood protection	+	<p>To diminish pressure on maritime and estuarine margins</p> <p>To reduce population exposure to natural, technological and environmental risks</p>
23. Maintenance of physical, chemical, biological conditions	+	<p>To enhance and preserve the rural and natural landscape</p>
2311. Pollination and seed dispersal	+	<p>To increase collective use and green spaces</p>
2322. Disease control	+	<p>To eliminate non-classical houses</p> <p>To regenerate in an integrated fashion the social</p>

		housing neighbourhoods
235. Atmospheric composition and climate regulation	+	<p>To improve the articulation of policies, planning and management of mobility</p> <p>To support intra-regional mobility</p> <p>To increase collective use and green spaces</p> <p>To preserve soils with more agricultural and forest value</p> <p>To reduce emission of atmospheric pollutants</p> <p>To increase energy efficiency of transport</p> <p>To integrate soft modes in trips</p>
3. Cultural	+	<p>To attract creative and artistic talents from the whole world</p> <p>To enhance the international touristic attractiveness of AML in a sustainability logic</p> <p>To reinforce the region as privileged destination for business, cultural sports and nature tourism</p> <p>To increase international visibility of the natural and cultural heritage</p> <p>To re-orient urban demand to rehabilitation of existing urban areas</p> <p>To consolidate and enhance rural agglomerations</p> <p>To promote a nucleated and structured rural settlement</p> <p>To invest in urban rehabilitation instead of new construction for housing</p>

		<p>To promote urban social development, interculturality and the sense of belonging to place</p> <p>To invest in the cultural development of the population</p>
31. Physical and intellectual interactions with biota, ecosystems, and land-/seascapes [environmental settings]	+	<p>To enhance tourism in the rural space, ensuring synergies with the agricultural activity</p> <p>To enhance and preserve the rural and natural landscape</p>
311. Physical and experiential interactions	+	To increase collective use and green spaces
3124. Entertainment	+	To increase collective use and green spaces
3125. Aesthetic	+	<p>To eliminate non-classical houses</p> <p>To regenerate in an integrated fashion the social housing neighbourhoods</p>
43. Energy	+	<p>To reduce dependency in fossil fuel sources</p> <p>To reduce energetic dependence from the exterior, increasing supply security</p> <p>To increase energy efficiency and the exporting capacity of high technological intensity based on renewable energies and energy efficiency</p>
51. Mediation of waste, toxics and other nuisances	+	<p>To reduce emission of atmospheric pollutants</p> <p>To increase energy efficiency of transport</p> <p>To integrate soft modes in trips</p>
6. Cultural settings dependent on abiotic structures	+	To know, conserve and enhance the geological heritage

Table A.3.8 – Ecosystem services considered more relevant by each workshop participant. Only items with 13 or more votes (50% or more of participants) are shown.

Section	Division	Group	Class	Votes (no.)
Provisioning	Nutrition	Water	Surface water for drinking	14
			Ground water for drinking	13
	Materials	Water	Surface water for non-drinking purposes	13
Regulation and maintenance	Mediation of flows	Mass flows	Mass stabilisation and control of erosion rates	14
		Liquid flows	Flood protection	16
	Maintenance of physical, chemical, biological conditions	Atmospheric composition and climate regulation	Global climate regulation by reduction of greenhouse gas concentrations	13
			Micro and regional climate regulation	16

Table A.3.9 – Ecosystem services considered most relevant by each working group of the participatory workshop.

CICES				Group ^a						
Section	Division	Group	Class	LA1	LA2	LA3 ^b	LA4 ^c	NA	AC	
Provisioning	Nutrition	Biomass	Cultivated crops		X	X	X (A)			
			Reared animals and their outputs							
			Wild plants, algae and their outputs							
			Wild animals and their outputs							
			Plants and algae from in-situ aquaculture							
			Animals from in-situ aquaculture							
		Water	Surface water for drinking							
			Ground water for drinking					X (B)	X	
	Materials	Biomass	Fibres and other materials from plants, algae and animals for direct use or processing							
			Materials from plants, algae and animals for agricultural use							
			Genetic materials from all biota							
		Water	Surface water for non-drinking purposes					X (B)		
			Ground water for non-drinking purposes							
		Energy	Biomass-based energy	Plant-based resources					X (C)	

		sources								
			Animal-based resources							
		Mechanical energy	Animal-based energy							
Regulation & Maintenance	Mediation of waste, toxics and other nuisances	Mediation by biota	Bio-remediation by micro-organisms, algae, plants, and animals							
			Filtration/sequestration/storage/accumulation by micro-organisms, algae, plants, and animals							
		Mediation by ecosystems	Filtration/sequestration/storage/accumulation by ecosystems	X						
			Dilution by atmosphere, freshwater and marine ecosystems							X
			Mediation of smell/noise/visual impacts							
		Mediation of flows	Mass flows	Mass stabilisation and control of erosion rates						
	Buffering and attenuation of mass flows									
	Liquid flows		Hydrological cycle and water flow maintenance	X				X (B)		
			Flood protection			X			X	X
	Gaseous / air flows		Storm protection							
			Ventilation and transpiration							
	Maintenance of physical, chemical, biological con-	Lifecycle maintenance, habitat and gene pool	Pollination and seed dispersal			X				

	ditions	protection										
			Maintaining nursery populations and habitats	X								
		Pest and disease control	Pest control									
			Disease control									
		Soil formation and composition	Weathering processes									
			Decomposition and fixing processes									
		Water conditions	Chemical condition of freshwaters					X (B)				
			Chemical condition of salt waters									
		Atmospheric composition and climate regulation	Global climate regulation by reduction of greenhouse gas concentrations									
			Micro and regional climate regulation									
		Cultural	Physical and intellectual interactions with biota, ecosystems, and land-/seascapes [environmental settings]	Physical and experiential interactions			Experiential use of plants, animals and land-/seascapes in different environmental settings		X		X (A)	
							Physical use of land-/seascapes in different environmental settings					

	Intellectual and representative interactions	Scientific						X
		Educational						
		Heritage, cultural						
		Entertainment						
		Aesthetic						
	Spiritual, symbolic and other interactions with biota, ecosystems, and land-/seascapes [environmental settings]	Spiritual and/or emblematic	Symbolic					
			Sacred and/or religious					
		Other cultural outputs	Existence					X (A)
			Bequest					
	Abiotic Provisioning	Nutritional abiotic substances	Mineral					
Non-mineral								
Abiotic materials		Metallic						
		Non-metallic						
Energy		Renewable abiotic en-				X (C)		

		ergy sources							
		Non-renewable energy sources							
Regulation & Maintenance by natural physical structures and processes	Mediation of waste, toxics and other nuisances	By natural chemical and physical processes							
	Mediation of flows by natural abiotic structures	By solid (mass), liquid and gaseous (air)flows							
	Maintenance of physical, chemical, abiotic conditions	By natural chemical and physical processes							
Cultural settings dependent on abiotic structures	Physical and intellectual interactions with land-/seascapes [physical settings]	By physical and experiential interactions or intellectual and representational interactions							
	Spiritual, symbolic and other interactions with land-/seascapes [physical settings]	By type							

^a Legend: LA1 to LA4 – local authorities; NA – national authority; AC – academia.

^b Results of group LA3 were not considered for the final voting, since they were too broad (section level). This was proposed to and accepted by workshop participants.

^c Group LA4 aggregated classes of ES that are not always under the same group or division. Aggregated ES are marked with the same letter (A, B, C or D).

Table A.3.10 – Final voting of most relevant ecosystem services by workshop participants.

CICES				Final voting ^a								
Section	Division	Group	Class	CICES Division			CICES Group			CICES Class		
				LA	NA	AC	LA	NA	AC	LA	NA	AC
Provisioning	Nutrition	Biomass	Cultivated crops							3		
			Reared animals and their outputs									
			Wild plants, algae and their outputs									
			Wild animals and their outputs									
			Plants and algae from in-situ aquaculture									
			Animals from in-situ aquaculture									
	Water	Surface water for drinking				9		0.5 ^b				

		Ground water for drinking						4	6	
Materials	Biomass	Fibres and other materials from plants, algae and animals for direct use or processing								
		Materials from plants, algae and animals for agricultural use								
		Genetic materials from all biota								
	Water	Surface water for non-drinking purposes				1		0.5 ^b		
		Ground water for non-drinking purposes								

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	Energy	Biomass-based energy sources	Plant-based resources								
			Animal-based resources								
		Mechanical energy	Animal-based energy								
Regulation & Maintenance	Mediation of waste, toxics and other nuisances	Mediation by biota	Bio-remediation by micro-organisms, algae, plants, and animals								
			Filtration/sequestration/storage/accumulation by micro-organisms, algae, plants, and animals								
		Mediation by ecosystems	Filtration/sequestration/storage/accumulation by ecosystems						1	2	1
			Dilution by atmosphere, freshwater and marine ecosystems								
			Mediation of smell/noise/visual impacts								

Integration of ecosystem services in spatial planning: a mixed methods approach

Mediation of flows	Mass flows	Mass stabilisation and control of erosion rates							3	1	
		Buffering and attenuation of mass flows									
	Liquid flows	Hydrological cycle and water flow maintenance						1	6	5	2
		Flood protection							2		1
	Gaseous / air flows	Storm protection									
		Ventilation and transpiration									
Maintenance of physical, chemical, biological conditions	Lifecycle maintenance, habitat and gene pool protection	Pollination and seed dispersal	6								
		Maintaining nursery populations and habitats									
	Pest and disease control	Pest control									
		Disease control									

		Soil formation and composition	Weathering processes							
			Decomposition and fixing processes							
		Water conditions	Chemical condition of freshwaters							
			Chemical condition of salt waters							
		Atmospheric composition and climate regulation	Global climate regulation by reduction of greenhouse gas concentrations					4	1	
			Micro and regional climate regulation							
Cultural	Physical and intellectual interactions with biota, ecosystems, and land-/seascapes	Physical and experiential interactions	Experiential use of plants, animals and land-/seascapes in different environmental settings							4

		Other cultural outputs	Existence										
			Bequest										
Abiotic Provisioning	Nutritional abiotic substances	Mineral											
		Non-mineral											
	Abiotic materials	Metallic											
		Non-metallic											
	Energy	Renewable abiotic energy sources			3								
		Non-renewable energy sources											
Regulation & Maintenance by natural physical structures	Mediation of waste, toxics and other nuisances	By natural chemical and physical processes											

and processes												
	Mediation of flows by natural abiotic structures	By solid (mass), liquid and gaseous (air)flows										
	Maintenance of physical, chemical, abiotic conditions	By natural chemical and physical processes										
Cultural settings dependent on abiotic structures	Physical and intellectual interactions with land-/seascapes [physical settings]	By physical and experiential interactions or intellectual and representational interactions										
	Spiritual, symbolic and other interactions with	By type										

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land- /seascapes [physical set- tings]												
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^a Legend: LA1 to LA4 – local authorities; NA – national authority; AC – academia. Two participants of the academia group had to leave the workshop before the final voting took place.

^b One vote was given to an item that aggregated ‘surface water for drinking’ with ‘surface water for non-drinking purposes’ .

Appendix 4 – Scenario narratives

Scenario A – “Re-Naturing”

A declining population due to low attraction potential of the region (unfavourable economic situation) is seen as an opportunity to promote a compact urban model to free up artificial areas and convert them into other land uses / land covers, like forest areas (which can be regarded as green infrastructure) – a process known as re-naturalisation. Good examples of re-naturalisation found in cities and regions undergoing shrinkage for a longer time are transferred. The Metropolitan Ecological Network is safeguarded. This scenario can be considered a “Re-naturing” scenario.

Scenario B – “As planned”

In face of growing population due to high attraction potential of the region (favourable economic situation) on the one hand, and the need to provide quality of life through nature as well as anticipating the EU target of no net land take by 2050 on the other hand, a compact urban model is adopted, taking advantage of already existing built infrastructure through strong urban rehabilitation programs, densifying the urban fabric. Therefore artificial areas do not take over existing agricultural, forest and other semi-natural and natural areas. The Metropolitan Ecological Network is safeguarded. This can be considered the “As planned” scenario, since it represents what is generally desirable as expressed in planning documents.

Scenario C – “Dumb decline”

Despite a population decline due to low attraction potential of the region (unfavourable economic situation), urban expansion proceeds following a dispersed pattern, due to the reduction of the number of people per household, increasing floor space area and real estate speculation, as already observed in some parts of the region. Discontinuous urban fabric areas increase (along with empty buildings), land take and territorial fragmentation take place, including in areas of the Metropolitan Ecological Network. This can be considered a “Dumb decline” scenario (in opposition to “smart growth”).

Scenario D – “Sprawling growth”

In order to accommodate a growing population due to a high attraction potential of the region (favourable economic situation), artificial areas increase following a dispersed urban development model, as already observed in most parts of the region, associated with a reduction of the number of people per household, increasing floor space area, real estate speculation and no urban rehabilitation measures. Discontinuous ur-

ban fabric areas increase, land take and territorial fragmentation take place, including in areas of the Metropolitan Ecological Network. This can be considered a “Sprawling growth” scenario.

**Appendix 5 – Lookup table to derive f -
evapotranspiration, surface emissivity and
carbon storage for each land use and land
cover (LULC) class**

Table A.5.1 – Lookup table to derive *f*-evapotranspiration, surface emissivity and carbon storage for each land use and land cover (LULC) class. The transfer algorithm columns show the adaptation of each study’s LULC classes to the Urban Atlas 2012 LULC classes.

Urban Atlas 2012 LULC classes	<i>f</i> -Evapotranspiration	Transfer algorithm (<i>f</i> -Evapotranspiration)	Surface emission (mean)	Emission index	Transfer algorithm (Surface emission/index)	Net C storage (Mg/ha)	Transfer algorithm (Net C storage)
Continuous urban fabric (S.L. > 80%)	0.8	90% sealed, 10% non-sealed (=5% grass+5% mixed forest)	153.6	2.4	Continuous urban fabric	5.7	Multifamily residential or mixed residence and commercial
Discontinuous dense urban fabric (S.L. 50% - 80%)	0.9	65% sealed, 35% non-sealed (=17.5% grass+17.5% mixed forest)	154.0	2.7	Discontinuous urban fabric	15.4	65% Multifamily residential + 35% urban forest
Discontinuous medium density urban fabric (S.L. 30% - 50%)	0.9	40% sealed, 60% non-sealed (=30% grass+30% mixed forest)	154.0	2.7	Discontinuous urban fabric	19.5	50% Multifamily residential + 50% urban forest
Discontinuous low density urban fabric (S.L. 10% - 30%)	1.0	20% sealed, 80% non-sealed (=40% grass+40% mixed forest)	154.0	2.7	Discontinuous urban fabric	23.0	Residential
Discontinuous very low density urban fabric (S.L. < 10%)	1.0	5% sealed, 95% non-sealed (=47.5% grass+47.5% mixed forest)	154.0	2.7	Discontinuous urban fabric	28.2	50% Residential + 50% Urban forest
Isolated structures	0.8	Sealed surface	154.0	2.7	Discontinuous urban fabric	21.4	50% Residential + 50%

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					fabric		Natural forest
Industrial, commercial, public, military and private units	0.8	Sealed surface	156.2	4.2	Industrial or commercial units	2.4	50% Industrial or commercial + 50% Institutional
Fast transit roads and associated land	0.8	Sealed surface	155.9	4.0	Road and rail networks and associated land	7.6	Transport
Other roads and associated land	0.8	Sealed surface	155.9	4.0	Road and rail networks and associated land	7.6	Transport
Railways and associated land	0.8	Sealed surface	155.9	4.0	Road and rail networks and associated land	7.6	Transport
Port areas	0.8	Sealed surface	151.4	1.0	Port areas	4.4	Institutional
Airports	0.8	Sealed surface	156.7	4.5	Airports	4.4	Institutional
Mineral extraction and dump sites	0.8	Area without vegetation	153.7	2.5	50% Mineral extraction sites + 50% Dump sites	10.6	Intensively used area without buildings
Construction sites	0.8	Area without vegetation	155.8	3.9	Construction sites	10.6	Intensively used area without buildings
Land without current use	0.8	Area without vegetation	155.8	3.9	Construction sites	10.6	Intensively used area without buildings
Green urban areas	1.1	20% grass + 80% mixed forest	149.9	0.0	Green urban areas	33.3	Urban forest
Sports and leisure facilities	1.0	20% sealed surface + 40% grass + 40% mixed forest	150.4	0.3	Sport and leisure facilities	24.7	70% Urban forest + 30% Institutional
Arable land (annual	0.9	Arable land	153.6	2.4	33.3% Non-irrigated	8.0	Cultivated and managed

crops)					arable land + 33.3% Permanently irrigated land + 33.3% Rice fields		areas
Permanent crops	0.9	Arable land	156.2	4.2	33.3% Vineyards + 33.3% Fruit trees and berry plantations + 33.3% Olive groves	40.0	Mosaic: Cropland/Tree cover
Pastures	0.8	Pastures, grassland	154.6	3.1	Pastures	9.0	Herbaceous cover, closed-open
Complex and mixed cultivation	0.9	80% arable land + 15% mixed forest + 5% pastures, grassland	155.7	3.9	25% Annual crops associated with permanent crops + 25% Complex cultivation patterns + 25% Land principally occupied by agriculture, with significant areas of natural vegetation + 25% Agro-forestry areas	40.0	Mosaic: Cropland/Tree cover
Forests	1.1	Mixed forest: 50% broad-leaved forest + 50% coniferous forest	150.8	0.5	33.3% Broad-leaved forest + 33.3% Coniferous forest + 33.3% Mixed forest	19.8	Natural forest
Herbaceous vegetation associations	1.0	50% mixed forest + 50% grass	152.1	1.5	25% Natural grasslands + 25% Moors and	9.0	Herbaceous cover, closed-open

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					heathland + 25% Sclerophyllous vegetation + 25% Transitional woodland-shrub		
Open spaces with little or no vegetation	0.8	Area without vegetation	148.5	-0.9	50% Beaches, dunes, sands + 50% Bare rocks	9.0 ¹	Sparse herbaceous or sparse shrub cover
Wetlands	1.1	50% water + 50% pastures, grassland	145.0	-3.3	25% Inland marshes + 25% Salt marshes + 25% Salines + 25% Intertidal flats	9.0 ²	Regularly flooded shrub and/or herbaceous cover
Water	1.4	Water	136.5	-9.0	20% Water courses + 20% Water bodies + 20% Coastal lagoons + 20% Estuaries + 20% Sea and ocean	0 ³	Water

¹ Adapted from Schwarz et al. (2011).

² Adapted from Chaparro and Terradas (2009).

³ Adapted from Gibbs (2006).