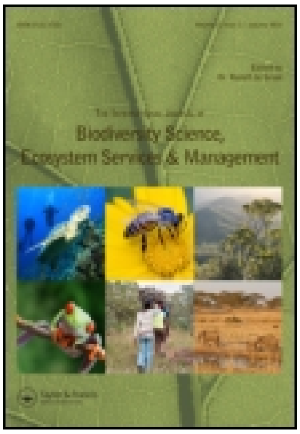

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Reasons and options for integrating ecosystem services in strategic environmental assessment of spatial planning

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Reasons and options for integrating ecosystem services in strategic environmental assessment of spatial planning

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Despite the attention that research on ecosystem services has attracted in recent years, its use to support real-life decision-making processes is still very limited, especially at the planning level. Spatial planning results in actions that may affect the distribution and quality of a wide range of ecosystem services. Hence, spatial planning decisions would benefit from systematic considerations of their effects on ecosystem services. Strategic Environmental Assessment (SEA) provides an excellent platform to this purpose. This paper aims at providing insights on why it is important to promote ecosystem service-inclusive SEA processes, and on how to do it, with particular emphasis on spatial planning. First, possible actions to include relevant information of ecosystem services throughout the SEA process are presented. Second, the advantages are discussed by considering both the characteristics of ecosystem services approaches and the criteria of good-quality SEA. Finally, four main challenges are identified, concerning scoping, scale issues, trade-offs, and indicators, respectively. Addressing these challenges is bound to produce more effective SEA processes and better planning decisions.

Keywords: land use; strategic environmental assessment; planning; trade-offs; scale; ecosystem services

Introduction

Research on ecosystem services has attracted a lot of attention in recent years and has become one of the most significant and fastest evolving areas in environmental sciences and ecological economics. It has been defined as a 'cornerstone of sustainability science' for its focus on the interaction between nature and society (Clark and Dickson 2003). The publication of the Millennium Ecosystem Assessment (MA 2005) fuelled a number of studies aimed at analyzing and quantifying the importance of ecosystems for human well-being to eventually make better decisions regarding the sustainable use of Earth's resources. Recent research has revealed the possibilities for measuring and projecting the effects of policy choices on the structure and processes of ecosystems and the services they provide (Carpenter et al. 2009; Tallis and Polasky 2009). However, despite this increasing body of literature, the use of ecosystem service concepts to support real-life decision-making processes is still limited. As Daily et al. (2009) put it: 'The Millennium Ecosystem Assessment advanced a powerful vision for the future, and now it is time to deliver'.

The narrow use of ecosystem services information affects especially the planning level of decision making (von Haaren and Albert 2011), whereas more applications are found at the policy level (e.g., payment for ecosystem services policies, see Jack et al. (2008) for a review). In particular, spatial planning decisions would benefit from systematic considerations of their effects on ecosystem services. Spatial planning aims at 'creating a more rational territorial organization of land uses and the linkages between them, to balance demands for development with the need to protect the environment and to achieve social and economic development objectives' (European Commission 1997). Key issues in spatial planning concern land and resource use, the physical organization of space, and the integration of sectoral strategies (agriculture, nature protection, transportation, tourism development, etc.). Spatial planning eventually results in actions that may affect the distribution, quality, and use of a wide range of ecosystem services and that are instrumental to their conservation and enhancement (The Economics of Ecosystems and Biodiversity 2010, p. 106). Hence, it is crucial to use information on ecosystem services to support planning processes.

The internalization of ecosystem service concerns into spatial planning should take advantage of existing procedures to support plan making. Strategic Environmental Assessment (SEA) is particularly suited to this purpose. SEA refers to a 'range of analytical and participatory approaches that aim to integrate environmental considerations into policies, plans and programmes and evaluate the interlinkages with economic and social considerations' (OECD 2006). One of the key SEA tasks consists in supporting the development of policies, plans, and programs, by assessing the environmental impacts that are likely to results from their execution. A recent review of influential cases highlighted the topicality of ecosystem service-inclusive SEA, but also the fact that no methodological reference exists in the literature (Slootweg and van Beukering 2008).

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This paper aims at providing insights on why it is important to promote ecosystem service-inclusive SEA processes, and on how to do it, with particular emphasis on spatial planning. Section 2 elaborates on the SEA process and on the inclusion of ecosystem services throughout it. Section 3 illustrates the advantages related to the integration of ecosystem service information in SEA, whereas Section 4 presents and discusses some of the open challenges. Finally, conclusions are drawn in Section 5.

Key SEA stages and relevant ecosystem service information

To ensure a proper consideration of environmental impacts, risks, and opportunities from the early decisional stages onwards, SEA needs to be fully integrated into the planning process (see Partidário (2007a) for a thorough discussion on this). Only in this way, SEA can contribute to decision making, from the very preliminary identification of the plan's scope and objectives, until the final implementation and monitoring. Hence, SEA must be flexible and able to adapt to the planning context, which is very different among countries (in terms of content, level of detail, timing, consultation with stakeholders, etc.) and among planning tiers (national, regional, etc.). A number of guidance documents have been produced over the years to tailor the application of SEA to different decision-making contexts (e.g., OECD 2006; Partidário 2007b). For these reasons, a standard and internationally accepted procedure does not exist for SEA, even though some key common stages can be identified.

In very general terms, and for the purpose of illustrating the key SEA stages, the planning process has been decomposed into four main operational moments: defining the scope and the objectives of the plan, identifying suitable actions to achieve such objectives, drafting and refining the plan, and finally implementing it. In practice, these stages are often not organized in a linear sequence and interactions and feedback loops are common. For example, the objectives of a plan may be revised after a discussion on possible options to achieve them has taken place. SEA is a parallel process, which aims at supporting each of these stages by providing insights on the implications of the plan's strategies and decisions, as well as by broadening the plan's scope to ensure that appropriate sustainability objectives are taken into account (Partidário 2007a; Bonde and Cherp 2000). Table 1 lists the typical SEA activities linked to each of the four stages and provides a description of possible analysis to include information on ecosystem services. Public participation is an essential element of both planning and SEA; however, it was not listed in Table 1 because ideally it is carried out in different moments of the process, rather than representing a separate stage.

In the first stage, the role of ecosystem service information consists mainly in supporting the identification of the most pressing issues related to the territory under analysis, as well as to the scope and content of the plan. During this phase, information can be collected and processed to understand opportunities and constraints related to the conservation and use of ecosystem services, for instance by generating graphs or maps of production and fruition patterns. These data can also be compared with information on population density and socioeconomic conditions to perform a screening of critical sites. For example, GIS-based analysis could inform on populated area with and without suitable access to a given service (Geneletti et al. 2007).

In the second stage, the spatial plan begins to take shape, and proposals for land-use changes, infrastructure development, or new regulations are made. Ecosystem service information can be used to identify constraints to development and to perform land suitability analysis. The effects of alternative actions can be tested, by predicting changes in important ecosystem services, and evaluate them in biophysical and/or monetary terms. The pros and cons of the different alternatives can be highlighted by unveiling trade-offs among ecosystem services, locations (where changes are likely to occur?), and beneficiaries (who wins and who loses?).

During the third stage, the plan is drafted and then completed, and SEA performs important tasks such as the assessment of the cumulative effects (i.e., the combined effects of all the actions of the plan, as well as of external driving forces) on key ecosystem services, and the comparison of the new proposal with alternative proposals (e.g., no plan, execution of the existing plan). This can be done by generating future land-use scenarios that make different assumptions about key drivers (population growth, climate change, market prices, etc.). Land-use scenarios can be constructed in a qualitative or quantitative and spatially explicit form (Geneletti 2011a), depending on the availability of data and on the level of detail of the plan. The results of these analyses are used to suggest revisions and mitigations in an iterative fashion until the plan reaches its final form. Mitigations may include measures to limit the negative impacts of the plan on ecosystem services, but also measures directed, for instance, at reducing the dependency of the plan's objectives from ecosystem services that may become scarcely available in the future.

Finally, during the implementation stage, the purpose of SEA is to monitor the execution of the plan's actions and strategies, as well as the evolution of the environmental and socioeconomic context. This allows to test whether the plan is achieving its objectives and whether patterns of use and production of services are evolving as expected. Adaptive management practices can be included in monitoring, in order to steer the plan's implementation whenever required.

Advantages of ecosystem service-inclusive SEA

Using SEA for the purpose of including ecosystem services in planning is appropriate for a number of reasons. First, SEA provides a window of opportunity to formally mainstream ecosystem services into decisions at the strategic level. This is because SEA has a legal basis in several

Table 1. Planning stages associated with Strategic Environmental Assessment (SEA) activities and with examples of actions to include relevant information on ecosystem services throughout the process.

Planning stages	SEA activities	Actions to include information on ecosystem services (ES)
Defining the scope and the objectives of the plan	• Describe environmental baseline • Identify environmental and sustainability objectives relevant to the territory being planned • Identify other relevant plans and policies and test for consistency	• Identify what ES the plan's objectives depend upon or affect (see also Table 3) • Map areas of production and fruition of key ES (including analysis of beneficiaries and stakeholder) • Collect data on spatial and temporal trends • Analyze issues of scale and spatial relationships (see also Section 'Overview of the main challenges')
Identify actions to achieve the objectives	• Propose and compare alternative actions, possibly in different scenario conditions • Predict and assess environmental effects • Support the selection of the preferred options • Test for consistency among plan's actions	• Track the direct and indirect drivers of changes in ES, by paying particular attention to the foreseen land-use changes • Test the effects of different options on ES, by quantifying changes whenever possible and evaluating them in biophysical and/or monetary terms • Make trade-offs and synergies among ES explicit, considering both the production of services (where is it likely to increase/decrease?) and their use by different groups of beneficiaries (who wins and who loses?)
Drafting the plan, revision and final approval	• Suggest mitigations • Assess overall impact of the plan and suggest mitigations • Write SEA report	• Suggest solutions to reduce the impact of the plan on critical ES • Suggest solutions to reduce the dependency of the plan from critical ES • Assess cumulative effects on the ES, under different future scenarios
Implementation	• Monitoring and follow-up	• Verify if patterns of use and production of ES are evolving as expected and suggest adaptive management strategies

dozen countries around the world. In Europe, for example, it is mandatory under the European Commission SEA Directive (Directive 2001/42/EC). Additionally, a growing number of countries (mostly in the developing world), international organizations, and NGOs are applying SEA-type processes (Dalal-Clayton and Sadler 2005).

Second, the scenario-analysis approach used by several studies on ecosystem services is consistent with the typical framework adopted in impact assessment, and hence can be easily applied in SEA. This approach is based on the analysis of expected changes in the distribution, value, and fruition of services following the implementation of a given strategy or proposal, as opposite to the 'static' evaluation of services (see, for instance, Balmford et al. 2008, p. 9; Nelson et al. 2009; Birch et al. 2010). In SEA, baseline and policy scenarios are often used to understand the possible future status of a system with or without a proposed strategic action and under different assumptions on uncertainty factors. This is very similar to many scenario analyses conducted for ecosystem services at various spatial scales (Carpenter et al. 2006; Willemen et al. 2010). SEA is essentially an 'exercise in futuring' (Duinker and Greig 2007), aimed at providing support to decision processes undertaken under conditions of uncertainty and scarcity of information. For this reason, scenario analysis is commonly listed in the SEA toolbox (Therivel 2004; OECD 2006), and its use is advocated by a number of scientific papers (Noble 2008; Zhu et al. Forthcoming).

Third, exploring methods to include ecosystem services in SEA is instrumental to the development of integrated approaches to assess the sustainability of proposed plans. In many contexts, SEA is increasingly including social and economic effects, and it is largely seen (both in the scientific literature and in practical applications) as a key entry point to sustainability assessment (Pope et al. 2004; Dalal-Clayton and Sadler 2011). Obviously, a proper consideration of the effects of spatial plans on ecosystem services cannot be limited to the analysis of the biophysical environment, but must include key socioeconomic issues. As a matter of fact, addressing ecosystem services implies addressing the beneficiaries of such services and their characteristics (spatial distribution, socioeconomic status, contribution of services to well-being, etc.).

One last consideration is that the integration of information of ecosystem services can be highly beneficial to the SEA process, enhancing its quality. This concept is illustrated in Table 2, where examples of possible contribution of ecosystem services to good-quality SEA are provided, by referring to the list of SEA performance criteria developed by International Association for Impact Assessment (2002).

Table 2. Examples of contributions of ecosystem services information to the quality of SEA, associated with the six characteristics of good SEA processes (as defined in International Association for Impact Assessment 2002).

Characteristics of a good-quality SEA process	Contribution of ecosystem services (ES) information
Integrated	• ES inherently address the interrelationships between biophysical and socioeconomic aspects. • The analysis of ES-related scale issues facilitates the interaction with relevant plans and policies at different decision-making tiers.
Sustainability-led	• ES approaches explicitly link changes in ecosystems and biodiversity with effects on human well-being. Hence, ES-inclusive SEA processes extend beyond the assessment of biophysical and environmental factors only and promote plans that are more sustainable.
Focused	• ES approaches offer a key to read the most important interactions between human society and the environment, identifying issues that are important for the specific decision-making context.
Accountable	• Analysis of expected future trends in ES under different scenario conditions can be used to document how sustainability issues were taken into account and to justify planning choices.
Participative	• Information on ES by definition requires the identification of beneficiaries and stakeholders, paving the way to more participative SEA processes.
Iterative	• The analysis of ES can be included, in different forms, throughout the whole process (see Table 1), so as to provide information on the expected impacts of a plan's choices during the different 'decision windows' of the planning process.

Overview of the main challenges

Four main challenges to the development of ecosystem service-inclusive SEA can be identified. The first one concerns the selection of key ecosystem services from the very extensive lists developed in the literature. In order for SEA to be effective in influencing plan making, the number of services included in the analysis should be kept to a minimum, by considering only the ones that are relevant to the specific decision problems addressed by the plan and to the characteristic of the area. This selection can be performed by identifying the services that are required for the implementation of the spatial plan and the services that the plan will affect (see OECD 2008, p. 11). The first group refers to services upon which the plan depends. For instance, if the plan aims at promoting nature-based tourism, the achievement of this depends upon cultural services, such as the aesthetic value of unspoiled landscapes. The second group refers to services that will be positively or negatively affected by the plan. Achieving the objectives of the plan may trigger drivers that in turn will alter the quality, quantity, and/or spatial distribution of a given (bundle of) service(s). These drivers can be of a direct nature (e.g., physical interventions, such as the choice of location of land uses) or an indirect one (policies that may affect the way in which society makes use of ecosystem services, such as for instance the ones that regulate accessibility to recreation areas).

As an illustration of this concept, Table 3 presents the results of an empirical analysis of the possible relationships between the objectives of an exemplary spatial plan and ecosystem services (details can be found in Geneletti 2011b). This type of analysis helps to set the context for SEA (see Table 1, first row), by identifying critical interactions that deserve to be studied in more detail. For instance, potential inconsistencies among a plan's objectives exist whenever the achievement of one objective relies on a given service, which in turn can be affected by a different objective. These situations can be detected by looking at each row of Table 3 (see, for instance, the case of water regulation and supply). This analysis is useful to define and revise the objectives of the plan, to suggest suitable stakeholder groups to be consulted (i.e., beneficiaries and users of the services affected in different ways by the plan), as well as to understand where further data and investigation are needed (e.g., quantification of service provision and fruition expressed in biophysical and/or economical units). Much of the quality of the overall SEA depends on this specific stage, so the open challenge is to perform it in a comprehensive way and early enough in the planning process.

The second challenge concerns scale. A spatial plan focuses on a geographically bounded area. Ecosystem services are provided and used at different spatial scales, and those scales may be much broader than the boundaries of a particular planning effort. The differences between the area that is being planned and the area that is being affected in terms of ecosystem services complicate the process of predicting the effects of spatial plans. Recent papers have attempted to examine the various scales at which services are provided and used (Hein et al. 2006) and to classify possible types of spatial relationships between the area of a service production and the area of use (Costanza 2008; Fisher et al. 2009). In SEA for spatial planning, a proper recognition of services and stakeholders must be performed, in order to understand situations where benefits accrue at one scale, but costs are borne at another. As an illustration of this concept, in Table 3 services whose production involves also areas outside the boundary of the region being planned are highlighted in bold. The challenge consists in understanding scale issues and pushing

Table 3. Exemplary analysis of the possible relationships between the objectives of a spatial plan and ecosystem services.

	Spatial plan's objectives															
	Increase competitiveness in the nature tourism sector		**Increase competitiveness in the timber sector**		**Increase competitiveness in the aquaculture sector**		**Increase competitiveness in the horticulture sector**		**Reduce exposure to natural risks**		**Protect areas with high natural value**		**Respect and promote cultural and ethnic diversity**		**Promote polycentric development**	
	Depend	Affect	Depend	Affect	Depend	Affect	Depend	Affect	Depend	Affect	Depend	Affect	Depend	Affect	Depend	Affect
Ecosystem services																
Climate regulation				+												
Water regulation and supply				–	**×**		**×**					+				–
Waste treatment						–		–							**×**	
Soil formation			×				×					+				
Erosion control			×				×					+				
Raw materials				+								–				
Cultural	×			–		–						+	**×**			
Recreation	×					–						–				+
Food production				–		+		+								
Disturbance regulation				–		–			**×**			+				
Refugia	×	–				–				+	×	+				–

Notes: The objectives were selected from the ones of the regional spatial plan of The Araucania, Chile (*Proyecto Plan Regional de Desarrollo Urbano y Territorial Región de La Araucanía, Laboratorio de Planificación Territorial de la Universidad Católica de Temuco*). Ecosystem services were selected from Costanza et al. (1997). For each objective, the first column indicates the ecosystem services required for its achievement. For instance, the development of the horticulture sector relies on soil formation and retention. The bold font indicates that such dependency may extend beyond the boundary of the area being planned, hence requiring a broader scale analysis. For example, the regulation of water to support horticulture may depend upon water-use decisions taken outside the region. The second column identifies situations where the achievement of the objective will have a positive/negative effect on the ecosystem services. For instance, the protection of natural areas is bound to contribute to soil formation and retention, but it may reduce recreation opportunities. The table is not exhaustive and aims at illustrating the concept only. Positive or negative influences are indicated by '+' or '–', respectively. The '×' indicates whether the objectives and ecosystem services link up.

the analysis further to unveil the degree of dependency from outside conditions that characterize the services that are required to achieve the objectives of the plan. This will enable identifying other relevant plans and policies at the different tiers (national, regional, local, etc.), whose contents and regulations must be taken into account during SEA to exploit synergies and reduce inconsistencies.

The third challenge concerns trade-offs among ecosystem services. Spatial plan policies may change the relative mix of ecosystem services within a region by trading-off the increase in one service with the decrease in another one. It has been observed that such trade-offs can be an explicit choice, but can also arise without awareness (Rodríguez et al. 2006). Research on ecosystem service trade-offs and on how to make them explicit in planning and decision making is limited (Carpenter et al. 2009). Land-use planning is about resolving conflicts on competing demand for limited resources and uneven distribution of costs and benefits. Hence, trade-offs represent a pivotal issue. Developing methods to systematically analyze the main trade-offs between a range of selected ecosystem services and to link them to plans' policies and decisions is still an open challenge. The literature has mainly focused on the trade-offs between the production of services (Nelson et al. 2009; Raudsepp-Hearne et al. 2010), with limited efforts directed toward understanding the implications of such trade-offs for different groups of beneficiaries, characterized by different needs and levels of dependency of such services (Geneletti 2011b).

Finally, there is the problem of selecting a manageably small set of indicators of ecosystem services that serve the needs of planners. Recently, modeling tools have been developed to spatially represent the distribution of multiple ecosystem services and highlight trade-offs (Tallis and Polasky 2009). These tools are based on the generation of land-use/land-cover scenarios and represent a promising path toward the inclusion of ecosystem services in spatial planning. However, the process of analyzing multiple ecosystem functions in different scenario conditions is associated with extraordinarily high amounts of information. It is unclear to what extent these tools can be used in actual spatial planning settings, with all the constraints that those settings involve. The open challenge consists in finding ways to present information to decision makers in a manageable way, possibly by creating new indicators that consist of combinations of existing ecosystem services indicators and indicators traditionally used in land-use planning (e.g., indicators of land suitability for different uses).

Conclusion

This paper discussed why and how SEA may be useful for bringing information on ecosystem services to bear in planning decisions. This paper focused on spatial and land-use planning, being the area where the effects of plans' decisions on service provision and use are perhaps more evident and straightforward. However, most considerations can be extended to planning processes in other sectors, such as tourism, water, energy, and so on. Four open challenges to the implementation of effective ecosystem service-inclusive SEA were identified, concerning scoping, scale issues, trade-offs, and indicators, respectively. These challenges can be addressed by carrying out pilot applications in real planning contexts and by taking advantage of the data, tools, and methods for ecosystem service representation and modeling that are becoming increasingly available.

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