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Integrating ecosystem services in spatial planning and strategic environmental assessment: The role of the cascade model

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ABSTRACT

Over the last decade, the ecosystem service (ES) approach has gained increasing attention because it offers important advantages for enhancing decision-making. However, a key and remaining challenge is how to implement this approach in real-world decision problems. This challenge is particularly relevant for governance and policy instruments, such as spatial planning and strategic environmental assessment (SEA), where including the ES approach is recognized as a great opportunity for achieving sustainable development goals. Consequently, this opinion paper proposes the use of the ES cascade model, as the basis to develop a framework that makes explicit the links among development objectives, sustainability goals, and the overall dependency on the ES supply. The main reflections address the need for a collaborative work between policy and science as a cross-cutting aspect for an interactive, participative and transparent research process that allows 1) the development of spatial indicators of ecosystem structures, 2) valuation and spatial modeling of ES, 3) identification of benefits and networks of actors, 4) the definition of values and, 5) generation of scenarios for a trade-off assessment of development alternatives. Finally, in addition to the information and knowledge generation regarding multi-scale relationships of the different components of the ES cascade, real-world evidence is urgently needed.

1. Introduction

Over the last decade, the ecosystem service (ES) approach has gained increasing attention because its rationality presents important advantages for enhancing environmental planning and decision-making processes. A key aspect convincing for many actors is that human well-being is the central component of the approach, thus it allows moving beyond the purely economic and monetary perspective by also including health, social relations, indigenous and local knowledge and perceptions (Potschin-Young et al., 2018; Tengö et al., 2017). The approach effectively documents and communicates the human-system dependency on ecosystems (La Notte et al., 2017), and thus, facilitates collaborative work among different actors from a range of disciplines or socio-cultural backgrounds (Fürst et al., 2013). Therefore, from an integrated perspective, the ES approach concretizes the notion of social-ecological systems (SES) as a fundamental view to reflect human-nature relationships (Anderies et al., 2004).

The potential of the ES approach for supporting strategic decisions has increased rapidly the number of scientific works and analyses of planning and policy documents (Cortinovis and Geneletti, 2018), as well as the development of guidelines by international organizations such as IUCN (Neugarten et al., 2018), UNEP (UNEP, 2014) and the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) (Tengö et al., 2017), among others. However, despite years of extensive research and empirical work that recognize ES as a suitable approach for including the value of nature in the decision-making process, a significant remaining challenge is how to implement ES in real-world decisional problems (MEA, 2005; Rozas-Vásquez et al., 2017; Ruckelshaus et al., 2015). This challenge is particularly relevant for governance and policy instruments oriented to sustainable territorial development, such as spatial planning and strategic environmental assessment (SEA), where including the ES approach is recognized as a great opportunity for enhancing decision-making processes (Geneletti, 2015; Geneletti, 2011; Mascarenhas et al., 2015;

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Partidario and Gomes, 2013; Rozas-Vásquez et al., 2018; UNEP, 2014). Therefore, progress in a scheme of integration that shows in an explicit manner the connections between nature and the societal dependency on a range of ES (e.g. provisioning, regulating, cultural) is one of the central issues that needs to be addressed for moving towards concrete applications in sustainable spatial planning and development (Frazier et al., 2019).

This opinion paper aims at discussing the opportunities and advantages of the use of the ES cascade model suggested by Haines-Young and Potschin (2010), as the basis to develop a framework that makes explicit the links among the development objectives proposed by the spatial planning process, the achievement of sustainability goals pursued by SEA, and the role of each step of the cascade for the final generation of benefits for the society. In this manner, to make explicit these links for a range of actors, we highlight the need to develop a set of spatial indicators, which are fundamental for analytical work as well as for communication.

1.1. Spatial planning and the ecosystem services approach

The integration of objectives and criteria for sustainability in the development of policies, plans, and programs (PPP) is recognized as a key task for the achievement of global sustainable development goals (UN, 2014; UNDP, 2010). In 2015, the United Nations (UN) ratified the sustainable development goals (SDGs) as part of Agenda 2030. The UN SDGs include 17 goals (https://sustainabledevelopment.un.org/sdgs) to achieve national priorities that include social, economic and environmental dimensions of development under an integrated view (Fleming et al., 2017). A significant number of these SDGs rely on the land system because it supports a number of interactions between human and nature that include different uses of land that produce ES for the society (Verburg et al., 2015). However, the quality, quantity and spatial distribution of those ES are strongly affected by spatial planning decisions (Fürst et al., 2013; Geneletti, 2013; Geneletti et al., 2018; Rozas-Vásquez and Gutiérrez, 2018). Thus, land-use activities have significantly modified land systems by generating a range of environmental impacts as it has been confirmed after several decades of research. Some examples are the changes in the global carbon cycle and possibly in the global climate, alterations in the hydrologic cycle, increments in the amount of anthropogenic inputs of fertilizers, and polluted disposed into the biosphere and atmosphere (Foley et al., 2005). In this regard, human decisions and policy-making are recognized as one of the key drivers for land-use change, which operate at multiple scales including individual decisions from local landowners to regional and national scales as well as international trade agreements (Schosser et al., 2010; Verburg et al., 2015).

In terms of instruments for policy decision making with a multiscale influence over the land system, their users and their land-use change processes, spatial planning arises as the most relevant, and today with legal basis in most countries around the world. According to the definition provided by the Council of Europe in the European regional/spatial planning charter (Council of Europe, 1983), spatial planning is understood as a scientific discipline, an administrative technique and a policy instrument that gives geographical expression to the economic, social, cultural and ecological policies of a society. Within the key functions of this instrument, achieving long-term sustainability and economic development through integrating environmental issues into decision-making are essential tasks (UN, 2008). At the same time, the spatial planning process is the result of a wide set of values and rationalities that are strongly context-dependent in terms of a specific society in a specific moment of time and under specific institutions and rules (Daily et al., 2009; Fisher et al., 2009; Goncalves and Ferreira, 2015). These context-dependent conditions and the feasibility of an explicitly spatial representation, make spatial planning a suitable instrument for promoting the integration of the ES approach into the decisional frame of the planning process (Polasky et al., 2015; Raymond et al., 2013). However, despite the existence of a range of approaches to perform planning processes such as landscape approach, ecosystem approach, integrated natural resource management, among others, all of them overlap in many aspects and the overall success will depend on the final implementation and the capacity to move from theory to practice (Greiber and Schiele, 2011).

Currently, a diversity of strategies and procedures have been applied for including sustainability objectives as well as concerns regarding the impacts generated by development planning policies (Runhaar, 2016). Perminova et al. (2016) provide some examples for assessing land-use impacts such as life cycle assessment, material flow analysis, ecological footprint, among others. In the particular case of spatial planning, there is no general agreement regarding any particular approach, although nowadays in an increasing number of countries worldwide, the use of SEA is strongly encouraged even as a legal requirement for the development of the planning process (Kumar et al., 2013; Loiseau et al., 2012; Runhaar, 2016). In general terms, SEA is defined as a formal and systematic process to analyze and address the environmental effects generated by the development of a policy, plan or program, as well as by any other strategic instrument (UNEP, 2004).

SEA provides a number of common entry points, which can be coupled for enhancing the effectiveness of the planning process in terms of sustainability by implementing the ES approach (Helming et al., 2013). Some of them are related to participatory work, scenario modeling and trade-off analysis, which might significantly increase the effectivity of the spatial planning (Geneletti, 2015). It also proposes a strategic, participative and transparent procedure that supports a more effective integration of sustainability issues in decision-making. Opportunities for supporting development objectives and achieving sustainability targets through the spatial planning process by considering the ES approach are present at many stages of SEA (Kumar et al., 2013). Then, it is considered as a suitable instrument for implementing this integrated approach ES-spatial planning (Geneletti, 2011; OECD, 2006; Partidario and Gomes, 2013; Rozas-Vásquez et al., 2018).

A fundamental remaining task is to find a pathway to guide and make concrete the applicability of this integrated view under a policy-science platform of collaboration that promotes its implementation in real-world planning processes and sustainability decision-making (Rozas-Vásquez et al., 2017; Ruckelshaus et al., 2015; Scott et al., 2018). Significant international initiatives such as The Economics of Ecosystems and Biodiversity (TEEB) and IPBES, recently established in 2012, provide an interface for communication and action between scientists and policy makers (Albert et al., 2014; Ruckelshaus et al., 2015). However, despite this growing interest, the use of ES in spatial planning coupled with SEA is still limited given a lack of scientifically sound policy-contextual guidelines, and the scarce availability of practical examples (Mascarenhas et al., 2015; Rozas-Vásquez et al., 2017; Slootweg, 2015).

2. Integrating perspectives: the role of the ES cascade

Territorial development is understood as a process of social construction of the environment, driven by geographical conditions, multiple interactions of different actors, economic, technological, socio-political, cultural and environmental forces present in a certain territory (FAO, 2018). Spatial planning aims to coordinate these human activities and their impacts on land systems under a SES perspective and a sustainability focus. There are two fundamental aspects that need to be considered as analytical basis 1) ecosystems and biodiversity, under a perspective of landscape structure and patterns (Almenar et al., 2018) and 2) human well-being. Both are critical components in the "chain of production" from ecosystem structures and processes to human well-being (Spangenberg et al., 2014). These aspects are the basis of the cascade model proposed by Haines-Young and Potschin (2010), which is a simplified representation of a pathway that starts from 1) ecosystem structures and processes present in a territory such as patch shape, diversity of plants and animals, and all the interactions between the biotic and abiotic components of a specific place (Vihervaara et al., 2018; Wu and Li, 2019), 2) ecosystem functions, defined as the ecological interactions of the components of an ecosystem over time, which have the potential to provide ecosystem services (de Groot et al., 2010; La Notte et al., 2017; van Oudenhoven et al., 2012), 3) ecosystem services supply, understood as the actual contribution in terms of goods and services from nature to human well-being, either today, in the past or in the future (Albert et al., 2016), 4) benefits generation, defined as an explicit and positive contribution for human well-being (Fisher et al., 2009; La Notte et al., 2017), and 5) the translation of those benefits into values for a range of actors and under different perceptions according to particular goals, objectives or conditions to be specified by the users (van Oudenhoven et al., 2012). Then, the valuation might be associated with health, cultural, conservation, and monetary values, among others (Maes et al., 2016). The main advantage of proposing this model for supporting decision-making in planning processes is because it effectively communicates the societal dependence on ecosystems. In addition, it offers other benefits as those described by Potschin-Young et al. (2018): 1) it can be used as a tool for making complex systems as simple as needed for understanding purposes, 2) it is useful for a proper structuration and prioritization of work, 3) it is a way for clarifying and focusing thinking about complex relationships human-nature, then it enhances communication across disciplines and societal actors, knowledge systems and between policy and science, and 4) it serves as a common reference point that promotes "buy-in" from different participant groups.

Moreover, it also includes implicitly the presence of formal and informal regulations in the use and management of land (private and public) as well as for the delivery of ES to the society, and the consideration of use value attribution, which is critical for the evaluation of policy and planning measures (Spangenberg et al., 2014). In the specific case of spatial planning and SEA, this cascade model plays an important role because it might facilitate to recognize the links between such processes and the overall dependency on the ES provision for the achievement of both sustainability and development objectives. Yet, a scheme of analysis that includes the ES cascade would make more explicit common inputs of information for performing spatial planning and SEA.

As relevant outcomes; consistency, understanding by actors with different backgrounds, feedback, and focus on the decisional process might be significantly enhanced. The latter is a crucial aspect because frequently the development of a spatial plan and its corresponding SEA is not consistently related under the same strategic focus (Partidario, 2012). Time and budget might be also reduced since the coordinated use of the ES cascade makes more transparent the generation of information at each of the steps, then, the duplicity of efforts might decrease considerably. Fig. 1 shows a simplified scheme of the potential interactions between the different steps of the ES cascade and each of the requirements for performing spatial planning and SEA. In the central section, the scheme illustrates the steps of the cascade under a socio-ecological systems perspective (see also Fürst, 2015). Here, a range of actors and institutions at multiple scales interact and potentially generate synergistic effects that modify the final generation of benefits. In the upper and lower section, general requirements for both processes are indicated as a reference. However, they can be adapted according to the specific context of application following an iterative process of feedback. Finally, the traditional use of the ES cascade is considered under a top-down view, from the biophysical structures and ecosystems present in a territory (starting point of the cascade) moving down until the benefits and values delivered to the society (ending point of the cascade). However, in this opinion paper and considering the work by Spangenberg et al. (2014), we also propose a bottom-up approach where, based on the supply of concrete benefits and values, a range of actors might be able to go back to the ecosystem services, functions, ecosystems and landscapes that produce those benefits. In this manner, the dependency on nature might be communicated more clearly to society and at the same time the use of the cascade model increases its potential to be used under a more flexible approach by planners and researchers according to the different contexts of spatial planning.

3. Current challenges and next steps for this integrated approach

Spatial planning is a key policy instrument, whose decisions over the land system have clear and direct effects on the supply of a range of ES. Thus, for an effective ES integration in SEA there are at least four open challenges related to: scoping, scale issues, trade-offs, and indicators (Geneletti, 2011). For all of these, progress has been made during the last years (see for instance: http://www.teebweb.org, http://www.aboutvalues.net, https://www.ipbes.net). However, the issue of indicators still presents a critical challenge since they are the core for analytical work by decision-makers and practitioners, and at the same time they are essential for understanding and communication to the society. The proposed framework of integrating ES in spatial planning and SEA builds on previous efforts such as those presented by Geneletti (2011), Mascarenhas et al. (2015), Partidario and Gomes (2013) and Rozas-Vásquez et al. (2018). However, it innovates by including the ES cascade as a common source of information from the SES, which has the potential to provide inputs for both processes.

Consequently, we argue that a crucial next step for exploring these potential interactions in relation to the biophysical, social, cultural and economic components of the ES cascade is the development of a set of spatial indicators. Diehl et al. (2016) point out that the ES approach might improve the performance of a comprehensive assessment by structuring information at different levels of complexity and scales of decision-making (proposed as *soft application* of the ES concept). Likewise, this approach can be applied for a quantitative assessment of benefits from ecosystems under an anthropocentric socio-economic perspective (proposed as *hard application* of the ES concept). In both types of applications, the use of spatial-explicit and non-explicit indicators provide aggregated information from a specific phenomenon, which might contribute to enhance SEA and spatial planning. Then, the use of indicators presents a number of advantages for evaluating the current state, changes, and trends from any component of the ES cascade as well as the links with the final generation of benefits to society. At the same time, they act as a communication instrument for facilitating the understanding of complex issues by a range of stakeholders and decision-makers (Kandziora et al., 2013).

In this way, a collaborative work between policy and science will be a crosscutting aspect for an interactive, participative and transparent process of strategic analysis. This process also includes mutual learning and the development of guidelines and methodological support to envision more clearly the contribution to human well-being from each of the steps of the ES cascade, by considering for instance: 1) the development of spatial indicators of ecosystem structures (e.g. diversity, complexity, ecological integrity), 2) indicators related to ecosystem functions (e.g. water infiltration, photosynthesis, denitrification), 3) valuation and spatial modeling of ES (e.g. biophysical valuation, societal valuation, mixed valuation), 3) identification of benefits and networks of actors such as users and beneficiaries (e.g. health indicators, income indicators, employment indicators), 4) the definition of "value" understood as priority ES for supporting territorial development objectives and, 5) generation of scenarios for a trade-off assessment of development alternatives. In addition, for supporting decision-makers, the selected indicators must be easy to understand, widely applicable, cost-effective and feasible to obtain over time and space. In the same way, they must be scientifically valid in terms of quality and credibility. Therefore, the proposed indicators need to be legitimated under a policy-science perspective. The latter is a crucial aspect to be considered when finding a balance between practicality and over-simplification of the indicators set (Hauck et al., 2016).

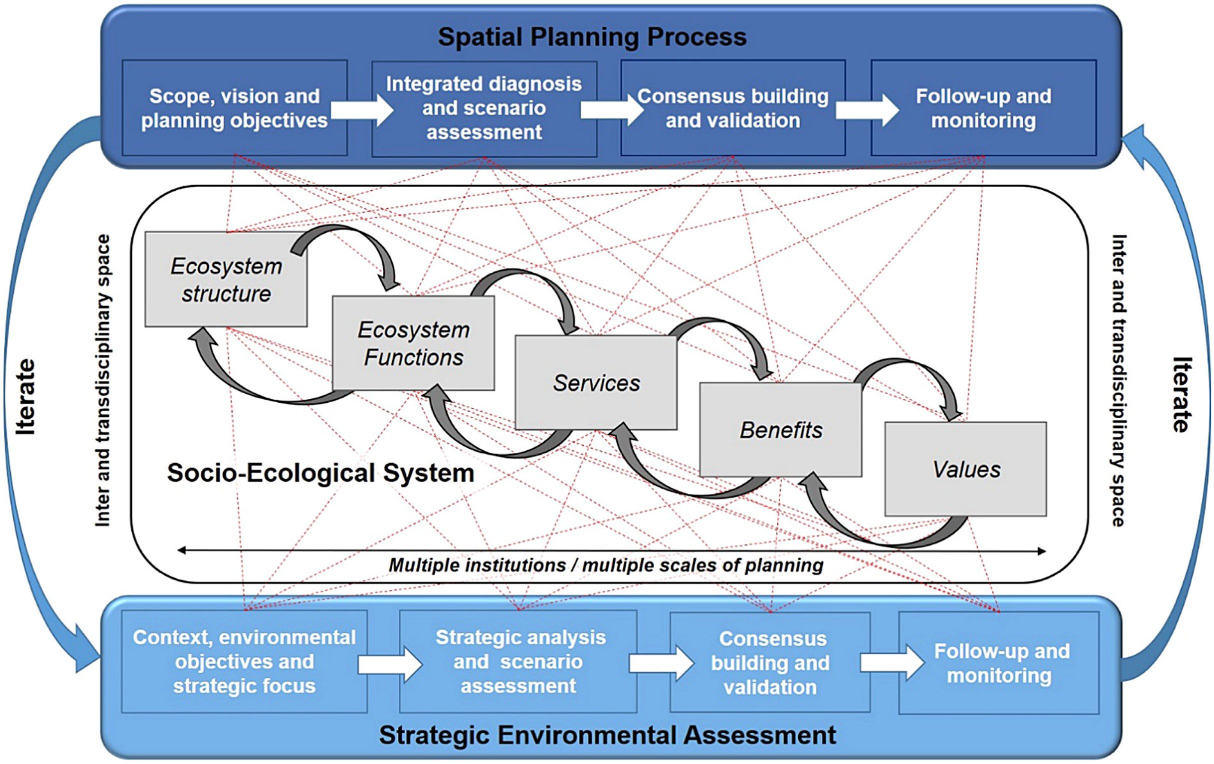

Fig. 1. Simplified framework of integration between the different steps of the ES cascade and key stages of spatial planning and SEA processes. Adapted from Haines-Young and Potschin (2010).

At present, some progress and examples are available regarding the use of ES indicator frameworks for supporting decision-making in spatial planning (e.g. Albert et al., 2016; Hauck et al., 2016; van Oudenhoven et al., 2012), although without including specifically neither SEA nor the cascade model. Thus, the issue of connecting explicitly ecosystem services and its contribution for supporting spatial planning and SEA by using the ES cascade model, is in a very early stage of progress.

Despite an increasing body of research and empirical information, practical applications in the development of policy instruments such as spatial planning are still scarce (Rozas-Vásquez et al., 2018). Then, through this opinion paper, we encourage the increase of practical applications and policy-science evidence for the ES application in real-world problems, based on successes and failures from a range of case studies.

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