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Special Issue Editorial

Developing and applying ecosystem service indicators in decision-support at various scales

1. Introduction

On-going processes, such as the work of the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES, Larigauderie and Mooney, 2010) and the implementation of the EU Biodiversity Strategy (e.g. Maes et al., 2014) show that ecosystem services (ES) have not gained only high perception in research, but have meanwhile reached the status of a concept for supporting policies, programs and plans. However, the gap between theory and implementation in planning and decision making concerning (ES) is still wide, as proven by the number of scientific papers that address how to move from scientific knowledge about ES to real-world decision making (e.g. Daily et al., 2009; Bastian et al., 2012; Hauck et al., 2013; Ruckelshaus et al., 2013; Albert et al., 2014). Many ES indicators have been developed, e.g. Van Reeth (2013) found over a hundred ES indicators for a case study on the regional level in Belgium alone. Researchers continue to develop indicators or even indicator frameworks for decision making (e.g. Burkhard et al., 2012; Koschke et al., 2012; van Oudenhoven et al., 2012; Kandziora et al., 2013; Turkelboom et al., 2013; Helfenstein and Kienast, 2014; Maes et al., 2014; UK NEA, 2011, http://uknea.unep-wcmc.org/; Albert et al., 2015a). However, according to Burkhard et al. (2012), the different approaches illustrate that the definition of a general classification framework remains a major challenge, because ES studies are rather singular, question-dependent and context related. Another reason for the gap might be that most of these indicators, or sets of indicators, have only been tested in scientific studies alone, but more often than not still need to be applied in real world decision making (e.g. Bagstad et al., 2013). Therefore, most recent methods such as balanced score cards are suggested to assess how valuable and practicable ES have been to support and improve decision making (Fürst et al., 2014). Despite these issues, national governments started to conduct continuous assessments of biodiversity and ES (Ruckelshaus et al., 2013). Among the main problems encountered, there is the lack of mutual agreement about what indicators are (Heink and Kowarik, 2010), the complexity they address (Turnhout et al., 2007), how they have to be designed (Failing and Gregory, 2003) and the mismatch between their scale, and the decision-making scale (Dick et al., 2014).

2. Objective

In order to help to bridge the science-policy gap, this special issue assembles contributions concerning the development and application of ES indicators in policy and decision making processes at various scales, contexts and cultural settings. The objective is to advance the understanding of the requirements for ES indicators in decision making. Moreover, this special issue discusses different forms of stakeholder involvement and related social processes of how ES indicators are defined, assessed, and communicated to provide useful decision support for policy, planning and management. The individual contributions to the special issue provide insights into the following key themes of ES indicator development and application:

- Ambiguities of the ES concept
- Addressing the issues of scales
- Requirements for policy-relevant ES indicators
- Conceptual frameworks for ES indicator development
- Normative bias of indicator selection and interpretation
- Transdisciplinarity

2.1. Ambiguities of the ES concept

Ambiguities of the ES concept, as pointed out by Heink et al. (2015) and Albert et al. (2015a) can, for example, be related to measuring the potential or actual use of ES. Another ambiguity concerns the question if indicators cover only the natural capitals in the delivery of ES or also include other capitals, such as machines, skills, and labour. A further questions concerns which ES values are included. For instance, often monetary values are promoted on the expense of non-monetary values. Ambiguities also revolve around the question of which phenomena are included in the ES concept. For example ecosystem disservices, i.e. “functions of ecosystems that are perceived as negative for human well-being” (Lyytimäki and Sipilä, 2009: 311) are rarely included in general and consequently in indicator discussions in particular (Haase et al., 2014; La Rosa et al., 2015).

The ambiguities can cause considerable confusion, particularly for those people that have limited ES literacy, i.e. less familiarity with the ES concept and its benefits and shortcomings. This can lead to reservations, e.g. to use of economic valuation approaches (Schröter et al., 2014). Furthermore, it can lead to scepticism concerning the usefulness of ES indicators in (biodiversity) conservation contexts (e.g. Saarela and Rinne, 2015) or more generally in planning and decision making (Fürst et al., 2012). It can, however, also lead to enthusiasm ignoring some of the shortcoming associated with the ES concept (Albert et al., 2014).

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2.2. Addressing the issues of scales

Many contributors of the special issue (e.g. Pelorosso et al., 2015; Norton et al., 2015; Tratalos et al., 2015; La Rosa et al., 2015) identify scale-mismatches, i.e. indicators and associated (available) data sets do not fit the specific scale of decision making. This becomes more critical when decision making processes span across scales, or beyond national borders (Fürst et al., 2010; Spyra, 2014). Considering multiple scales in decision making becomes important, because ES are not only consumed at one scale but at multiple scales (La Rosa et al., 2015) and because this allows accounting for trade-offs between ES provision for different uses (Albert et al., 2015b). Therefore ES indicators require a multi-level governance approach taking into consideration international classifications like the Common International Classification of ES framework (CICES, Haines-Young and Potschin, 2010) and policy contexts such as the IPBES. However, indicators also need to fit to specific biodiversity policy context, for example in the EU that have to be consistent with the framework suggested for implementation of Action 5 of the Biodiversity Strategy (Maes et al., 2014). Furthermore, many decisions for the conservation and sustainable use of ES and biodiversity need to be made on the national and more importantly on the regional and local level. Indicators to support decision making processes, particularly on these two lower levels, still need to be in line with those on the levels above, but have different requirements e.g. concerning accuracy and detail (Norton et al., 2015; Albert et al., 2015b).

Using the example of cultural ecosystem services (CES), Tratalos et al. (2015) show possible approaches for dealing with scalar issues. One approach includes assessing CES only at local scale. Alternatively the authors recommend investigating whether cost effective indicators, using currently available data, could be established. Although the resulting set of indicators may not have the depth, they could still be relevant on a national level, e.g. for contributing to ES literacy; showing areas of particular importance e.g. to create new protected areas; revealing trends in the effects of landscape change on CES provision; improving the understanding of the relationship between local provision of CES and the current demand for them between different locations.

2.3. Requirements for policy-relevant ES indicators

While there seems to be a general consensus about the necessity to resolve conceptual ambiguities and pay attention to scale issues, this is often in contrast to questions of ES indicators practicality. Diehl et al. (2015) for example found that many discussions in the ES context resulted in its perception of an altogether too complex framework for decision making. For decision makers, indicators need to be: easy to understand (e.g. in monetary terms), widely applicable, cost-effective, valid over time and space, i.e. preferably coverable with data that are already collected for other purposes, and may stand legal challenge in negotiations. In other words, decision makers require ES indicators that are legitimate (Fürst et al., 2013; Mononen et al., 2015; Albert et al., 2015a,b; La Rosa et al., 2015; Tratalos et al., 2015; Diehl et al., 2015; Heink et al., 2015; Saarela and Rinne, 2015). While these are valid considerations, fulfilling these criteria can lead to oversimplification and biased debate on economic significance of ES, ignoring other values (Mononen et al., 2015). This concerns particularly CES leading to a prominent lack of indicators beyond recreation and tourism and landscape aesthetics (La Rosa et al., 2015; Tratalos et al., 2015; Heink et al., 2015).

Apart from the criteria posed by decision makers, scientific quality criteria should not be sidelined. The validity of indicators, i.e. the extent an indicator represents the subject to be indicated, should also be considered as a crucial part of the scientific credibility (Heink et al., 2015; Saarela and Rinne, 2015). This is particularly true in cases of proxy indicators, i.e. substitute measures used to provide insight into the area of interest when it is not possible to measure the issue directly but still are reasonably synchronous with a good direct measure (ESID, 2012). This discussion is particularly relevant in the context of cultural ES, where the challenge is to find quantitative indicators able to express the cultural dimension of specific ES in a spatially-explicit way (La Rosa et al., 2015; Tratalos et al., 2015). Innovative tools, like participatory GIS tools, such as smart phone applications, could be used for example in the context of Citizen Science to assess, in spatially explicit way, the actual use, i.e. demand for CES (Priess et al., 2014; Frank et al., 2015).

2.4. Conceptual frameworks for ES indicator development

To strike a balance between practicability and oversimplification, and deal with other challenges mentioned a number of authors found conceptual frameworks helpful (e.g. Albert et al., 2015b; Mononen et al., 2015; La Rosa et al., 2015; Diehl et al., 2015; Wissen Hayek et al., 2015). Mononen et al. (2015), and Diehl et al. (2015) suggest using the "ecosystem service cascade" proposed by Potschin and Haines-Young (2011). Mononen et al. (2015) propose to use four indicators for each step in the cascade and for each ES to cover the whole delivery process from ecosystem structure to values. Benefits of such an approach would be an increased understanding of the topic by presenting clear, systematic, and qualitative information and a common technical language (Mononen et al., 2015; Diehl et al., 2015). Apart from a clear structuring, the use of such a blueprint would also enable comparisons between studies for decision making and monitoring on higher levels, such as the European Union (Diehl et al., 2015).

Albert et al. (2015b) suggest an alternative approach. The authors suggest to adapt the ES concept to current conceptual models of decision making rather than the other way around. At the example of landscape planning, the authors introduce an ES-in-Planning framework, which combines ES assessment and valuation indicators with the widely used Driving Forces, Pressures, State, Impacts and Responses (DPSIR) model. In their framework, ES indicators become part of landscape planning as a means of assessing the current state of the environment and for determining how it might change in the future.

2.5. Normative bias of indicator selection and interpretation

Mononen et al. (2015), Diehl et al. (2015), and Saarela and Rinne (2015) point out that indicators are not only a means to structure and communicate information, but also the result of politically normative decisions on what is important. In other words: what is considered as relevant for analysis and the justification of an indicator is context sensitive and depends on the norms and customs of the actors selecting indicators (Diehl et al., 2015; Saarela and Rinne, 2015). This turns indicator selection into a political process which is likely to be challenged by stakeholders, who might think that their agenda is not properly implemented, in the worst case causing battle of impact assessments (Diehl et al., 2015). Concerns to create such situations may seriously hamper discussions concerning to ES indicators. For example, in the case provided by Saarela and Rinne (2015) assessments where only allowed for land use planning situations where mutual, policy-level understanding and agreement existed. Assessments in contested situations were not carried out due to concerns to complicate future processes.

2.6. Transdisciplinarity

A crucial component of any approach to developing and applying ES indicators in decision-support is transdisciplinarity. Transdisciplinarity is here defined following Lang et al. (2012) as

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