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National ecosystem service indicators: Measures of social–ecological sustainability

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ABSTRACT

Until present, it has been challenging to turn the concept of ecosystem services into a practical tool in the formulation of day-to-day policies on a national or regional scale. This is largely due to the overarching nature of the concept of ecosystems services (ESs) and the lack of concrete ecosystem service typologies. In this paper, we describe the foundation process of a national ecosystem service indicator framework for Finland, beginning with the selection of nationally important ESs. We also evaluate how this set of national indicators could be scaled down to regional circumstances, or integrated in the international ecosystem assessment processes. Our aim was to develop a national framework that complies both with national circumstances and with international typologies such as the Common International Classification of Ecosystem Services (CICES) and the cascade model. We developed indicators for 28 ecosystem services (10 provisioning, 12 regulating and maintenance, and 6 cultural services), a set of four indicators for every stage of the cascade model; altogether 112 indicators. We hope that the indicator framework draws attention to questions of resilience by providing information on the different aspects of ecosystem functioning that are crucial to the provisioning of ecosystem services. Furthermore, we hope to highlight the societal dependence on ecosystem services by providing indicators of both benefits and values. Besides higher-level decision-making processes, our attempt was to provide novel ecosystem service information for regional environmental managers and decision-makers, as well as the wider public interested in local issues. Integrating both ecological and socio-economic data into one platform may help to bridge the gap between science and practical decision-making resulting in more sustainable environmental management.

1. Introduction

The concept of ecosystem services (ESs) was originally formulated as a communication and educational tool to support efforts to conserve biological diversity (Daily, 1997; Gómez-Baggethun et al., 2010). As the focus of environmental management and protection has turned to the role played by species and ecosystems in securing our livelihood, the concept holds much promise in attracting wider societal interest in biodiversity. This wider interest in the function of biodiversity in supporting life and human economy can, in turn, be anticipated to increase our willingness to protect biodiversity, while severe disruptions of the provisioning of ecosystem services have been reported (e.g. MEA, 2005; TEEB, 2010).

During the early years of ecosystem service research there was a wide pluralism in the terms and concepts used (Vihervaara et al., 2010). However, initiatives such as the implementation of the Common International Classification of Ecosystem Services (CICES) and the formulation of the cascade model

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(Haines-Young and Potschin, 2010a) have attempted to unify the terms and brought some consensus amongst different fields of science.

The European Commission emphasizes the importance of accurate ecosystem service information as a basis of implementation of the EU Biodiversity Strategy for 2020 (European Commission, 2011) which is implemented, for instance, via the MAES (Mapping and Assessment of Ecosystems and their Services; especially Target 2, Action 5) working group – a procedure which aims to support national ES assessments of the member states of European Union. Time is now getting ripe for testing ecosystem service classifications in real-life situations. Examples of practical applications of the CICES classification include the Belgian national ES classification (Turkelboom et al., 2013) and the GreenFrame approach to map green infrastructure (Kopperoinen et al., 2014). National level ecosystem service indicators have already been discussed in national or regional TEEB (The Economics of Ecosystems and Biodiversity) reports but the focus of these studies has been more on the socio-economic side of ESs (e.g. Kettunen et al., 2012). The United Kingdom's national ecosystem assessment provided comprehensive ecosystem data and, by doing so, set a benchmark for future assessments (UKNEA, 2011; http://uknea.unep-wcmc.org/). Structured ES indicator frameworks have been developed for identifying ESs in decision-making processes concerning land use (van Oudenhoven et al., 2012) and, in Germany, national indicators covering both supply and demand side of ESs have also been developed (Burkhard et al., 2012; Kandziora et al., 2013; Albert et al., 2014).

Despite many advances during the three decades of active development of ecosystem service related concepts and their applications – including the rapid development of ecosystem function commodification (Kosoy and Corbera, 2010) – we are still a long way from having turned the concept of ecosystem services into a practical tool in the formulation of day-to-day policies on a national or regional scale. This is largely due to the overarching nature of the concept and the lack of concrete examples and ecosystem service typologies. In Finland, as presumably in many other countries, there is an urgent need to interpret the concept from a national point of view: What are the relevant ecosystem services in Finland? Which of them are the most important? How much do we know about them?

Our aim was to develop a national framework of ecosystem service indicators for Finland, which is built on a consideration of national circumstances and also complies with international typologies such as CICES and the cascade model. The CICES classification includes also abiotic services but at this point they are not included in our ecosystem service listing. In fact, many selected ESs involve a combination of biotic and abiotic elements (e.g. ESs related to the water cycle). We have, nevertheless, decided to start from those ESs whose provision is most obviously linked to living ecosystems. The foremost goal of the framework is to concretize the concept of ecosystem services nationally and to provide a foundation for further development. Furthermore, the indicator framework is much needed for assessing the effectiveness of biodiversity related policies, for instance when reporting to the Convention on Biological Diversity (e.g. Ahokumpu et al., 2014), as well as when monitoring the implementation of EU Biodiversity Strategy 2020. The indicators may also support science-policy platforms such as the Intergovernmental Panel on Biodiversity and Ecosystem Services IPBES (www.ipbes.net). One of the challenges for internationally comparable ecosystem assessments is that available data sets and used measures are different e.g. in European countries. The challenge is even bigger for the global biodiversity and ecosystem services assessment that is planned as a part of the IPBES process by 2018 (Objective 2; www.ipbes.net). Consistent national and European quantification systems are necessary to achieve this goal.

Besides providing ecosystem service information to higher-level decision-making processes, our attempt has been to consider the needs of regional environmental management and decision-making and the interest of the wider local public in the way we provide the information. Integrating both ecological and socio-economic data into one platform may help to bridge the gap between science and practical decision-making resulting in more sustainable environmental management.

In this paper we describe the foundation process of the national ecosystem service indicator framework for Finland, beginning with the selection of nationally important ESs and a discussion on the preferred value indicators for different ecosystem service categories. We report our ES indicators online in order to disseminate information swiftly to different target audiences at different levels of the decision-making process.

In short, our aims were to (I) describe the path of the determination and selection of nationally relevant ecosystem services, (II) provide four indicators describing each stage of the cascade model for each ecosystem service, (III) evaluate how the indicators could be applied and downscaled to regional and even local scale to be used in e.g. land use planning, and (IV) discuss their applicability in decision-making and their usefulness for the wider public. A description of indicator data sources is provided as supplementary material (Auvinen et al., 2007; Fang and Ling, 2003; Finnish Forest Research Institute, 2013a,b; Haines-Young and Potschin, 2010b; Hanski et al., 2012; Hoehn et al., 2008; Karjalainen et al., 2010; Korpela et al., 2011; Kraufvelin and Salovius, 2004; Kumpula et al., 2000; Känkänen et al., 2012; Mattila et al., 1999; Metsähallitus, 2014a; Ministry of Agriculture and Forestry, 2003, 2004, 2014a,b; Ministry of the Environment, 2014; Nowak et al., 2006; OSF, 2014a; Rassi et al., 2010; Salo, 1995; Sievänen and Neuvonen, 2011; Tike, 2014; Tyrväinen and Tuulentie, 2007). The most recent versions of the indicators themselves can be found at www.biodiversity.fi/ecosystemservices

2. Methodology

2.1. Selection of nationally important ecosystem services

Our categorization of ecosystem services (Fig. 1) began by identifying the most important ecosystem services in Finland. By the help of the CICES classification (V.4.3) we formulated approximately ten classes for each of the three ecosystem services sections; provisioning, regulating and maintenance, and cultural services (Haines-Young and Potschin, 2010a). We omitted some CICES classes that we deemed marginal for Finland such as animal based mechanical energy. All classes were given an accessible and nationally relevant title (e.g. CICES class level title 'Wild plants, algae and their outputs' was formulated as 'Berries and mushrooms'). We focused on ESs that are currently relevant in Finland while being aware that new ESs may emerge in the future.

We consulted multidisciplinary national biodiversity indicator expert groups of main ecosystem types: forests, mires, the Baltic Sea, inland waters and farmlands. These groups, each containing approximately ten members from a wide spectrum of research institutes, universities, administration, NGOs and other organizations (www.biodiversity.fi/en/about/expert-groups), have been operational since 2010. Having provided the preliminary CICES class list as an introduction into the subject we asked each expert group, which ESs are most relevant from their point of view. Once the general framework was constructed, relevant indicators chosen and a preliminary review of data availability conducted, we organized a second meeting, where all the expert groups joined.

After the expert consultations we organized a one-day stakeholder workshop for a wide national audience, including ministries,

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