Ecological Indicators 70 (2016) 181–195

Contents lists available at ScienceDirect

Ecological Indicators

journal homepage: www.elsevier.com/locate/ecolind

Assessment of ecosystem services at the national level in Germany—Illustration of the concept and the development of indicators by way of the example wood provision

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ARTICLE INFO

Article history:
Received 4 February 2016
Received in revised form 30 May 2016
Accepted 7 June 2016

Keywords:
Biodiversity
CICES classification
Ecosystem services
Forest management
Raw wood production

ABSTRACT

The EU Biodiversity Strategy stipulates in Target 2, Action 5 that the member states must map and assess the state of the ecosystems and their services and promote the integration into the reporting systems at the EU and national level by 2020. Therefore indicators for capturing and assessing ecosystem services (ES) are needed. In this paper we report for which ES class types currently ES indicators are being developed for Germany in the context of an ongoing research project. Additionally, we provide the indicator specifications, which are based on underlying framework concept. By way of the example of the provisioning service 'raw wood production' and the development of the main-indicator 'annual wood accrual' and six sub-indicators, we illustrate the concrete procedure, including discussion of results and target values. The indicators for the ES wood provision are not only suitable for an exemplary illustration of procedure, data selection and data basis in Germany. Furthermore, it shows that indicators for provisioning ES can eminently conflict with biodiversity and other ES.

1. Introduction

The EU Biodiversity Strategy stipulates in Target 2, Action 5 that the member states must "map and assess the state of ecosystems and their services, and to better integrate the value of ecosystem services into national and EU accounting and reporting systems" by 2020 (European Commission, 2011). So far, the member states have fulfilled this target to different degrees. The "Working Group on Mapping and Assessment of Ecosystems and their Services" (MAES) set up by the EC Directorate-General for Environment was tasked with coordinating the activities for Europe (Maes et al., 2014).

The German environmental authorities at the federal level have initiated various research projects for capturing, assessing and mapping ecosystem services (ES). Besides the European target, the objective is also to support the implementation of the National Biodiversity Strategy. These activities also lend new relevance and topicality to §1 of the Federal Nature Conservation Act (BNatSchG, 2009), which requires the performance and functioning of the natural balance to be safeguarded.

To improve understanding of how biodiversity and ES could be better protected, enhanced or restored at national or subnational level, several countries worldwide initiated ecosystem assessments. Some assessments were designed as comprehensive studies similar to the Millennium Ecosystem Assessment (e.g. in Spain and the U.K.), some were part of national follow-ups of the international TEEB study (*The Economics of Ecosystems and Biodiversity*, e.g. TEEB Finland), or focussed preliminarily on indicator development (e.g. Switzerland). In view of the requirements and the complexity of the subjects ES and biodiversity, there is a clear challenge to meet all of the requirements of scientific precision, availability of data bases, and of political usability (Egoh et al., 2012; Haines-Young et al., 2012; Burkhard et al., 2013).

Indicators for capturing and assessing ES are required as an essential instrument of operationalizing these goals and for measuring success (Müller and Burkhard, 2012). They are intended to provide information on existing ES (including supply and demand) and on temporal trends as selected, readily comprehensible param-

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http://dx.doi.org/10.1016/j.ecolind.2016.06.010
1470-160X/

eters. In many areas of environmental and nature protection, there is extensive experience with indicator systems, in particular with indicators related to environmental status, landscape protection, biodiversity, sustainability and land use.[1] The development of ES indicators can be built on this experience.

In the framework of the research project "TEEB Germany Overview Study" ("*TEEB Deutschland Übersichtsstudie*"), the possibilities of capturing ES in Germany at the federal level were examined. Building on this, "Recommendations for developing a first national indicator set for capturing ecosystem services" ("*Empfehlungen zur Entwicklung eines ersten nationalen Indikatorensets zur Erfassung von Ökosystemleistungen*") were prepared as a basis for further discussion (Albert et al., 2015). In the overview study, 17 ES relevant for Germany were proposed, and the selection was justified. These ES were selected from a compilation of possible ES for Germany based on a prioritization by experts with a view to federal relevance and representability. Monitoring is the detection of temporal developments using indicators. However, this requires the data bases to be reliably available in comparable quality. This significantly restricts the selection of indicators.

These results are now being updated and further developed in the framework of a further research project.[2] One of the main objectives of the project is to determine whether it is possible to provide argumentation aids by creating ES maps for Germany, in order to justify measures for improving the state and the performance of the ecosystems (Grunewald et al., 2015). A particular focus is on developing summarizing quantities at the federal level and cartographically representing the indicator values for different spatial units and evaluations with respect to selected content.

The approach further developed and presented here is based on the definition of the ES and their classification in a system of categories developed by Grunewald and Bastian (2015a). The classification of the ES was performed according to Common International Classification of Ecosystem Services (CICES, Haines-Young and Potschin, 2013), as agreed in the MAES working group at the Directorate-General for the Environment (Maes et al., 2013).

The following illustrates for which ES class types indicators for Germany are to be developed in the framework of the project, and how the indicandum (ES) is intended to be described using indicators. We provide the outline of the full version of the ES indicator specification. This will be illustrated and discussed using the example of a selected provisioning service (raw wood production).

In view of the requirements and the complexity of the subjects ES and biodiversity, there is a clear challenge to meet all of the requirements of scientific precision, availability of data bases, and of political usability. There is also the risk of producing misleading ES assessment results due to indicated selection of ES indicators (e.g. Morelli and Møller, 2015).

As addressing this problem poses an enormous challenge, a broad initiative and network of experts has now been formed to support the process of recording and assessing ES in Germany and beyond. The objective of the paper is to present a systematic approach for developing national ES indicators, as it is being pursued in the framework of the above mentioned research project in Germany. This could be seen as a case study which can also be applied in other areas.

[1] http://www.bfn.de/0315_indikator-naturschutz.html [in German].

[2] "Implementation of Action 5 of the EU Biodiversity Strategy. Development and implementation of a methodology for capturing and assessing ecosystem services at the federal level in the context of the implementation of Target 2 and Action 5 of the EU Biodiversity Strategy for 2020" ("*Umsetzung Maßnahme 5 der EU-Biodiversitätsstrategie. Erarbeitung und Umsetzung einer Methodik zur bundesweiten Erfassung und Bewertung von Ökosystemleistungen im Rahmen der Umsetzung von Ziel 2 und Maßnahme 5 der EU-Biodiversitätsstrategie für 2020*") (2014–2016, research contractors: IÖR Dresden/ifuplan München).

The roadmap of the paper is as following: the starting point is the conceptual-methodological approach (Section 2.1–2.3), how the EU-MAES requirements can be implemented in Germany (preliminary work, priorities, data situation etc.). In the second step we explain the selection of ES classes for which national indicators will be developed in the framework of our research project (Section 2.4); here 'relevance' is an important criterion. Practical implementation is illustrated on the basis of a concrete example (Section 3). This include more technical principles (template of indicator description, calculation steps) on the one hand and interpretation of results on the other. In the latter, the focus is placed on the relationship between ES indicators and biodiversity, as the indicator development takes place within the scope of the EU Biodiversity Strategy 2020.

2. Methodological framework and target category ES indicators

The basic approach primarily follows the recommendations of the MAES working group (Maes et al., 2013, 2014) as well as internationally and nationally accepted approaches (Staub et al., 2011; Brouwer et al., 2013; Econcept/WSL, 2013; Burkhard et al., 2014; Grunewald and Bastian, 2015a; Grunewald et al., 2015 and others). For assessing ecosystems and their services, the MAES conceptual framework includes the modules (1) mapping the ecosystems, (2) assessing the ecosystem conditions, (3) assessing the ecosystem services and (4) integrated ecosystem assessment.

The first three modules will be briefly outlined in the following. The subsequent remarks on implementation focus on step (3) – the development of indicators for assessing ES. The foundations for module (4) will be worked out in the research project by 2016, but a complex, integrated presentation, e.g. of the connections between ecosystem state and ES, is beyond the scope of our project. But trade-offs between sustainable use of timber and aspects of biodiversity are discussed in an exemplary manner, because MAES is implemented as part of the EU Biodiversity Strategy.

2.1. Mapping the ecosystem types in Germany

It is recommended that EU member states use CORINE Land Cover data (CLC, EEA, 2007) to classify ecosystems at the national level (Maes et al., 2014). In case land use data should be regionally available with better spatial resolution or additional information, these should be used if suitable. CLC provides a concept and system across states for acquiring and assessing this information and changes in it. The data acquisition of CLC was first carried out in the 1990s across Europe on the basis of satellite data at a scale of 1:100,000. The initial acquisition for the reference year 1990 (CLC 1990, EEA, 2016a) distinguished 44 land use classes, of which 37 classes – e.g. settlement areas, agriculture, forest, wetlands and water areas – occur in Germany. The second acquisition for the reference year 2000 (CLC 2000, EEA, 2016b) was the first to document the changes in land cover and land use with respect to 1990. According to these data, the proportion of built-up areas, but also of forests and water areas, has increased in Germany. By contrast, the extent of land in agricultural use and wetlands decreased. A further update to CLC has been performed for the reference year 2006 (CLC, 2006; EEA, 2016c).

The usability of CLC data for small-scale areas and structures is limited due to the relatively low spatial resolution of 25 ha, the lack of linear structures with a width under 100 m and the limited thematic resolution (37 classes in Germany, see above). It has also been criticized that, due to their small scale, many habitats which are valuable from a nature protection perspective are assigned to neighboring land use classes (e.g. small copses in the agricultural