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Editorial

Mapping and assessing ecosystem services: Methods and practical applications

Fernando Santos-Martín[‡], Davide Geneletti[§], Benjamin Burkhard[|,¶]

‡ Autonomous University of Madrid, Madrid, Spain
§ University of Trento, Trento, Italy
| Institute of Physical Geography and Landscape Ecology, Leibniz Universität Hannover, Hannover, Germany
¶ Leibniz Centre for Agricultural Landscape Research ZALF, Müncheberg, Germany

Corresponding author: Fernando Santos-Martín (fernando.santos.martin@uam.es)

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ESMERALDA Special Issue Editorial

The EU Biodiversity Strategy to 2020 called on EU member states to map and assess the state of ecosystems and their services in their national territory (European Commission 2011). This knowledge-base should be designed to be a primary resource for developing Europe's green infrastructure, to identify areas for ecosystem restoration and to set a baseline against which the goal of 'no net loss" of biodiversity and ecosystem services can be evaluated. Thus, appropriate methods, information and data are needed to know where and how, for example, food, water, clean air, other materials and recreation are provided, and how climate, nutrients, natural disasters, pests and diseases are regulated. Information and data on actual ecosystem services (ES) demands, beneficiaries and potential mismatches with their supply location as well as ES quality and quantity are essential to make informed decisions for appropriate management of natural resources. ES are a very complex topic and their integrative assessment and implementation asks for truly transdisciplinary approaches.

ESMERALDA*1 (Enhancing ecosystem services mapping for policy and decision-making) was an EU Horizon 2020 Coordination and Support Action dedicated to create a strong pan-European network and to identify and apply methods and case studies for the implementation of MAES*2 (Mapping and Assessment of Ecosystems and their Services)

in EU member states (Burkhard et al. 2018b). ESMERALDA aimed to deliver a ‘flexible methodology’ that can provide innovative building blocks for pan-European, national and regional ES mapping and assessment. The Special Isssue "Mapping and assessing ecosystem services: methods and practical applications" is one of the main outcomes of the EU-funded project ESMERALDA. This Special Issue contains a total of twenty four papers, divided into three main sections. The first section concentrates on mapping and assessment general issues and frameworks and contains six papers. The second section focuses on methodological aspects and includes nine papers that dentify and document methods for ES mapping and assessment (biophysical, economic and socio-cultural methods) used in the EU. Finally, the third section, consisting of nine papers, illustrates the application of the approaches in a range of case studies representative for different contexts and conditions. With this Special Issue, the ESMERALDA team aims to support the timely delivery by all EU member states to Action 5 of the European Biodiversity Strategy 2020, by providing an overview of up-to-date ecosystem mapping and assessment methods and their applications in local assessments required, for instance, for spatial planning, agriculture, climate, water or nature policy.

The first Section of the Special Issue includes six papers that focus mainly on the theoretical and conceptual approaches developed by ESMERALDA. Burkhard et al. (2018b) provide an overview of the ESMERALDA project, its objectives, implementation, achievements and 'lessons learnt'. One key objective of the project was to promote transdisciplinary ecosystem assessments that integrate biophysical, social and economic value domains on different levels. A respective conceptual framework for such integrated ecosystem assessments was developed by Brown et al. (2018). When working in interdisciplinary teams, not only a commom conceptual framework is needed, but the team also needs to be aware about using a consistent terminology. The 'Glossary of ecosystem services mapping and assessment terminology' by Potschin-Young et al. (2018) provides probably the most up-to-date collection and definitions related to ecosystem services mapping and assessment. Consistency is also needed when ES are to be defined and categorised. Here, the revised version 5.1 of CICES*4, the Common International Classification of Ecosystem Services, provides clear guidance by categorising ecosystem services using a five-level hierarchy, with each level being progressively more detailed and specific (Haines-Young and Potschin-Young 2018). The 'tiered approach' helps structure existing ES mapping and assessment approaches in order to find the most suitaible methodology related to the details of analyses needed, the purpose of the study and data and resources availability. Weibel et al. (2018) describe how such a tiered approach can be developed in an appropriate manner by involving a broad stakeholder network. The variety of stakeholders as potential users of MAES-related products is large, including people from policy, business and society. All of them have specific questions, which can be addressed by MAES and Action 5 of the EU Biodiversity Strategy. A typology of questions was developed by Maes et al. (2018) along the five categories: i) knowledge requests, ii) policy support questions, iii) questions on resources and responsibilities, iv) application questions and v) technical and methodological guidance questions.

The second Section contains nine articles concentrating on methodological aspects and includes papers that identify and document methods for ES mapping and assessment at biophysical, economic and socio-cultural dimensions. Santos-Martin et al. (2018) describe the process of creating an operational database for existing studies on ecosystem services mapping and assessment, which records relevant information (e.g. methods used, the scale, ecosystem type, ecosystem service categories) and other relevant attributes that need to be considered. This review of related studies, therefore, formed the basis for an online method database for mapping and assessing ES (Reichel and Klug 2018). As an example for the methodolgicial aspects of biophysical methods, Steinhoff-Knopp and Burkhard (2018) compared two approaches to assess erosion regulating ecosystem services in croplands in northern Germany. For economic methods, Marta-Pedroso et al. (2018) describe how to bring the economic value of protected areas (Natural Park of Serra de São Mamede, Portugal) to the decision-making process and how to contribute to extend current EU Member States' experience in mapping and assessing economic values of ES in the context of the EU Biodiversity Strategy to 2020. For the socio-cultural methods, Ruskule et al. (2018) demonstrate how to map and assess cultural ES of Latvian coastal areas. The method involved the compilation of field data from a survey of visitors at the beach and on coastal infrastructure, serving as input for the multi-criteria assessment of cultural ES. Additionally, lessons learned using specific methods at different scales were presented. Campagne and Roche (2018) present how the 'ES matrix approach' links ecosystem types or land cover types to ES by providing a score for ES capacity, ES supply, ES use, ES demand or other concepts. The authors concluded that using expert elicitation enables quick and integrative ES scoring that can meet general requirements for validated ES mapping and assessment at different scales. At the national level, Vačkář et al. (2018) discuss selected methodological aspects of ES valuation for the Czech Republic. The tiered approach, developed in ESMERALDA (Weibel et al. 2018), was tested by Villoslada et al. (2018). In that paper, the authors outline the adaptation of the tiered approach for ES mapping and assessment provided by grasslands in the Baltic States (Estonia, Latvia and Lithuania). Finally, Vihervaara et al. (2019) describe how different methodological interlinkages can be used in ES mapping and assessment studies and how the integration of information can be facilitated to assist in decision-making processes related to sustainable use and protection of ES.

The third Section contains nine papers that illustrate the application of the different ES mapping and assessment approaches and methods to a range of case studies across Europe. In Geneletti et al. (2018), the authors describe how the selection of case studies in ESMERALDA aimed at covering the variety of geographical regions and biomes, levels of implementation of the EU Biodiversity Strategy, themes (e.g. forestry, water, agriculture, protected areas) and policy and planning processes that can be used to mainstream ES in real-life decisions. Hence, case studies show how the ESMERALDA 'flexible methodology' can be used to select and apply appropriate (combinations of) methods for ES mapping and assessment under different conditions (e.g. data availability, time requirements, expertise and experience, scale of application) and for specific contexts and purposes. Particularly, Kokkoris et al. (2018) present the first national-level assessment of ecosystem conditions in Greece, focused on forest types. The study is based on the assessment of

conditions using the conservation degree at plot level as an indicator, followed by a large-scale analysis, based on pressures and typical plant species richness. Another study, performed at the national scale, is illustrated by Lotan et al. (2018). The authors mapped three ecosystem services in Israel, adopting different methods: Genetic resources were mapped using spatial observations of the crop wild relatives species; pollination by wild bees was mapped using expert-based habitat modelling and, finally, recreation was mapped by analysing the distribution of geotagged digital photographs.

Czúcz et al. (2018) describe a regional-level ES mapping and assessment effort in Central Romania. The study focuses on the services provided by Natura 2000 sites and describes the steps undertaken to design a conceptual framework that accounts for stakeholders' advice and data availability, emphasising the importance of actors' ownership and communication in fostering future policy uptake of the findings. Update by actual policy-making is also a key issue in the paper by Cortinovis and Geneletti (2018), which focuses on spatial planning at the urban scale. The authors present a case study in Trento (Italy), where alternative planning scenarios related to brownfield re-development are compared against the effects on two ES of critical importance for the city (microclimate regulation and nature-based recreation) and on the associated beneficiaries, broken down into different vulnerability classes. Another application in the urban context is presented by Balzan and Debono 2018, who developed an approach to assess urban recreation ES through the use of geocache visitation and preference data. In this study, a quantitative analysis of geocaching data in the Maltese islands was used together with their visit rates and number of favourite points, supplemented by questionnaires.

Nedkov et al. 2018 present a set of selected mapping and assessment methods tested in the Central Balkan area in Bulgaria. The paper provides relevant examples that can support the implementation of integrated ES mapping and assessment at local and regional level, where different mapping approaches and techniques are embedded within diverse policy contexts. Similarly, a two-scale analysis is shown by Bicking et al. (2018) with a focus on nutrient regulation. The potential supplies and demands of/for nutrient regulation were assessed and mapped both for the German federal state of Schleswig-Holstein (regional scale) and the Bornhöved Lakes District (local scale). The approach allows the identification of spatial mismatches between the potential supply and demand, which can provide information on future policy-making in this sector. Finally, Sieber et al. (2018) focus on the Outermost Regions and Overseas Countries and Territories of the European Union, regions where the ES concept has so far received limited attention. Their study aims at analysing the current state of knowledge and implementation of ES mapping and assessment, in order to identify current gaps and provide recommendations from both a research and a policy perspective.

Conclusions

All the above publications demonstrate that, by leveraging the expertise of its pan-European network, ESMERALDA mobilised relevant ES mapping and assessment knowledge, resources and initiatives. The objective of this Special Issue was to exploit existing concepts, methods and case studies through a diversity of 24 high-quality open access scientific articles. This Special Issue provided opportunities for improving ES mapping and assessment methodologies and knowledge sharing, as well as for fulfilling commitments under Action 5. Additionally to this Special Issue, all results from ESMERALDA are collected and made available in the ESMERALDA MAES Explorer*3, an open-access online tool which aims to provide guidance for MAES implementation for stakeholders from policy, practice, business, science and society along a seven-steps approach (Burkhard et al. 2018a). ESMERALDA proved to be a very successful and productive project, bringing together scientists and stakeholders from all 28 EU member states, Switzerland, Norway and Israel, delivering numerous outcomes such as an open access text book on mapping ecosystem services (Burkhard and Maes 2017). We conclude that ES mapping and assessment, as promoted by ESMERALDA, helps understand the services that a specific ecosystem supplies, in order to incentivise decision-makers and businesses to protect or restore the functionalities of ecosystems and to help combat biodiversity loss (Willmer 2019). We hope that science and applications of ES are supported by the ESMERALDA outcomes and contribute to a more sustainable decision-making process on local, regional, national and global scales.

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Endnotes

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*2 http://biodiversity.europa.eu/maes
*3 http://www.maes-explorer.eu/
*4 https://cices.eu/