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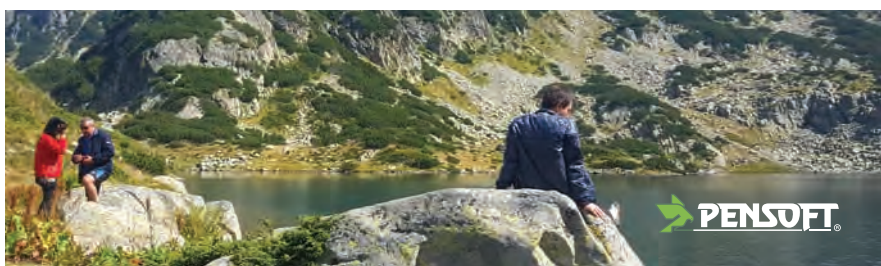
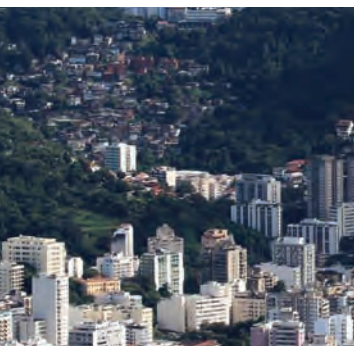
ECOSYSTEM SERVICES



edited by
**Benjamin
Burkhard**



& **Joachim
Maes**



Mapping Ecosystem Services

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Benjamin Burkhard &

Joachim Maes



MAPPING ECOSYSTEM SERVICES

Edited by: Benjamin Burkhard, Joachim Maes



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Foreword

Mapping Ecosystem Services

The world's economic prosperity and well-being are underpinned by its natural capital, i.e. its biodiversity, including ecosystems that provide essential goods and services for mankind, from fertile soils and multi-functional forests to productive land and seas, from good quality fresh water and clean air to pollination and climate regulation and protection against natural disasters. This is the reason why, for example, the first priority objective of the 7th Environment Action Programme (7th EAP) of the European Union (EU) is to protect, conserve and enhance the EU natural capital. In order to mainstream biodiversity in our socio-economic system, the 7th EAP highlights the need to integrate economic indicators with environmental and social indicators, including by means of natural capital accounting, to measure the changes in the stock of natural capital at a variety of levels, including both continental and national levels.

The EU Biodiversity Strategy to 2020 called on Member States to map and assess the state of ecosystems and their services in their national territory by 2014, with the assistance of the European Commission. The economic value of such services should also be assessed, and the integration of these values into accounting and reporting systems at EU and national level should be promoted by 2020 (see Target 2¹, Action 5).

This specific action aims to provide a knowledge base on ecosystems and their services in Europe to underpin the achievement of the six specific biodiversity targets of the strategy as well as including a number of other

sectoral policies such as agriculture, maritime affairs and fisheries and cohesion.

Mapping ecosystem services is essential to understand how ecosystems contribute to human wellbeing and to support policies which have an impact on natural resources. In 2013, an EU initiative on Mapping and Assessment of Ecosystems and their Services (MAES) was launched and a dedicated working group was established with Member States, scientific experts and relevant stakeholders. The first delivery was the development of a coherent analytical framework² to be applied by the EU and its Member States in order to ensure consistent approaches. In 2014, a second technical report³ was issued which proposes indicators that can be used at European and Member State's level to map and assess ecosystem services. The indicators are proposed for the main ecosystems (agro-, forest, freshwater and marine) and the important issue of how the overarching data flow from the reporting of nature directives can be used to assess the condition of ecosystems is also addressed.

From the start of MAES, some exploratory work was undertaken in parallel to assess how some of the biophysical indicators could be used for natural capital accounting. It was also important to ensure that the data flows available at European level and, in particular, those from reporting obligations from Member States would

¹ http://ec.europa.eu/environment/nature/biodiversity/strategy/target2/index_en.htm

² http://ec.europa.eu/environment/nature/knowledge/ecosystem_assessment/pdf/MAESWorkingPaper2013.pdf

³ http://ec.europa.eu/environment/nature/knowledge/ecosystem_assessment/pdf/2ndMAESWorkingPaper.pdf

be used for the mapping and assessment of ecosystems and their condition⁴. More recently, dedicated work on urban ecosystems was initiated with the active contribution of many cities and a fourth technical report⁵ on mapping and assessment of urban ecosystems and their services was published. An overlapping activity on the strengthening of the mapping and assessment of soil condition and function in the long-term delivery of ecosystem services is also being developed.

In the context of The Economics of Ecosystems and Biodiversity (TEEB⁶), a study of available approaches to assess and value ecosystem services in the EU⁷ was supported by the European Commission to support EU countries in taking forward Action 5 of the EU Biodiversity Strategy.

In 2015, a Knowledge Innovation Project on an Integrated System for Natural Capital and Ecosystem Services Accounting (KIP INCA)⁸ was launched jointly by four Commission services (Eurostat, Environment, the Joint Research Centre and Research and Innovation) and the European Environment Agency. This project aims to design and implement an integrated accounting system for ecosystems and their services in the EU, to serve a range of information needs and inform decision making of different policy sectors, building on existing work in EU countries. Important ecosystems services provided by nature will therefore be explic-

itly taken into account and demonstrate, in physical and to the greatest extent possible in monetary terms, the benefits of investing in the sustainable management of ecosystems and natural resources.

Finally, the European work undertaken under Target 2, Action 5, is actively contributing to major ongoing initiatives, such as the global, regional and thematic assessments under the Intergovernmental Platform on Biodiversity and Ecosystem Services (IP-BES⁹) and the UN guidelines on experimental ecosystem accounting from the System of Environmental-Economic Accounts (UN SEEA EEA¹⁰).

At present, with the constructive support of research and innovation projects and actions, such as ESERALDA¹¹ and with the amount of work already accomplished in the Member States and at EU level, the momentum for the next steps is impressive¹².

The policy developments in Europe, but also in many other countries and at global scale, have spurred the scientific community to map ecosystem services, to develop new methods, to assess uncertainty of maps and to provide practical applications of using maps in various decision-making processes. This book is an excellent summary of the achievements of ecosystem service mapping and provides guidance for scientists, students, practitioners and decision makers who need to map ecosystem services.

There are still big challenges ahead of us such as the improvement of the mapping and assessment of the ecosystem condition

⁴ http://ec.europa.eu/environment/nature/knowledge/ecosystem_assessment/pdf/3rdMAESReport_Condition.pdf

⁵ http://ec.europa.eu/environment/nature/knowledge/ecosystem_assessment/pdf/102.pdf

⁶ <http://teebweb.org/>

⁷ http://ec.europa.eu/environment/nature/biodiversity/economics/index_en.htm

⁸ http://ec.europa.eu/environment/nature/capital_accounting/index_en.htm

⁹ <http://www.ipbes.net/>

¹⁰ http://unstats.un.org/unsd/envaccounting/eea_project/default.asp

¹¹ <http://esmeralda-project.eu/>

¹² http://biodiversity.europa.eu/maes/maes_countries

and the integration of the assessment of the ecosystem condition with ecosystem services and the construction of the first ecosystem

accounts. As highlighted in this book, we are however on a very positive track!

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Chapter 1. Introduction

BENJAMIN BURKHARD & JOACHIM MAES

Ecosystem services (ES) are the contributions of ecosystem structure and function (in combination with other inputs) to human well-being. This implies that mankind is strongly dependent on well-functioning ecosystems and natural capital that are the basis for a constant flow of ES from nature to society. Therefore, ES have the potential to become a major tool for policy and decision making on global, national, regional and local scales. Possible applications are numerous: from sustainable management of natural resources, land use optimisation, environmental protection, nature conservation and restoration, landscape planning, nature-based solutions, climate protection, disaster risk reduction to environmental education and research.

ES maps constitute a very important tool to bring ES into practical application. Maps can efficiently communicate complex spatial information and people generally prefer to look at maps and to explore their content and practical applicability. Thus, ES maps are very useful for raising awareness about areas of ecosystem goods and services supply and demand, environmental education about human dependence on functioning nature and to provide information about interregional ecosystem goods and services flows. Furthermore, maps are mandatory instruments for landscape planning, environmental resource management and (spatial) land use optimisation. To fulfil the requirements of the above-mentioned applications, high quality, robust and consistent data and information on ES supply, flow and demand are needed at different spatial and temporal levels.

The interest of policy and decision makers, the business sector and civil society in ES-maps has been steadily increasing in the last years. To bring ES maps into practical application and to make them useful tools for sustainable decision making is an important step and a responsibility of all parties involved. Maps can be applied to portray trade-offs and synergies for ES as well as spatial congruence or mismatches between supply, flow and demand of different ES. Additionally, flows of services from one ecosystem to another and source-sink dynamics can be illustrated. Based on such information, budgets for ES supply and demand can be calculated on different spatio-temporal scales. Such budgets can help to assess the dependence of a region (or even a whole country) on ES imports or its potential to export certain goods and services. However, in addition to the high application potential of ES maps in sustainable decision-making that would benefit human society, there is also a risk of abusing the maps for further exploitation of natural resources, fostering land conversions or supporting land-grabbing activities. That is the reason why it is so important to communicate the ES concept properly and to prepare and document all related information carefully and with the best knowledge available.

Well-documented maps of ES which are developed following rigorous guidelines and definitions will be of crucial importance for natural capital accounting. Across Europe, as well as elsewhere and at local to global scales, natural capital accounts are being developed with the aim of supporting policies on ag-

riculture, natural resources use or regional development programmes or to support decision-making. These accounts are intended to measure and monitor the extent, the condition, the services and the benefits of ecosystems to support different policies. Regularly updated and high quality geo-referenced data on capacity, use and demand of ES are essential inputs for natural capital accounts.

The development of respective ES mapping approaches, models and tools has profited from the increasing popularity of the ES concept in science, especially within the last decade. However, this popularity of ES mapping studies has, together with the rapid development of computer-based mapping programmes, also led to an almost inflationary generation of various ES maps. Besides the many very promising and well-derived mapping products, maps of inferior quality have also, unfortunately, been published. It takes more than just some data and a software package to make a good map that fulfils the criteria of being a geometrically accurate, correctly-scaled and appropriately-explained graphic representation of three-dimensional real space. Cartography, the art and science of graphically representing a geographical area usually on a map, has served humanity since its emergence by providing information on the environment, resources, risks, paths, connections and barriers.

The theory, methods and practical applications of ES mapping are presented in this book, thus bringing together valuable knowledge and techniques from leading experts in the field. The different chapters can be explored to learn what is necessary to make proper and applicable ES maps.

This book addresses an audience which is broader than the research community alone. ES are becoming mainstream outside the academic world: national and regional authorities are calling for or are involved in

large-scale studies to map ES for mapping their natural capital. Cities need ES maps to design, implement or maintain urban green infrastructure. Large businesses start assessing ecosystems and their services on their sites so that they can better understand possible impacts of their operations on the environment. Nature managers need to know how parks and reserves contribute to human wellbeing. Whereas, although not all of these stakeholders will suddenly start mapping ES, they may rely on consultants, students, ecologists and other researchers to help them with spatial data analysis, to understand problems related to mapping or to give practical guidance. Full Open Access to this book is provided to better reach this audience.

After this introductory chapter, **Chapter 2** provides the conceptual ES background, including a short history of the concept, introduces the nature-ecosystem service-human society connections and explains ES categorisation systems. The necessary background of mapping is given in **Chapter 3**, starting from basic cartography knowledge, methods and tools and ending with the specific challenges of mapping ES. There is no mapping without adequate information or data behind it. Therefore, **Chapter 4** is solely dedicated to various ES quantification approaches. These approaches include biophysical, socio-economic, model-, expert- and citizen-science-based quantification methods. **Chapter 5** on ES mapping is the most extensive of this book. After elaborating what, where, when and why to map ES, the individual subchapters explain what has to be taken into account when mapping specific or bundles of ES using various (including integrative) approaches. The chapter ends by presenting mapping approaches on different and interacting scales. Each map represents a more or less complex but generalised model of reality and each model comes with specific uncertainties. Uncertainties can be related to data, specific ES

properties or concerning the eventual map interpretation and use. Thus, uncertainties are a highly relevant topic in ES mapping that need to be dealt with properly. The whole of **Chapter 6** is therefore solely dedicated to uncertainties of ES mapping. As mentioned above, there is a broad range of applications for ES maps, which are explained in **Chapter 7**. Applications include policy making and planning, different land use sectors, human health, risk and impact assessments as well as visualisation. The final **Chapter 8** provides some conclusions and synthesises the contents presented in the preceding chapters.

Several chapters include practical examples which are meant to facilitate the understanding of the sometimes complex and often technical topics. The editors' and authors' aim was to present chapters in a professional but understandable language in order to facilitate their readability and comprehension. Therefore citations and references were avoided in the text. Instead, footnotes with direct links and suggestions for further reading are provided at the end of each chapter. We hope this book is helpful and supports the appropriate mapping of ES!

Further reading

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