Ecosystem Services xxx (2017) xxx–xxx

Contents lists available at ScienceDirect

Ecosystem Services

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

Selecting methods for ecosystem service assessment: A decision tree approach

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ARTICLE INFO

Article history:
Received 18 January 2017
Received in revised form 29 May 2017
Accepted 27 September 2017
Available online xxxx

Keywords:
Guidance
Method
Tool
Decision trees
Biophysical
Monetary
Socio-cultural

ABSTRACT

A range of methods are available for assessing ecosystem services. Methods differ in their aims; from mapping and modelling the supply and demand of ecosystem services to appraising their economic and non-economic importance through valuation techniques. Comprehensive guidance for the selection of appropriate ecosystem service assessment methods that address the requirements of different decision-making contexts is lacking. This paper tackles this gap using the experience from 27 case studies which applied different biophysical, socio-cultural and monetary valuation methods to operationalise the ecosystem service concept towards sustainable land, water and urban management. A survey of the reasons why the case study teams selected particular methods revealed that stakeholder-oriented reasons, such as stakeholder participation, inclusion of local knowledge and ease of communication, and decision-oriented reasons, such as the purpose of the case study and the ecosystem services at stake, were key considerations in selecting a method. Pragmatic reasons such as available data, resources and expertise were also important factors. This information was used to develop a set of linked decision trees, which aim to provide guidance to researchers and practitioners in choosing ecosystem service assessment methods that are suitable for their context.

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https://doi.org/10.1016/j.ecoser.2017.09.016
2212-0416/

1. Introduction

Research related to ecosystem service assessment has grown considerably over the last two decades (Luck et al., 2009; Martín-López et al., 2014; Vihervaara et al., 2010). Numerous efforts are also emerging where the concept is being applied to real-world situations with the goal of supporting sustainable land, water and urban management (Dick et al., 2018, this issue; Ruckelshaus et al., 2015; Saarikoski et al., 2018, this issue). The number of methods and tools that have been developed for assessing ecosystem services in specific situations is multiplying (Bagstad et al., 2013). These can be categorised as (i) *biophysical methods* for mapping ecosystem services, such as matrix or spreadsheet approaches (e.g. Burkhard et al., 2012; Kopperoinen et al., 2014), or modelling ecosystem services, such as InVEST (Sharp et al., 2016), E-Tree (Baró et al., 2015) or ESTIMAP (Zulian et al., 2018, this issue); (ii) *socio-cultural methods* for understanding preferences or social values for ecosystem services, such as deliberative valuation methods (e.g. Kelemen et al., 2013; Pereira et al., 2005), preference ranking methods (e.g. Calvet-Mir et al., 2012), multi-criteria analysis methods (e.g. Langemeyer et al., 2016; Saarikoski et al., 2016), and photo-elicitation surveys (e.g. García-Llorente et al., 2012a); and (iii) *monetary techniques* for estimating economic values for services, such as stated preference methods (Bateman et al., 2002) using contingent valuation (e.g. Gürlük 2006) and choice experiments (e.g. García-Llorente et al. 2012b), and revealed preference methods through the use of the travel cost method (e.g. Langemeyer et al., 2015; Martín-López et al., 2009) or hedonic pricing methods (e.g. Gibbons et al., 2014). The selection of a particular method to apply in a specific case can depend on many factors, including the decision-making context, the ecosystem services at stake, the strengths and limitations of different methods, and pragmatic reasons such as available data, resources and expertise.

Given this plethora of methods, guidance is essential to help researchers or practitioners who are new to ecosystem service assessment to be able to select and test relevant approaches that take account of their needs and constraints. This demand for guidance has been recognised (Bagstad et al., 2013, Martinez-Harms et al., 2015) and there is a growing pool of guidance documents for practitioners on how to include ecosystem services in policy and management decisions aimed at different sectors or stakeholder groups. Much of this guidance is published through websites and the grey literature, for example, the Royal Society for the Protection of Bird's (RSPB) Guidance Manual for Assessing Ecosystem Services at Natura 2000 sites (McCarthy and Morling, 2014); the Global Reporting Initiative's (GRI) Approach for Reporting on Ecosystem Services (GRI, 2011); the Ecosystem Services Guidance for the Oil and Gas Industry (IPIECA/OGP, 2011); the Convention on Biological Diversity's (CBD) Best Policy Guidance for the Integration of Biodiversity and Ecosystem Services in Standards (CBD, 2012); the Food and Agricultural Organisation's (FAO) Policy Support Guidelines for the Promotion of Sustainable Production Intensification and Ecosystem Services (FAO, 2013); the Business and Biodiversity Offsets Programme (BBOP) Biodiversity Offset Cost-Benefit Handbook (BBOP, 2009); and the UK Department for Transport's (DfT) guidance document on Applying an Ecosystem Services Framework to Transport Appraisal (Highway Agency/DfT, 2013). There are also a few academic papers related to general guidance for ecosystem service assessment (e.g. Gómez-Baggethun et al., 2016; Jacobs et al., 2015; Pascual et al., 2016; Seppelt et al., 2012). In addition, some guidance documents have been developed through major international initiatives such as The Economics of Ecosystems and Biodiversity (TEEB) (see TEEB, 2011, 2013) and the Intergovernmental Panel on Biodiversity and Ecosystem Services (IPBES) guidance on the diverse conceptualisation of multiple values of nature and its benefits (IPBES, 2016a). The majority of these guidance documents describe an overall ecosystem service assessment approach broken down into steps and/or checklists sometimes with associated indicators and/or methods.

Several websites provide access to multiple ecosystem service methods or tools, for example, the Ecosystem Knowledge Network's Tool Assessor[1], the NEAT Tree Short Tool Reviews[2] and the ValuES Project Methods Database[3]. Most of these provide a limited selection of tools or methods which can be searched or filtered. Perhaps the most comprehensive is the ValuES inventory of methods which contains information on 65 techniques that can be filtered by purpose, method type and ecosystem service. Most of these approaches to providing method guidance have not been published in the academic literature and those which have been tend to focus on either broad literature reviews of methods or tools (e.g. Grêt-Regamey et al., 2016) or comparisons between specific sub-sets of methods. For example, Kelly et al. (2013) provide guidance for selecting amongst modelling approaches for integrated environmental assessment, Bagstad et al. (2013) compare 17 decision-support tools for ecosystem services quantification and valuation, and Gasparatos and Scolobig (2012) discuss how to choose the most appropriate sustainability assessment tool. Kenter et al. (2015) analyse a range of socio-cultural valuation methods in terms of their capacity to address different types of values, resource requirements and suitability for different spatial and time scales, while Vatn (2009) applies a theoretical approach to guide the selection of deliberative valuation studies. Bateman et al. (2002) and Ward and Beal (2000) are examples of manuals for selecting stated preference and travel cost methods, respectively. Pullin et al. (2016) analyse the strengths and weaknesses of knowledge synthesis methods that can be used to inform biodiversity and ecosystem services policy or management. Finally, Jacobs et al. (2018, this issue) evaluate multiple biophysical, socio-cultural and monetary valuation methods to determine their suitability to elicit different value types, whilst assessing the data and resource requirements for their application.

In this study we aim to provide a more comprehensive guidance for coordinated selection of different biophysical, socio-cultural and monetary techniques for ecosystem service assessments based on their application in 27 case studies covering different land, water and urban decision-making contexts. Training and guidance was provided to the case study teams to implement a range of methods. We then surveyed the case study teams to understand the reasons why they selected particular methods and related these reasons to the characteristics, advantages and limitations of each method. This information was then used to develop a structured approach for ecosystem service method selection based on a set of inter-linked decision trees.

The paper is organised in four main sections. We first provide background information on the methods and case studies. We then present results showing which factors were key considerations for method selection across case studies and which features of the methods help to characterise their strengths and limitations, including how they differ from each other. We then describe how the decision trees were designed and tested in an iterative fashion between method experts and case study teams building on these results. Finally, we discuss the pros and cons of using decision trees for aiding the selection of specific biophysical, socio-cultural and monetary methods, compare this approach with other possible formats for providing similar guidance and illustrate how different forms of guidance might work together to better cover different user demands.

[1] http://ecosystemsknowledge.net/tool-search.
[2] http://neat.ecosystemsknowledge.net/short-tool-reviews.html.
[3] http://aboutvalues.net/about_values/.

Please cite this article in press as: Harrison, P.A., et al. Selecting methods for ecosystem service assessment: A decision tree approach. Ecosystem Services (2017), https://doi.org/10.1016/j.ecoser.2017.09.016