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Analysis

Monetary accounting of ecosystem services: A test case for Limburg province, the Netherlands

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ABSTRACT

Ecosystem accounting aims to provide a better understanding of ecosystem contributions to the economy in a spatially explicit way. Ecosystem accounting monitors ecosystem services and measures their monetary value using exchange values consistent with the System of National Accounts (SNA). We pilot monetary ecosystem accounting in a case study in Limburg province, the Netherlands. Seven ecosystem services are modelled and valued: crop production, fodder production, drinking water production, air quality regulation, carbon sequestration, nature tourism and hunting. We develop monetary ecosystem accounts that specify values generated by ecosystem services per hectare, per municipality and per land cover type. We analyse the relative importance of public and private ecosystem services. We found that the SNA-aligned monetary value of modelled ecosystem services for Limburg was around €112 million in 2010, with an average value of €508 per hectare. Ecosystem services with the highest values were crop production, nature tourism and fodder production. Due to the exclusion of consumer surplus in SNA valuation, calculated values are considerably lower than those typically found in welfare-based valuation approaches. We demonstrate the feasibility of valuing ecosystem services in a national accounting framework.

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1. Introduction

There is an increasing interest in environmental accounting as an approach to better understand economic implications of environmental change (Bartelmus, 2013; Obst and Vardon, 2014; UN et al., 2014b). A consortium led by the United Nations has recently released the third version of the System of Environmental-Economic Accounting (SEEA-2012), of which the Central Framework (SEEA CF) serves as an international statistical standard and guideline for environmental-economic accounting (UN et al., 2014b). The compartmental approach of the SEEA CF does not yet allow for the integration of ecosystem services (ES) into accounting (Edens and Hein, 2013). Therefore, a separate set of guidelines for ecosystem accounting were developed, the SEEA Experimental Ecosystem Accounting guidelines (SEEA EEA) (UN et al., 2014a). A key objective of ecosystem accounting is to measure ES in a way that is aligned with national accounts (as defined in the System for National Accounts (SNA), UN et al., 2009) (Edens and Hein, 2013; UN et al., 2014a). There has been steady progress in conceptualizing ecosystem accounting in recent years, yet, considerable challenges remain (e.g. Boyd and Banzhaf, 2007; Edens and Hein, 2013; Schröter et al., 2014a; Stoneham et al., 2012; UK NEA, 2011; Weber, 2011).

The SEEA EEA emphasizes the importance of a spatial approach for ecosystem accounting, for both biophysical quantification and monetary valuation of ES (UN et al., 2014a). The added value of using a spatial approach is threefold. First, it offers the opportunity to monitor local changes in addition to aggregated information collected in the SNA (Edens and Hein, 2013). Monitoring spatial changes can provide information for planning processes, such as land-use planning, for example by assessing whether specific ecosystems are degrading (Schröter et al., in press; Sumarga and Hein, 2014). Second, it can help to shed light on spatial interrelationships between ES and dependence of ES on socio-environmental conditions (Schröter et al., 2014a). Third, spatial modelling can offer wall-to-wall coverage of ES in the absence of complete datasets (Stoneham et al., 2012).

The SEEA EEA distinguishes between biophysical and monetary ecosystem accounting (UN et al., 2014a). While some empirical experience has been developed with biophysical ecosystem accounting (Remme et al., 2014; Schröter et al., 2014a, in press), only few studies apply monetary ecosystem accounting aligned with SNA principles for

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multiple ES in a spatially explicit way (e.g. Campos et al., 2014). Monetary valuation can be a valuable complement to biophysical ES assessments (Schröter et al., 2014b; Troy and Wilson, 2006) and, for instance, be used to quantify and sum ES using monetary estimates as a value measure and commensurable unit of account (Daily et al., 2009). In addition, monetary valuation can help to develop better informed land-use decisions (Goldstein et al., 2012).

The objective of this study is to test and apply a number of valuation approaches for ecosystem accounting building upon SEEA EEA. Specifically, we assess how SNA valuation principles can be applied to a set of ES and how resulting values can be represented in accounts for Limburg province, the Netherlands. Valuation is carried out for seven ES, namely crop production, fodder production, drinking water production, air quality regulation, carbon sequestration, nature tourism and hunting. All monetary valuation approaches were coupled to spatial biophysical models developed for Limburg province (Remme et al., 2014), with exception of nature tourism and hunting. For these two ES new biophysical approaches were developed (Section 2.2).

Although we do not aim to study specific policy applications of ecosystem accounting, we do elaborate on an example of how monetary accounting information can provide policy-relevant insights. We mapped public and private ES value, to raise awareness on the distribution of value to different types of beneficiaries across Limburg. We classified ES as public or private according to the degree of rivalry and excludability (cf. Costanza, 2008; Kemkes et al., 2010). An ES is considered rival if use of the ES by one person prevents another person from using it. A service is excludable if people can be prevented from using it (Kemkes et al., 2010).

2. Methodology

2.1. Case study description

Limburg province is located in the south-east of the Netherlands and covers approximately 2200 km^2 (Fig. 1). Limburg is densely populated (522 inhabitants per km^{-2} in 2010), with a total population of 1.1 million people (Statistics Netherlands, 2013c). Over half of the inhabitants live in the southern one-third of the province. The southern part of the province is also nationally renowned for its hilly landscape and is popular with domestic tourists. The province has a varied cultural landscape, which has been managed for many centuries (Berendsen, 2005; Jongmans et al., 2013). Most natural ecosystems have been converted, resulting in a highly fragmented landscape (Jongman, 2002). There is high competition for land between agriculture, nature and urban land-uses (Vogelzang et al., 2010).

2.2. Biophysical spatial ES models

Quantitative biophysical data of each modelled ES was used as input for valuation models. For the ES crop production, fodder production, drinking water production, air quality regulation and carbon sequestration, spatial biophysical models were used that are described in detail in Remme et al. (2014). All ES were modelled for the year 2010. Most biophysical models were developed based on the Dutch 25 × 25 m land cover dataset LGN6 (Hazeu, 2009), with the exception of drinking water production and nature tourism. The latter models were developed using administrative boundaries (see Remme et al. (2014) and Appendix I).

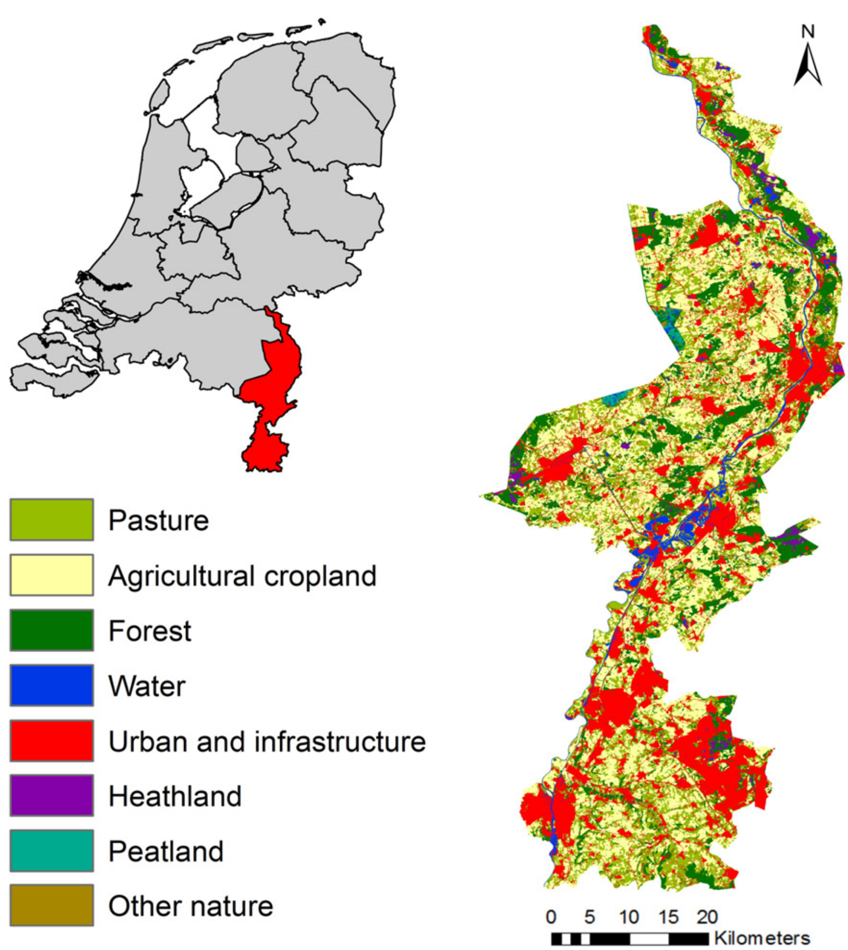

Fig. 1. Location and land cover of Limburg province, the Netherlands. Full colour version of this figure can be found on the journal website.

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