



Analysis

Towards a consistent approach for ecosystem accounting

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ABSTRACT

In spite of an increasing interest in environmental economic accounting, there is still very limited experience with the integration of ecosystem services and ecosystem capital in national accounts. This paper identifies four key methodological challenges in developing ecosystem accounts: the definition of ecosystem services in the context of accounting, their allocation to institutional sectors; the treatment of degradation and rehabilitation, and valuing ecosystem services consistent with SNA principles. We analyze the different perspectives taken on these challenges and present a number of proposals to deal with the challenges in developing ecosystem accounts. These proposals comprise several novel aspects, including (i) presenting an accounting approach that recognizes that most ecosystems are strongly influenced by people and that ecosystem services depend on natural processes as well as human ecosystem management; and, (ii) recording ecosystem services as either contributions of a private land owner or as generated by a sector 'Ecosystems' depending on the type of ecosystem service. We also present a consistent approach for recording degradation, and for applying monetary valuation approaches in the context of accounting.

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1. Introduction

There is a still growing interest in better understanding the economic implications of the ongoing changes to the world's ecosystems (EC, 2011; MA, 2005; TEEB, 2010; UK NEA, 2011). Among others, there has been a strong increase in interest in developing 'ecosystem accounts', building on the experiences gained with environmental economic accounting since the mid-1970s. As ecosystem accounting is not a standardized concept, we will define it here as the integration of ecosystem services and ecosystem capital into national accounts. The increasing interest in ecosystem accounting is illustrated in, for example, the recent EU Biodiversity strategy (EC, 2011) which calls upon Member States to "assess the state of ecosystems and their services in their national territory by 2014 and assess the economic value of such services, and promote the integration of these values into accounting and reporting systems at EU and national level by 2020". The progress in analyzing, modeling and valuing ecosystem services (e.g. Daily et al., 2009; De Groot et al., 2010) is facilitating the further development of ecosystem accounts. Early studies in the field tended to focus on the economic benefits provided by individual ecosystems, but there are now increasingly also

studies that analyze ecosystem services at landscape, national or even continental level (see e.g. TEEB, 2010).

Developing and applying ecosystem accounting methods requires the physical and monetary measurement of (changes in) ecosystem services supply and the capacity of ecosystems to supply services to be recorded in a way that is aligned with the measurement approaches prescribed for national accounts (as reflected in the System of National Accounts; SNA) and for environmental economic accounts (as reflected in the System for Environmental Economic Accounts Central Framework; SEEA CF). The SEEA CF is, as of 12 February 2012, a global statistical standard for environmental accounting (UN et al., 2012). However, neither the SNA nor the SEEA CF were designed for accounting for ecosystem services or ecological capital. For instance, the compartmental approach to natural resources applied in the SNA and SEEA CF is not easily aligned with the ecosystem service concept and the notion of ecosystems being a functional unit delivering multiple services to multiple stakeholders (e.g. Hein et al., 2006). To date, therefore, there is still insufficient understanding of how ecosystem services, once quantified, can be incorporated in an accounting framework such as the SNA or the SEEA (Banzhaf and Boyd, 2012; Campos and Caparrós, 2011; Mäler et al., 2009). In recognition of these issues, the SEEA Experimental Ecosystem Accounting guidelines have recently been developed by a consortium coordinated by the United Nations Statistics Division (UNSD, 2013); both authors have contributed to these guidelines.

The specific objective of this paper is to identify and analyze key methodological challenges related to the construction of ecosystem accounts. In particular, we review the efforts undertaken to date to incorporate ecosystem services into national and environmental accounts,

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identify four key challenges to be addressed when guidelines and potential approaches for ecosystem accounting are put in practice, and provide a number of specific recommendations and potential ways forward. These four issues were also recognized as needing further research in the SEEA EEA (UNSD, 2013). Testing and implementation of the SEEA EEA is the responsibility of national statistical offices together with a range of other agencies, and will involve the detailed biophysical and monetary quantification of ecosystem services and ecosystem capital. Some of the key issues that need to be resolved when the SEEA EEA guidelines are applied are addressed in this paper, and we hope this paper will contribute to the broader scientific debate on ecosystem accounting as well as provide a number of specific recommendations for the actual implementation of ecosystem accounts.

The set-up of the paper is as follows. First, we present a brief introduction to the complex topic of environmental and ecosystem accounting, in the context of the SNA, briefly highlighting the main developments in this field since the mid-1970s. Second, we analyze four key challenges in the field of ecosystem accounting, examine how these challenges have been addressed in the accounting and ecological economics literature, and present a consistent, conceptual approach to address these challenges. Third, in the Discussion section, we place our findings in the context of the ongoing efforts to develop guidelines and methods for ecosystem accounting. We present our key outcomes in the Conclusion section. In (on-line) Appendix A we present an illustration of how ecosystem services and ecosystem capital can be incorporated in a satellite sequence of accounts.

2. The Development of Ecosystem Accounting

2.1. The Accounting Context

The SNA (UN et al., 2009) is an international statistical standard with specific guidelines on how to compile a set of interrelated accounts, which are designed to provide a description of economic activity (e.g. production, consumption, and accumulation of assets). The SNA accomplishes this by describing the transactions (e.g. buying a product, or paying a tax) between so-called institutional units such as households or enterprises. These units can be classified either into institutional sectors (e.g. central government, or the financial sector) or into economic activities (colloquially called economic sectors) such as agriculture or mining.

Transactions are described in a sequence of accounts: the current accounts (production, distribution and use of income) provide information on production and value added by economic activities and various notions of income, with as main indicators gross domestic product (GDP), net national income (NNI), and savings. The accumulation accounts (capital, financial, other changes in volume) describe changes in assets by ownership. The resulting net worth and changes therein is recorded in the balance sheets.

The scope of the SNA is defined by a set of boundaries, most importantly the production boundary which defines when an activity is considered productive. For example, theft or cooking for household members is not considered a productive activity, but home grown vegetables in kitchen gardens are included. Another important principle is that the national accounts are restricted to 'resident' institutional units, whereby residency is determined based on the territory of predominant economic interest. For example, the production by someone who works part-time in a foreign country may be included. The accounts are therefore based upon economic considerations and do not follow citizenship or nationality.

Satellite accounting was invented to allow for conceptual variation of the standard SNA conventions (Edens and de Haan, 2010). Well known examples are tourism satellite accounts and health accounts. The System for Environmental Economic Accounts (SEEA) has been developed to provide a more comprehensive understanding of the interrelationship between economy and environment. The

SEEA recognizes that economic activities critically depend on the environment both as a source of inputs such as natural resources, and as a sink for its outputs in the form of emissions and waste. The SEEA integrates environmental statistics with economic statistics using the organizing principles, classifications and definitions of the SNA. At the same time, it takes a much broader perspective on the environment by expanding the SNA asset boundary. While the SNA defines assets in terms of two necessary conditions of benefits and ownership, the SEEA defines environmental assets more broadly as "the naturally occurring living and non-living components of the Earth, together comprising the bio-physical environment, that may provide benefits to humanity" (SEEA Central Framework, Para 2.17). Another important aspect of the SEEA is that it complements the monetary scope of the SNA with physical descriptions of stocks and flows, for instance of stocks and changes over time of standing timber, quantities of water abstractions, and land cover accounts. In the SEEA there is an explicit distinction of cultivated assets (e.g. a plantation) and natural assets (e.g. a natural forest). The SEEA also contains a set of accounts that describe environmental activities and transactions (e.g. taxes and subsidies) and environmental protection expenditure.

While the SEEA CF provides a much broader perspective on the environment than the SNA, it does not provide an analysis of ecosystem services or ecosystem capital. One of the main reasons is that while the SEEA CF relaxes the asset boundary, it keeps the SNA production boundary intact. For produced assets, the production boundary constrains the asset boundary, but this does not apply to many natural resources which are considered non-produced assets i.e. they are not the outcome of production processes and the services they provide are considered rent payments. Consequently, both the SNA and SEEA exclude from the production account various types of ecosystem services such as regulating services as well as the natural growth of biological assets. In addition, while the SEEA CF provides recommendations on the treatment of depletion, it does not contain a discussion of the treatment of environmental degradation or rehabilitation.

The Convention on Biological Diversity defines an ecosystem as 'a dynamic complex of plant, animal and microorganism communities and the nonliving environment, interacting as a functional unit' (United Nations, 1992). Importantly, ecosystem dynamics and the supply of ecosystem services depend on the functioning of the ecosystem as a whole, rather than on specific components in isolation (e.g. Arshad and Martin, 2002; Potter et al., 1993; Van Oudenhoven et al., 2012). One of the challenges of ecosystem accounting is to integrate the complex and multi-faceted concept of the ecosystem with the compartmental approach of the SNA accounting structure. Furthermore, in an ecosystem approach, the distinction between cultivated and natural assets is difficult to make; there are few if any ecosystems left on the planet that are not strongly modified by people, and even in cultivated assets ecosystem dynamics and natural processes remain important.

2.2. The Different Environmental and Ecosystem Accounting Approaches

It is useful to distinguish between *green accounting* – the notion used most frequently in the academic community – and *environmental accounting* (or environmental economic accounting) – the notion used predominantly in the statistical or empirical community. While both fields have a shared ambition to develop better indicators of progress that take environmental concerns into account, there are a number of clear differences in terms of the key research questions as well as methodologies applied (see Edens, forthcoming, for an illustration of these differences concerning 'depletion'). The green accounting literature has traditionally focused on studying the relationship between the concepts of welfare, income and wealth, in the setting of theoretical models which include extraction of natural resources and pollution (e.g. Dasgupta, 2009; Hamilton, 1996). By contrast, the environmental accounting community has followed a more pragmatic approach, focusing on how to integrate the use of environmental assets into the

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