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Editorial

Environmental accounting models and nature conservation strategies

1. Introduction

Increasing environmental problems at local and global scales, such as chemical pollution, water scarcity, soil erosion, and climate change, have drawn more attention to the issue of natural resources exploitation (Folke et al., 2011; Rockström et al., 2009; Steffen et al., 2018).

Governments commonly evaluate the performance of national economies through macroeconomic indicators such as the Gross Domestic Product (GDP). However, conventional monetary accounting systems often fail to reflect the consequences of anthropogenic impacts on national wealth and human well-being. For this reason, alternative environmental accounting systems have been developed to value natural resources while assessing the environmental consequences due to their exploitation (Costanza et al., 2014a; Kovacic and Giampietro, 2015; Ulgiati et al., 2011).

The "Green GDP - GGDP" is an alternative economic index based on the monetization of the environmental consequences due to economic growth. This index includes resource depletion, biodiversity loss, environmental degradation, and protective and restorative environmental initiatives, all subtracted from conventional GDP. While several countries attempted to calculate the GGDP, the United Nations published the System of Environmental-Economic Accounting (SEEA) to provide an international statistical standard for integrated environmental-economic accounting (United Nations, 1993; United Nations et al., 2014).

In this context, an international initiative was launched by Germany and the European Commission to develop a global study on the economics of ecosystems and biodiversity (TEEB, 2010). The goal of this study was to highlight the growing cost of biodiversity loss and ecosystem degradation, allowing the inclusion of nature's value into national accounts and policy-making.

Natural capital and ecosystem services assessment is a fast-increasing research area (Buonocore et al., 2018; Pauna et al., 2018) aimed at accounting for stocks and flows of natural goods and services used in support of human economy and vital for human well-being (Costanza et al., 1997; 2014b; 2017; de Groot et al., 2012; Diaz et al., 2015).

Protected areas are acknowledged worldwide as laboratories for experimenting nature conservation strategies and sustainable management of natural resources (Butchart et al., 2012; Pringle, 2017). A modern approach to biological conservation applies an ecosystem perspective based on the protection of natural capital stocks, thus also ensuring the long-term delivery of ecosystem services.

Environmental accounting systems allow exploring the interplay between natural ecosystems and human activities, assessing sustained environmental costs, received benefits, and generated impacts related to the exploitation of natural resources (Franzese et al., 2015; Häyhä and Franzese, 2014). This type of information can support local managers and policy makers in charge of implementing sustainable management schemes.

While a number of authors estimated natural capital and ecosystem services performing monetary valuations (Dasgupta, 2008; Farley and Costanza, 2010; Hein et al., 2016; Nikodinoska et al., 2018) others applied a biophysical perspective to environmental accounting recognizing the existence of non-anthropocentric measures of value (Berrios et al., 2017; Franzese et al., 2008, 2017; Jørgensen, 2010; Mellino et al., 2015; Picone et al., 2017; Vassallo et al., 2017). Among the biophysical environmental accounting methods there are:

1) the Ecological Footprint (Wackernagel and Kitzes, 2008), used to calculate direct and indirect demand of productive land,
2) the Material Flow Accounting (Christ and Burritt, 2015) used to account for direct and indirect material input flows,
3) the Embodied Energy Analysis (Boustead and Hancock, 1979), used to account for direct and indirect flows of fossil fuels, and
4) the Emergy Accounting (Odum, 1988, 1996), used to measure the donor-side value of goods and services in terms of environmental support for their production.

These different perspectives and related environmental accounting methods should not be considered as alternative to each other but, instead, complementary and all necessary to investigate fully the processes and systems across multiple spatial and temporal scales (Franzese et al., 2014).

2. Goal of this special issue

The main goal of this special issue is to present a set of articles exploring the state of the art and some theoretical and procedural advancement in the field of environmental accounting, emphasizing the use of different environmental accounting models in support of nature conservation strategies.

3. Papers presented in the special issue

Most of the papers gathered in this special issue were presented at the World Summit on Environmental Accounting held in July 2016 at the Beijing Normal University (China).

The special issue includes 15 papers showing the application of different environmental accounting models for the study of natural, human-dominated, and human-built ecosystems. The articles can be grouped into three main categories.

A first set of articles deals with the development and application of emergy-based models to assess the value of natural capital and ecosystem services in marine and coastal ecosystems. In particular,

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Vassallo et al. (2017) developed a biophysical and trophodynamic environmental accounting model for assessing the value of natural capital in marine protected areas. Franzese et al. (2017) applied an emergy-based environmental accounting model to assess the value of natural capital of benthic habitats in a marine protected area located in Central Italy. Picone et al. (2017) assessed the value of natural capital of the Egadi Islands marine protected area (Southern Italy) and used Marxan software to integrate the results of the environmental accounting with spatial data on main human uses. Paoli et al. (2018) used an emergy model to account for the biophysical value of natural capital in different marine ecosystems in Northern Italy. Berrios et al. (2017) developed an emergy-based accounting model to study three benthic ecosystem networks in northern Chile and the contribution to these coastal ecosystems to the regional economy. Campbell and Tilley (2016) investigated the relationships between renewable emergy storage or flow and biodiversity using a dynamic simulation model, a static scenario model, and a modified ecological network model.

A second set of articles focuses on ecosystem services assessment at city scale, and on carbon and energy urban metabolism. In particular, Endreny et al. (2017) estimated the existing and potential tree cover and its contribution to ecosystem services in ten megacity metropolitan areas, across five different continents and biomes. Nikodinoska et al. (2018) assessed and mapped ecosystem services generated by forest, agricultural, and urban areas in the city of Uppsala (Sweden). Xia et al. (2017) analysed the spatial pattern of carbon metabolism and its response to change of urban form using a combination of GIS and landscape indices. Zhang et al. (2017) constructed a network model based on 18 sectors to account for energy consumption and energy flow exchanges to explore the energy metabolism of a Chinese urban agglomeration.

A third set of articles proposes different integrated accounting frameworks modeling human-nature interactions within complex socio-ecological systems. In particular, Lai et al. (2018) examined how progress on ecosystem services indicators could contribute to ecosystem accounting within the scope of environmental-economic accounting in Finland. Patterson et al. (2017) discussed advantages and limitations of different environmental accounting methods, highlighting the need for an integrated perspective. Lomas and Giampietro (2017) proposed an approach to environmental accounting useful for studying the feasibility of socio-economic systems in relation to the external constraints posed by ecological compatibility.

Finally, two articles applied multi-criteria evaluation and numerical modelling to study the change of hydrodynamics and environmental factors in coastal areas. In particular, Liu et al. (2017) used the Lattice Boltzman method to study the change of hydrodynamics and environmental factors of the intertidal zone in the Laizhou Bay (China). Di Tullio et al. (2018) focused on the application of multi-criteria evaluation (MCE) technique to study the possible co-location of offshore wind farms and open-water mussel aquaculture.

4. Concluding remarks

The Guest Editors hope that this volume will boost the interdisciplinary knowledge on the interplay between environmental accounting and nature conservation.

In terms of impact of these publications, the emergy-based models developed in the framework of this special issue were applied in the context of a national project on natural capital assessment funded by the Italian Ministry of Environment. In addition, the article by Endreny et al. (2017) was awarded the Elsevier Atlas in September 2017 for “significantly impacting people’s lives around the world”.

In conclusion, we maintain that an ecosystem approach to nature conservation could benefit from the integrated use of complementary environmental accounting models aimed at ensuring the sustainable management of natural resources.

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