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Designing a framework for marine ecosystem assets accounting

Tao Wang[a], Guang-shun He[a,*], Qiu-lin Zhou[b], Jin-zhu Gao[a], Li-jing Deng[a]

[a] National Marine Data and Information Service, Tianjin, China
[b] Third Institute of Oceanography of the State Oceanic Administration, Xiamen, China

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ABSTRACT

Marine ecosystem assets accounting is a cornerstone of the marine resource assets management; however, it is facing an imperfect accounting system in the current situation. Based on the System of Environmental Economic Accounting (SEEA) Experimental Ecosystem Accounting, this paper initially combines the key concepts, the objectives, the extent, and the tabular structure in measuring the ecosystem assets. Subsequently, with the marine ecosystems as the research object, this paper attempts to design the accounting tables for the marine ecosystems extent, marine ecosystems conditions and the expected service flows of the marine ecosystems in physical terms. Furthermore, the technical issues such as trade-off, pricing and the choice of asset discount rate on expected marine ecosystem services are explored. With the accounting of the expected marine ecosystem services in monetary terms, the calculation of the marine ecosystem assets using the net present value method is possible, and the marine ecosystem assets accounts can be compiled. Finally, this paper proposes the existing challenges and directs the need for further research in designing the framework of marine ecosystem assets accounts.

1. Introduction

Marine resources are the natural capital and wealth of the nation and serve as an important basis of the national strategic resource. Marine ecosystems continue to provide products and services, and maintain the environmental conditions of human survival, thus benefitting the mankind. For a long time, marine ecosystems structure and function have been excessively disturbed. Hence, in order to strengthen the integrated marine ecosystems management accurately on a scientific basis (Hou and Wang, 2015), there is an urgent need to develop a framework for marine ecosystem assets accounting.

The current research on the accounting theories of the ecosystem assets and technical methods mainly focus the unit area value of the total static estimation (Yu, 2010; Wang and Wan, 2014; Zhu and Gao, 2011; Duan and Li, 2010) , without considering the spatial differences in the types and quality of an ecosystem, the estimation results fail to comprehensively reflect the real value of ecosystem assets in terms of spatial distribution. In order to realize these dynamic calculations, it is necessary to make further exploration and practice of ecosystem assets accounting.

In 2014, The United Nations Committee of Experts on Environmental- Economic Accounting (UNCEEA) formulated and released the System of Environmental-Economic Accounting (SEEA) – 2012 Experimental Ecosystem Accounting that expounds a series of rules and accounting concepts for the assessment and measurement of the ecosystem (European Commission, 2014b). As a supplement to the SEEA central framework (European Commission, 2014a), the experimental ecosystem accounting framework focuses the functional units of the ecosystems in different biophysical environments, from a research perspective. This leads to the exploration of the ecosystem services and ecosystem assets accounting frameworks, which in-turn explains and analyzes the accounting relationship between ecosystem and economic activities.

Although the SEEA Experimental Ecosystem Accounting does not accurately construct a comprehensive process for ecosystem accounting, yet it has clearly combined the central concepts and key disciplines in ecosystem assets and ecosystem services (Pan, 2013; Research Group of Forest Resource Accounting in China, 2015). Based on the SEEA Experimental Ecosystem Accounting, this paper attempts to outline a marine ecosystem assets accounting framework and makes a preliminary exploration in the comprehensive accounting of marine ecosystem assets.

2. An ecosystem assets accounting framework

Using a wide range of information, the SEEA Central Framework, through its structure, enables source data to be compared and contrasted and allows for the development of aggregates, indicators and

* Corresponding author.
E-mail addresses: mvpforever007@126.com (T. Wang), wojiushiwomvp@163.com (G.-s. He).

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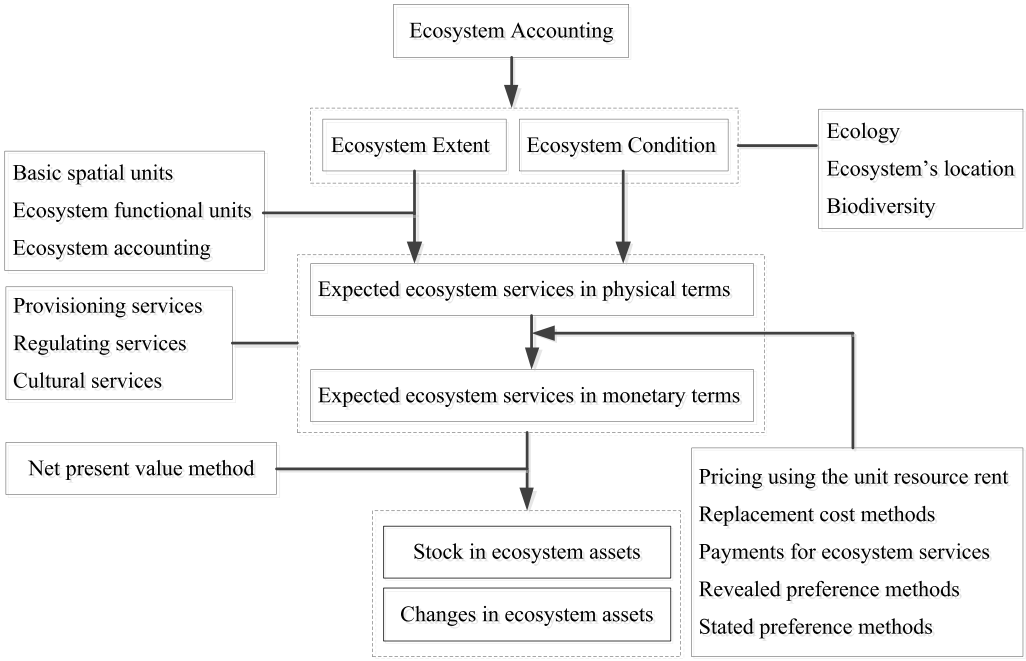

Fig. 1. Basic model of ecosystem assets accounting.

trends across a broad spectrum of ecosystems and economic issues. In the SEEA Experimental Ecosystem Accounting, the ecosystem assets are the spatial areas comprising of a combination of biotic and abiotic components, and other characteristics that function together (European Commission, 2014b). The accounting entity is represented by a spatial region, each of which constitutes an 'ecosystem asset'. Ecosystem assets are measured from two perspectives *viz.* from the ecosystem condition and ecosystem extent, and from the ecosystem services. The ecosystem assets are generated at a specific time point due to a specific combination or 'basket' of the ecosystem services.

The formation of ecosystem services from the ecosystem assets is similar to the generation of the equity dividends from the economic assets (Zhai and Li, 2015a, b). The ecosystem assets accounting should take into account the ability to generate a basket of expected ecosystem service flows at a time point, following to which the ecosystem service is a total revenue stream. The formation of the expected ecosystem service is also influenced by the conditions and extent of ecosystems. The relationship between ecosystem condition and ecosystem extent is relatively complex, possibly non-linear, and changes with time. The simplified process of ecosystem assets accounting is shown in Fig. 1.

2.1. Ecosystem extent

The ecosystem extent generally refers to the size of an ecosystem asset, which is generally measured in terms of surface area, for example, hectares of a land-cover type.[1] Three different, but related, types of units are defined in SEEA Experimental Ecosystem Accounting to accommodate the different scales and methods used to collect, integrate and analyze data: (1) Basic spatial units (BSUs), which are composed of a small grid, can reflect the accounting information, and the diversity of the landscape (2) Land-cover/ecosystem functional units (LCEUs), which is usually an ecosystem (3) Ecosystem accounting units (EAUs) in which the spatial unit consists of the spatial areas that are fixed or relatively stable over time and may be considered ecosystem assets for accounting purposes.

The measurement of the ecosystem extent could determine the boundary of the ecosystem assets and comprises of a variety of types of ecosystems, which need to be measured by their spatial size and their proportions of different water covers. It is an important variable index of ecosystem assets.

2.2. Ecosystem condition

Ecosystem condition reflects the overall quality of an ecosystem asset in terms of its characteristics. The assessment of an ecosystem condition involves two distinct stages with reference to both quantity and quality attributes of the ecosystem assets. In the first stage, it is necessary to select the appropriate key ecosystem condition characteristics and the relevant change of index in them. The selected indicators should take into account the current and the future use patterns of the ecosystem. In the second stage, the reference conditions and the evaluation criteria are set for the evaluation indicators. The changes in the ecosystem conditions are reflected after a comparison of the conditional evaluation scores at different time points.

Each ecosystem asset has a series of 'ecosystem characteristics' to describe the ecosystem conditions. In the accounting framework, the ecosystem condition is measured on the basis of ecology, location and biodiversity: (1) Key ecological characteristics such as ecological structure, components, processes, and functions. (2) Key characteristics of the location of an ecosystem such as the extent, configuration, landscape forms within which the ecosystem is situated, climate and associated seasonal patterns. (3) Key characteristics of the diversities in an ecosystem, at a number of levels that include the species diversity and ecosystem diversity.

2.3. Expected ecosystem service flow

Expected ecosystem service flow is the measurement of the capacity of an ecosystem asset to generate a given combination of ecosystem services (Xie, 2015). The expected flows are based on the parameters like the expected basket of provisioning, regulating services, and cultural services from an ecosystem asset (Campbell, 2012; Peter and

[1] Marine ecosystems may be classified by type of water cover (e.g., coastal water bodies, open wetlands) but also through aquatic ecosystem mapping systems which distinguish between marine and estuarine environments (see, e.g., Cowardin et al. (1979)). These mapping systems may consider different marine habitats (e.g., reefs and seagrass) and factors such as depth and light availability.