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Defining and classifying ecosystem services for economic valuation: the case of forest water services

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ARTICLE INFO

Article history:
Received 26 July 2011
Received in revised form
2 January 2012
Accepted 15 February 2012
Published on line 22 March 2012

Keywords:
Ecosystem services
Millennium Ecosystem Assessment
Water services
Tropical forests

ABSTRACT

The Millennium Ecosystem Assessment (MA) has become widely accepted as a framework for understanding and assessing the benefits that ecosystems provide to human well-being. Its classification of services into the categories of provisioning, regulating, supporting and cultural, has been increasingly widely adopted. However, several authors have recently argued that the MA's definition and classification of services may not be the most appropriate for monetary assessments. This paper seeks to understand in greater depth the sources of problems arising from the use of the MA's definition and classification of services for economic valuation. Firstly, we review and disentangle the critical literature to date. Secondly, we undertake a practical examination of existing primary valuation studies, which we analyse according to the MA classification and then compare with an output based-classification. We use water ecosystem services provided by tropical forests as an example for our analysis. Our results provide further evidence of the risk of double counting and the problems related to the secondary use of valuation estimates, as a consequence of service overlapping and service ambiguity.

1. Introduction

Since the release of the Millennium Ecosystem Assessment (MA, 2005), ecosystems have become widely recognised as natural capital assets supporting and supplying services which are highly valuable to humans. There is a growing appreciation of the important role that ecosystems play in providing goods and services that contribute to human welfare, and a recognition of the impact of human actions on ecosystems. The estimation of the economic value of ecosystem services (hereinafter called ES) is expected to play an important role in conservation planning and ecosystem-based management (Plummer, 2009; Stenger et al., 2009; Turner et al., 2007), and to become increasingly important for local, national, and global policy and decision making (Turner et al., 2010). It also has a role to play in ensuring that human actions do not damage the ecological processes necessary to support the continued flow of ecosystem services on which the welfare of present and future generations depends (MA, 2005), and therefore in ensuring sustainable development (Turner et al., 2010). This becomes more relevant under the threat of climate change, where a 3 °C warming is estimated to be sufficient to transform about one fifth of the world's ecosystems (Fischlin et al., 2007).

Not knowing the economic value of a resource can lead to the detriment and depletion of ecosystem services. As a consequence, the 'ecosystem service approach' as proposed by the MA is becoming more and more widely accepted at both

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1462-9011/$ – see front matter
doi:10.1016/j.envsci.2012.02.002

academic and policy levels. However, despite this widespread acceptance and an exponential growth in studies embracing the MA framework (De Groot et al., 2002; Fisher et al., 2009), quantifying the levels and values of these services has proven difficult (Bateman et al., 2011; Nelson et al., 2009; Turner et al., 2010). A recent review conducted by De Groot et al. (2010) identifies the understanding and quantification of how ecosystems provide services as one of the greatest unresolved questions. Also, there is still a great deal of confusion amongst decision-makers and academics from all disciplines about the validity and implications of ecosystem service valuation (Spangenberg and Settele, 2010; Turner et al., 2010).

This confusion is partly derived from the current definition of what represents an ecosystem service and what types of ecosystem services exist (i.e. how ecosystem services should be classified). The problems of the MA as a general ecosystem services framework have recently been highlighted by Norgaard (2010), who states that the literature explaining the scientific understanding of ecology and social sciences, including economics, does not fit neatly into the MA model. It has also been claimed that we have a limited ability to understand and manage the full socio-ecological system set by MA (Carpenter et al., 2009). In the case of economics, the literature on ES valuation is mixed as the terms ecosystem services, functions and benefits are often used with different meanings from one study to another (Fisher et al., 2009). Therefore, some recent studies have specifically claimed that when the objective of ecosystem service assessment is economic valuation the MA framework and its classification of services is not the most adequate (Wallace, 2007; Boyd and Banzhaf, 2007; Fisher et al., 2009, among others). Studies claim that MA is ambiguous as to the distinction between ecosystem functions (understood as the mechanisms by which services are generated) and the services themselves (Haines-Young and Potschin, 2010). There have been numerous attempts to classify ecosystem services (Daily, 1997; De Groot et al., 2002; MA, 2005), but the confusion prevails (Haines-Young and Potschin, 2010). Further efforts are needed in order to understand what limitations may potentially arise if the MA approach is employed directly for economic valuation, and how those limitations can be addressed.

The literature on this topic is moving very fast, but not always with clarity. Here we aim to shed light on the current debate about the definition and classification of ecosystem services by reviewing and clarifying the existing literature (mainly but not solely post-MA) to inform economic valuation. The added value of this paper over other critical papers is that we illustrate the discussion with a practical examination of actual primary valuation studies. So far the discussion has been mainly on a theoretical level but here we look at actual studies, adding new evidence on the practical implications of classifying ecosystem services for valuation. For this purpose, we compare the MA service classification with an alternative, output-based classification for a sample of original valuation studies. We focus on water ecosystem services provided by tropical forests to illustrate our analysis.

The paper is structured as follows: Section 2 reviews recent literature revisiting the MA framework and identifies the main sources of disagreement; Section 3 presents the case of water-related services in tropical forests to illustrate the controversies of ES classification and valuation; Section 4 analyses the main results; and Section 5 concludes with recommendations for future analysis.

2. Service classification and economic valuation

Different classifications of ES exist. Table 1 summarises the main classifications that have been used in recent literature. The MA classifies ecosystem goods and services as *provisioning services*, which consist of products obtained from ecosystems; *cultural services*, the nonmaterial benefits that people obtain from the ecosystem; *regulating services*, including benefits obtained from the regulation of ecosystem processes; and *supporting services*, those which are necessary for the production of all other ecosystem services (MA, 2005). The nature of these services is not reduced to purely ecological processes, and the MA regards cultural services as ecosystem services.

Boyd and Banzhaf (2007) define ecosystem services as the components of nature directly enjoyed, consumed, or used to yield human well-being. This definition advocates a pragmatic classification of nature's contributions to human welfare from the perspective of environmental accounting. These authors consider services as the end products of nature, and distinguish them from intermediate components and from benefits. They only value services, as defined above, and exclude benefits, in which anthropogenic inputs are involved (e.g. recreational angling would have non-natural inputs such as tackle, boats – Boyd and Banzhaf, 2007) and intermediate components, which they define as part of the processes resulting in ecosystem services. They suggest that these categories be excluded from the economic valuation to avoid double counting. Wallace (2007) relies heavily on the MA classification but argues that only end services should be considered in valuation. He presents three levels of classification: processes, ecosystem services or end services (what is valued) and benefits.[1] Fisher et al. (2009) define ecosystem services as the aspects of ecosystems utilised (actively or passively) to produce human well-being. Based on this definition, they provide a classification with four levels: (i) abiotic inputs such as sunlight, rainfall or nutrients; (ii) intermediate services such as soil formation, primary productivity, nutrient cycling, photosynthesis, pollination, etc.; (iii) final services such as water regulation, primary productivity; and (iv) benefits, such as water for irrigation, drinking water, electricity from hydro-power, food, timber, non timber products. Benefits are valued in economic terms and are always derived from intermediate or final services. The concept of final services has been followed in recent assessments such as in the latest TEEB report (TEEB, 2010), in the recent UK National Ecosystem Assessment (UK NEA) (Bateman et al., 2011), and in Haines-Young and Potschin (2010).

[1] One example would be water erosion and regulation. These are considered as regulating services under the MA approach, while according to Wallace both are processes for achieving potable water, which would be the final service.