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Analysis

More than total economic value: How to combine economic valuation of biodiversity with ecological resilience

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ABSTRACT

The assessment of total economic value has become a pragmatic and popular approach in nature valuation, yet criticisms have been raised. One major point of critique is that total economic value bases the monetary value of ecosystems purely on the flow of human benefits of services of ecosystems and consequently ignores questions of sustainable use of natural capital per se. This paper explains why total economic value by itself is in principle an inadequate concept to guide sustainable use of ecosystems and gives an overview of essential ecological theory that needs to be taken into account in addition to total economic value to fully include ecosystem sustainability. The paper concludes with a framework for combining ecological theory with economic valuation. The key elements here are theoretical ecological insights about ecosystem resilience and portfolio theory which offers an economic perspective on investment in biodiversity. Portfolio theory puts total economic value in a framework where investment in biodiversity is expanded to cover functional diversity and mobile link species in order to maintain ecosystem resilience and so fosters sustainable use of ecosystems.

1. Introduction

Economic valuation of the services provided by nature is widely perceived by scientists and policy makers as an appealing and important approach to support management decisions (Costanza et al., 1997; Losey and Vaughan, 2006; Nunes and Van den Bergh, 2001; Pimentel et al., 1997). The use of economic values is attractive in that it enables nature to be taken into account in social development, research and policy and promises sustainable use of natural resources, landscape restoration and efforts of conservation. The most inclusive way of economic valuation of nature is through a total economic value assessment. Total economic value is an expression of the total value of the benefits derived from a marginal change in an ecosystem, expressed in monetary terms, which can subsequently be used in cost–benefit models. Total economic value is especially attractive because it aims to cover all expressions of value, including use values and non-use values of ecosystems. For an overview, see Bateman et al. (2011), Dziegielewska (2009) and TEEB (2010).

Yet, during the last decade criticisms have been raised (Bockstael et al., 2000; Chee, 2004; Gatto and De Leo, 2000; Ludwig, 2000; Morse-Jones et al., 2011). Existing economic valuation methods that are used in total economic value calculations, such as production function approaches and contingent valuation methods, refer to the value of nature to humans, supposedly acting as rational actors (Bockstael et al., 2000; Farber et al., 2002). The aggregate of their individual preferences forms total economic value and supports decisions in ecosystem management. However, if consumer preferences are not in line with the requirements of ecosystem sustainability, total economic value will not express these requirements either (Common and Perrings, 1992). Assuming that ecosystem sustainability would be a preferred status by consumers, one reason why consumer preferences might not be in line with such requirements is an information problem, where the consequences of action and decision on ecosystem sustainability are not well known by consumers (Chee, 2004; Ludwig, 2000). For example, Peterson et al. (2003) describe an ecosystem management model of oligotrophic lakes, which deliver ecosystem services such as water for consumption, irrigation and industrial use, recreation and fish catch. The example shows how a management decision making process that aims to maximize net present value of a lake does not take into account ecosystem resilience, and leads to ecosystem collapse.

There is a necessity to solve this information problem. Ecosystems behave in erratic ways and display time-lagged responses (Holling, 1992; Scheffer and Carpenter, 2003; Scheffer et al., 2001), and because economic valuation of services tracks marginal changes in ecosystem's benefits to humans, the method is blind to erratic behavior of ecosystems. Loss of species and resilience can happen unobserved while ecosystem functioning itself can remain largely unchanged (Chillo et al., 2011; Scheffer et al., 2001; Sundstrom et al., 2012; Walker et al.,

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2010). Hence, total economic value by itself cannot give an indication of an ecosystem's ability to maintain future provision of services, as collapse of an ecosystem may be only one marginal change ahead (Fisher et al., 2008). Thus, projects that use economic valuations to inform decisions on how much nature to keep and how much to convert to other uses, fail to safeguard ecosystem functioning for future benefit. Anderies et al. (2006) describe an example from management of an agricultural system in Southeastern Australia in which too much vegetation was cleared to keep the ecosystem resilient against flooding. Decision making based on enhancing economic efficiency and productivity became increasingly reactive and incremental, leading to loss of resilience and a lock-in to an unsustainable management trajectory.

Examples of ecosystem collapse in the literature on ecosystem management suggest that higher levels of caution are required in modifying or removing nature for the purpose of economic efficiency (Anderies et al., 2006; Steneck et al., 2011). A more fundamental criticism comes from Ridder (2008), who argues that more cautious management trajectories are not in line with economic valuation of ecosystem services. This is because total economic value resides mainly in certain functional species or species groups, except for some specific ecosystem services such as scenery and ecotourism. According to this reasoning, only the species needed for generating the ecosystem service of choice are to be maintained or cultivated and non-intervention in an ecosystem only applies to those cases where ecosystem services are provided by species or groups that are rare or very sensitive to human disturbances. Then, why have more species than just those that contribute to human benefits as reflected in total economic value? Steneck et al. (2011) consider the case of lobster monocultures in the Gulf of Maine that are threatened by collapse. Through relying on a few economically valuable species and removal of most apex predators through fishing, the lobster fisheries are on the verge of closure and collapse. Lobster monocultures offer large financial gains, but are vulnerable to perturbations such as rising ocean temperature, causing a decline of more than 70% in lobster abundance and potential great socio-ecological consequences. Low diversity cultivation has been known to increase the chances of pest outbreaks, disease outbreaks, fire and other expected or unexpected consequences (Hooper et al., 2005; Larsen, 1995; Weitzman, 2000). In addition, strategies in land use that support the maintenance of bundles of ecosystem services are recognized as practices to confront negative environmental impacts, while maintaining economic benefits and ecological resilience (Foley et al., 2005).

As is seen from these examples, economic valuation bases the monetary value of ecosystems only on the output of ecosystems at one point in time and space and not on the state of ecosystems (Morse-Jones et al., 2011) (see Fig. 1.). Hence, a major economic challenge is left unaddressed through the total economic value concept, namely how to manage biological diversity to assure a provision of ecosystem services through wider time and space (Perrings et al., 2009). In other words, how to manage the sustainable use of ecosystems (Farber et al., 2002). Using the analogy with factory production, the Millennium Ecosystem Assessment (2005) describes how the flow of goods sold is neither an accurate measure of manufacturing performance nor of the factory's management. The goods could either have been newly produced or taken from an existing built-up stock that is depleting.

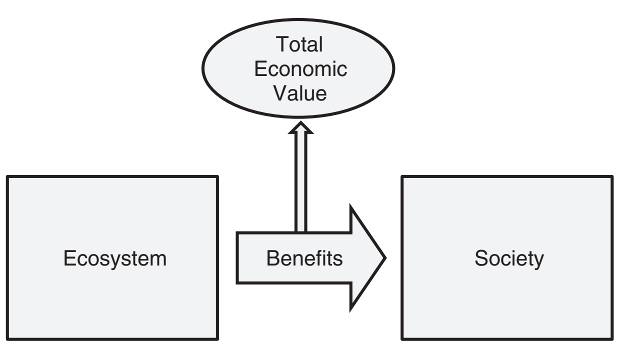

Fig. 1. Total Economic Value represents the value of the output of ecosystems to society, but is no indication of the state of ecosystems.

In sharp contrast to these characteristics of the total economic value approach, the ecological way of describing the functionality of ecosystems is non-anthropocentric. It describes causal relationships between parts of a system. If ecosystems are seen as assets of humankind, as stocks of natural capital from which ecosystem services flow, ecological "valuations" concern themselves with effects within the stock (Banzhaf and Boyd, 2005). Ecological valuation of ecosystems concerns itself with the maintenance of an ecosystem's complexity, structure, capacity for self-renewal and resilience (Gamborg and Rune, 2004). Ecology may, for example, describe how trees can stabilize slopes or the survival value of certain traits in organisms (Farber et al., 2002). With that, ecological theories are intimately linked to the concept of ecosystem sustainability and therefore have a potential to fill in the information gap in economic valuation, as it offers a perspective on ecosystem functioning that has economic meaning.

These problems cannot be resolved within total economic value theory as it exists today, because the empirical methods used to calculate total economic value are inadequate to address the ecological importance of species functions to sustain ecosystems. This is because, as pointed out by Diamond and Hausman (1994), existing valuation methods suffer from embedding effects in addition to several other limitations. This weakness of economic valuation methods has been recognized, and inclusion of some ecological theory in economic models has become commonplace. The decision on what ecological theory should be included in the economics depends on the spatial scale of the projects considered. Eppink and Van den Bergh (2007) give an overview of the ecological theories already in use in economic models. Some ecological theories tell us something about small-scale dynamics and are therefore useful in small scale cost-effectiveness and resource extraction models. Other theories offer broader system-wide views, and are more useful for economic models that are applied at large spatial scales. Eppink and Van den Bergh conclude that these applications predominantly deal with ecological theory at the species level with a clear absence of ecosystem wide theories of ecosystem resilience. This absence of theory about ecosystem resilience in economic models is problematic.

Inclusion of notions of ecosystem sustainability is essential for sound decision making in ecosystem management. We define ecosystem sustainability in line with the resilience concept (Holling, 1973) as the ecosystem's ability to maintain the provision of ecosystem services into the future. We address the following research questions to explore how the concept of Total Economic Value can be combined with ecosystem sustainability in economic models of nature conservation:

1. What notions of ecosystem resilience need to be added to Total Economic Value assessments in decision making to foster sustainable use of ecosystem services?
2. How can the concept of Total Economic Value be combined with these notions of ecosystem resilience?

The subsequent sections follow this order of research questions. The research questions imply that we maintain an economic and functional outlook on nature. Hence we will not touch on intrinsic values and priorities to protect endangered or characteristic species.

2. Notions of Ecosystem Resilience to Foster Sustainable Use of Ecosystems

2.1. Ecosystem Resilience

As mentioned above, we define ecosystem sustainability in line with the resilience concept of Holling (1973). More specific, ecosystem resilience according to Holling is the amount of perturbation