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Commentary

Monetary valuation of ecosystem services: It matters to get the timeline right

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ABSTRACT

In the abundant literature dealing with the monetary valuation, or monetization, of ecosystem services (MES), with very few exceptions, the concept is presented as having emerged in 1997. In fact, there is a long history, starting in the late fifties but largely ignored, of sustained attempts to assign monetary values to nature's services. These early efforts encountered many conceptual and methodological roadblocks, which could not be resolved and led a number of researchers to argue that monetary valuation was not a fruitful approach. It is in that context that MES was hailed by some in 1997 as a promising way to integrate environmental goods and services into the logic of economic markets. Knowledge of the full timeline casts a very different light, in particular on the difficulties currently encountered in the practice of MES; far from being the expected growing pains of a young discipline, these difficulties turn out to be long-standing problems that have eluded solution over the last half-century and appear intrinsically unresolvable. This perspective suggests that, at this point, it is advisable to look at alternatives to MES for the integration of nature into economic decisions.

1. Background: Standard Timeline

In the last few years, a significant amount of work has been devoted to the monetary valuation or "monetization" of the multitude of services that nature renders to human societies. This monetization of ecosystem services (MES) has been advocated by many as an optimal strategy to make nature visible to decision makers and financial markets, with the hope that this would lead eventually to the sustainable use of natural resources and their preservation. Thousands of articles have been devoted so far to MES, addressing a wide range of aspects of the topic, from its theoretical foundations to practical attempts at assigning monetary values to specific ecosystem services. In parallel to these academic pursuits, many international organizations, and more and more governmental agencies in numerous countries, are elaborating policies based on MES or on the occasionally-related "Payments for Ecosystem Services" (PES).

In a significant portion of the huge (and exponentially expanding) literature devoted to ecosystem services, MES is presented as a novel concept that emerged sort of out of the blue in 1997, and no historical information is provided on the process that led to its elaboration (e.g., Fisher et al., 2008; Juniper, 2013; Keddy, 2010; Pittock, 2013). Whenever scholarly articles or "grey literature" reports dealing with MES provide slightly more background on the genesis of the concept itself, the account that is given then in almost all cases is a variant of the self-described "fragmentary" history presented by Mooney and Ehrlich (1997, p. 11). Their chronology leapfrogs through time and involves only a few key dates, which are considered to be of particular significance. The timeline starts with various writers in antiquity who noticed disruptions caused by human actions in the provision of nature's benefits. Plato [c. 400 BC] acknowledged that deforestation could lead to soil erosion and the drying of springs. Pliny the Elder, in the first century AD, reported links between deforestation, rainfall, and the occurrence of torrents. The next landmark in the standard timeline occurs in 1864 when George Perkins Marsh, pointing out changes in soil fertility in the Mediterranean region, challenged the idea that the Earth's natural resources are unbounded. He alluded to the waste-disposal and pest-control services of nature, as well as to the multiple functions of "minute organisms" inhabiting the earth and water. Almost a century later, a number of authors, in particular Osborn (1948), Vogt (1948), and Leopold (1949), attempted to promote the recognition of human dependence on the environment. Vogt (1948, p. 67) also described in detail the notion of "resource capital". Closer to us, in 1970, the expression of "environmental services" was allegedly first introduced in the Study of Critical Environmental Problems (SCEP, 1970, p. 122), which listed a number of ecosystem services like insect pollination, fisheries, climate regulation, and flood control. The next significant date in the standard timeline is when the term of "ecosystem services" is considered to have been coined, by Ehrlich and Ehrlich (1981, p. 86). Then, finally, sixteen years later, a number of landmark articles (Costanza et al., 1997; Pimentel et al., 1997) and books (Daily, 1997) brought the concept of MES in the limelight. As a result, many authors appear to regard 1997 as the onset of the

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current MES movement. A slight variant of this timeline, adopted by some, acknowledges that mainstreaming of the ES really started with the publication of the influential Millennium Ecosystem Assessment (MEA, 2005), which was instrumental in making MES the de facto norm for the integration of nature into economic decisions.

2. Foundational Work Not Mentioned in the Standard Timeline

A handful of articles (e.g., Gómez-Baggethun et al., 2010; Liu et al., 2010; Wilson and Carpenter, 1999) provide additional historical background on the process that led to the monetization of ecosystem services. Gómez-Baggethun et al. (2010), for example, show how intimately connected MES is to the neoclassical theory of economics that supplanted classical economics and has become dominant in the second part of the 20th century. Liu et al. (2010) argue that economists started decades ago to consider valuating the contribution of nature to human well-being, and developed several of the methods now routinely used in attempts to assign monetary values to the many ecosystem services that are not traded in actual markets. In particular, Hotelling's (1949) discussion of the value of parks implied by travel costs stimulated the development of several *revealed preference* valuation approaches, like the travel cost valuation method, formally proposed by Clawson (1959) a decade later, and hedonic pricing methods (Ridker and Henning, 1967). Similarly, suggestions by Ciriacy-Wantrup (1947) eventually led to the use of *stated preference* techniques, like contingent valuation (Davis, 1963). Other types of values considered early on by economists include the so-called *option value*, i.e., the value of avoiding commitments that are costly to reverse (Weisbrod, 1964), and values associated with cultural services of nature (Krutilla, 1967).

There is an apparent contradiction between the fact that many current methods to evaluate nature's services were developed in the 50s and 60s, and the general understanding that their use started in earnest in the late 90s. In fact, nothing is farther from the truth, as it becomes immediately clear to anyone who does not focus exclusively on the expression "ecosystem services" in literature searches. A very large body of work was carried out in the 60s and 70s on what was at the time referred to as ecosystem functions (Odum, 1959), "environmental goods and services" (Vatn and Bromley, 1994, p. 130), "environmental amenities" (Adamowicz, 1991, p. 609) or, simply, "nature's services" (Westman, 1977, p. 960). In a comprehensive review of the state of the art of evaluating intangible benefits and costs associated with the use of the environment, Coomber and Biswas (1973) list around 300 articles, books and reports. A few years later, an extensive annotated bibliography assembled by Leitch and Scott (1977) comprises no less than 691 articles, reports, theses, and other publications, dealing solely with the economic values of fish and wildlife and their habitats. Most importantly, these early attempts to value nature were quickly followed by detailed analyses of the shortcomings of MES. These are highly relevant to current efforts to monetize nature.

3. Early Examples of Market Failures

One of the early sources mentioned by Leitch and Scott (1977), and one of the most enlightening, is a 426-page technical report by a committee headed by Wollman (1962), concerning an extensive research project carried out in New Mexico in the late fifties. A group of investigators from different disciplines (economics, sociology, engineering, biology) attempted over a number of years to determine how to most profitably allocate a portion, considered "unappropriated" (Wollman, 1962, p. xii), of the water resources in the San Juan and Rio Grande basins, in New Mexico. Through interviews, surveys, physical measurements, and in-depth analysis of extant population, economic, environmental and climatological data, the authors estimated, per unit volume of water, the value-added resulting from water use in agriculture, recreation, and industry, with a number of subcategories in each case. In their work, the authors encountered what they refer to as "methodological weaknesses" (Wollman, 1962, p. 71), in particular the fact that they could consider only the readily monetizable aspects of water use, and therefore had to implicitly ignore other (e.g., cultural, spiritual, and esthetic) components. Within these constraints, the authors came up with the conclusion that by far the least profitable use of the unappropriated water was in agriculture. Five to six times more profitable was water usage for recreation purposes (i.e., as fish and wildlife habitat), whereas industrial/municipal uses of water were between 60 to 85 times more profitable than in agriculture. On the basis of these estimates, the logical conclusion reached in the project was that, if the sole decision criterion were to maximize monetary profit in the region, all available water should go to industry. This perspective was not novel: Gertel and Wollman (1960) had described earlier a similar type of "market failure" and had come to the same conclusion when they calculated the economic yield per unit of water, finding that the monetary return on 1 gal of water is much higher when water is used in manufacturing and mining than when used in agriculture or for drinking by people. Nevertheless, the committee led by Wollman considered this outcome to be unrealistic, in line with the committee's view that "the 'free market' is a limited instrument for determining the relative desirability of water's alternative uses (Wollman, 1962, p. xii)."

4. Critical Appraisals

A decade later, after a number of researchers had made similar observations, Krutilla argued that "private market allocations are likely to preserve less than the socially optimal amount of natural environments" (Fisher et al., 1972, p. 605). Clark (1973) gave a particularly vivid endorsement of the same view, with his simple mathematical model of the commercial exploitation of a natural animal population. His key conclusion was that, depending on certain easily stated (and quantifiable) biological and economic conditions, in particular a preference of harvesters for present over future profit, extermination of the entire population may appear to be the most attractive policy, more profitable in the short run than conservation. Clark's (1973) and other similar calculations stimulated eloquent critiques of cost–benefit analyses and market-based principles for the management of ecological systems. In particular, Pearce (1976), in a critical analysis repeatedly echoed in the literature (e.g., Godard, 2009; Hanley, 1992; Heinzerling and Ackerman, 2002), argued that cost–benefit analysis has direct relevance only to pollutants that have "nuisance" features and do not have sustained ecological effects. He demonstrated further that in situations where the effective assimilative capacity of the environment is zero and the pollutants in question have biological effects, cost–benefit analysis has only limited relevance, whereas for conventional pollutants that have ecological effects, the ecologically-optimal solution diverges from that dictated by cost–benefit analysis.

A few other critical appraisals appeared in the 70s. Ghiselin (1977, p. 297) described cost–benefit analyses applied to environmental goods and services as the "commensuration of the incommensurable. […] The usual technique of cost–benefit analysis is based on an inherently delusive method. Instead of assessing costs and benefits on the same basis, it ignores costs and benefits that cannot be monetized at all." Georgescu-Roegen (1977, p. 125), in a discussion of the economics of food and energy, wrote: "We cannot possibly rely on a market mechanism to avoid ecological catastrophes because the market is the parameter of demand and supply only of current generations, whose horizon is just a brief spell in comparison with the life span of the whole species. Prices can never be ecologically right, simply because future generations are not present to bid on scarce resources side by side with current generations."

The many fundamental and methodological problems associated with the monetization of ecosystem services and identified in the 60s and 70s were summarized with remarkable clarity in an extensive

report by Westman and Conn (1976), including a very thorough section on problems associated with the adoption of specific discount rates (see also Ferguson and Reilly, 1976). This report was followed a year later by an equally penetrating yet seldom-cited essay in *Science*, in which Westman (1977, p. 963) argues that attempts to quantify nature's services "have heuristic value", yet that it is both "sobering and important to recognize" that, even in the long run, quantitative estimates of the worth of nature to man are likely to be akin to estimates of the worth of a flower to a poet: "What is the value to societies, present and future, of the inspirations that flowed from Wordsworth's poetry, and indirectly from nature?" (Westman, 1977, p. 960).

5. Renewed Interest and Further Criticisms

A detailed bibliometric analysis of the literature published in the following decade could help determine if these various assessments, and in particular Westman's (1977), slowed down the work on MES. Liu et al. (2010) argue that the amount of work on MES increased exponentially in the 80s, but this observation may change if one broadens the scope of the analysis to more than just the buzzwords "ecosystem services". Definitely, articles continued to appear in the late 70s and 80s on what was still referred to then as the monetization of nature's or environmental services. There are, in particular, various accounts of heated debates (e.g., Odum, 1979; Shabman and Batie, 1978), and frequent restatements of previous criticisms, like the perspective that "it is incorrect to assume that the capitalized value of the present benefits is the full cost of losing a wetland" (Thibodeau and Ostro, 1981, p. 21). Nevertheless, for a variety of reasons, it appears that the topic became once again the focus of significant attention in the late 80s and early nineties, leading to a surge in the number of publications on MES (Vatn and Bromley, 1994). In the Spring of 1991, the U.S. Environmental Protection Agency convened an expert group of ecologists, economists and other social scientists for the purpose of advancing the state of the art of ecosystem valuation methods. This "Ecosystem Valuation Forum" was organized as a dialog because it was clear from the outset that agreement even on the meaning of the term "ecosystem valuation" could not be taken for granted. Individuals from diverse disciplines, and from industry, environmental groups and government agencies disagreed about what information about ecosystem services was needed, how it should be used and, therefore, what would constitute an advance in the methods that analysts should employ. The Forum discussed the varied ways in which experts from different disciplines approach valuation, what ecosystem attributes or services are important to value, and the various factors that complicate the task of assigning values to ecosystem attributes (Bingham et al., 1995).

Consensus on most of the issues addressed by the EPA Forum was virtually absent in the early 90s, as is abundantly clear in a flurry of articles published right around that time. In applications, the various methods proposed in earlier decades to assign monetary values to nature's services were all criticized on a number of grounds. For example, Diamond and Hausman (1994, p. 62), at the end of a detailed analysis on the valuation of public goods, expressed their belief that "contingent valuation is a deeply flawed methodology for measuring nonuse values, one that does not estimate what its proponents claim to be estimating." Hanley (1992), in an analysis of the literature dealing with various methods for the valuation of non-marketed goods, including hedonic pricing and the travel cost method, found severe limitations with all of them. At a broader level, a very clear statement was made by De Groot (1992, p. 140): "the monetary value of environmental functions is but one of many different human value standards and, from an environmental point of view, certainly not the most important. Clearly, translating the many functional interactions between man and the natural environment into monetary indicators is quite impossible and often even undesirable. Especially for some information functions such as the esthetic and spiritual value of nature, monetary evaluation is a difficult if not impossible procedure. Therefore, there should be room in the economic planning and decision-making process to take account of 'priceless experiences', without having to express them in monetary values." Vatn and Bromley (1994, p. 145) made essentially the same point: "pricing is not sufficient to ensure informed and coherent collective choices about environmental goods and services. […] The collective choice problem about environmental goods and services is complex and problematical precisely because it entails aspects of our social existence that defy reduction to the venerable fiction of commodities". In other words, three decades after the Wollman (1962) report, which in essence stumbled on the same obstacle, the state of the art had not advanced at all.

6. MES Goes Mainstream

It is in this general context, with a profusion of conceptual and practical issues still to be resolved, that MES was advocated around 1997 as an ideal strategy to get market economies to pay attention to the environment. Several ecologists (Costanza et al., 1997; Daily, 1997; Pimentel et al., 1997) decided to go mainstream and to promote actively what, among academics, was at the time an obviously controversial idea, which had been extensively tested but had not until then generated very many positive results. It would probably be illuminating to try to understand which specific socioeconomic and political drivers in the US encouraged this development to occur. Some of these drivers may be similar to the ones Vogel (2012) has identified with respect to environmental regulations. Various economic, political, sociological, and religious reasons were instrumental after 1990 in encouraging increasingly skeptical American policymakers to call for steadily higher levels of scientific certainty before imposing additional environmental or health-related regulatory controls on business, unlike their counterparts in Europe who increasingly relied on the precautionary principle. In some decision-making circles in the US, "scientific" came to mean numbers generated by economic models.

7. Significance of Considering the Detailed Timeline

Aside from historical reasons, the fact that the research on MES and on its practical applications has a significantly longer chronology than what is traditionally acknowledged in the literature on ecosystem services, does matter in a number of respects. In particular, it forces a different interpretation on the many accounts of methodological difficulties that have appeared these past few years in the literature (e.g., Barbier, 2011; Dempsey and Robertson, 2012; Fisher et al., 2008; Lamb, 2013; Sagoff, 2011), especially with regards to cultural values of environmental services (Chan et al., 2012a,b; Kirchhoff, 2012). If one considers that the idea of MES emerged in 1997, and took off in earnest a few years after that, when the Millennium Assessment got published, in other words if MES as a field of study were merely 10 or 15 years old, one could readily understand the kind of growing pains that researchers are now facing. However, the picture is entirely different when one looks at the complete timeline. The field, in reality, is more than fifty years old, and started having growing pains decades ago. Researchers from the onset struggled with methodological problems, and one could argue that the research community still has not managed to resolve any of them satisfactorily, as illustrated vividly by Hausman's (2012) recent downgrading of the status of the contingent valuation method from dubious to "hopeless". Spurred by government agencies in many countries to evaluate ecosystem services, researchers and field practitioners are laboriously trying to provide monetary estimates of ecosystem services, but in many ways it seems that questions about the soundness of these numbers are still as challenging, and their answers as uncertain, as they were in the past (Gowdy et al., 2013; Norgaard, 2010; Parks and Gowdy, 2013).

From this perspective, it is legitimate to ask whether, after more than half a century of one-sided efforts, the time may not have come to give

consideration to alternative ways to integrate nature and economics. One possible avenue would be to look at approaches that do not require monetary values to be assigned to every single one among the multitude of services we derive from nature. In this respect, several frameworks exist for assessing ecosystem values without forcing all of them into the straightjacket of neoclassical economic theory. The TEEB (The Economics of Ecosystems and Biodiversity) initiative (Kumar, 2010; Kumar et al., 2013), as well as recent uses of multicriteria decision analysis (Linkov and Moberg, 2011), for example, stress the importance of multiple valuation approaches. Economic values such as ecotourism can be expressed in monetary units, non-economic benefits to human society can be quantified using a variety of measures (health or well-being indices for example), and such things as the value of biodiversity to ecosystems can be described in detail even if they cannot be quantified. The fact that this approach does not end up with a single number to compare all policies should be seen as an advantage, not a drawback. Beyond this non-monetary valuation of ecosystem services, there may be a number of other alternatives where, while recognizing the many services nature renders to human populations, one does not attempt to value them directly, monetarily or otherwise. Some aspects of ecosystem functioning, such as the proximity of tipping points, call for precautionary approaches prior to any consideration of valuation (TEEB, 2010, p. 12). These approaches include the adoption of safe minimum standards or measures aiming at the maintenance or restoration of the critical natural capital (the preservation of which is essential for environmental sustainability). The problem is then to decide what must be deemed critical in a particular context (Ekins et al., 2003). Given the current gaps in scientific knowledge, this is undoubtedly a challenging endeavor. It might nonetheless serve the environment better than monetary valuation.

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