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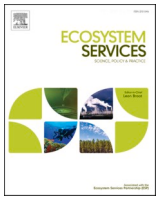

Misconceptions about the valuation of ecosystem services

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ABSTRACT

The concept of ecosystem services – the benefits humans derive from functioning ecosystems – has been around for at least 4 decades. Attempts to value those services in monetary and other units have been around for just as long. However, several misconceptions have sprung up about ecosystem services, and especially the valuation of those services in monetary units, that are counterproductive to further dialogue, research, and solutions. This paper attempts to address some of those misconceptions, including showing that: (1) ecosystem services is not an anthropo*centric* concept; (2) economics is not only the market; (3) valuation is not commodification or privatization; (4) expressing relative values in monetary units is not necessarily 'market-based'; (5) in a world of trade-offs, whether to perform a valuation is not a choice since it happens implicitly; (6) 'intrinsic values' are about rights, not relative valuation; and (7) relative valuation and rights-based approaches are complimentary not mutually exclusive. I address each of these misconceptions in turn and end with a plea for constructive dialogue on these important issues, not continuing unproductive debate founded on fundamental misconceptions.

1. Introduction

It has been over 25 years since two seminal publications about ecosystem services (ES) were published: (1) an edited book (Daily, 1997) titled '*Nature's services: societal dependence on natural ecosystems*' with a collection chapters covering definitions, history, economic valuation, overarching services like climate and biodiversity, services from specific biomes including marine, freshwater, forests, and grasslands, and case studies in specific ecosystems including wetlands and South African fynbos, and (2) an article in *Nature* on the value of the world's ecosystem services (Costanza et al., 1997) that attempted to estimate their value in monetary units. These publications kicked off an explosion of research, policy, and applications of the concept of ecosystem services (ES) (Braat, 2012). Fig. 1 shows the number of academic publications in SCOPUS over time on the topic of "ecosystem services" (top line), the fraction of those that also included 'value' OR 'valuation' in their title or abstract (middle line), and the fraction of those that also included 'economic' (bottom line). These totals do not include non-academic publications such as news articles, blog posts, or policy documents. Nevertheless, they indicate the rapidly growing interest in ecosystem services, and valuation as a subset of that interest.

This explosion of interest has also brought continuing debates, controversies, and misconceptions. In particular, the *Nature* paper's estimate of the value of global ES in monetary units was both surprising and controversial. The results showed that the value of global ES was substantially greater than global GDP at the time, even though it was acknowledged to be a conservative underestimate. There were three basic objections to this result: (1) some (mainly environmentalists) thought the estimate was too low – an 'underestimate of infinity' by one account (Toman, 1998); (2) others (mainly economists) thought it was too high – how could it be larger than the entire world's GDP? (Bockstael et al., 2000); and (3) still others thought it was profane and vulgar to value ES at all (how can you put a price on nature?) and that this kind of monetary valuation played into the hands of those who wanted to commodify and privatize nature (Monbiot, 2014; Sagoff, 2017).

The first two of these objections were 'researchable' and there have been thousands of subsequent research articles that have addressed them in various ways (Fig. 1). One of these was an update of the *Nature* paper including some of the subsequent research on ES valuation and updated data on global land use (Costanza et al., 2014b). However, the third objection is based on some fundamental misconceptions about ES and their relative valuation in monetary (or other) units.

These misconceptions are not new, but they have led to ongoing unnecessary debates that have hampered or diverted energy from the progress needed to further develop the ES concept and its applications. They have been addressed independently in a number of fora (i.e. Islar et al. (2022)). This article aims to summarize and clarify these misconceptions in order to move beyond further unproductive either-or arguments and debates to a more nuanced and constructive dialogue

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and consensus building toward real solutions.

2. Ecosystem services is not an anthropo*centric* concept

One of the most prevalent misconceptions about ecosystem services is that it is a purely 'anthropocentric' concept concerned *only* with exploiting ecosystems for human benefit. This misconception can be understood, to some extent, based on a narrow reading of the term 'services' as 'servant' or 'in service' as if ecosystems were only there as servants for the benefit of humans. But the intended meaning of the term is much broader and more nuanced than that. Ecosystem services are defined as the ecological characteristics, functions, or processes that directly or indirectly contribute to human wellbeing: that is, the benefits that humans derive from intact functioning ecosystems (Costanza et al., 1997; Millennium Ecosystem Assessment (MEA), 2005). The Intergovernmental Panel on Biodiversity and Ecosystem Services (IPBES) has, to some extent, tried to address this misconception by relabeling ecosystem services as 'nature's contributions to people'– eliminating the 'services' term that seems to be the root of the misconception for some people (Díaz et al., 2018)[1]. It could also be called 'ecosystem's contributions to human wellbeing' or any number of near synonyms if that would help communicate the intended meaning better.[1] Regardless, the basic idea of ecosystem services (or contributions) implies recognition that humans depend on the rest of nature for their wellbeing and survival. It also implies that *Homo sapiens* is an integral interconnected part of the current biosphere. If our species hopes to remain an integral part of the biosphere we need to recognize and manage this complex interdependence and the ecosystem services concept is one way to help do that.

So, rather than ecosystem services (ES) being anthropo*centric*, it is based on the recognition of humanity's complex *interdependence* with the rest of nature. Or, as Costanza et al. (2017) have argued: "rather than implying that humans are the only thing that matters, the concept of ecosystem services makes it clear that the whole system matters, both to humans and to the other species we are interdependent with." From this 'whole systems' perspective, the concept is neither anthropocentric nor 'ecocentric'.

To emphasize this, one can also think of the benefits to other species of functioning ecosystems (Farley et al., 2024). This is what the whole field of ecosystem ecology is about. The focus on ES to humans was necessary because that connection had been underappreciated by both ecologists and economists. Being able to quantify and communicate the degree of interdependence in units that can be broadly understood is a major strength of the concept.

Ecosystems are complex interdependent systems that don't really have a center, so 'centric' with any prefix doesn't really describe or connote this complex interdependence and only leads to a fundamental misunderstanding of the concept.

3. Economics is not only the market

Much of the existing literature on valuing ES is based on mainstream economic ideas about supply, demand, and markets and this has led to the misconception that all attempts to value ecosystem services in monetary units are based on markets. However, natural ecosystems do not fit the market model. The supply of most ES (except provisioning services like timber) does not respond to demand by humans for those ES. Ecosystems do not behave like factories with managers who can quickly adjust production and supply. The atmosphere and climate respond to human impacts like CO2 emissions, but the biosphere does not make adjustments to the supply of climate services based on human demand for those services (see (Costanza et al., 1997) Fig. 1). Thus, there must be different approaches to valuing some ES (especially regulating and cultural services) than assuming a market or pseudo-market exchange value based on supply, demand, and individual human preferences.

Thus, valuing ES must take a different approach to economics – both what the economy is and what it is for. The mainstream view is that the

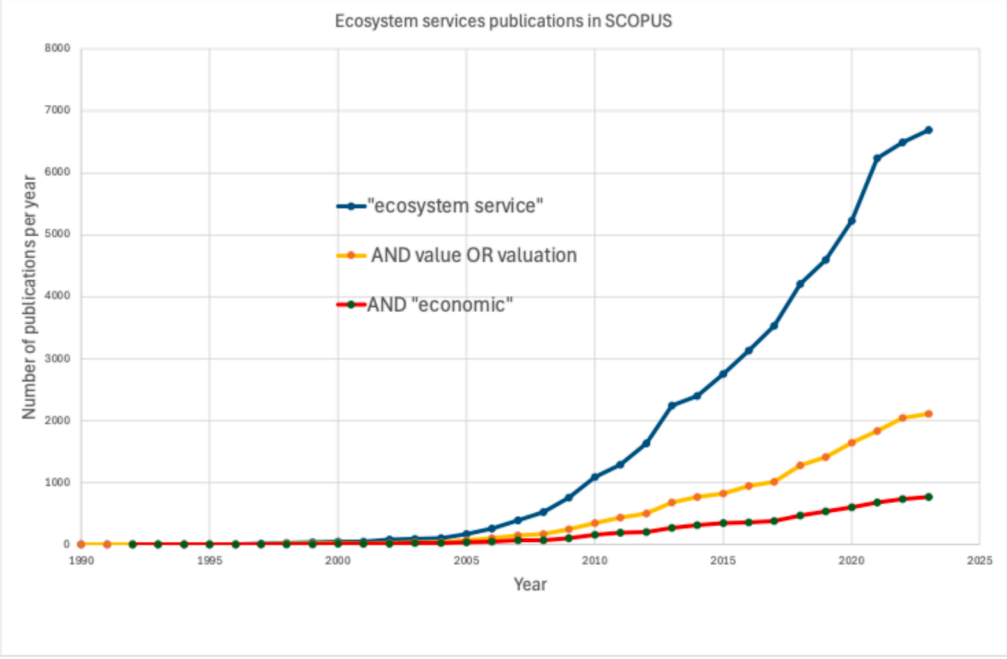

Fig. 1. The number of academic publications per year in SCOPUS (as of 2/9/2024) with 'ecosystem service' in the title or abstract (top line). The middle line is the fraction of those that also include 'value' or 'valuation' in the title or abstract. The bottom line is the fraction of those that also include 'economic' in the title or abstract.

[1] However, the attempt to cast this relabeling as a substantially new or different concept from ecosystem services is misplaced, inaccurate, and counterproductive. The two terms should be viewed as synonyms Braat, 2018).

goal of the economy is satisfying individual human preferences recognizing constraints and that the market is an efficient way to do this. There are a lot of assumption embedded in this definition (Keen, 2011), but it has led to the emphasis being put on markets and how they function and how they price commodities.

But the economy is much more than the market. The market is just one imperfect institution humans have developed to allocate resources. In addition, the goal of the economy *should be* to support sustainable human wellbeing and all that that entails. This requires the complex interaction of all of our assets – built, human, social, and natural capital (Costanza et al., 2014a). It also requires achieving the sub-goals of sustainable scale, fair distribution, and efficient allocation (Daly, 1992). A more comprehensive approach to the valuation of ES must address all three of these sub-goals, not just the efficiency goal (Costanza, 2020).

4. Valuation is not commodification or privatization

One of the most common objections to the idea of valuing ES in monetary units is that stating a value in monetary units is a direct and almost inevitable precursor to commodification, privatization and the trading of those services in private markets. However, the fundamental characteristics of many important ES precludes this. These characteristics underly the reasons that many ES have not been commodified and privatized already and why they never will or should be.

One way to classify ecosystem services is according to their 'excludability' and 'rivalness' status. Fig. 2 arrays these two characteristics against each other in a matrix which leads to four categories of goods and services. Goods and services are 'excludable' to the extent that individuals can be excluded from benefiting from them unless they pay compensation. Most privately owned, marketed goods and services are relatively easily excludable. One can prevent others from eating the tomatoes they have grown and fish they have caught, using the timber they have harvested, or drinking fresh water they have in their pond unless they pay for them. But it is difficult or impossible to exclude others from benefiting from many public goods, like a well-regulated climate, fish in the open ocean, or the aesthetic benefits of a forest. Goods and services are 'rival' to the extent that one person's benefiting from them interferes with, or is rival with, another also benefiting from them. If I eat a tomato or a fish, you cannot also eat it. But if I benefit from a well-regulated climate, you can also benefit from it to the same extent, at the same time, with no reduction of my benefits.

Excludability is largely a function of technical, cultural, and institutional mechanisms available to enforce exclusion, while rivalness is a characteristic of the good or service itself. Fig. 2 places ecosystem services into four categories that this two-by-two matrix creates. Only rival and excludable ES, mainly provisioning services, lend themselves to commodification, privatization, and market solutions. These are the ones that have already been privatized, commodified, and traded in markets. For example, timber and fish in the market. Other ES, mainly regulating and cultural ES, are non-rival and difficult to make excludable, or both, and therefore do not lend themselves to market solutions – for example climate regulation and nature-based recreation.

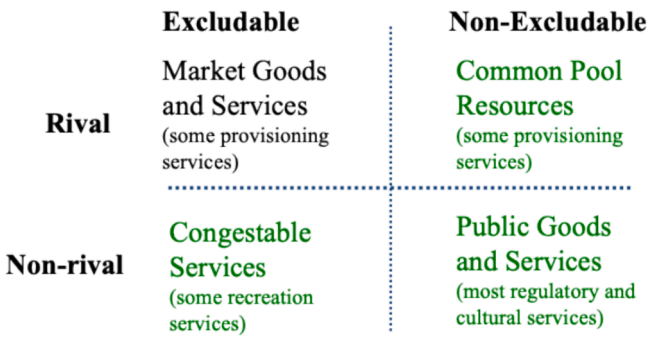

Fig. 2. Ecosystem Services classified according to rivalness and excludability (Costanza, 2008).

Carbon markets are probably the most widespread attempt to commodify the ES of carbon sequestration for climate regulation. However, climate regulation is non-rival and non-excludable – a pure public good. Carbon sequestration by plants and soil is an ecosystem service that is a proxy for climate regulation. Carbon sequestration can be estimated, albeit with some difficulty, expense, and imprecision. This makes 'commodifying' this service difficult and expensive. What are buyers of carbon credits actually buying? Would the sequestered carbon have been sequestered anyway? Essentially, the transaction costs of the actual market in carbon credits often outweigh the value of the credits themselves. This does not mean that carbon sequestration, and the climate regulation it provides, are not valuable. Quite the contrary. It means that market exchange is not an appropriate way to measure or manage this value due to the inherent difficulty of trying to make rival and excludable goods out of ones that are inherently non-rival and/or non-excludable.

For example, most of the successful Payment for Ecosystem Services (PES) schemes have not relied on markets to set exchange values. Rather, they function more like Common Asset Trusts (Costanza et al., 2021b) where a trustee uses financial incentives to achieve management goals. For example, in Costa Rica, the Forestry agency (FONIFIFO) pays private landowners to convert some of their land from pasture to forest. The conceptual basis for these payments is the value of the ecosystem services of forests versus that of pasture. In the case of Costa Rica, they list these forest services as carbon sequestration, biodiversity, water regulation, and landscape beauty. But the actual payment to farmers is the opportunity cost – an amount that is slightly larger than the farmers could make by using the land as pasture. This system has worked very well in reforesting Costa Rica because the transaction costs are very low relative to trying to measure and document the value of each of the four ecosystem services and create markets for them.

One might argue that the Costa Rican farmers are being treated unfairly because they are only getting the opportunity cost while the public good value of the four services has been estimated to be much higher. In a market-based approach should the farmers not demand that higher value? This just highlights the public goods nature of these services. They are not 'owned' by the farmer. They benefit the public and are non-excludable and non-rival. The farmer should be rewarded for helping to produce them, but the real producer is the ecosystem and the farmer's role is steward of a common asset, not producer of a rival and excludable commodity. This does not mean that the farmer cannot extract some of the provisioning services (i.e. timber) and sell them as commodities. But this extraction must be in the context of protecting the forest for the other public ES (i.e. climate regulation, nature-based recreation, biodiversity) that it is also producing, and the PES scheme provides an additional incentive to do that.

5. Expressing relative values in monetary units is not necessarily 'market-based'

There are many and varied ways to estimate the trade-offs between ecosystem services and other contributors to human wellbeing. This is an ongoing area of research and there is no one method that applies to estimating the trade-offs of all ES. A subset of these methods apply to ES sold in markets (mainly provisioning services), which use market prices and information about other inputs to the production process, to estimate the contribution of the ecosystem to the market value. However, as discussed above, many regulating, cultural, and supporting services are not, and should not be, marketed. Estimating their value needs to employ a range of different methods. The majority of the more than 10,000 value estimates currently catalogued in the open access

Ecosystem Services Valuation Database (ESVD)[2] are derived from non-market methods (Brander et al., 2024). The most straightforward of these are damage cost avoided and replacement cost methods, which estimate the ES value based on the damage costs that are avoided due to functioning ecosystems or the cost of replacing services with man-made technology, respectively.

Examples of the replacement cost method include using the cost of water or sewage treatment plants to estimate the value of these services done by natural ecosystems like forests or wetlands. These estimates can be expressed in monetary units but are not 'market-based.' There is no market exchange involved. Just because a value of an ecosystem service is expressed in monetary units, does not mean that it is 'market-based' or that it will lead to a market being established for the service or that it will be commodified or privatized.

Another example is the value of coastal wetlands for storm protection. A recent study (Costanza et al., 2021a) estimated this value as the 'avoided cost' – what the damages and lives lost from major storms would have been if coastal wetlands were not in place to protect the built coastal infrastructure and the people living there. The estimates were based on the probabilities of particular locations being hit by a tropical cyclone of a given magnitude based on historical storm frequency and the results of a statistical model of the relationship of damages to wetland area, gross domestic product (GDP) in the swath of the storms, and storm strength. This was used to produce global maps of the value of coastal wetlands for storm protection in terms of avoided property damages and lives saved for each coastal pixel. The global total value of the storm protection ES was estimated to be approximately 450 Billion $US per year and 4,500 lives saved per year.[3]

The point is that none of this was based on market exchanges. It required a fairly sophisticated analysis of spatially explicit historical data and it did not require data on individual human preferences. Nevertheless, the results are very useful in determining whether it is better to build seawalls for storm protection or to protect and enhance coastal wetlands, which also provide the full range of other ES. The results strongly favor the later. These kinds of 'nature-based solutions' are becoming more popular as non-market ES valuations like this become more sophisticated and available.

6. In a world of trade-offs, valuation is not a choice

Even without any subsequent valuation, the process of listing all the services derived from an ecosystem helps ensure their recognition in public policy. This makes the analysis of ecological systems more transparent and helps inform decision-makers of the relative merits of different decisions. Many decisions involve trade-offs between ES and a range of other contributors to human wellbeing. In these cases, ES, and other wellbeing contributors, are implicitly valued once we know they exist (Pearce, 1991). As (Costanza et al., 1997) pp. 255) put it: "The decisions we make as a society about ecosystems imply valuations (although not necessarily expressed in monetary terms). We can choose to make these valuations explicit or not; we can do them with an explicit acknowledgement of the huge uncertainties involved or not; but as long as we are forced to make choices, we are going through the process of valuation." Every time we build homes, schools, and hospitals, which are essential for human wellbeing, we utilize ecosystems and impact our natural capital. Thus, being more explicit about the valuation of ES can help society make better and more transparent decisions when trade-offs exist (Braat and de Groot, 2012; de Groot et al., 2010) and simply saying that the valuation of ES is wrong or inappropriate does not mean that it is not happening anyway. In democratic decision processes, transparency is critical and explicit valuations of ES can help to make clear what is being traded-off when ecosystems are impacted. They have, therefore, been a topic of research that has attracted much attention.

7. "Intrinsic value" is about rights, not relative valuation

Another popular argument against valuing ES is that we should preserve and protect nature strictly 'for its own sake', for its 'intrinsic value' (Chee, 2004; McCauley, 2006).

There are two common but distinct meanings of 'value:' (1) Things we think are important: i.e. "I value biodiversity" (but I may also value freedom, fairness, sustainability, income, human life, and many other things); and (2) relative valuation estimating the trade-offs with other things: i.e. the value of protecting biodiversity is greater than the cost required to protect it. This exercise of estimating trade-offs can best be called 'valuation', to distinguish it from a rights-based assertion of 'value.'.

'Intrinsic value' refers more to the first of these meanings. It is about the 'rights' of the goal (i.e. biodiversity) to exist. For example, if one says that biodiversity has *intrinsic* value, one is really claiming that protecting biodiversity is an important goal in itself – it is something we value in the first sense. Relative instrumental values (in the second sense as defined above) are based on the relative contribution that something makes to achieving goals (directly or indirectly) in the presence of trade-offs. The valuation of ecosystem services (in monetary or other units) is based on the second meaning.

8. Valuation and rights-based approaches are complimentary, not mutually exclusive

It is important to recognize that relative instrumental valuation of trade-offs and rights-based or intrinsic value approaches are not mutually exclusive. In fact, they can best be thought of as complimentary and can be mutually supportive in efforts to conserve and protect ecosystems.

Likewise, it should be clear that the two meanings of 'value' mentioned above are not mutually exclusive and should not be compared directly with each other. It is not a case of instrumental value *versus* intrinsic value. We can estimate the relative instrumental value of biodiversity while we recognize the rights of biodiversity to exist as a goal in itself. Both of these approaches can help to understand and protect biodiversity and ES, but they can be most effective is used together in collaboration rather than misunderstanding them as opposites.

For example, there are statements like: "The monetary valuation of nature is inherently antithetical to how many communities, especially Indigenous communities, relate to their environment".[4] Indigenous communities certainly value nature in the first sense of having rights to exist that must be respected. But that is not 'antithetical' to *also* valuing nature for its ongoing relative contributions to other things that are valued by indigenous communities, like food, water, aesthetic beauty, etc. I believe that what is really behind the view that monetary valuation is antithetical to intrinsic or rights-based value is the misconception discussed above that valuation in monetary units is a direct and inevitable precursor to commodification and privatization and therefore that the valuation of Indigenous communities' ES will lead to them being privatized and sold out from under them. I hope I have explained why this is not the case. It is commodification and privatization that must be guarded against, not valuation, which only highlights the public value of the ecosystem commons.

[2] https://www.esvd.net/.

[3] This also indicates that the ES values need not be in monetary units only. One could also use energy, time, or other units as common denominators to express trade-offs if those units communicated more effectively.

[4] https://daily.jstor.org/should-environmental-policy-commodify-nature/.

9. The way forward

We live in what Deborah Tannen has called "the argument culture" (Tannen, 1998). In this culture, even the most complex, problems are framed as black and white polar opposites. All discussions are cast as debates between two extremes in which one side is correct while the other is wrong. The media, law, politics, and especially academia are all caught in the argument culture. While there is nothing inherently wrong with debate and direct confrontation on certain topics, the problem is that this does not work for all topics. The complex problems that we face today, including the ones described in this paper concerning the valuation of ES, require a more multifaceted, complex approach— one that encourages real dialogue and does not cast every discussion as a zero-sum, win-lose, either-or dichotomy.

The argument culture encourages creating and protecting disciplinary and other boundaries on the intellectual landscape. Sharp intellectual boundaries, unique languages and cultures, and lack of whole-system perspectives makes problems that cross boundaries very difficult, if not impossible, to solve. There are also large gaps that are not covered by any discipline or framing.

To move forward we need a more intelligently pluralistic approach to discussing the problems outlined in this paper based on trying to find synthesis and solutions rather that perpetrating unproductive debate and argument. This does not mean that all approaches to valuing ecosystems are equally valid. As George Box once said: "All models are wrong…but some are useful." We need humility about our models and understanding of the world and we should continue searching for models that are useful in achieving our shared goals.

For example, instrumental relative valuation and intrinsic or rights-based value are not polar opposites requiring one to pick a side. They are alternative, but complimentary, ways of thinking about how best to understand the complex interdependence between humans and the rest of nature. But we need to recognize that they are playing different roles and take advantage of that to build stronger, more comprehensive, and more useful approaches.

Recognizing the misconceptions outlined in this paper can help to build constructive dialogue on these important issues and help to move past continuing unproductive debate and argument. We can't afford to waste intellectual resources in our shared quest to conserve ecosystems and must direct our efforts to finding collaborative solutions.

CRediT authorship contribution statement

Robert Costanza: Writing – review & editing, Writing – original draft, Conceptualization.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Associate Editor, Ecosystem Services, RC If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

No data was used for the research described in the article.

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