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Short Communication

Has the value of global marine and coastal ecosystem services changed?

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ABSTRACT

In 1997, Robert Costanza and his colleagues published a groundbreaking study [1] that estimated the monetary value of the contribution of the world's ecosystems to human wellbeing. The methods used were cited as preliminary and received considerable criticism [2,3]. In two more recent peer-reviewed studies [4,5], the authors update the original estimates of ecosystem service value and find: (1) that original per area ecosystem service values were underestimated and (2) using these revised per area values, the total global value of ecosystem services has declined. Just under ninety-five percent of the estimated loss in ecosystem service value comes from revisions by the authors in the value estimates of marine ecosystem services. These revisions include additional per area value estimates of coral reefs and coastal wetlands that are many times the value of estimates used in the original analysis. The reasons cited by Costanza et al. for the increases in revised value estimates are examined and rejected. The data are found to be insufficient for a rigorous estimate of the global value of marine ecosystems services.

1. Introduction

In 1997, Robert Costanza and his colleagues published a groundbreaking study that estimated the monetary value of the contribution of the world's ecosystems to human wellbeing. While the publication was the subject of a lively debate with many critics emphasizing the limitations of such valuation exercises [2,3], there is no doubt the paper changed the way many viewed the value of ecosystem services to humanity. Because additional valuation data are available [5,6], Costanza et al. [4] set out to re-estimate the value of the Earth's ecosystem services, compare these with the earlier estimates and try to determine what this comparison says about how the value of Earth's natural capital has fared over time.

Using additional data to estimate the value of ecosystem services and changes in the aerial extent of specific ecosystems from 1997 and 2011, the authors find (i) that the 1997 assessment of the aggregate value of ecosystem services was substantially underestimated, by almost int$100 trillion; and (ii) that this corrected value decreased by int$20.2 trillion (14%) between 1997 and 2011, which the authors believe is a conservative estimate of the loss in global value of ecosystem services over that time. Much of the increase in the estimated baseline and decrease in the estimated global value of ecosystem services is due to new estimates by the authors for the value of global marine and coastal ecosystem services.

2. Calculation

In their more recent analyses, the authors estimate that the value of ecosystem services provided by marine and coastal ecosystems, including wetlands, (tidal marshes and mangroves)[1] were originally undervalued by int$62.3 trillion. In particular, the mean per hectare value of coral reefs and coastal wetlands in the revised analysis is dramatically larger than the original estimates of Costanza et al. [1]: it increased from int$8384/ha to int$352,249/ha for coral reefs, and from int$13,786/ha to int$193,843/ha for tidal marshes and mangroves. According to the new estimates, the revised mean per hectare values of these two biomes would be an order of magnitude larger than that of the next most valuable

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[1] While Costanza et al. (2012) place tidal marshes and mangroves under terrestrial resources, these ecosystems are inextricably linked to near-shore marine systems.

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biome; the revised per hectare value of coral reefs is 67 times larger than that of tropical rainforests. Based on these new values and the large proportionate loss of coral reef and coastal wetland area, the authors estimate that the global value of marine and coastal ecosystem services declined by int$19.1 trillion – accounting for approximately 95% of the estimated change in the value of global ecosystem services.

The authors acknowledge three reasons for why per hectare values may be larger between the estimates of 1997 and 2007/2011. First, the larger values could reflect improved accuracy in estimates of the total economic value (TEV) of ecosystem services[2] due to improved valuation methods and a better understanding of the multiple services provided by these ecosystems[3]. Second, the demand for certain services may also have changed (increased) leading to increases in unit values of these services. Third, the authors suggest that values may have changed due to a loss of functionality in ecosystems. The authors assume that most of the changes in estimated values per hectare are due to more numerous and accurate estimates of total ecosystem service value.

On closer inspection, however, the proposition that the comprehensiveness and magnitude of values has increased over time is not supported by the coral reef and coastal wetland data presented. For the new analysis, eleven key components of the estimate of TEV of coral reefs had already been measured by 1992; eight of thirteen components for coastal wetlands had been estimated by 1994. What has changed is that the authors have included additional value estimates, many that were estimated before 1997, that include more components of TEV[4] including some types of ecosystem service values that are mutually exclusive (e.g. raw materials extraction and food provisioning in coral reefs).

The data also do not seem to support the proposition that better valuation methods have led to higher per hectare estimates of the value of specific coral ecosystem services. An examination of per hectare values shows that for seven of the eight coral reef ecosystem service types for which there were three or more years of data, the trend in values was downward[5]. While the trends are mixed for coastal wetlands, the estimated value of waste treatment, which accounts for 84% of the revised value of coastal wetlands, showed a strong downward decline (int$640,099/ha in 1974 to int$6/ha in 1993 and int$2068/ha in 2003). Such a downward trend in welfare estimates is to be expected as more sophisticated methods do a better job of accounting for the ability of people to switch to substitute areas, ecosystem services, and built capital as natural capital is lost – a consideration not addressed by the authors.

While it is possible that coral reefs, tidal marshes, and mangroves are more valuable than other ecosystems, it is important to consider the source of the value estimates for the services they provide. The data used by de Groot and colleagues (2013), upon which the new estimates are based, show that the number and variability of estimates differ widely across the component values of the coral reef and coastal wetland biomes. Erosion prevention, which accounts for 44% of the new estimated per hectare value of coral reefs used by de Groot et al. and then Costanza et al., shows a mean revised value of int$153,880/ha with a relative standard deviation, RSD, of 1.40 and a range of int$1333/ha to int$306,427/ha. In addition, roughly 83% of the revised estimated value for coastal wetlands come from only four studies on water treatment which have a range from int$6 to int$640,099 per hectare (mean = int$162,000/ha, RSD = 1.97). The mean value for coral reef recreation and tourism, which is also large, is even more variable (mean = int$96,302/ha, RSD = 3.44).

Given this variability in estimates, the selection of the summary statistic used to extrapolate per hectare value estimates to entire biomes has significant consequences on total value estimates. Costanza et al. [4] chose to use mean, rather than median values. This, however, tends to inflate total value estimates. For example, in the authors' revised value estimates, the mean value of waste treatment by tidal marsh/mangrove is int$162,125/ha, while the median is int$4197/ha. If median value estimates, instead of mean, are used for only coastal wetlands and coral reefs, the estimated int$20.2 trillion loss in global ecosystem services would be reduced by nearly 60% to int$8.3 trillion. With so few estimates, the question here is which of the underlying set of estimates best represents the characteristics of the ecosystem service across the entire range of the biome. The authors argue that more recent estimates are more accurate, but this fact is not reflected in the choice of mean values in the analysis.

3. Conclusions

Studies that aggregate global ecosystem service values, like the ones undertaken by Costanza et al. [1] and de Groot [5] help us refine our understanding of the essential importance of natural capital, specifically ecosystems, to human wellbeing. Closer examination of the data compiled by the authors, however, shows that, to date, and despite the efforts devoted to the evaluation of the world's ecosystem services over the last three decades, these data generally are insufficient to do much more than raise awareness. In fact, the limitations of the results produced by this new study illustrate the enduring lack of accurate and comprehensive, global data for ecosystem services – especially for marine and coastal areas.

Have marine and coastal ecosystem services increased or declined in total value over the last thirty years? Some indications are that they may have declined. The authors rightly note the decline in coral reefs and coastal wetland areas. The effects of scarcity, a growing population and an associated growing global economy, may all have affected the per hectare ecosystem service values of coral reefs and coastal wetlands, possibly offsetting the loss in area.

It is clear that public awareness for the value of marine ecosystems has grown, including as a result of, inter alia, the awareness campaign initiated by the work of Costanza and his colleagues. However, according to this new study, until now, the most significant changes toward higher unit values in the new estimates provided by Costanza et al. [4] come either from previously ignored studies, or from the summation of values for non-compatible uses.

The vast spatial heterogeneity and variability in value estimates, the fact that many of the estimates are more than twenty years old, and the relatively small number of value estimates from too few places, make meaningful aggregation of marine ecosystem services at the global level imprudent and estimates of changes in value highly uncertain.

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[2] The authors write “we can attribute most of the increase in unit values to more comprehensive, value estimates available in 2011 than in 1997.” p155.

[3] The authors write “We also anticipate that more sophisticated techniques for estimating value will lead to larger estimates.” P 156.

[4] In some cases the authors include some components that arguably should not be summed as they are mutually exclusive (e.g. coral extraction and coral reef recreation are usually expected to be incompatible uses).

[5] The one exception, raw materials, showed the following pattern: 1992-int$9/ha, 1998-int$64,328/ha. 2005 int$245/ha.

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