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Ecosystem services value, research needs, and policy relevance: a commentary

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The purpose of this note is to provide constructive suggestions for future research on ecosystem services valuation following recent attempts by a multidisciplinary team to estimate service values on a global scale. The position adopted in this note is that while there are limits to the economic calculus, i.e. not everything is amenable to meaningful monetary valuation, economic valuation methods and techniques can and should play a significant role in the project, programme and policy appraisal process which leads to the setting of relative values (including environmental assets values). Costanza et al. (1997) estimated the current economic value of 17 ecosystem services on a biosphere-wide basis at between US \$16–54 trillion (10^{12})/year, giving an average annual value some 1.8 times the current global Gross National Product. The rationale behind this valuation exercise could be based on a number of arguments.

- Due to a lack of adequate market price data (or absence of data), together with inadequate (or absent) property rights regimes which ensure that resource values can be practicably appropriated, ecosystem services are assigned too little or zero value and weight in policy decisions.
- Some important environmental science research and debate, together with related policy making (i.e. international agreements and conventions) necessarily takes place at the global scale. There is a need therefore for social science research to 'engage' science and policy at this scale. But such an engagement must, in our view, encompass analysis which will show clearly why globally aggregated social science data/estimates are often not meaningful, if the objective is to move beyond mere dialogue towards a more rational policy process.
- It is important to prove how valuable ecosystem services really are and to formulate mechanisms by which such function-based values can be realistically captured. Such capture must be relevant for everyday socio-economic and political activity and decision taking, through national income/resource accounting and project cost–benefit appraisal, down to the grass roots level in developed and developing countries.

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It seems to us that the pioneering study of Costanza et al. (1997) goes some of the way towards meeting the arguments set out previously. Their paper has engaged environmental scientists and policy makers, but the global, biome scale economic value calculations risk ridicule from both scientists and economists. In our view, on the basis of the data and methods cited in the article and supporting inventory, the conclusion that the value of the biosphere services really is, on average US$33 trillion/year, is not supportable. Apart from raising policy maker, scientist and citizen awareness of the environment's economic value and the possible significance of the loss of that value over time, the global value calculations do not serve to advance meaningful policy debate in efficiency and equity terms, in practical conservation versus development contexts. Such calculations with their 'single number' outcomes shroud a number of fundamental 'scaling' problems to do with valuation contexts, i.e. the temporal, spatial and cultural specificity of economic value estimates.

The specificity problem (relative scarcity basis of value) is generic and serves to constrain the transfer of site-based function and/or system services economic values across time and geographical and cultural space. We are not arguing that all such 'benefits transfer' is invalid, but we do believe that such procedures must be handled with extreme caution and have real limits. Many value estimates will not be amenable to legitimate aggregation beyond local to 'regional' (defined biogeographically and including cross-national boundaries where necessary) scales. Further research to more precisely define these limits and to formulate a robust validity and reliability testing protocol is an urgent requirement.

At the core of the Costanza et al. (1997) valuation approach is a conceptual model which links ecosystem processes and functions with outputs of goods and services, which can then be assigned monetary economic values. In principle, both economic use and non-use value estimates can be derived from sustainable or 'healthy' ecosystems. We believe that this model does provide a sound basis for future multidisciplinary/interdisciplinary research on ecosystem services valuation expressed as ranges, not point estimates. But the function-based approach must be undertaken on the basis of procedural rules which ensure scientific and economic validity and reliability. Its validity is conditioned by the existence of full knowledge about the relevant ecosystem structure, as well as temporal and spatial scale effects. Thus the raw empirical data inventory on environmental values utilised by Costanza et al. (1997) is not amenable to simple translation and aggregation (Table 1).

The foundation of economic valuation based on a functional approach is a 'proper' appreciation of the links between ecosystem structure, the characteristics of which provide society directly with extractive and/or non-extractive benefits (goods and services) and ecosystem processes providing indirect benefits. This appreciation of the system's underlying dynamics is essential in order to sort out the stocks and flows involved and to ensure against possible double counting. Both stock and flow value estimates have, for example, been calculated and reported in forest services valuation studies, and researchers seeking to obtain aggregate figures have incorrectly summed both types of numbers. The often-quoted world median value for non-timber forest products (NTFPs) of US$50/ha per year is an example of such an error (Batagoda and Turner, 1997). There is a need therefore for researchers to carefully unpick the existing value data work, in order to separate out individual function stock and flow estimates. For NTFPs, four types of value exist, but only the last three are economic and policy-relevant: (i) the total inventory stock value; (ii) the total extractable stock value (based on some sustainability rule(s)), (iii) the potential extractable flow value (linked to physical accessibility factors and the non-uniformity of species distribution across a forest area); and (iv) the actual extracted flow value (conditioned by market accessibility, market demand and cultural value factors). It may then be legitimate to estimate a mean value for each of the last three value categories, as long as they are further 'regionally' differentiated across the major forest types, i.e. tropical rainforests, tropical dry forest, and temperate forests (Batagoda and Turner, 1997).

Table 1
Aggregation and scaling problems

Stage	Ecological systems perspectives	Economics perspective	Ethical perspective
I: Identification, estimation and aggregation of individual function service value estimates; and compilation of ecosystem values.	Systems behaviour is complex and characterised by interrelationships and feedback effects, not all of which are obviously related to human welfare concerns on the basis of existing science; total system value is > total economic value.	Stock and flow concepts need to be distinguished; not all value estimates are strictly welfare changes and are not additive; other double counting mistakes need to be avoided.	Non-anthropocentric intrinsic value in nature can exist and is not commensurate with the other value dimensions.
II: Individual function value estimates and/or ecosystem value estimates scaled up to global level.	Area basis of world's ecosystems not the appropriate unit, e.g. overlap of ecosystem classification.	Limits to scaling up (on a per hectare basis) in terms of temporal, spatial and cultural specificity of value estimates.	

Aggregation across different functions provided by a given ecosystem should be constrained by the danger of double counting. Exploitation of one function may preclude another, while some keystone processes and related functions may underpin others and the system infrastructure. There may also be possible incompatibilities between different valuation measures (such as opportunity costs, consumer surplus, market prices) as they are applied to different functions. Within a wetland, the exploitation of a particular function service such as wastewater cycling, for example, will preclude, or limit, the provision of other services, such as recreation. The global value of mangroves cited in Costanza et al. (1997) of $9990/ha, for example, is in fact made up of substitution cost estimates for the coastal protection function, replacement cost estimates for the nutrient cycling service, market price value of food production, and a travel cost estimate of the recreation service.

The issue of double counting and the extent of control necessary in economic valuation studies of complex ecosystems, to account for their characteristics and functional values, has been addressed in a recent meta-analysis of wetland valuation studies (Brouwer et al., 1997). In this study, a distinction is made between economic use and non-use values associated with the ecological, biogeochemical and hydrological functions provided by wetlands. The latter were shown to have a significant impact on stated preferences for a large number of wetland conservation projects or programmes in different countries. Average values were derived for different wetland functions after controlling for issues like population sample and procedural valuation characteristics.

Scaling up values of single functions of an ecosystem, or even more ambitiously, aggregate systems' value to biogeographical and global scales, on a per hectare basis, increases the difficulties by an order of magnitude. If a single ecosystem service, in economic welfare terms, is relatively independent of location and its socio-cultural context, then the scaling-up procedure can be regarded as more or less valid. Thus the economic value of carbon sequestration provided by coastal or terrestrial ecosystems has equal global social value (postponement of possible global climate change and its impacts) wherever it is provided. Or, in the case of coral reefs, the recreation value of reef visits and diving may be conditioned by a reasonably common set of site characteristics, regardless of precise location, and excluding totally inaccessible sites cases.

On the other hand, the value of many services is primarily determined by the locational factors. The recreational value of mangroves in the Costanza et al. study, for example, is based on a very small number of published studies (Hamilton and Snedaker, 1984). A study in Trinidad and Tobago, for example, used the zonal travel cost method to estimate the recreational use value of Caroni swamp (Rambial, 1980). This site is of national significance as the only nesting site for the national emblem bird, the scarlet ibis. The large visitation rate at this site can be explained by this symbolic significance value and by its proximity to Port of Spain, the island's largest population centre and magnet for cruise-ship visitors. Clearly, similar site and demand characteristics are not present in all other mangrove forest locations and therefore scaling up site value is very problematic. Although some criteria for 'benefits transfer' have been discussed in the literature, a comprehensive testing protocol is not in prospect (Brouwer and Spaninks, 1997). More research is required on these scaling possibilities and limits. Our intuition is that the biogeographical regional scale will be the limit for a large number of service values.

Finally, from a systems perspective, the aggregation and scaling up of individual ecosystem services value estimates does not lead to the quantification of a total ecosystem value. An evolving 'healthy' ecosystem presumably requires some, currently unknown, minimum configuration of structure, processes and functions to retain its resilience property. Economic valuation studies estimate the value of the flow of services assuming the sustainability of ecosystems and their interrelationships between themselves and the abiotic environment. The policy implications are that there is a role for the precautionary principle and the 'safe minimum standards' notion (combined with social opportunity cost assessments). Mean-while, science works to reduce some aspects of the uncertainty, e.g. is it species preservation, or populations, or something else, that should be the basis for conservation policy? (Hughes et al., 1997; Myers, 1997; Nee and May, 1997). Social scientists are also still required to provide valuation data in order to make more transparent the choices involved in socio-economic terms. Such choices are made in a number of institutional settings and at and across various levels. Biodiversity conservation policy will be determined just as much by socio-economic gains and losses and their distribution across humans, as by concerns about the loss of evolutionary history per se.

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