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SPECIAL SECTION: FORUM ON VALUATION OF ECOSYSTEMS SERVICES

The concept of environmental function and its valuation

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1. Functions and their valuation

The concept of environmental function and its economic valuation methodology was introduced by Hueting (1970, 1974a,b) and supplemented and summarized in numerous articles, e.g. Hueting (1975, 1989, 1992), Hueting et al. (1992, 1995). They are summarized below, briefly and incompletely.

Environmental functions are defined as possible uses of the natural, biophysical surroundings that are useful for humans. Uses can be either passive or direct and practical. The ‘services’ of environmental functions are defined as their possibilities or potential to be used by humans for whatever end. Some functions can be conceived as consumption goods, others as capital goods.

‘Producing’ is defined, in conformity with standard economics, as ‘adding value’ (by transforming one ‘good’ into another to satisfy wants). Value is added by labor. Environmental functions do not produce in the economic sense of the concept, nor are they produced. Economically speaking, a fish in the water is not the same good as a fish caught. The difference is brought about by the value added by labor.

Because we ultimately depend on labor and environmental functions, we stand literally empty handed if we destroy vital functions, unless we find substitutes (e.g. solar for fossil fuels). Most functions of natural ecosystems cannot be substituted.

As soon as the use of a function is at the expense of another (or the same) function, or threatens to be so in the future, there is competition of functions. Competing functions are economic goods, because they fully meet the definition of scarcity. Functions have been changed from free goods with an economic value of zero into scarce goods with an ever higher positive value. This increase in value is basically an increase in scarcity (costs).

For the valuation of functions, the construction of both a supply and a demand curve is indispensable. If there are no opportunity costs or no

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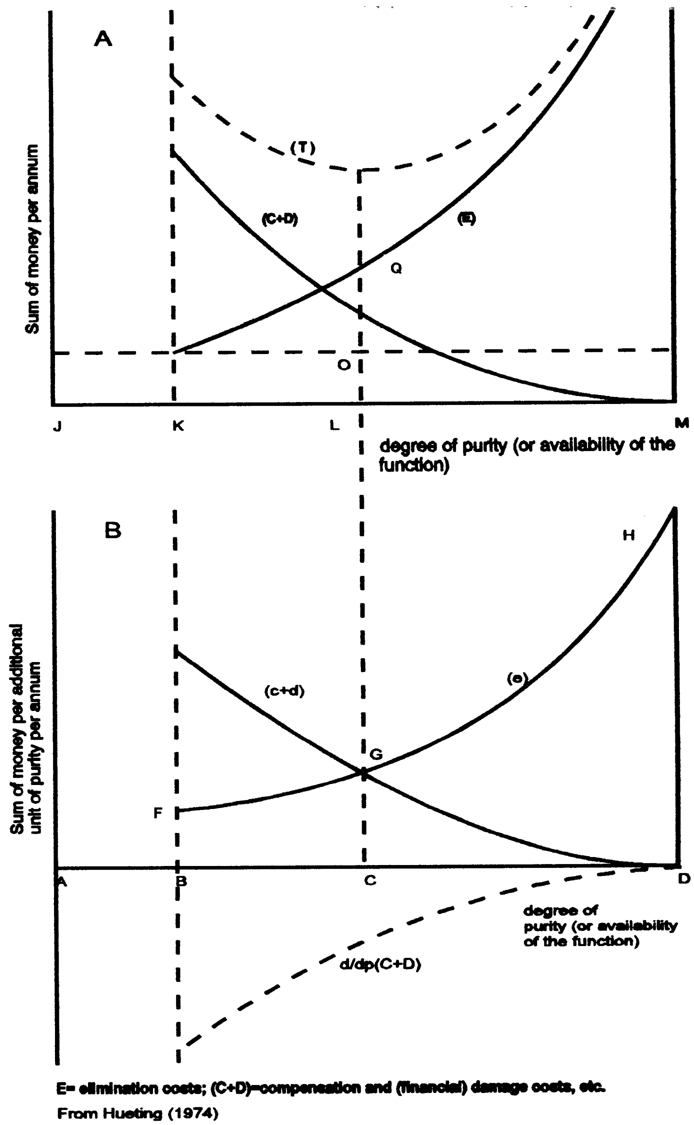
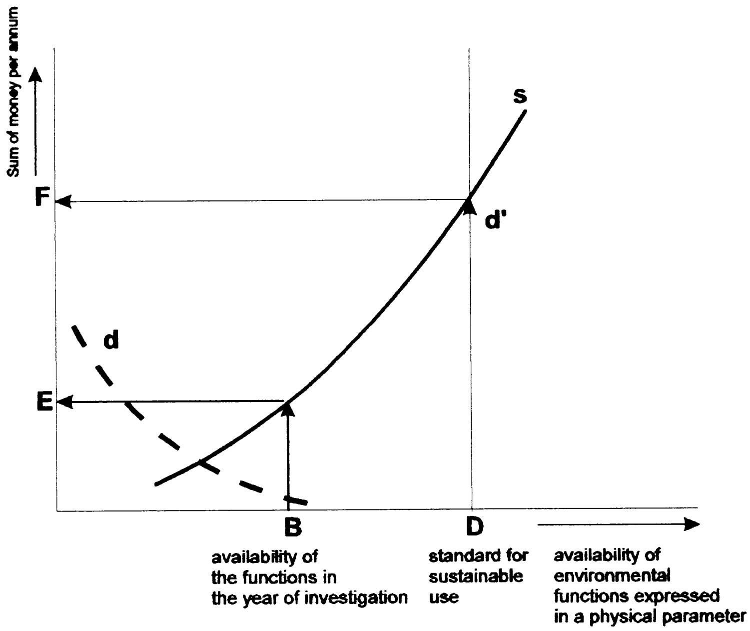


Fig. 1. Costs of elimination and revealed preferences for an environmental function; (A) total curves, (B) marginal curves.

preferences, the economic value of a good equals zero. Supply curves reflect the costs of all kinds of measures needed to restore and conserve functions: opportunity costs. They can always be constructed, except for irreversible actual losses. Demand curves can only very partially be constructed with the aid of data on expenditures on compensatory measures that replace a function, on financial damage etc. (revealed preferences) and willingness-to-pay techniques (see Fig. 1).

Consequently, for finding shadow prices for functions, it is necessary to make assumptions about (individual and social) preferences, in CBA's and green accounting. Thus the assumption that we want to use vital functions sustainably can yield Sustainable National Income (with the aid of a comparative-static model) (see Fig. 2).



S = supply curve or elimination costs curve
d = incomplete demand curve based on individual preferences (revealed from expenditures on compensation of functions etc.)
d' = demand curve based on assumed preferences for sustainability
BD = distance that must be bridged in order to arrive at sustainable use of environmental functions
EF = costs of the loss functions, expessed in money
The arrows indicate the way via which the loss of environmental functions recorded in physical units is translated into monetary units

Fig. 2. Translation of costs in physical units into costs in monetary units; total curves.

2. Some comments on the *Nature* article

On the face of it, it looks as if the authors of the *Nature* article used supply and demand curve analyses for their estimates, in line with Section 1. But the supply curve in Fig. 1B is not a supply curve and it is not clear what the Fig. 1A supply curve represents. Also their demand curve is probably not appropriate in either figure.

Fig. 1B supply curve is almost perpendicular to the abscissa, thus intersecting it. This means that the services of the function (see Section 1) can be supplied without costs up to the perpendicular. This conflicts with economic theory and environmental fact.

It conflicts with economic theory because, as Fig. 1B shows, the authors are valuing free goods with a value above zero, which is by definition impossible: opportunity costs cannot overlap the abscissa (see Section 1).

Fig. 1B conflicts with fact because nowhere on our planet is there any place where ecosystem services (see Section 1) are not threatened. Both actual and anticipated use involve opportunity costs (forgone alternatives). The availability of environmental functions depends on biophysical processes: life support systems. These systems are today being disturbed to such a degree that the availability of vital functions is jeopardized worldwide, risking the possibilities of future generations to fulfill their needs. Research shows that the opportunity costs of restoring and safeguarding those systems and functions are very high indeed. A rough estimate by Tinbergen and Hueting (1991) arrives at 50% of World Income.

Such opportunity costs are not reflected on the curve in Fig. 1B. Therefore this curve cannot be a supply curve in the economic sense and cannot be used for economic valuation of environmental functions. Fig. 1B tells us only that the price of each quantity of function greater than indicated by the perpendicular would approach infinite: the (near) perpendicular does not supply a function or its services. Their text (page 257, first column), states: "…to the extent that ecosystems cannot be increased or decreased by actions of the economic system, their supply curves are more nearly vertical…". We agree that ecosystems, as a result of millions of years of evolution, cannot be increased by human action. But they certainly can be—and are—decreased by human production and consumption.

As stated before, ecosystems can be maintained and restored by human actions, if no irreversible losses have been caused: by doing certain things and refraining from others. It looks as if the authors realize that irreplaceable functions cannot be supplied. However, it is possible to formulate measures (what has to be done and what has to be refrained from) in order to safeguard irreplaceable ecosystems and to estimate opportunity costs. This yields an elimination cost or supply curve as described in Section 1: the less risks one wishes to take, the higher the costs.

The authors write that the demand curve is mainly derived from willingness-to-pay inquiries. We agree with the drawbacks mentioned: lack of information about the significance of ecosystems leading to underestimates. Other drawbacks to this technique make it questionable whether this approach can yield reliable figures for vital global functions (Hueting, 1989, 1992).

Quite apart from this, we question the way in which the authors seem to use this approach. For example, p. 255 reads: "…if ecological services provided a $50 increment to the timber productivity, the beneficiaries of this service should be willing to pay up to $50 for it…". We understand that this means that if, for example, a hectare of forest has a yearly increment in cubic meters of wood that would yield $50 on the market, the beneficiaries should be willing to pay $50 for this service. So the yearly services of an ecosystem are basically valued by their potential market revenues. Valuing environmental functions by their potential market revenues is also used elsewhere (De Groot, 1992).

However, market prices reflect the sum of the values added involved in harvesting the services of the function, such as wood, and not the costs of maintaining the environmental service function up to a desired degree (see Section 1). Value added by labor and the value of functions are completely different. Consequently the authors demand curve cannot be a demand curve for functions. Ecosystem functions are not valued at all.

For vital functions of ecosystems, valuation is based on an alleged producer surplus, as shown in Fig. 1B. However, as stated above, the Fig. 1B 'supply curve' cannot be a supply curve in the economic sense. This makes any comparison with a producer surplus on a market impossible. There cannot be a producer surplus without opportunity costs, that is: without producers.

For other functions the economic value is said to equal the sum of producer and consumer surplus (excluding the cost of production: p. 257, column 1). A consumer surplus is the amount of money people are willing to pay beyond the price of a good. It is the difference between the total utility of a good and the product of quantity and price (as the criterion of marginal utility). There are several objections to using this concept as a basis for valuing functions, especially on a world scale.

First, at the macro level, a consumer surplus has little or no significance because all available production factors have been used on that level. People might be willing to pay more for the total amount of goods (including environmental functions) available, but they are unable to do so.

Second, unavoidable choices are almost always between quality and quantity (availability) of functions and goods produced. The intra-marginal utility of goods produced also approaches infinity, just like that of functions. After all, it includes the utility of medical care that saves the life of a child; the first slice of bread; and the first sip of water. A sincere comparison should either include or exclude consumer surplus with both categories of goods (this is one of the four reasons why the comparison with GNP on p. 259 is incorrect).

Third, consumer surpluses are very difficult to measure, if at all.

It follows from the above that the total economic value of functions does not equal the sum of producer and consumer surplus. Total utility also includes the surface cqb in Fig. 1A. It also follows that any practical economic analysis, (e.g. cost-benefit, or green national accounting) should use either price times quantity as the value of functions or, according to some authors (e.g. R. Hueting) surface cqb (cf Fig. 2).

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