Valuation techniques applied to tropical forest environmental services: rationale, methods and outcomes

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Introduction

Few ecosystems can support such diverse human activities and provide as many services as tropical forests. The activities of forest users are situated at various levels and have different motives: from the villager who sees the forest as a source of natural products to the government that wants to preserve biodiversity, from the logging company that considers it as a stock of timber resources to the Global Environment Facility which sees an opportunity to store carbon, the tropical forest is quintessentially a multi-use and multi-user environment. The aim of sustainable forest management is to coordinate these diverse activities in order to bring out their complementarities, while at the same time maintaining the quality of the ecosystem. To accomplish this, it is necessary to seek operating principles that can guide policy making.

Probably because of the perceived urgency of combating deforestation in tropical regions, approaches stemming from the natural sciences have played a predominant role in determining strategies for the conservation and utilisation of forests. Until the early 1980s, this debate was dominated by conservationists, who recommended ecological management of forest environments. In this approach, ecological criteria are used to designate the natural areas to be protected, and these areas are then given full protection, with human communities being relegated to the surrounding areas and their rights of use restricted. Such approaches are now known to have failed (Cernea, 1986; Weber, 1996).

The emergence and establishment of environmental economics in the 1970s helped to define a new approach to managing natural environments, in which economic criteria were taken into account along with ecological criteria. In fact, the former soon became a major factor in collective decision-making: thus, the model shifts from ecological management of nature to economic management. A brief description of this management mode by Godard (1992) points to three distinguishing features:

- nature is represented as a scarce resource for which a social demand exists;
- the issue for collective action is to develop forest resources and manage them efficiently;
- the policy instruments used are economic mechanisms, incentives and contracts.

This new economic argument is increasingly influential with regard to decision making on tropical forest management. This approach was quickly taken up by environmentalists and by the main international donors, who see it as providing objective justification for their resource conservation projects in tropical countries.

The reasoning and assumptions behind economic management of tropical forests

The aim of economic analysis is to ensure optimal use of the resources available to society, i.e. to allocate these resources where they will be best used and will maximise social well-being. To this end, cost-benefit analysis is currently the decision support tool most widely employed by policy makers, who use to measure economic efficiency in resource utilisation (Hanley & Spash, 1993; Brent, 2006). The central purpose of such analysis is to help decision-makers select the projects and strategies that use resources most efficiently. The most commonly used criterion is that of net present value (NPV), which is formulated as follows (in discrete time):

$$NPV = \sum_{t=1}^{T} BD_t - CD_t \;/\; (1+r)^t$$

where BD_t and CD_t represent respectively the direct benefits and costs of the project for periods t from 1 to T (the term of the project) and r is the discount rate.

The main advantage of cost-benefit analysis is that it places costs and benefits on a common conceptual basis, reducing them to comparable monetary quantities. This approach is not easily applied in the case of natural assets, however, because many goods and services flowing from the environment are used by human beings in a way that cannot be likened to market consumption. No prices are established for these natural goods. Thus, if such natural resources are to be properly taken into account and allocated in optimal fashion, an economic valuation of these resources must be performed.

Economic valuation of goods and services flowing from the natural environment is based on a body of theory built up over the last twenty-odd years, particularly in the British and US literature. Two strands of research have been developed:

- The first endeavours to identify and formalise the various economic benefits expected from the environment (Munasinghe, 1992). Aggregating these benefits gives the "total economic value" of a given natural asset. This value represents the change in the well-being of economic agents if this good were to disappear, and it is generally broken down as shown in Figure 1:

Figure 1: Breakdown of total economic value

TOTAL ECONOMIC VALUE

Use values			**Non-use values**	
Direct use values	Indirect use values	Option values	Bequest values	Existence values
Value of goods or services having direct utility (consumption or production)	Value of goods or services having indirect utility	Value of future use (direct and indirect) or future non-use	Value reflecting the wish to allow descendants to benefit from use and non-use values	Value attached to the fact that a given good exists

- The other strand of research focuses on techniques for assessing the monetary value of these benefits. Generally accepted practice is to distinguish between valuation methods based on observation of preferences as revealed in a real market, preferences revealed in a fictitious market and preferences expressed indirectly (Faucheux & Noël, 1995). These environmental valuation techniques have been used in Western countries since the 1970s, but in developing countries they have come into play only in the last few years (Pearce *et al.*, 2004).

Overview of economic valuation techniques

Tropical forests provide many goods and services whose value we wish to estimate in order to know what forests contribute to human welfare. These economic benefits will be valued in one of three ways, depending on whether the good is available on a competitive market:

- In the ideal case, the environmental good is offered on a market characterised by perfect competition. The price formed on this market is considered to be equal to the economic value of the good. This is the case, for example, of tropical timber sold on the international market.
- More often, a natural asset is available on a market not fully subject to the rules of competition. In this case, the market price is merely a piece of financial information and is not equal to the economic value of the good. A number of adjustments have to made to the market price to obtain the correct value ("shadow price") of the environmental good (Garrabé, 1994). The economic value of the environmental good is thus derived from an adjusted market price.
- Lastly, most natural assets have no specific market price that can be used as a basis for estimating their economic value. In this case, one or more monetary valuation techniques must be employed.

Generally speaking, these methods of economic valuation of the environment fall into two categories (OECD, 2002; Faucheux & Noël, 1995):
- Direct valuation of a natural asset means that its value is estimated on the basis of economic agents' preferences, as expressed on the market in the form of a demand curve. These methods are thus based on observation of the behaviour of agents in real or hypothetical markets.
- Indirect valuation, instead of seeking to reconstruct the demand curve of the good, tries to give a monetary value to a physical consequence (positive or negative) of environmental change by making use of existing estimations, which are often in macroeconomic terms. These valuations thus do not reflect the preferences of economic agents and cannot provide the theoretically exact economic value of the natural asset.

These two broad categories may also be divided into sub-groups, which are presented in Table 1 and briefly described just below.

Table 1: Methods of monetary valuation of the environment

Direct valuation			Indirect valuation
revealed preferences		stated preferences	no preference
on real market	on substitute market	on fictitious market	
- change in productivity - expenditure on protection - substitutable goods	- hedonistic prices - transport costs	contingent valuation method	- dose-effect method - replacement costs

- **Economic valuation by means of revealed preferences**: when the preferences of individuals are expressed on the basis of observed market data, we speak of *revealed preferences*, drawing a distinction between information available on a real market and that taken from a substitute market.

Preferences concerning an environmental good are revealed on a real market when the price of a marketed good depends directly on the condition of the natural environment. Three techniques may be used to estimate the value of such benefits:

Change in productivity: the economic value of the environment may be assessed through its impact on output of market goods and services. The projected variation in output of a marketed good as a result of environmental degradation can be used to establish a minimum monetary value for the natural asset when it is conserved. This valuation technique is often used for rural areas of developing countries, in particular to put a monetary value on the effects of a change in soil use. Bojö (1991), for example, uses this technique to assess the social utility of a Farm Improvement with Soil Conservation programme in Lesotho. Bojö estimates the ecological value of the preserved natural environment on the basis of the soil degradation expected in the absence of this project (a decline of 1% per year), of the resulting decline in farm productivity (annual decline of 7 kg of maize and 8 kg of sorghum per hectare) and of the probable future trend in the prices of these two products (+2% a year for maize, -2% a year for sorghum). These market data make it possible to give a minimum estimate of the value of the ecological function.

Expenditure on protection: the economic value of natural assets can be assessed by estimating the real expenditure on forest protection that economic agents are willing to incur to prevent degradation of the

environment. Based on real household spending, it is possible to construct a demand curve for protection against these negative impacts, by relating the amount of protection desired to the price of that amount of protection.
Substitutable goods: if two goods with equivalent uses have similar exchange values, then the economic value of a non-market natural asset used for a given purpose may be estimated from the prices of marketed goods that provide the same service. For example, the price of "modern" drugs may be so used to assign an economic value to traditional medicines that procure the same curative effect.

Preferences are revealed on a substitute market when the price of a marketed good is influenced by the presence of a non-market environmental good or service but no direct relationship can be established. The prices of these market goods can then be broken down to obtain the implicit value of the environmental assets incorporated in these goods. On the property market, for example, home prices depend partly on the quality of their surroundings (the *hedonistic prices* method). Similarly, the time and money spent by individuals to visit a national park or a spring of clean water can reflect the economic value they place on this natural asset (the *transport costs* method).

- **Economic valuation via the stated preferences** of a consumer on the fictitious market for an environmental good. This *contingent valuation* method involves three stages:

- a phase devoted to preparing the survey, in which the aim is to construct a fictitious market in which individuals will be able to respond as realistically as possible: the surveys must be able to make their responses to the hypothetical scenario an accurate imitation of their behaviour on real markets.
- a phase of individual interviews in which individuals are invited, via a questionnaire, to give accurate indications of their preferences for the good offered on the hypothetical market. To accomplish this, the indicator of preferences (willingness to receive or to pay) and payment method proposed to interviewees must be realistic and consistent with the hypothetical scenario.
- a data processing phase in which the demand curve for the environmental good is estimated on the basis of the willingness expressed. Calculating average willingness to pay requires statistical analysis in order to reject aberrant responses or to distinguish "true" from "false" responses of zero willingness. A second reason for performing statistical analysis of responses is to check on whether the stated willingness to pay for the natural asset is consistent with the socio-economic characteristics of the individuals surveyed.

- **Indirect valuation** (no preference):

The *dose-effect method* assigns a monetary value to qualitative/quantitative change in the environment by observing the physical consequences of such change. The approach is identical to that used for the change in productivity method, except that in this case the degradation of the environment does not directly modify households' production function: it has an overall physical impact that is valued by using monetary data that are not connected to statements of individual preferences. This indirect valuation method offers two advantages. First, it is relatively easy to use, since if the monetary data are available, it requires only correct quantification of the dose-effect relationship. Second, it is particularly suitable considering that the population is not aware of the effects of environmental degradation.
Replacement costs: it is also possible to estimate the value of a natural asset based on what it would cost to replace its productive functions through artificial capital. In contrast to environmental valuation performed by estimating *real* expenditure on protection, this method of valuing environmental benefits seeks to estimate the *potential* expenditure that would have to be incurred to counteract the degradation of the environment.

Growing scope of application

Economic valuation of the environment is being used increasingly by international donors as part of their projects. In 2003, for example, the World Bank had more than a hundred environmental economic valuations carried out, one-third of which concerned the "Agriculture, fishery and forestry" sector (Silva & Pagiola, 2003) (see Table 2).

Table 2: World Bank projects subject to environmental economic valuation

	Sub-Saharan Africa	East Asia and Pacific	Europe & Central Asia	Latin America & Caribbean	Middle East & North Africa	South Asia	**TOTAL**
Energy	*2*	6	10	1	0	6	**25**
Transportation	*5*	5	0	3	0	3	**16**
Agriculture, fishery and forestry	*4*	*4*	*7*	*8*	*4*	*5*	***32***
Water and flood protection	*6*	8	6	7	5	3	**35**
TOTAL	***17***	**23**	**23**	**19**	**9**	**17**	**108**

Although there are many handbooks on such valuation methods, they are not yet really oriented towards the developing countries. There are, however, a substantial number of case studies, some more elaborate than others, that give us a range of estimates for the main goods and services provided by tropical forests, either in general (Pearce & Pearce, 2001), or specific to Cameroon (Ruitenbeek, 1990; Lescuyer, 2000; Yaron, 2001) (Table 3).

Table 3: Economic values of tropical forests

Forest Good or Service (in discounted US$/ha or *in US$/ha/yr*)	**General**	**Estimates in Cameroon**
Timber	200 - 4,400	560
Fuelwood	*40*	61
NTFPs	*0 - 100*	41 - 70
Genetic resources	*0 - 3,000*	7
Recreation	*2 - 470*	19
Watershed benefits	*15 - 850*	54 - 270
Climate benefits	360 - 2,200	842 - 2,265
Option values	*2 -12*	3
Non-use values	*4,400*	19 - 32

Although timber remains an important economic resource, it can be seen that certain ecological functions provided by the forest also make non-negligible contributions to human well-being and should be given more consideration in forest policies.

Practical difficulties of economic valuation of forests

In theory, these valuation methods can be applied to biodiversity in order to calculate its total economic value, i.e. its contribution to human well-being. In practice, however, this exhaustive approach faces many obstacles, which explains why so few studies try to estimate the total economic value of an ecosystem or any other aspect of biodiversity (Lescuyer, 2000). Thus, although the concept of total economic value seems valid theoretically, in the real world it provides only partial and often subjective information on the benefits that can be expected from use of biodiversity.

Four reasons are generally advanced to explain why this valuation exercise is so difficult:
- The total economic value of an ecosystem can be estimated directly only by using the contingent valuation method, and this technique is difficult to apply in contexts having a low level of monetisation (Lescuyer, 1998).
- Monetary quantification of natural assets is a tricky matter because we have only partial knowledge of how ecosystems work.
- It is very frequently observed that the assumptions used to estimate economic values are deliberately conservative: given the uncertainty of the valuation procedure, the analyst generally opts for a low estimate of the benefits derived from the environment. This choice indicates how much latitude the analyst has in producing the estimate.
- The literature shows that, in practice, estimates of total economic value result not from aggregating all the benefits drawn from the ecosystem concerned, but from aggregating only certain values that the analyst was able to quantify in monetary terms (Lampietti & Dixon, 1995; Nunes & van den Bergh, 2001). The concept of total economic value thus corresponds to the sum of a few economic values selected subjectively by the analyst, rather than to the sum of all the values that actually constitute total value.

These practical difficulties do not, however, negate the legitimacy of economic valuation of tropical forests. Although estimating total economic value is indeed an ideal objective, monetary valuation of certain benefits of biodiversity often provides important information for users and/or managers of these resources.

Beyond economic valuation: shifting the focus from values to real benefits

Calculation of the total economic value of an ecosystem, and indeed the benefits expected from various scenarios of management of an ecosystem, can help to determine which utilisation of these resources is economically optimal. By this we mean the scenario offering the greatest net benefits (benefits less costs) to society as a whole, which is thus the optimal scenario for allocation of the scarce resources at the disposal of the society. However, a number of these benefits defy quantification, as they are not used in transactions between economic agents. For example, carbon storage in forests is an important benefit that depends on forest conservation, but no instrument yet exists to remunerate those who preserve this ecological function. In fact, such agents provide a service to the international community for which they are not compensated.

Various instruments and approaches are being proposed to remunerate these “providers” of non-market goods and services derived from tropical forests, regardless of whether they provide physical goods or environmental services (Richards, 2000; Pagiola *et al*., 2002; Khare & White, 2003):
- direct public payments to private owners of stocked forest land or forests in exchange for the services they render;
- issuance of tradable certificates of ownership of these environmental goods and services, modelled after the European market in CO_2 emission certificates;
- private contracts between demanders and suppliers of these goods and services, for example between communities and pharmaceutical companies;
- eco-labelling of certain marketed goods indicating that they are products of sustainable forest management.

Many such approaches to give concrete expression to goods and services related to sustainable management of tropical forests are emerging A few years ago, Landell-Mill & Porras (2002) counted some 300 case studies, most of them having to do with carbon, biodiversity, watershed areas and landscape. These tools are still little used in Central and West Africa, for a number of reasons (Lescuyer, 2005). These issues will undoubtedly lie at the heart of future debates over not only sustainable and multi-resource management of tropical forests but also the combat against rural poverty.

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