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The Economic Value of Ecosystems: 1 – Tropical Wetlands

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LONDON ENVIRONMENTAL ECONOMICS CENTRE

GATEKEEPER SERIES

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THE ECONOMIC VALUE OF ECOSYSTEMS:

1 - TROPICAL WETLANDS[1]

Introduction: Valuing Tropical Versus Temperate Wetlands

The core of any economic evaluation - or assessment - of a natural resource system is the actual valuation - or the quantification and valuing - of the resources, services and attributes of the system. The economic techniques and methods of valuing natural systems such as wetlands rely on the collection and analysis of extensive ecological, hydrological and economic data. This often takes time, which may not be possible given the vast numbers of wetland areas - especially in tropical zones- that are currently being converted or more intensively exploited. In addition, many developing countries face severe resource constraints on research. What is often required, therefore, is a rapid assessment of essential wetland values while minimizing the inevitable trade-offs in terms of accuracy that a more elaborate and extensive analysis might provide.

To a large extent, any economic analysis of tropical wetlands can benefit from the extensive literature on valuing temperate wetlands. One important prerequisite is to come to grips with the different economic and ecological terminology. Wetlands have natural functions (water purification, storm surge protection, flood control, etc.) and economic uses (recreation, resource harvesting, etc.). Both functions and uses have economic values. For both temperate and tropical wetlands the purpose of an economic analysis is to make these values explicit. It is therefore helpful to distinguish between:

i. direct use values (e.g., the values derived from the economic uses made of a wetland's resources and services);

ii. indirect use values (the indirect support and protection provided to economic activity and property by the wetland's natural functions, or `environmental services'); and

iii. non-use/ preservation values (the values dervied neither from current direct or indirect use of the wetland).

However, the use and non-use values of temperate wetlands - which are largely in developed countries - may differ significantly from those of tropical wetlands - which occur mainly in the developing world. For example, many tropical wetlands are being

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[1] This paper is based on a report prepared for Centro Agronomico Tropical de Investigacion Y Ensenanza (CATIE) and the Regional Wetlands Programme of the International Union for Conservation of Natural Resources and Nature (IUCN). See Edward B. Barbier, Economic Evaluation of Tropical Wetland Resources: Applications in Central America, London Environmental Economics Centre, 1989.

directly exploited, often through non-market, 'informal' economic activity, to support human livelihoods, e.g., through fishing, hunting, fuelwood extraction, and so on, whereas recreation/tourist use may often be limited. In contrast, direct exploitation to support livelihoods - except perhaps commercial fishing in some areas - may be small for most temperate wetlands, but their recreational value is often significant. Thus the more sophisticated valuation techniques now being developed with regard to temperate wetlands to assess individuals' willingness to pay for services, such as contingent valuation, bidding games and travel-cost methods, may be currently less relevant to tropical wetland valuation.

Characterizing the Wetland Area

No satisfactory general definition of 'wetlands' exists. In addition, coastal wetland areas interact differently with the surrounding environment than do inland areas. And, as unique ecosystems, there is a practical problem of no two wetland areas ever displaying the same characteristics. The first task must therefore be to agree on how to delineate the wetland system from its surrounding environment.

This task is crucial for establishing the system boundary of the project area. Resources and activities occurring within this boundary can therefore be identified as 'internal' to the system, whereas those occurring outside should be considered 'external'. Establishing the system boundary is important in determining the identification, ranking and evaluation of wetland functions, attributes and components.

Identifying and Ranking Wetland Characteristics

In ecology, a distinction is usually made between the ecological functions of an ecosystem (e.g., nutrient cycles, micro-climatic functions, energy flows, etc.) and its structural components (e.g., biomass, abiotic matter, species of flora and fauna, etc.). This distinction is useful from an economic perspective, as it corresponds to the standard categories of resource stocks (i.e., the structural components) versus environmental flows or services (i.e., the ecological functions). In addition, ecosystems as a whole often have certain attributes (biological diversity, cultural uniqueness/heritage) that have economic value either because they induce certain economic uses or because they are valued in themselves.

Thus the resource stocks of a wetland ecosystem - fish, woody biomass, animals, food and fiber production - are usually harvested to serve directly human needs. This direct use of the wetland's structural components is different from the more indirect use made of its environmental functions. The latter usually assist or support economic activity, such as agricultural production, maintenance of water quality, fishing and so forth, in the wetlands or neighboring areas. The special attributes of

a wetland - its biological diversity and its importance to culture/heritage - are not necessarily directly or indirectly 'used' but nevertheless are seen to have a value in themselves, which arises through maintaining the wetland 'intact' or 'preserved'.

The first task is therefore to identity the resources provided and the functions performed by the wetland ecosystem, as well as noting any special attributes. For example, the far left columns in Tables 1 and 2 indicate the different characteristics of the Petexbatun Wetlands in Peten, Guatemala and the North Pacific Coastal mangroves in Nicaragua.

Relating Characteristics to Use

The next step is determining whether the economic value of each structural component, attribute and function is obtained through direct use, indirect use, or in some cases, through no physical use or interaction with the wetland area at all. It is therefore helpful to think of three categories of values in classifying wetland functions and components: direct use values, indirect use values and non-use/preservation values. A common misconception that must be avoided is that a direct economic use of a wetland, such as fuelwood harvesting, is more valuable than a natural wetland function, such as storm protection, the value of which is derived from its indirect support or protection of economic activity and property. The latter, indirect use value may be difficult to estimate, but it may prove to be more valuable over the long run than fuelwood harvesting.

In general, the values gained from virtually all the structural components, or resource stocks, of a wetland will be derived from the direct use, or harvesting, of these resources (see Tables 1 and 2). For example, grazing of pasture land, fuelwood collection, food cropping on flood plains and fishing are all direct uses of wetland ecosystem resources. Recreation and navigation are special cases of non-ecological functions, or services, performed by wetland systems that also involve direct use values. Recreation and tourism requires visiting and using wetland sites for various leisure activities, and navigation involves the direct use of wetland waterways. The biological diversity of the ecosystem as a whole might also have direct use value for scientific research, education and as a source of genetic material.

All the ecological functions of wetlands appear to have indirect use values. That is, their values derive from supporting economic activities that have directly measurable values. For example, flood flow control by wetland systems may protect agricultural production, infrastructure, properties, land values and even human lives downstream. Groundwater recharge might replenish aquifer supplies that are used for domestic, agricultural and industrial purposes. And sediment retention might prevent siltation of irrigation networks downstream and at the same time replenish the fertility of agricultural flood

plains within the wetlands area. The special attribute of biological diversity might also have an indirect use value in assisting the stability of the entire ecosystem and thus its functions and resources.

Some individuals might derive values from wetland ecosystems without even benefiting either directly or even indirectly from their services and components, or alternatively, might derive values in addition to those derived either directly or indirectly from their current use of wetlands. The former values will be termed non-use values; the latter preservation values. For example, some people may derive satisfaction just from knowing that certain wetland systems exist and will be preserved; hence, the systems are said to have existence value for these individuals. Similarly, some individuals may have no intention of using wetlands, but value the fact that future generations, including perhaps their progeny, have the opportunity to use them. This is the bequest value attached to preserving ecosystems. This bequest motive may also be an additional value that people who benefit directly or indirectly from wetlands hold, for instance, if they feel that future generations ought to be able to use and enjoy the same level of functions and resources that they have had access to during their lifetime. Finally, if society is risk averse, if the future value of some of the functions and resources of wetland areas are unknown and if development involves irreversible loss of wetland resources and functions, then individuals may place an additional 'premium' on the option of preserving wetlands. This option value can be seen as extra insurance today against the risk of losing wetland services and resources that might prove valuable in the future.

These preservation and non-use values are difficult to ascribe to any one particular component or function of a wetland but rather tend to be associated with the wetland as a whole or any special attributes that are attributed to the wetland as an integral whole. Thus the biological diversity of the ecosystem and any uniqueness to culture and heritage it has may contribute to the existence, bequest and option values that individuals attach to preservation. In temperate zones, preservation values, particularly option and bequest values, might also be strongly associated with the recreation use of wetland systems, but these values might be less strong in tropical wetlands which are primarily located in developing countries.

Valuing Wetland Characteristics

Many sophisticated techniques, such as contingent valuation, hedonic pricing, simulation/econometric modelling, and so forth, are now being used in advanced industrialized countries to value various benefits of temperate wetlands. While the application of these techniques to tropical wetlands in developing countries should be encouraged where appropriate, in many instances the financial and time constraints under which an economic evaluation of wetland conservation must be conducted in developing countries limits the feasibility of sophisticated valuation approaches.

Figure 1 shows the general approaches for valuing wetland benefits. Some of these approaches, such as alternative/substitute (replacement) costs, relocation costs, indirect opportunity cost approaches and indirect substitute approaches, are second-best, but may have to be used if other approaches cannot be applied. Table 3 indicates which of the methods in Figure 1 are probably most applicable to the essential components, functions and attributes of tropical wetland systems. The general approach is facilitated by separating the characteristics by direct use, indirect use and non-use/preservation values. In each case, the most appropriate valuation method in a developing country context is suggested.

In short, the objective of valuing the direct uses, indirect uses and non-use/preservation values is to measure society's willingness to pay (WTP) for these various uses. In a competitive economy with no constraints on the movement of prices, one can assume that market prices reflect the WTP for goods and services. However, two complications arise in conjunction with wetland uses.

First, in many developing countries, market prices may be distorted by deliberate interventions or imperfect competition, such as the existence of exchange rate controls, price ceilings or supports, subsidies or taxes, monopoly conditions, etc. In such instances, shadow prices are often advocated. These are actual prices 'adjusted' to eliminate any distortions caused by policies or market imperfections so as to reflect true WTP. However, one should be cautious in indiscriminantly using shadow prices in place of market prices as:

i. market prices are often more readily accepted by decision-makers than are artificial values derived by the analyst;

ii. market prices are generally easy to observe, both at a single point in time and over time;

iii. they reflect the decisions of many buyers, whereas calculating shadow prices may often rely just on the judgement of the analyst; and

iv. the procedures for calculating shadow prices are rather imperfect and, therefore estimates can, in certain cases, introduce larger discrepancies than the simple use of even imperfect, market prices.[2]

A second complication is that many wetland values are not directly reflected in market prices at all. This is true for all the environmental functions, for resources harvested for own use by households, for most recreation and water transport services,

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[2] See H.M. Gregersen, K.N. Brooks, J.A. Dixon and L.S. Hamilton, Guidelines for Economic Appraisal of Watershed Management Projects, FAO, Rome, 1987.

and for all preservation/non-use values. In some cases, techniques such as travel cost methods, contingent valuation and hedonic pricing might be employed to estimate WTP directly. As noted above, however, these more sophisticated techniques are not easily applicable in remote and rural settings in developing countries. The analyst may have to resort to second-best approaches to valuation, such as indirect substitute, indirect opportunity cost, relocation costs and replacement costs methods, which do not relate uniquely to WTP.

In some instances, non-market values can be approximated through use of surrogate market prices, i.e. the use of an actual market price of a related good or service to value the wetland use that is non-marketed. For example, in the case of harvested or directly used wetland resources that are not marketed (e.g., fuelwood), the value of their use can be approximated by the market price of similar goods (e.g., fuelwood purchased from other areas) or of the next best alternative/substitute good (e.g., kerosene or charcoal). If there is apparently no marketed substitute/alternative, then second-best methods of valuing a non-marketed wetland resource may have to be employed. One method is the indirect opportunity cost approach, where the time spent collecting or harvesting is valued in terms of foregone rural wages - the opportunity cost of labor based on other employment. Another method is the indirect substitute approach, where the opportunity cost of using a substitute for the wetland resource is employed as its value measure - e.g., the opportunity cost of using dung that is normally applied as fertilizer as a substitute for fuelwood, the costs of obtaining water from sources outside the wetlands, and so forth.

The actual expenditures on directly used wetland services (e.g., recreation/tourism, water transport) may not reflect individuals' WTP for them. If this is the case, alternative methods of valuation may be required. For recreation/tourism, the travel/cost approach may be applied, where the value of visiting wetland areas is expressed in terms of the cost of travel time quantified via foregone wages. For water transport, the value can be expressed in terms of the cost of alternative/substitute means of transport.

The values of wetland environmental functions arise indirectly through their support or protection of economic activity and property. Where economic production is being supported, the value of these functions can be measured in terms of the value of changes in productivity attributed to these functions operating normally. Where economic activity or property is being protected, the values can be expressed in terms of preventive expenditures that would be required if the functions were degraded or irrevocable disrupted; the damage costs avoided by these functions operating normally; the costs of alternative/substitutes to replace these functions; or the relocation costs required if these functions were lost.

Estimating non-use/preservation values is extremely difficult unless use is made of such techniques as contingent valuation.

The contingent valuation method denotes a set of procedures used to generate, through direct questioning, estimates of individuals' willingness to pay for something they value. The general approach is to ascertain from the individual either how much he or she is willing to pay to ensure that the wetland attributes are preserved, or alternatively, how much he or she is willing to accept in compensation for some or complete loss of these wetland attributes.

Much progress has been made in advanced industrialized countries in developing the contingent valuation approach with regard to environmental values, including those of temperate wetlands.[3] Eventually, these techniques will and should be extended to tropical wetlands of developing countries. For now, assessment of the non-use/preservation values of wetlands may have to be largely qualitative and based on accurate interpretation of theses values.

Any option value associated with preservation will also be difficult to assess and quantify. The general presumption is that the option values attached to the majority of tropical wetlands may be very high, as they represent unique and irreplaceable natural environments that generate significant environmental benefits. Moreover the full value of these benefits may not always be realized currently but may only become apparent as these wetlands are `preserved' over time. Thus, option values arise out of the uncertainty of irreversible change; i.e., deciding today to convert wetland areas to other uses rather than preserving them. But precisely because option values arise out of the uncertainty over future unknown wetland benefits, they are extremely difficult to estimate.

A qualitative assessment of option value should nevertheless be possible. For example, if the analysis of the indirect and direct use values of a tropical wetland indicates that it yields extremely significant environmental benefits, then it clearly would also yield as least as important benefits in the future if it were preserved. Any analysis of development options should indicate the extent to which such benefits are irreversibly lost through total or partial conversion. The extent to which such benefits are lost through development would indicate a high option value for preservation.

However, if the current environmental benefits of a wetland area appear to be low, this does not necessarily imply that there is a

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[3] For a review of contingent value studies, see Christine Seller, John R. Stoll and Jean-Paul Chavas, "Validation of Empirical Measures of Welfare Change: A Comparison of Nonmarket Techniques", Land Economics 61: 156-75, 1985, and as applied to wetlands, in R. Kerry Turner, "Wetland Conservation: Economics and Ethics", Chapter 9 in D. Collard, D. Pearce and D. Ulph (eds.), Economics, Growth and Sustainable Environments: Essays in Memory of Richard Lecomber, The Macmillan Press, London, 1988, pp. 121-59.

low option value attached to the area. The resources and functions of the wetland may currently be underutilized due to the lack of people and economic activity in the area and in neighboring ecosystems. However, in the future economic activity may increase, and if it does so in a 'sustainable' fashion (i.e., without over-exploiting the renewable resources or degrading the environmental functions of the wetland), then the future benefits of a preserved wetland could be significant as its direct and indirect use values are 'realized'. There may be also additional option value attached by those non-users of the wetland area who hold existence or bequest motives for valuing its preservation. Any assessment of option value should take into account such considerations.

Conclusion and Final Considerations

The valuation methods and techniques suggested in this paper aim to facilitate an economic evaluation of tropical wetlands. For tropical wetlands, it may currently be difficult to employ sophisticated techniques, such as contingent valuation, to estimate non-use/preservation values. Even some complex wetland functions will prove difficult to assess and value. Often the hydrological and ecological data required may be unavailable without long-term observation or more detailed analysis. At the end of the day, a valuation of only the primary direct uses of a tropical wetland and a few of its functions may be possible.

The methodological approach recommended here should at least ensure that the most important uses of the wetland area are identified and valued. The general guiding principle should be that the marginal benefit in terms of improved 'accuracy' in results from extending the analysis should exceed the marginal cost of acquiring additional information. For example, if further valuation of the wetland's flood control function is desired, it should be conducted only if the time and effort spent collecting additional, hydrological, ecological and economic data are worth any improvement in the estimation of this function's value. In many instances, this may not be the case.

A further consideration is whether current uses of a wetland are necessarily sustainable. Direct uses of a wetland area, such as harvesting for fuelwood and timber, may over the long run lead to significantly affect ecological relationships. Such trade-offs between current direct uses and the long-run sustainability of important environmental functions may not be readily apparent. Thus some attention must be paid to determining the 'sustainable yield' of wetland resources with regard to current direct uses. Where it is apparent that current harvesting or exploitation levels exceed the sustainable yield of wetland resources, this must be taken into account in the analysis.[4]

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[4] There are currently two approaches for doing this. The first would be to incorporate an alternative sustainability scenario in the evlauation and conducting a comparative analysis.

Table 1. Use of Wetland Characteristics: Petexbatun, Peten State, Guatemala

Components	Economic Values: Direct	Indirect	Non-Use
1. Forest resources	xxx		
2. Wildlife resources	x		
3. Fisheries	xx		
4. Forage resources	xx		
5. Agricultural resources	xx		
6. Water supply	xxx		
Functions			
1. Groundwater recharge/discharge		x	
2. Flood and flow control		xxx	
3. Shoreline/bank stabilization		xxx	
4. Sediment retention		xxx	
5. Nutrient retention		x/xx	
6. External support		xxx	
7. Recreation/tourism	x		
8. Water Transport	xxx		
Attributes			
1. Biological diversity	xx	xx	xx
2. Uniqueness to culture/heritage			x

Key: x = low
xx = medium
xxx = high

Notes: See Table 2.

If the comparative analysis reveals that the alternative sustainability scenario yields higher social returns than the current use scenario, then clearly the former is socially more optimal. See Barbier, op. cit., for further explanation. The second approach would be to incorporate within a 'portfolio' of projects at least one environmentally compensating project to ameliorate the environmental degradation generated by other projects, thus ensuring overall sustainability of natural systems. Discussion of the latter approach can be found in David W. Pearce, Edward B. Barbier and Anil Markandya, Sustainable Development and Cost Benefit Analysis, LEEC Paper 88-03, London Environmental Economics Centre, London, 1988.

Table 2. Use of Wetland Characteristics:
North Pacific Coast Mangroves, Area 1, Nicaragua

Components	Economic Values: Direct	Indirect	Non-Use
1. Forest resources	xxx		
2. Wildlife resources	x		
3. Fisheries	xx		
4. Forage resources	x		
5. Agricultural resources	xx		
6. Water supply	xxx		
Functions			
1. Groundwater discharge		xx	
2. Flood and flow control		xxx	
3. Shoreline stabilization		xx	
4. Sediment retention		xxx	
5. Nutrient retention		xxx	
6. Water quality maintenance		xx	
7. Storm protection/wind break		xxx	
8. External support		xxx	
9. Micro-climatic stabilization		xx	
10. Recreation/tourism	xx		
11. Water Transport	xxx		
Attributes			
1. Biological diversity	x	x	x
2. Uniqueness to culture/heritage			xx

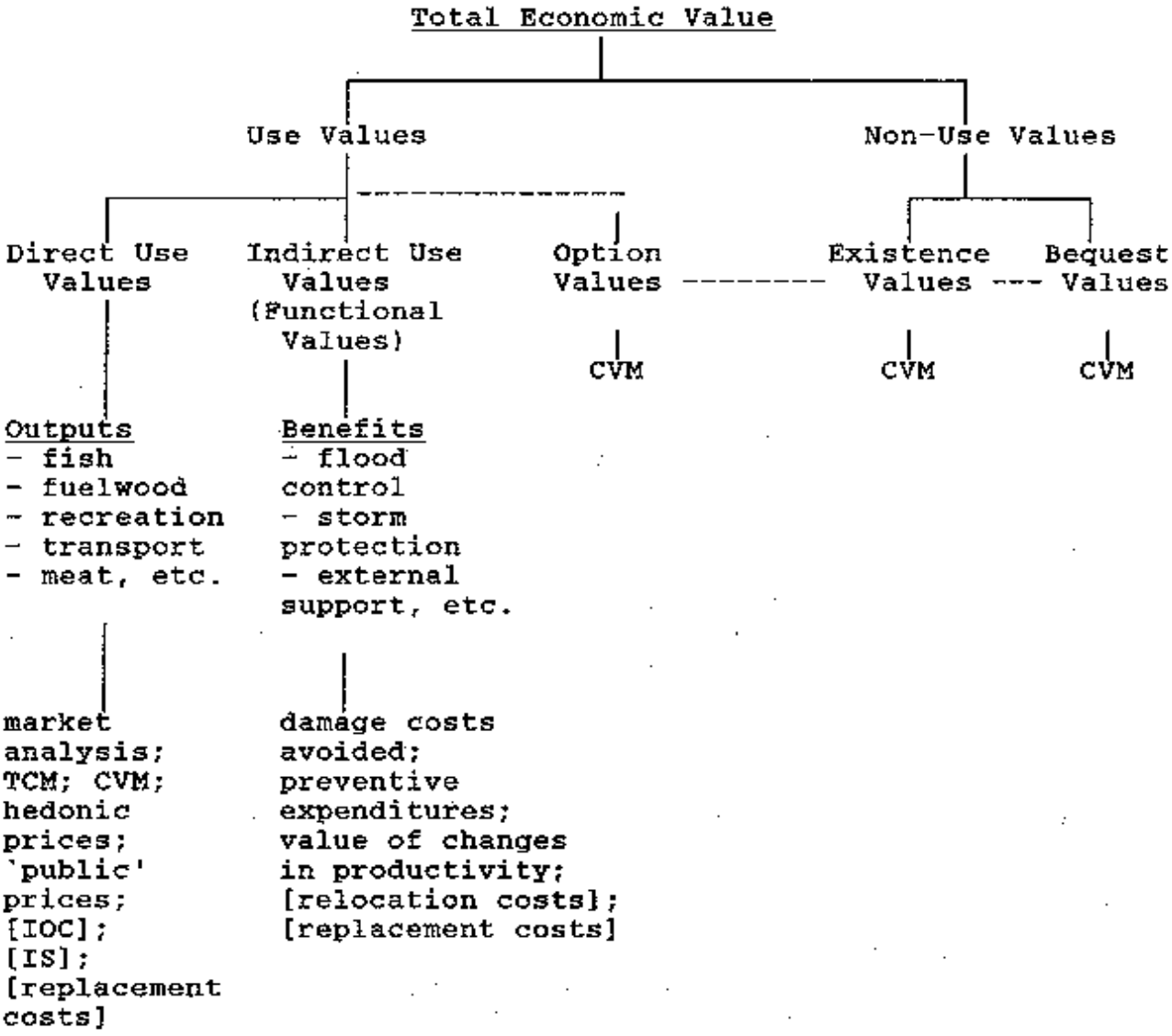
Key: x = low
xx = medium
xxx = high

Notes: See Table 3, Area 1. Areas 2 and 3 have the same pattern of use, although different relative importance of characteristics.

Table 3. Wetland Characteristics: Measurement and Valuation Techniques

Direct Use	Approach
Forest resources Wildlife resources Fisheries Forage resources Agricultural resources Water supply Energy resources	Valuing the marginal productivity of the resource net of any human effort; Marketed substitutes/alternative supplies; Indirect opportunity cost; Indirect substitute.
Recreation/tourism	Travel cost methods.
Water transport	Alternative/substitute costs.
Biological diversity	Value of genetic material, scientific and educational use.
Indirect Use	
Groundwater recharge/discharge Flood and flow control Shoreline stab./erosion control Sediment retention Nutrient retention Water quality maintenance Storm protection/wind break Micro-climate stabilization External support	Preventive expenditures; Damage costs avoided; Alternative/substitute costs; Relocation costs; Value of changes in productivity.
Biological diversity	Value of changes in productivity.
Non-use/Preservation	
Uniqueness to culture/heritage Biological diversity	Contingent valuation.

Figure 1. Valuing Wetland Benefits



Notes: CVM = contingent valuation method
TCM = travel cost method
IOC = indirect opportunity cost approach
IS = indirect substitute approach
[ ] = valuation methodology to be used with care

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Edward B Barbier,
Economics, Natural-Resource Scarcity and Development: Conventional and Alternative Views. Earthscan Publications Limited, London, 1989. (£29.95)

The history of environmental and resource economics is reviewd, then using insights provided by environmentalism, ecology and thermodynamics, Barbier begins the construction of a new economic

approach to the use of natural resources and particularly to the problem of environmental degradation. With examples from the global greenhouse effect, Amozonian deforestation and upland degradation on Java, Barbier develops a major theoretical advance and shows how it can be applied. This book breaks new ground in the search for an economics of sustainable developement.

David W Pearce, Edward B Barbier and Anil Markandya, Sustainable Development: Economics and Environment in the Third World, Edward Elgar Publishing Limited, London 1989 [in press].

The authors attempt to give some structure to the concept of sustainable development and to illustrate ways in which environmental economics can be applied to the developing world. Beginning with an overview of the sustainable development concept, the authors indicate its implications for discounting and economic appraisal. Core studies on natural resource management are drawn from Indonesia, Sudan, Botswana, Nepal and the Amazon.

David W Pearce, Anil Markandya and Edward B Barbier, Blueprint for a Green Economy, Earthscan, September 1989, £6.95

This book by the London Environmental Economics Centre was prepared as a report for the Department of Environment, as a follow up to the UK government's response to the Brundtland Report. Here it stated that: '...the UK fully intends to continue building on this approach (environmental improvement) and further to develop policies consistent with the concept of sustainable development.'
The book attempts to assist that process.

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