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in environmental economics

THE ECONOMIC VALUE OF ECOSYSTEMS:

2 — TROPICAL FORESTS

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GATEKEEPER SERIES

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Pearce (1990) and Barbier (1989 and 1991) have suggested ways in which the cost-benefit approach (CBA) can be modified for decision-making about the use of natural areas, e.g. tropical forests and wetlands.

The following table indicates the many use and non-use values of a tropical forest that may comprise its total economic value (TEV):

Classification of Total Economic Value for Tropical Forests

Use Values	Non-Use Values

(1) Direct Value	(2) Indirect Value	(3) Option Value	Existence Value
Sustainable Timber	Nutrient	Future	Biodiversity
			a/
products	cycling	Uses as per (1), (2)	Culture, Heritage
Non-timber products	Watershed protection		
Recreation value	Air pollution		Intrinsic
Medicine	Reduction		
Plant genetics	Microclimatic functions		
Education	Carbon store		
Human habitat			

Note: a/ Biodiversity is essentially an attribute of the tropical forest; hence, it may also serve important direct and indirect use values. For example, the diversity found in a tropical forest may have direct use value for scientific research, education and as a source of genetic material. Similarly, biological diversity may have an indirect use value in assisting the ecological stability of the entire tropical forest system. See Aylward and Barbier (1991).

Source: Adapted from D.W.Pearce, An Economic Approach to Saving the Tropical Forests, LEEC Paper 90-06, London Environmental Economics Centre, London, 1990.

Direct use values are the resources and 'services' provided directly by the forest. Indirect use values are essentially the environmental functions of the forest, which indirectly support economic activity and human welfare. Option value relates to the amount that individuals would be willing to pay to conserve a tropical forest, or at least some of its uses, for future use. Individuals are essentially valuing the guaranteed 'option' of future supply of these uses, the availability of which might otherwise be uncertain. Existence value relates to valuation of the resource as a unique asset in itself, with no connection to its use values. This would include forests as objects of intrinsic and 'stewardship' value, as a bequest to future generations and as a unique cultural and heritage asset.

Calculation of the above components of total economic value is important for assessing the costs and benefits of different forest land use options. Of crucial importance is the distinction between preservation, which would be formally equivalent to outright non-use of the resource; sustainable conservation (management), which would involve limited uses of the forest consistent with leaving the original natural forest and ecosystem broadly intact; and complete development (conversion), e.g. clear-cutting the forest and converting the land to some alternative, agricultural use.

In all approaches, the basic cost-benefit analysis (CBA) rule for any pair of alternative land use options, A and B, is to compare the net benefits of each. That is, as the opportunity cost of choosing option A is forgoing the net benefits of B, it is not sufficient for the net benefits of In to be positive. The net benefits of A (NB_a) must exceed the forgone net benefits of B (NB_b) :

$$NB_a - NB_b > 0 \quad (1)$$

For example, if the forest is to be cleared for agriculture (option A), not only should the direct costs of conversion (e.g. clearing and burning the forest, establishing crops) be included as part of the costs of this land use option but so must the forgone values of the forest that has been converted, which would could have been preserved in its natural state (option B). These may include both the loss of important environmental functions (e.g., watershed protection, micro-climatic maintenance) and resources (e.g., commercial hardwoods, non-timber products, wildlife) that comprise important use and non-use values.

The following examples, using illustrative data, highlight these points. It is assumed that all costs and benefits are in present value, per hectare terms.

Preservation Versus Conversion

The choice between conversion and preservation indicates a stark conflict between one direct use of the forest, for timber extraction and land conversion, and other use and non-use values. This trade-off between components of TEV must be captured by the basic CBA rule (2). Let:

BD_1 = the gross income, or returns, to the development option of clear-cutting the forest for timber (BT_1), \$150 per hectare), and converting to agriculture (BA_1), \$20

CD_1 = direct costs of timber extraction and conversion, \$50

Bf_o = all use and non-use values of the preserved tropical forest. \$100

Cf_o = direct costs of preserving the forest. \$25

Thus, as the opportunity cost of development is forgoing the net benefits of preservation, then development cannot proceed unless:

$$(BD_1 - BD_2) - (BF_o - CF_{o)} > 0 \ (3)$$

which is the case as:

$$(\$170 - 50) - (100 - 25) = \$45 > 0.$$

Note also that application of the TEV formula (1) to each development option yields:

$$TEV_o = BF_o = \$100$$

$$TEV_1 = BT_1 = \$150.$$

That is, the actual TEV attained will depend on the development option. However, as BT, and BF_o are mutually exclusive, neither option can realize the full potential TEV of the forest as measured by (1). For preservation, actual TEV is limited to BF_o, whereas for development, it is BT_1.

Sustainable Management Versus Preservation

Instead of complete conversion, an alternative development option to preservation might be sustainable management of timber production. This may be coupled by other sustainable conservation uses of the forest, such as commercial exploitation of non-timber products and a managed eco-tourist industry. Although some losses of indirect, option and existence values may occur, the result should be less of a trade-off between these values and exploitation of timber and other direct uses than the conversion option. Let:

BD_2 = gross income, or returns, from sustainable timber exploitation (BT2), e.g. selective cutting combined with natural regeneration, \$100, and from other direct conservation uses (BC2), \$40

CD_2 = direct costs of sustainable timber and conservation management, \$70.

BF_2 = all remaining indirect, option and existence values of the sustainably managed forest, \$60

Following (2), sustainable management cannot proceed unless:

$$(BD_2 - CD_2) + BF_2 \ (BF_o - CF_o) > 0 \ (4)$$

which is the case as:

$$(\$140 - 70) + 60 - (100 - 25) = \$55.$$

Under the sustainable development option, the actual TEV is:

$$TEV_2 = BT_2 + BC_2 + BF_2 = \$100 + 40 + 60 = \$200.$$

This again differs from TEV_o and TEV_1. Yet, even though $BT_2 < BT_1$ and $BF_2 < BF_o$,

$$TEV_2 = \$200 > TEV_1 = \$150 > TEV_o = \$100, (5)$$

as timber benefits and other forestry values, especially indirect option and existence values, are no longer mutually exclusive, while at the same time additional conservation values, e.g. CB2, can be realized. This is one of the attractive features of a sustainable management regime over other options:

i. it minimizes the trade-offs among the various use and non-use value components of TEV; and thus,

ii. its actual TEV is more likely to approach the full potential TEV for the forest.

In fact, to make TEV an operational concept, one could define the full potential TEV of a forest to be the maximum actual TEV achieved through sustainable management. For example, if there were no other sustainable management regime that achieved a higher level of TEV than the one described above, then the latter can be considered, for all practical purposes, the full potential TEV development option for the forest system.

Sustainable Management Versus Conversion

However attractive such an option might appear, maximizing TEV is not sufficient for the sustainable management option to be preferred over all other development options. It must still conform to the basic CBA rule (2). As indicated by (4), sustainable management is preferable to the preservation option. But then (3) indicated that conversion is also a better option than preservation. CBA criterion (2) should now be used to compare the sustainable management and conversion options. If it is assumed that the opportunity cost of conversion is forgoing the net benefits of sustainable management of the forest, then conversion should not proceed unless:

$$(BD_1 - CD_1) - [(BD_2 - CD_2) + BF_2 > 0$$

As this yields:

$$(\$170 - 50) - [(140 - 70) + 60) = - \$10,$$

then conversion should not take the place of sustainable management. In fact, the same result would have emerged from comparing (3) and (4); their difference produces CBA rule (6).

Discussion

Several important points arise from this analysis. First, calculating the components of TEV is essential to analyzing development options for tropical forest development. However, care should be taken in adding up the various components of TEV, as suggested by (1), to arrive at any measure of the full <u>potential</u> TEV of a tropical forest. As there are inevitable trade-offs among the various components of TEV, the most useful approach is to estimate full potential TEV assuming that any such trade-offs are minimized as far as possible. That is, the assumption should be that full potential TEV is the maximum actual TEV obtainable by some feasible sustainable management. regime. To use equation (1) to arrive at a higher level of TEV than is feasible would be erroneous.

For example, TEV_2 = \$200 was actually defined as the maximum TEV arising from any possible sustainable management regime. However, if the trade-offs between the components of TEV were ignored, it would be possible to arrive at a higher level of TEV by taking the maximum individual components across TEV_o, TEV_1 and TEV_2:

$$TEV = BT_1 + BC_2 + BF_o = (\$150 + \$40 + \$100) = \$290.$$

But since BT, is mutually exclusive with both BC_2 and BF_o, this level of TEV is not practically attainable. Such a measure of TEV is not correct. It would be equally wrong to limit any measure of TEV to just one of its components, say BF_o.

Important though a measure of TEV is, it is not sufficient to justify any sustainable management regime - even one that achieves maximum TEV. Adherence to the CBA criteria derived above is the correct approach for determine which development option should take place. The following table summarizes the CBA criteria for the three development options considered:

CBA Rules for Three Forest Development Options

Conversion vs. Preservation: $(BD_1 - CD_1) - (BF_o - CF_o) > 0$

Sust. Mgt. vs. Preservation: $(BD_2 - CD_2) + BF_2 - (BF_o - CF_o) > 0$

Conversion vs. Sust. flat.: $(BD_1 - CD_1) - [(BD_2 - CD_2) + BF_2] > 0$

However, a major difficulty in applying the above CB rules is that many of the component values in total economic value have no market - especially subsistence or underdeveloped non-timber products and the indirect use, option and existence values of forests. Choice of land use is therefore often biased in favour of land uses that do have marketed outputs, e.g. development options such as ranching, timber exploitation, agriculture, mining, hydroelectricity. The result is too much conversion and over-exploitation of forest and too little natural management of forest land.

The basic reason for the imbalance is that the non-market values of the natural/managed systems are not automatically reflected in the price of forested land. For example, the market value of land converted to agriculture fails to reflect the lost environmental benefits, such as watershed protection. if 'owners' (i.e. those with legal title and those who have acquired the land on a first-come basis) had to pay the full social cost of developing forested land, less land would be converted or over-exploited. Forested land is clearly underpriced. An important consequence is that once the land occupied has become sufficiently degraded and thus significantly less productive, the 'owners' have a strong incentive to abandon the land for new, virgin forested land which is 'cheap' to acquire and develop. The process repeats itself until it becomes difficult to get access to new forest lands, for example due to the lack of roads or waterways into a region.

There is clearly a role for government in ensuring that the total economic value of forest land lost through conversion and exploitation is accounted for as part of the costs of these development options. This suggests a policy of:

> carrying out <u>cost-benefit analysis (CBA) of land use</u> options, where the CBA takes as full account as possible of both market and non-market values. For example, the environmental functions of forests must be fully evaluated;
>
> lowering the <u>incentives to exploit 'new' land</u> so that a better pattern of land uses is secured; and
>
> improving the <u>incentives to stay on/restore degraded land</u> by raising productivity of that land.

An Example: CBA of Korup Project, Cameroon

The following illustrates the type of comprehensive cost-benefit analysis required for tropical forest land use options, with the example of the Korup Project, Cameroon. The analysis essentially follows CBAII rule (3) above; although the project is a conservation rather than a <u>development</u> option, the approach is essentially the same. Thus the net benefits of the Korup protected area and project in terms of sustained forest and susbsistence use, tourism, genetic value, watershed protection, control of flooding and soil maintenance, are compared with the opportunity costs of forestry and other development options.

The Korup Project is an on-going programme to promote conservation of the rain forest in Korup National Park in Southwest Province, Cameroon. la social cost-benefits analysis (CBA) of the Project undertaken on behalf of the Government of Cameroon and World Wide Fund for Nature UK yielded the following results:

Base Case Result

(NPV £ 000, 8% Discount Rate)

Direct Costs of Conservation		- 11,913
Opportunity Costs		- 3,326
- Lost stumpage value 706	- 706	
- Lost forest use	- 2,620	
Direct Benefits		11,995
- Sustained forest use	3,326	
- Replaced subsistence production	977	
- Tourism	1,360	
- Genetic value	481	
- Watershed protection of fisheries	3,776	
- Control of flood risk	1,578	
- Soil fertility maintenance	532	
Induced Benefits		4,328
- Agricultural productivity gain	905	
- Induced forestry	207	
- Induced cash crops	3,216	
NET BENEFIT - PROJECT		1,084
Adjustments		6,462
- External trade credit	7,246	
- Uncaptured genetic value	- 433	
- Uncaptured watershed benefits	- 351	
NET BENEFIT - CAMEROON		7,545

Source: H.J. Ruitenbeek, Social Cost-Benefit Analysis of the Korup Project, Cameroon, Prepared for the World Wide Fund for Nature and the Republic of Cameroon, London, 1989.

The CBA includes not only the direct operating and capital costs of the Project but also the opportunity costs of lost timber earnings (lost stumpage value) and lost production from the six resettled villages (lost forest use). Against this must be weighed the direct benefits of the Project in the form of sustained forest use beyond the year 2010 when the forest would otherwise have disappeared, replacement subsistence production of the resettled villagers, tourism, minimum expected genetic value of the forest resources in terms of pharmaceuticals, chemicals, agricultural crop improvements, etc., and environmental functions - watershed protection of fisheries, control of flooding and soil fertility maintenance. Also included are induced benefits, agricultural and forestry benefits of the Project's development initiatives in the buffer zone. The external trade credit shows a positive benefit to Cameroon of direct external funding of the project. 'Uncaptured genetic value' is a negative adjustment reflecting the fact that Cameroon will be able to capture only 10% of the genetic value through the licensing structures and institutions which it has in place, and 'uncaptured watershed benefits' indicates that some of the watershed protection benefits will flow to Nigeria and not Cameroon.

Thus the analysis indicates that the Korup Project offers substantial net economic benefits as a land-use option at the project level and to Cameroon as a whole.

Conclusion

Calculating the components of TEV is essential to applying the above cost-benefit rules to the various land use options proposed for tropical forest development. However, care should be taken in adding up the various components of TEV, as there are inevitable trade-offs among them. Furthermore, a measure of TEV is in itself not sufficient to justify any sustainable management regime - even one that achieves maximum TEV. Such a measure does not tell us anything about the opportunity costs - the next best land use option forgone - of the sustainable management regime. By applying the above CBA rules, it is possible to determine which development option should take place. The appraisal of the Korup Project, Cameroon illustrates the importance of these rules in development decisions.