

**Adger, W.N., Brown, K., Cervigni, R. and D. Moran. 1995. "Total Economic Value of Forests in Mexico" in *Ambio*, 24(5): 286-296.**

**Type of assessment & main findings:** The study presents a total economic valuation of the Mexican natural forest estate, when used for tourism and recreation, NTFPs, carbon storage, watershed protection, potential pharmaceutical products, and existence values. The study concludes that non-timber forest benefits are significant, with the value for carbon storage alone being greater than typical forest land values in many parts of the world.

**Empirical data:** The analysis uses benefit estimates from a variety of secondary studies, and transfers, or extrapolates, these to the entire Mexican forest estate.

**Economic values considered:** Direct use, indirect use, option and existence values

**Valuation techniques used:** The forest estate was divided into four forest types: tropical evergreen, tropical deciduous, temperate coniferous and temperate deciduous. The valuation techniques used for the range of forest benefits are described below. Some of the benefits were estimated according to the type of forest.

*Tourism and recreation:* Draws on secondary sources and no specific information is provided on the techniques used. Reference is made to consumer surplus and WTP estimates, implying that TCM and CVM were used in the valuation. Data was gathered on six different forest reserves and extrapolated to the national level. The analysis differentiates between eco-tourist visits (estimated revenues of US\$14 million per year) and multi-purpose visits (estimated consumer surplus of US\$16.6 - 19.6 million per year). The combination of these priced and unpriced benefits produces a total benefit range of US\$30.6 - 33.6 million per year.

*NTFPs:* Shadow pricing of market and substitute goods was used in the secondary study to value the direct use benefits of a range of products (including building materials, medicines, fuelwood and fruits). This resulted in a value of US\$330 per hectare per year for tropical evergreen and temperate deciduous forests. But as this estimate is based on one area, the study does not extrapolate it across the forest estate. The authors note however that this result accords with estimates from other Latin American countries.

*Carbon storage:* The study used previous studies to estimate the amount of carbon retained by not converting the forest estate to pasture or agricultural land. This ranges from about 30 to 160 tonnes of carbon per hectare depending on the forest type. Fankhauser's (1995) estimate of the value of a tonne of carbon (US\$20) is used. This reflects the damage cost avoided by maintaining the land under forest. The present value of the forest carbon storage service comes to US\$650 - 3,400 per hectare. This produces a total benefit of almost US\$3.8 million per year.

*Watershed protection:* Of the various benefits resulting from forest watershed protection services, this study limits itself to estimating the water purification benefits which result from lower sedimentation rates.

Other benefits of watershed protection, e.g. reduced flooding, were omitted owing to data limitations and estimation difficulties. A “damage cost avoided” approach is used to estimate the value of water purification benefits. The likely cost of water purification is estimated using existing studies of sediment production in Mexico and average US treatment costs. An earlier study estimated that approximately 113 million tonnes of deposition induces some form of purification on an annual basis. Valued at the US average of US\$20 per 1000 tonnes of discharge, the authors obtain an estimate of US\$2.3 million savings per year. The study notes that this result supports other research that likely savings in water treatment costs from reduced erosion are a relatively minor benefit.

*Option value of pharmaceuticals:* The option value of novel pharmaceuticals derived from genetic material in Mexican forests is estimated using a model developed by Pearce and Puroshothaman (1992). The model multiplies the number of species present in the forest by the probability of a species yielding a useful product. This number is then multiplied by the royalty rate on sales of such a product, a coefficient of rent capture and the average value of internationally traded pharmaceutical products. This overall value can then be divided by the total forest area to yield an option value expressed in per hectare terms. Many of the variables in this model suffer from a high degree of uncertainty leading to estimates of between US\$1 and US\$90 per hectare per year. The study uses a central estimate of US\$6.4 per hectare per year, or US\$330 million per year for the entire forest estate.

*Existence value:* To estimate existence values, the study gathered information on a variety of transactions related to natural area conservation in Mexico, including contributions to conservation organisations and programmes, a tourism survey and debt for nature swaps. Such transactions are interpreted as indications of WTP for the maintenance of existence values. The study notes that this only includes captured values; a large proportion of existence value, which is difficult and costly to estimate, remains uncaptured due to their public good nature. This approach reveals a range of US\$0.03-US\$10 per hectare. The study uses the upper bound to derive an estimate of US\$60 million for the entire forest estate, acknowledging that only a proportion of this value is attributable to forest areas.

**Socio-economic groups affected:** The groups vary according to the benefits: subsistence forest dwellers (NTFPs); Mexican consumers (tourism, watershed protection, option values, existence values); developed country consumers (tourism, existence values); global community (carbon storage).

**Comments:** The authors chose not to include timber values. The study points out that large gains can be obtained from measures to capture a greater proportion of these values.

### **Key references:**

Pearce, D. and S. Puroshothaman. 1992. *Protecting Biological Diversity: The Economic Value of Pharmaceutical Plants*. Global Environmental Change Working Paper 92-27. CSERGE, UEA and UCL, London.

**Alcorn, J.B. 1989. “An Economic Analysis of Huastec Mayan Forest Management” in Browder, J.O. (ed.) *Fragile Lands of Latin America: Strategies for Sustainable Development*, pp. 182-206. Westview Press: Boulder.**

**Type of assessment & main findings:** The study calculates the net benefits associated with a social forestry system employed by indigenous (*Huastec*) farmers in northeastern Mexico in 1987. The system is a mix of commercial (sugarcane, coffee) and subsistence (*milpa*) plantations and managed forest groves (*te’lom*) containing elements of primary and secondary forests. The study concludes that when coffee is produced alongside *te’lom*, the total return on investment comes to about US\$598 per hectare, of which 65% is accounted for by *te’lom*. This result is contrasted with production excluding coffee, in which case *te’lom* accounts for only 29% of total returns. The conclusion suggests that the main economic returns from *te’lom* are derived from exotic products (like coffee) rather than from native species.

**Empirical data:** Estimates are provided of the inputs and outputs of the main cultures (*milpa*, sugarcane, *te’lom* and livestock) in terms of:

- labour input on *Huastec* farms, in person-days/hectare/year and person-days/community/year
- animal labour input, in horse-days
- production inputs on *Huastec* farms, both cash (market prices) and non-cash (shadow prices), in Pesos/community/year
- value of *Huastec* production consumed (subsistence) and sold, in Pesos/community/year
- economic return on cash and non-cash ‘investment’ (more precisely, current costs) from *Huastec* production (total inputs and benefits), in Pesos/community/year

**Economic values considered:** Direct uses. There are qualitative references to other values, but no monetary estimation is presented:

*“For the Huastec, over 90% of te’lom species have ‘use values’. And Huastec farmers do perceive that the te’lom has an ‘option value’, because they believe that its constituent species may have some future use not known today. It also seems that Huastec give the te’lom some ‘existence value’ in their land use decisions in so far as (1) they give traditional respect to the Earth and its vestment of plants, and (2) the comfortable prosperous Huastec farmer is seen as one who has a te’lom on his farmstead” (p.197).*

**Valuation techniques used:** Market prices and shadow prices (for non-cash inputs).

**Comments:** The discussion focuses on a land use system in which the managed forest grove has a complementary role with other cultures.

**Almeida, O.T. de and C. Uhl. 1995. “Developing a Quantitative Framework for Sustainable Resource-Use Planning in the Brazilian Amazon” in *World Development*, 23(10):1745-1764.**

**Type of assessment & main findings:** The study presents a comparative CBA of logging, ranching and rainfed crop production in the county of Paragominas, northeastern Brazil. The costs and benefits of these activities are considered under alternative management systems: extensive (90 year cutting cycle) versus intensive (30 year cycle) forest management; extensive (unimproved) versus intensive (“reformed”) pasture; and extensive (slash-and-burn) versus intensive (permanent perennial) rainfed cropping. These alternative land uses are compared in terms of their gross returns, profits, tax payments, start-up capital requirement and employment generation per hectare. Estimates are presented of the current importance and sustainability of each activity in the economy of Paragominas country. The authors also provide guidelines for economic development planning at a county-level in the Brazilian Amazon. They conclude that more intensive land use systems generate higher financial returns, although forest management for timber and extensive cattle ranching are not viable when capital costs are included (see Table 1). The authors calculate that intensive land uses generate more tax revenue for government and more employment, on a per hectare basis. They also estimate carbon losses associated with each land use option, compared to mature forest, in physical terms (tons of carbon per hectare).

**Table 1. Comparison of land use options in Pará, Brazil (1992 US\$/hectare/year)**

Land Use	Gross Return <sup>a</sup>	Profit <sup>b</sup>	Start-up Investment	Taxes Paid	NPV (r=6%) <sup>c</sup>	NPV (r=12%) <sup>c</sup>
Timber (extensive, 90 yrs.) <sup>d</sup>	31	11	2,391	4	35	12
Timber (intensive, 30 yrs.) <sup>d</sup>	92	28	2,504	11	(36)	(123)
Ranching (extensive)	31	2-6	307	5	(285)	(279)
Ranching (reformed)	104	55	539	18	516	(8)
Slash-and-burn Agric.	90	33	291	15	648	384
Intensive/Perennial Agric.	2,366	802	2,695	367	13,502	6,049

Notes: a/ Average annual cash flow over sustainable management cycle.

b/ Includes depreciation and taxes but not the opportunity cost of capital.

c/ Based on 90 year time horizon; percentages are discount rates used.

d/ NPV is for extraction only (not processing) and includes the cost of buying logging rights (\$70/ha) under the extensive model and the cost of buying land (\$150/ha) for the intensive model.

**Empirical data:** The paper is a synthesis of previous studies of land use activities in the county of Paragominas. Data for the financial CBA is drawn mainly from previous studies carried out by IMAZON, an independent research group based in Belem, Para (see Barreto *et al.* 1993; Mattos and Uhl 1994; Toniolo and Uhl 1995; Veríssimo *et al.* 1992).

**Details of CBA:** The analysis focuses on financial returns to land and capital under alternative land use systems. Allowance is made for the opportunity cost of capital, but no adjustment is made for economic policy distortions. Based on secondary data the authors calculate:

- gross return, profit, capital investment and tax receipts for each land use system;
- net present value (at  $r=6\%$  and  $12\%$ ) and the internal rate of return for each land use system;
- employment generation by each system (in hectares required to employ one person);
- carbon losses associated with different land uses, compared to mature forest;
- area required to supply the calorie and protein requirement of the population of Paragominas following the prevailing extensive land use model and under more intensive approaches; and
- total area available and sum of gross returns, profits, capital investment required, tax and job generation for the six land use options in the county of Paragominas.

**Economic values considered:** Mainly direct uses (ranching, crop and timber production). Indirect use values (carbon storage) are considered in physical terms only.

**Valuation techniques used:** Market prices for financial analysis of land use options.

**Socio-economic groups affected:** Farmers, ranchers, loggers and timber millers; casual labour (employment), government (tax receipts), global community (CO<sub>2</sub> emissions).

#### **Key references:**

Barreto, P., Uhl, C. and J. Yared. 1993. "O potencial de produção sustentável de madeira em Paragominas-Pa, na Amazonia Oriental: considerações ecológicas e econômicas" in *Anais do 7<sup>o</sup> Congresso Florestal Brasileiro*, Vol. 1 (Sao Paulo: Sociedade Brasileira de Silvicultura / Sociedade Brasileira de Engenheiros Florestais), pp. 387-392.

Mattos, M. and C. Uhl. 1994. "Economic and ecological perspectives on ranching in the Eastern Amazon" in *World Development*, **22**(2): 145-158.

Toniolo, A. and C. Uhl. 1995. "Economic and ecological perspectives on agriculture in the Eastern Amazon" in *World Development* (forthcoming).

Veríssimo, A., Barreto, P., Mattos, M., Tarifa, R. and C. Uhl. 1992. "Logging impacts and prospects for sustainable forest management in an old Amazonian frontier: The case of Paragominas" in *Forest Ecology and Management*, **55**: 169-199.

**Anderson, A.B. and M.A.G. Jardim. 1989. “Costs and Benefits of Floodplain Forest Management by Rural Inhabitants in the Amazon Estuary: A Case Study of Açai Palm Production” in Browder, J.O. (ed.) *Fragile Lands of Latin America: Strategies for Sustainable Development*, pp. 114-129. Westview Press: Boulder.**

**Type of assessment & main findings:** The authors undertake a CBA to compare the returns to managed and unmanaged plots of *açai* palm in the floodplains of the Amazon estuary (State of Pará, Brazil). The management techniques studied in 16 permanent plots are thinning and pruning, and are traditionally practised by the local river dwellers (*Ribeirinhos*) in sustainable harvesting of *açai* fruits and palm-hearts.

The results show that selective thinning of forest competitors produces a statistically significant ( $P < 0.05$ ) increase in fruit productivity. In conjunction with pruning, this treatment serves to concentrate production in a smaller number of stems, facilitating the task of fruit collection. The average net return to treatment is US\$109.50 per hectare, equal to a 47% return on the effort invested. The benefit of palm heart extraction was estimated at an additional income of US\$47 per hectare. The authors conclude that the land use option of managed *açai* harvesting “is in fact a rational one from ecological, cultural, and economic perspectives” (p.115).

**Empirical data:**

- (i) An inventory of species with diameter at breast-height (DBH)  $> 5$  cm in 0.25 hectare of unmanaged floodplain forest on *Ilha das Onças* (an island close to the city of Belém), where the study was conducted.
- (ii) Average sample results of *açai* fruit output (kg/year) per plot, vegetative clump and stem, under four different treatments: pruning and thinning, thinning only, pruning only and control (no treatment).
- (iii) Market prices of *açai* fruits and palm hearts, obtained in the *açai* market of Belém.
- (iv) Labour input and cost (estimated using the mean minimum wage).
- (v) Relative proportion of monetary income derived from natural products [*açai* fruit (63%), timber (13%), palm heart (12%), shrimp (6%), rubber (5%) and other (1%)] obtained by a single family on *Ilha das Onças* during 1986.

**Valuation techniques used:** Market prices for direct uses only. The authors make qualitative reference to a non-monetary benefit of managed areas, which is the greater facility of obtaining other forest resources.

**Socio-economic groups affected:** Local inhabitants (*Ribeirinhos*).

**Comments:** The analysis does not refer to the total costs and benefits of harvesting *açai* products, but rather to the costs and relative productivity of alternative management techniques. No data is presented for other forms of land use.

**Appasamy, P.P. 1993. “Role of Non-Timber Forest Products in a Subsistence Economy: The Case of a Joint Forestry Project in India” in *Economic Botany*, 47(3): 258-267.**

**Type of assessment & main findings:** Describes the role of NTFPs in the subsistence economy of Tamil Nadu State, India, including a case study of NTFP extraction from the Kadavakurichi Forest Reserve. For all products, the total estimated value extracted was Rs 1.9 million per year, or about Rs 2,090 (US\$70) per hectare per year.

**Empirical data:** Reports data from a forestry survey of 324 villages conducted in Tamil Nadu (Neelakantan 1991), including the number of “head-loaders” (men, women and children) entering the forest daily and the quantity (in tonnes) of product removed annually (fuelwood, small timber and fodder). Also reports data from a case study carried out under a social forestry project managed by the Palni Hills Conservation Council (PHCC). The latter included surveys of forest product extraction by local villagers, i.e. fuelwood, fodder, honey and other products (medicinal plants, small game, green manure, etc.). Data derive from “footpath” surveys in which 43 entry paths into the FR were monitored over a seven week period to determine the number of trips made, the quantity of each product extracted and other variables (age and sex of collector, intended end use, etc.). Data from an inventory of vegetation occurring in the reserve, and their uses, are also reported.

**Valuation techniques used:** Market prices were used to estimate direct use values only. NTFP extraction is expressed in term of the average (per headloader) and total (for the entire Forest Reserve) value per annum.

**Key references:**

Neelakantan, K.S. 1991. “Survey of Fuelwood Use in Tamil Nadu.” Paper presented at 21st Interdisciplinary Research Methodology Workshop, Madras Institute of Development Studies: Hyderabad.

Palni Hills Conservation Council. 1991. *Kadavakurichi Interface Forestry: Surveys and Analysis*. Kodaikanal, Tamil Nadu: India.

**Aylward, B., Echeverria, J., Allen, K., Mejias, R. and I.T. Poras. 1999. *Market and Policy Incentives for Livestock Production and Watershed Protection in Arenal, Costa Rica.* CREED Working Paper no. 25. IIED: London.**

**Type of assessment & main findings:** This paper undertakes financial and economic CBAs of ranching in the Rio Chiquito watershed of the Arenal region of Costa Rica. The study concludes that ranching for beef and dairy production are more economically valuable land uses than timber production or forest protection. Apart from on-site productive benefits associated with ranching, significant and unexpected off-site hydrological benefits mean that the social benefits from ranching outweigh private benefits.

**Empirical data:** Data was collected from numerous primary and secondary sources. The main data presented include:

- official statistics on production and sales of beef, milk and cheese since 1995;
- costs of forest protection based on experience in other Costa Rican protected areas;
- questionnaire responses regarding landholders' inputs in ranching, soil erosion problems and the age of their pasture(s);
- software programmes, e.g. CALSITE, and related literature on sediment loads and water yields from watersheds under different land uses;
- information on hydro-electric power generation costs and revenues, reservoir capacity and operating constraints; and
- price and cost information for thermal power generation.

**Details of CBA:** The costs and benefits of ranching (for beef, dairy or a mix of the two) are compared with forestry production/protection from both the private landholder's perspective and from a wider social perspective. NPV is calculated for seven different types of holdings (ranging from small pastures used for ranching to large, mechanised dairy operations) and for four life zones which relate to the forest type and level of run-off. Values are considered over a 70 year time horizon. The key factor distinguishing the private CBA from the social CBA is the consideration of hydrological impacts. While the private CBA considers on-site costs and benefits, the social CBA also incorporates the off-site impacts of alternative land uses on the hydrological system and downstream water users.

#### *Private CBA*

Using an incremental approach, the authors start by considering private cash flows and then add the opportunity costs of non-monetary inputs and outputs. In a third step they undertake a private economic CBA. The evaluation of cash flows, or the financial CBA, shows all three land uses to yield positive returns (although the larger units yield considerably more than smaller plots). These are on average far higher than the returns obtained in forestry (timber production). A broader opportunity cost-based CBA includes non-monetary factors such as household labour and subsistence consumption of milk and beef, as well as cash flow. On this basis returns to ranching fall, and small ranches in particular (less than 80 hectares) appear to lose money.

The economic CBA converts all costs and prices to their shadow values by removing tax and price distortions. Discount rates of between 10% and 13% used for the private CBA are replaced by a lower value of 9% in the economic CBA. These changes improve returns, but small-scale ranchers continue to make losses. An attempt is made to assess the user cost of soil erosion associated with conversion of forests to pasture, but no evidence is found to support a link between the age of pasture (a proxy for soil erosion) and production levels.

### *Social CBA*

The social CBA focuses on the impacts of forest conversion on three hydroelectric power plants which draw water from Lake Arenal. These plants account for 44% of Costa Rica's hydroelectric power, which itself accounts for over 70% of the nation's total electric power generating capacity. Other off-site impacts (e.g. irrigation and drinking water) are passed over as relatively insignificant. Other environmental impacts (e.g. biodiversity) are also excluded from the quantitative analysis, but are considered in qualitative terms and some estimates are made for the benefits of carbon storage. No attempt is made to incorporate existence or option values.

The evaluation of off-site hydrological impacts is based on an algorithm developed by Aylward (1998) which links land use change to welfare change. The algorithm incorporates changes in sedimentation and run-off associated with forest conversion, and provides a framework for estimating impacts on dead and live storage in reservoirs, in a context of changing demand and supply of electricity through time.

Contrary to expectations, the analysis shows that the impact of forest conversion on hydroelectric power production is broadly positive. Increased sedimentation due to forest conversion does slightly reduce the capacity of the reservoir to hold water for electric power generation. However, the benefits of increased water run-off in terms of additional electric power generating capacity are far more significant. The analysis suggests that conversion of forests to ranching results in net economic benefits ranging from US\$610 per hectare in the least profitable case of small-scale ranching to over US\$8,700 per hectare in the case of dairy farming by Dos Pinos Producers. Only small holders undertaking ranching in the lower west region achieve negative returns of US\$(185) per hectare. These figures include the avoided costs of forest protection (the alternative land use).

For each CBA, the authors undertake sensitivity analyses. The main factors tested for their importance to the results include:

- the social and private discount rates;
- input and output prices related to ranching production; and
- assumptions relating to hydrological impacts such as seasonal water flows and the order and length of the wet and dry seasons.

**Valuation techniques used:** Market prices are used in the calculation of landowners' cash flows which form the basis of the financial CBA. Shadow prices are used to calculate both the non-marketed costs and benefits and to adjust market prices for policy distortions in the private opportunity-cost CBA and the economic CBA.

Valuation of off-site impacts on hydroelectricity production is more complex. The authors draw on both production function and replacement cost approaches to calculate the impacts of forest conversion. Both techniques are incorporated into an algorithm, which in turn has four key parts: (1) formulas linking land-use types to deposits of sediment in the reservoir; (2) formulas linking these deposits to certain operational features of the reservoir, e.g. inflows, storage and capacity; (3) a production function linking reservoir productivity to hydroelectricity generation; and (4) the marginal opportunity cost of alternative power sources, e.g. thermal power. Application of the algorithm to the Rio Chiquito study site involved considerable background research of existing literature, as well as primary data collection.

**Comments:** The study presents a detailed analysis of the impacts of forest conversion on hydroelectricity production. The results are of interest to both land-use planners and researchers, illustrating how forest conversion can sometimes have positive external impacts, as well as presenting a methodology for use in similar assessments in other watersheds. As with many valuation exercises, however, wider application in other countries may be limited by available resources (labour, funding and data).

The report is less thorough with regards to other elements of the CBA. For instance, apart from impacts on hydroelectric power generation, no other offsite impacts (e.g. drinking water) are included in the social CBA. Moreover, the alternative land use option associated with forest cover is not explained in detail here and appears to change from forest extraction in the case of private CBAs to protection in the case of the social CBA. No explanation is given for not including multiple-use forestry as an alternative to ranching in the social analysis. Also, as the authors note, there are potential revenues consistent with forest protection (e.g. from eco-tourism and bioprospecting) which are not explored here.

#### **Key references:**

Aylward, B. 1998. *Economic Valuation of the Downstream Hydrological Effects of Land Use Change: Large Hydroelectric Reservoirs*. Ph.D dissertation, Fletcher School of Law and Diplomacy: Medford, MA.

**Baldares C., Laarman, M.J. and J.G. Laarman. 1990. "User Fees at Protected Areas in Costa Rica" in Vincent, J.R., Crawford, E.W. and J.P. Hoehn (eds.) *Valuing Environmental Benefits in Developing Economies: Proceedings of a seminar series held February-May 1990*, pp. 87-108. Michigan State University: Ann Arbor, MI.**

**Type of assessment & main findings:** The paper presents the results of a study of willingness-to-pay (WTP) for four protected areas in Costa Rica (three National Parks - Poas, Manuel Antonio, and Cahuita - and one private reserve - Monteverde). Respondents are distinguished according to whether they are local residents or foreign visitors. All visitors are found to be willing to pay higher fees than the existing charges, on average 25 Colones (US\$ 30) more, but the increase varies by place of residence and according to whether the respondent is a local resident or foreigner. Both residents and non-residents agree that residents should pay less. The paper concludes that an increase of 100% in the resident user fee (to 50 Colones) and of 200% in the non-resident fee (to 100 Colones) would generate substantial revenues.

**Empirical data:** Willingness-to-pay was estimated using survey responses from more than 860 visitors during selected days in August through October 1989. Respondents were asked to select among ten possible fee levels, ranging from zero to 1000 Colones. The following variables were expected to affect WTP: place of residence (Costa Rica or elsewhere), the area visited, number of family members entering together, main purpose of the visit, length of stay, perceived satisfaction with the visit, number of previous visits or other experience factors, income, education, age and sex (the latter four as control variables). Responses of zero charge were not considered.

**Economic values considered:** Direct use values (recreation).

**Socio-economic groups affected:** Visitors of protected areas.

**Comments:** The main purpose of the paper is to show that different user fees for residents and non-residents (in order to account for income disparities) is a valid and feasible instrument to achieve greater fairness and higher revenues to National Parks in Costa Rica.

**Bateman, I.J., Lovett, A. and J. Brainard. 1996. "Transferring Benefit Values: A GIS Approach". Paper presented at the Posford Duvivier Environment/CSERGE seminar and workshop: *The Contingent Valuation Method: Academic Luxury or Practical Tool*, 7-8th May. Department of Economics, UCL: London.**

**Type of assessment & main findings:** The paper explores the potential for using existing valuation estimates for amenity benefits in specific woodland areas to value other sites. While such "benefit transfer" studies have been conducted in the USA, this paper represents the first attempt in the UK. Two applications of benefit transfer are presented.

**Empirical data:** Information for the analysis was taken from an earlier joint travel cost and contingent valuation study reported in Bateman (1993) and Bateman and Turner (1993). Integrating information on woodland visitor origins with a geographical information system (GIS), the authors produced maps indicating travel time to Thetford Forests in East Anglia.

For the second study, information on socio-economic characteristics (unemployment) and substitute recreation sites is gathered from secondary sources including the 1991 UK Census, the Land Cover Map of Great Britain and Whiteman (1995).

**Economic values considered:** The authors analyse existing TCM and CVM studies in the UK in an attempt to establish a mathematical relationship between rates of visitation at recreational sites and various exogenous factors (e.g. the distance between recreational sites and different residential areas, the time taken to travel there, the accessibility of substitute sites, socio-economic characteristics of visitors, etc.). Such a model could be used to predict visits to recreational sites and WTP for each site's amenity values and thus reduce the need for land-use planners to commission new studies each time they wish to consider options for new or existing recreational sites.

As a first step in developing such a model, the authors consider a case study. Using data on visitation rates, road networks, time and distance travelled to Thetford Forest in East Anglia, they devise a model linking visitation rates from particular points of origin to travel times. A statistically significant inverse relationship is found. The model's predictive power is tested in a sample of Welsh recreational sites for which information on distances from urban centres, road networks and travel time are collected. The model predicts over 90% of actual visitation rates.

In addition to predicting visitation rates, the authors aim to predict individuals' WTP for access to woodland sites for recreational purposes. Based on a review of existing CVM studies, the authors identify nine previous studies reporting 48 estimates of WTP (per person and per visit). These are considered sufficiently robust and comparable to support a predictive model, despite the fact that the nine studies used slightly different techniques to elicit WTP bids.

In a second part of the paper, the authors describe more recent efforts to develop predictive models for land-use planners. The aim is to elaborate the relatively simple model described above, which uses just one independent variable - travel time. A new model proposed here includes additional determinants of

visitation rates, namely a socio-economic factor (male unemployment levels), and the proximity of substitute recreational sites. Information on these variables is grouped into 4 and 3 classes respectively and combined with information on travel time before being mapped and integrated in the GIS. Visitation rates are then calculated as a function of all three factors.

Despite various drawbacks with the model highlighted by the authors, notably problems associated with grouping data into categories, both the socio-economic and substitute factors are found to improve the model's predictive power. The authors conclude that the use of existing studies to predict recreational values in new sites has potential, but there is a need for more data to allow more accurate comparisons.

**Comments:** The study presents an interesting approach to cutting the costs of valuation studies. Generic models which relate environmental benefits or costs to physical and socio-economic factors in a consistent way would allow land-use planners to avoid commissioning expensive studies each time they consider a new project. This approach may have special appeal in developing countries, where resources to conduct valuation studies are limited.

On the other hand, while the cost-savings to be gained through the development of predictive models may be substantial, the authors' argument is somewhat weakened given their emphasis on the need for plenty of high quality data for such models to be developed in the first place. Given the difficulties they faced in assembling the necessary data in the UK, the prospects for using a similar approach in poorer countries are daunting.

#### **Key references:**

Bateman, I.J. 1993. *Valuation of the Environment, Methods and Techniques: Revealed Preference Methods* in Turner, R.K. (ed.) *Sustainable Economics and Management: Principles and Practice*. Belhaven Press, London, pp. 192-265.

Bateman, I.J. and R.K. Turner. 1993. *Valuation of the Environment, Methods and Techniques: The Contingent Valuation Method* in Turner, R.K. (ed.) *Sustainable Economics and Management: Principles and Practice*. Belhaven Press, London, pp. 120-191.

Whiteman, A. 1995. *The Supply and Demand for Timber, Recreation, and Community Forest Outputs from Forests in Great Britain*. Ph.D dissertation, University of Edinburgh.

**Bennett, E.L. and C.J. Reynolds. 1993. "The Value of a Mangrove Area in Sarawak" in *Biodiversity and Conservation* 2: 359-375.**

**Type of assessment & main findings:** A financial CBA is undertaken to evaluate the case for maintaining Sarawak Mangroves Forest Reserve, Malaysia, versus its conversion for oil palm plantations and prawn ponds. The main finding is that the returns to conversion are outweighed by the forgone benefits of conservation.

**Empirical data:** The study reports the following data:

- market value of commercial forestry products extracted from the Reserve in 1989 (mangrove poles, charcoal, semi-charcoal and cordwood); and
- revenues from fishing and tourism in the area for 1989.

**Economic values considered:** Direct and indirect use values for several products:

- on-site mangrove products (mangrove poles and charcoal);
- off-site mangrove products (tourism and fish production);
- oil palm plantation products; and
- prawn pond products.

**Valuation techniques used:** Market prices and a simplified production function approach (PFA) are used to estimate the benefits of maintaining the mangrove. Market prices are used to calculate the direct use values of on-site mangrove products. The PFA is used to estimate off-site fishing and tourism benefits which are supported indirectly by the existence of the mangrove. Additional indirect benefits such as conservation of wild species, mitigation of flood risk/damage, prevention of coastal erosion and protection of adjacent agricultural land from saline intrusion are mentioned but not estimated in monetary terms.

*Fishing:* The authors argue that virtually the entire marine fishery catch in the Kuching Division of Sarawak is dependent on the mangrove, in part because the reserve is the last remaining large area of relatively intact mangrove in the region. On these grounds they estimate that converting the mangroves could result in a loss of up to US\$19.3 million, which was the total income derived from commercial fisheries in the Kuching Division in 1989. While the study does not undertake a full cost appraisal, the authors estimate that the capital costs of commercial fishing accounted for less than US\$1 million of this figure. In addition, subsistence fishing valued at 10-20% of the income from commercial fisheries (i.e. US\$1.9 - 3.9 million per year) is also considered to be threatened by mangrove conversion.

*Tourism:* The authors claim that conversion of the mangroves could lead to the slow death of nearby coral reefs and the silting of local beaches, in an area they call "the most important coastal tourism spot in Sarawak". The authors estimate that at least half the tourism industry would be lost. The industry generated total revenues of about US\$3.7 million in 1989.

*Conversion benefits:* The benefits of converting the reserve consist of potential revenues from oil palm plantations and/or prawn ponds. Gross revenues from palm oil production are estimated from

secondary data and total US\$14 million per year. Due to high capital costs, estimated net revenues are much lower, at US\$1.67 million per year. The latter, in turn, is far less than the income from fisheries associated with preservation of the reserve. Estimated output of fish biomass from prawn ponds (again based on secondary data) is less than that from existing onshore and offshore fisheries. Cost differences between prawn ponds and other fishing activities are not considered.

**Socio-economic groups affected:** Local residents engaged in fishing, forest product harvesting and tourist industries; urban residents; international tourists.

**Comments:** The authors acknowledge that their quantitative analysis is very approximate, using data for just one year and including output figures which may represent excessive (unsustainable) harvest levels for various products. Moreover, the costs of different activities are treated inconsistently, with deductions in some cases but not others. Notwithstanding these limitations, the authors argue that conservation is a more attractive than conversion.

**Browder, J.O. 1985. *Subsidies, Deforestation, and the Forest Sector in the Brazilian Amazon*. World Resources Institute: Washington, D.C.**

**Type of assessment & main findings:** The author undertakes financial analyses of the net returns to livestock ranching (and thus pasture formation). The aim of the study is to investigate the impacts of government subsidies on deforestation. Three principal incentive schemes considered are capital investment incentive programmes, rural credit programmes and colonization programmes (some since discontinued).

The main means of financing was through the Superintendency for the Development of the Amazon (SUDAM), which provided tax credits and exemptions for the establishment of large-scale pasture formation and ranching operations. Survey data was used to examine the cost structure and returns for a typical SUDAM-financed beef cattle ranch during a five-year development period. The analysis indicates that, on average, the subsidy amounted to 54% of livestock project development costs in Amazonia. In addition, half of the remaining investment by private ranch operators was financed through subsidized rural credit loans.

**Empirical data:** Cost data for livestock ranching was collected through a survey of 21 government-financed livestock ranching operations in the Legal Amazon in 1984-85. Regional data on deforestation due to pasture formation are presented, along with estimates of the effects of government subsidies on land use, prices and quantities.

**Economic values considered:** Direct use values for livestock, crop and timber production.

**Valuation techniques used:** Market prices and expenditures.

**Socio-economic groups effected:** Ranchers, farmers, timber producers.

**Comments:** The analysis of the impacts of government subsidies on financial returns to pasture formation is persuasive and relevant, notwithstanding subsequent policy reforms. Much of the information contained in this report was re-used in Browder (1998), Browder (1990) and Repetto and Gillis (1988). The first of these is reviewed below.

**Key references:**

Browder, J.O. 1988. The Social Costs of Rainforest Destruction: A Critique and Economic Analysis of the 'Hamburger' Debate" in *Interciencia* 13(3): 115-120.

Browder, J.O. 1990. *Social and Economic Constraints on the Development of Market-Oriented Extractive Systems in Amazon Rain Forests*. Draft paper. Virginia Polytechnic Institute: Blacksburg, Virginia.

Repetto, R. and M. Gillis (eds.) 1988. *Government Policies and the Misuse of Forest Resources*. World Resources Institute, Washington, DC.

**Browder, J.O. 1988. “The Social Costs of Rain Forest Destruction: A Critique and Economic Analysis of the ‘Hamburger’ Debate” in *Interciencia* 13(3): 115-120.**

**Type of assessment & main findings:** The paper presents an economic CBA of ranching in Amazonia, with an emphasis on the social opportunity costs of foregone timber and government expenditure on subsidies to ranchers. Government subsidies are valued at US\$224 per hectare, on average, while foregone timber values are estimated at US\$511 per hectare, for a total social opportunity cost of US\$735 per hectare, on average. This may be compared to the estimated average NPV of ranching (US\$162 per hectare).

**Empirical data:** see Browder (1985), above.

**Details of CBA:** The evaluation builds on earlier work reported in Browder (1985) and includes the estimated social costs of pasture formation, in terms of the opportunity cost of public funds used to subsidize ranching and the opportunity cost of merchantable timber lost during forest clearance and conversion to pasture.

**Economic values considered:** Direct use values (timber, livestock).

**Valuation techniques used:** The opportunity cost approach is used to value the social costs of the government’s ranching subsidy schemes. The opportunity cost of government expenditure is calculated using the average annual returns on investments in US long-term corporate bonds, government securities and Treasury Bills. This is multiplied by the total US\$ equivalent annual government disbursements for ranching between 1966 and 1983 (for tax credits) and from 1977 to 1983 (for rural credit subsidies). The opportunity cost of lost timber is calculated based on an estimate of the volume of timber felled but not sold. Browder assumed 50% of timber was lost. Social opportunity costs are aggregated over the period 1966 to 1983.

**Socio-economic groups affected:** Ranchers and timber producers.

**Comments:** The study focuses on timber wastage to evaluate the opportunity cost of lost timber, but does not consider the loss of potential future streams of income from sustainable timber production as an alternative land use to ranching. The analysis also excludes the costs of pasture formation linked to environmental impacts, lost NTFPs and foregone option and existence values.

**Key references:**

Anderson, A.B. 1989. “Ecological Ingredients for Successful Extraction”. Paper presented at the *Symposium on Extractive Economies in Tropical Forests: A Course of Action*. National Wildlife Federation, 30 November - 1 December 1989, Washington, D.C.

Lafluer, J. 1989. "Alternative Economic Models for Elevating Forest Value in Amazonia." Paper presented at the *Symposium on Extractive Economies in Tropical Forests: A Course of Action*. National Wildlife Federation, 30 November - 1 December 1989, Washington D.C.

**Browder, J.O., Matricardi, E.A.T. and W.S. Abdala. 1996. "Is Sustainable Tropical Timber Production Financially Viable? A Comparative Analysis of Mahogany Silviculture Among Small Farmers in the Brazilian Amazon" in *Ecological Economics* 16: 147-159.**

**Type of assessment & main findings:** The paper presents a financial CBA comparing net returns per hectare of three small-scale mahogany planting regimes in the Brazilian state of Rondonia: degraded fallow enrichment planting; agroforestry (mahogany and coffee); and pure-stand mahogany plantations. The authors conclude that pure-stand plantations are the least risky and most financially lucrative option, although they require greater capital inputs and may be more environmentally damaging.

**Empirical data:** The study reports the following data:

- details of mahogany plantings on seven farms. Information is provided on planting, spacing, mortality, diameter at breast height (DBH), average annual increment, expected years to harvest, rate of shoot-borer attack, etc.
- local unit costs for key inputs, including fertiliser, insecticide, fungicide, ant killer, seedlings and transport.

**Details of CBA:** The analysis is conducted from an individual farmer's perspective. Only financial costs and benefits and direct use values (timber) are considered. Sensitivity analysis is used to assess the vulnerability of net revenues to changes in tree survival, maturation period, real interest rates, the opportunity cost of labour, and the farm-gate price of mahogany roundwood.

Environmental impacts are considered in qualitative terms. Pure-stand plantations are the most desirable alternative from a strictly financial perspective, but may have negative environmental impacts. However, the authors note that investment in mahogany plantations outside the Amazon region could have a positive impact on tropical forest conservation, by alleviating pressure on the remaining natural forests. The authors also suggest that intensive mahogany production outside the Amazon region may justify the conservation of large tracts of undisturbed mahogany habitat, as a genetic seed bank.

**Valuation techniques used:** Market prices used where available. Other values are estimated using the opportunity cost of labour approach.

**Socio-economic groups affected:** Small-holder farmers.

**Comments:** No attempt is made to value non-marketed goods and services.

**Chopra, K. 1993. “The Value of Non-Timber Forest Products: An Estimation for Tropical Deciduous Forests in India” in *Economic Botany*, 47(3): 251-257.**

**Type of assessment & main findings:** The paper presents a financial CBA of non-timber benefits per hectare for tropical moist (37.0% of total forest area) and tropical dry (28.6%) deciduous forests in India. The sum of direct and indirect use values is estimated to fall between US\$220 and \$357 per hectare per year.

**Empirical data:** Secondary data on monetary values for fuelwood, fodder and other forest products, soil conservation, nutrient cycling, tourism and recreation are used, drawn from a range of studies carried out in India and elsewhere.

**Details of CBA:** The analysis includes direct and indirect use values, option and existence values, and is undertaken from an economic perspective. A 12% discount rate over a 30 year time horizon is used to convert annual returns into net present values (NPV).

**Valuation techniques used:** Various market and non-market techniques are used in the source studies, including substitute pricing, cost-based and experimental approaches. Details of the underlying data and valuation procedures are not described here. Where available, alternative estimates for a single good/service are reported.

Item	Valuation technique	Source
Fuelwood	1. Substitute good approach - price of soft coke. 2. Labour inputs - cost of time spent in collection.	Chopra (1987 - not listed) Sharma and Bhatia (1986)
Fodder	PFA - market value of fertilizer and milk output from cattle feeding on established pasture and scrubland.	Fleming (1983)
Other forest products ( <i>sal</i> and <i>bidi</i> leaves, <i>tassan</i> cocoons, dyes and lacquer)	Labour inputs (as above).	Bajaj (1990)
Soil conservation benefits	1. Replacement cost approach - cost of fertilizer required to restore nutrients lost due to soil erosion. 2. Restoration cost technique - cost of dredging accumulations of silt downstream.	Hufschmidt <i>et al.</i> (1983); Chopra, Kadekodi and Murty (1990)
Nutrient cycling function	Experimental data on litter fall in different kinds of forest.	Mishra (1969)
Tourism and recreational values	Based on aggregate expenditure data from the national accounts.	Lal (1992)

Option value	Assumed equivalent to user cost, i.e. the amount of annual income that must be invested in order to ensure an equivalent perpetual income stream upon exhaustion of the resource. With a 6% “rate of pure time preference” and assuming 30 years to exhaustion the resulting user cost or option value equals 16% of current annual revenue.	Based on methods suggested in Brookshire, Eubanks and Randall (1983)
Existence value	Estimated at 91% of the sum of use and option values.	Based on estimates in Pearce and Turner (1990)

### Key references:

Bajaj, M. 1990. “Natural Regeneration vs Afforestation: An Examination of the Potential for Investment in Natural Regeneration of Degraded Forests, with Community Participation”, Paper presented at a *Seminar on the Economics of the Sustainable Use of Forest Resources*, Centre for Science and Environment, New Delhi.

Brookshire, D., Eubanks, L. and A. Randall. 1983. “Estimating Option Prices and Existence Values for Wildlife Resources” in *Land Economics* 59:1-15.

Chopra, K., Kadekodi, G.K. and M.N. Murty. 1990. *Participatory Development: People and Common Property Resources*. Sage Publications India, Pvt. Ltd: New Delhi.

Fleming, W.M. 1983. “Phewa Tal Catchment Management Programme: Benefits and Costs of Forestry and Soil Conservation in Nepal” in Hamilton, L.S. (ed.) *Forest and Watershed Development and Conservation in Asia and the Pacific*. Westview Press: Boulder, CO.

Hufschmidt, M.M., James, D.E., Meister, A.D., Bower, B.F. and J.A. Dixon. 1983. *Environment, Natural Systems and Development: an Economic Valuation Guide*. Johns Hopkins: London.

Lal, J.B. 1992. “Economic Value of India’s Forest Stock.” In Agarwal, A.A. (ed.). *The Price of Forests*. Centre for Science and Environment: New Delhi.

Mishra, R. 1969. “Studies on the Primary Productivity of Terrestrial Communities at Varanasi” in *Tropical Ecology* 10:1-15.

Pearce, D.W. and R.K. Turner. 1990. *Economics of Natural Resources and the Environment*. Harvester Wheatsheaf: New York.

Sharma, R. and R. Bhatia. 1986. *India: Meeting Basic Energy Needs of the Poor*. Vol. 2 ILO-Artep: New Delhi.

**Davies, J., Richards, M. and W. Cavendish. 1999. *Beyond the Limits of PRA? A Comparison of Participatory and Conventional Economic Research Methods in the Analysis of Ilala Palm Use in South-eastern Zimbabwe*. Overseas Development Institute: London.**

**Type of assessment & main findings:** The study provides insight into the costs and benefits of alternative methods of collecting economic information on NTFPs. Participatory methods (PRA) and conventional surveys are used to evaluate the economic returns from Ilala palm extraction in south-eastern Zimbabwe. The focus of discussion is on the relative merits of different data gathering techniques rather than the value of alternative uses of palms.

**Empirical data:** Information was collected on the direct use values of Ilala palm using a random single-visit household survey, key informants and PRA. The key informant approach was found to be compatible with both PRA and household survey methods. Data include the relative importance of different palm-based occupations (wine producers, craftswomen and craftsmen), the main sources of cash income, output of Ilala palm-based products (wine, baskets, thatch, sleeping mats, crafts, etc.), and sales, trade and/or domestic use of these products. Information on labour inputs was also recorded.

**Economic values considered:** Information on direct use values (e.g. wine, food and craft production), indirect use values (the role of palms in stabilising soil) and non-use values (cultural and social) are collected using both household surveys and PRA. Data gathered are used to assess gross and net margins for different types of palm-based outputs.

**Comments:** The authors conclude that household surveys are not as effective as PRA for gathering qualitative information, but are more accurate where quantitative information is required, eg. cash income and levels of production. Whereas PRA tends to produce broad averages, household surveys highlight individual experiences and diversity within groups. The PRA approach also required much more of the community's time, up to five times as much as the survey. While surveys appears to offer more precise information at lower cost, the authors stress that this does not mean that surveys are always preferable. The choice depends on various factors including the type of information sought (PRA may be better for eliciting qualitative information) and whether the researchers wish to stimulate discussion among local stakeholders (PRA is again better at this). The authors also point out that the two approaches could be used in various combinations tailored to the needs of a particular study.

#### **Key references:**

Emerton, L. 1996. *Participatory Environmental Evaluation: Subsistence Forest Use Around the Aberdares, Kenya*. African Wildlife Foundation, Nairobi.

Lynam, T., Vermeulen, S. and Campbell, B. 1991. *Contingent Valuation of Multipurpose Tree Resources in the Smallholder Farming Sector, Zimbabwe*. Paper accepted for presentation at the 11th Annual AFSRE Symposium, October.

**Dixon, J. and P. Sherman. 1990. “Analyzing a National Park (Khao Yai)” in Dixon, J. and P. Sherman (eds.) *Economics of Protected Areas: A New Look at Benefits and Costs*. Earthscan: London.**

**Type of assessment & main findings:** The study involves an economic CBA of the continued protection of the Khao Yai National Park in northern Thailand compared to alternative land uses including hunting, logging and gathering of forest products.

**Empirical data:** Data is from field visits, secondary sources and collaboration with an IUCN-WWF supported Beneficial Use Project (Dobias 1988; Dobias *et al.* 1988).

**Details of CBA:** Includes use and non-use values; undertaken from a social perspective. Important use values associated with protection are tourism, research and education. Existence and option values are also considered. The indirect use value of biodiversity is thought to be partly captured by existence and option values, which are estimated at over 120 million Baht (US\$4.7million) per year. Benefits are weighed against the costs of giving up traditional forest uses such as logging, hunting, gathering and development for agriculture. Although benefits from hydrological impacts are not included in the CBA, they are quantified in physical terms.

**Valuation techniques used:** Both primary and secondary sources are used to value the various non-marketed costs and benefits using a range of different approaches.

Results of a CV study undertaken under the Beneficial Use Project are used to estimate existence and option values. The survey asked park users their maximum willingness-to-pay (WTP) to ensure the continued existence of elephants in the wild in Thailand. The average WTP came to 181 Baht (US\$7). Park users' value is aggregated for all Thai visitors and added to an estimated WTP for non-park users. The latter is assumed to equal one tenth of the park user's WTP.

Financial and economic values are calculated for tourism benefits. Financial value is derived using statistics collected for the Beneficial Use Project on the mean tourism-related expenditures per person, i.e. accommodation, gate fees, food, transport and guide service, multiplied by the annual number of visitors. The total comes to between 40 and 200 million Baht (US\$1.5 to \$7.7 million). An estimate of economic benefits is derived from a TC study of consumer surplus for the Lumpinee Park in Bangkok. The authors assume the surplus for Khao Yai is five times greater at 13 million Baht (US\$ 490,000) to account for inflation and the larger clientele.

Research and education benefits are based on scientific expenditures within the park. Reports on the Khao Yai Beneficial Use Project (Dobias 1988; Dobias *et al.* 1988) provide some data on scientific expenditure within the park. Research activities within Khao Yai have mainly focused on Gibbons, Hornbills, and Elephants, and involved expenditures of more than 3.6 m Baht. The research-cum-demonstration projects totalled more than 7.1 m Baht in expenditures (not all in Khao Yai). These expenditures do not represent economic value *per se* but they do indicate a minimum reveal preference to take advantage of the Park's resources. Furthermore, foreigners who come to Khao Yai to do

research add to the overall tourism statistics for the country and bring in foreign exchange, while some projects employ Thais as assistants and, therefore, provide employment and training opportunities. While hydrological benefits are not valued, they are described in physical terms. The Park is the main watershed for two major reservoirs which supply water for irrigation and for hydroelectric power. The authors refer to two studies showing that conversion from forest to agricultural land results in increased runoff (Kaeochada 1984; Kasetsart University 1982). They go on to identify data requirements for calculating the value of the Parks' watershed protection function, using either the mitigation cost approach or the production function approach.

The opportunity cost of park protection is assessed using estimates of village income foregone due to prohibitions on traditional hunting of animals, felling of trees and gathering of plants. The continuation of some extraction on an illegal basis is taken into account. A rough estimate of the gross value of resources extracted from Khao Yai is based on data found in a survey reported in the Khao Yai Management Plan (NPD 1986) and assumptions made about current and future use. In the survey 61% of the villages claimed that to support themselves they needed to supplement their income through illegal use of the park. The total income from park resources is estimated at 13.5 million Baht per year, i.e. 2,000 households (60% of those residing in the park) x 0.25 (assumption that the average family receives 1/4 of its income from park resources) x 27,000 Baht (average yearly income of a family of five according to a survey). Assuming that current enforcement reduces illegal use by about two-thirds, in the absence of any enforcement the total use value would be 40.5 m Baht (13.5 x 3). In this case the opportunity cost of protecting Khao Yai would be 27 million Baht per year (40.5 m Baht less 13.5m Baht). The main opportunity cost associated with Thale Noi NP is the benefit forgone from not being able to hunt certain species. Based on the results of a survey conducted by TISTR, it is assumed that 29% of those who cease hunting do so because of changes in hunting regulations and that approximately 1,750 households are affected by the regulations. The data required to estimate this opportunity cost, such as the average number and type of bird killed or captured each year, the value of each bird and the costs associated with hunting, were not available.

**Socio-economic groups affected:** villagers suffer income losses as a result of restricted access.

**Comments:** A number of possible valuation methodologies not used in this study are discussed. For instance the mitigation-cost method and the change-in-productivity approach are considered as potential options for estimating the hydrological benefits of forest protection. Improved survey methods to assess changes in visitors' knowledge and opinions before and after their visit to Khao Yai are also discussed.

#### **Key references:**

Dobias, R. 1988. *Influencing Decisions Makers About Providing Enhanced Support for Protected Areas in Thailand*. Report to WWF Beneficial Use Project, Contract 3757.

Dobias, R., Wangwacharakul, V. and N. Sangswang. 1988. *Beneficial Use Quantification of Khao Yai National Park: Executive Summary and Main Report*. Thorani Tech. for WWF: Bangkok.

Eutrarak, S. and S. Grandstaff. 1986. "Evaluation of Lumpinee Public Park in Bangkok, Thailand" in Dixon, J. and M. Hufschmidt (eds.). *Economic Valuation Techniques for the Environment*. John Hopkins University Press: Baltimore.

**Emerton, L. 1996. *Participatory Environmental Evaluation: Subsistence Forest Use Around the Aberdares, Kenya*. African Wildlife Foundation, Nairobi, Kenya, summarised in Bagri, A., Blockhus, J., Grey, F. and F. Vorhies (eds.). 1998. *Economic Values of Protected Areas: A Guide for Protected Area Managers*. IUCN: Gland.**

**Type of assessment & main findings:** Contingent ranking (modified CVM) is used to assess the importance of forest resources to local communities in the Aberdares of Kenya. A net present value of US\$306 per household per annum is estimated, expressing the potential losses to local people of restricting forest use.

**Empirical data:** Survey data was used to collect information on the value of timber and NTFPs as well as labour inputs to their collection.

**Economic values considered:** Direct use values for timber and NTFPs.

**Valuation techniques used:** The author argues that hypothetical cash payments (the usual CV approach) have little meaning in the communities surveyed. Hence questions relating to WTP are abandoned in favour of an alternative “contingent ranking” approach. This involves depicting various forest benefits on cards (e.g. timber, fuelwood, grazing, etc.) and asking people to weigh and rank their relative importance using seeds, stones or other counters. The resulting scores are “anchored” with respect to monetary value by including among the cards a common marketed product (e.g. a radio, bicycle or milk cow), which is weighed and scored at the same time as forest benefits. Based on the score attributed to the marketed item, other benefits are valued indirectly. For instance, if a radio is given a score of 5 seeds and costs \$20, then each seed is assumed to be “worth” \$4. On this basis, fuelwood scored using 10 seeds would be valued at \$40. Forest benefits valued in this way are discounted to 1996 prices and expressed in terms of annual averages per household (US\$306).

**Socio-economic groups affected:** The study focuses on the importance of forests to rural communities and, by implication, the distributional consequences of restricting forest use.

**Comments:** While the study limits itself to direct use values, the same methods could be extended to estimate other benefits, e.g. watershed protection services or non-use values. However, as with all applications of contingent ranking, the resulting value estimates may not reflect true WTP.

#### **Key references:**

Kramer, R.A., N. Sharma, P. Shyamsundar and M. Munasinghe. 1994. *Cost and Compensation Issues in Protecting Tropical Rainforests: Case Study of Madagascar*. Environment Working Paper No. 62, The World Bank: Washington, D.C.

**Evenson, R.E. 1990. "Genetic Resources: Assessing Economic Values" in Vincent, J.R., Crawford, E.W. and J.P. Hoehn (eds.). *Valuing Environmental Benefits in Developing Economies: Proceedings of a Seminar Series held February-May 1990*, pp. 169-189. Michigan State University: Ann Arbor.**

**Type of assessment & main findings:** The paper presents estimates of the economic value of rice genetic resources in India, and in the world, using the production function approach. A CBA is then developed, based on these estimates of the potential benefits of the preservation of genetic material and the costs of maintaining gene stock collections.

**Empirical data:** Data on varietal improvements in rice and changes in productivity for 240 districts of India are presented for the period 1959-84. The costs of maintaining germplasm collections in India and the world are also given.

**Details of CBA:** The study evaluates the net benefits of maintaining an *ex-situ* supply of genetic material for rice, using a two-stage regression analysis of data from 240 districts of India. The first stage involves an estimation of the relative contribution of overall varietal improvement to productivity growth in rice cultivation over the period 1959-84. If the contribution of modern high-yielding varieties (HYV variable) to rice productivity is significant, then in the second stage variables measuring the genetic content of varieties actually planted by farmers are substituted in the analysis for the HYV variable. The second stage was undertaken only for the most recent five-year period (1979-84), and the analysis focuses on whether rice yields were systematically related to the genetic content of the varieties planted by farmers.

The results indicate that varietal improvement was a significant determinant of rice yields for Indian districts over the 1959-84 period. Moreover, the estimates showed that varietal change contributed more than one-third of the total rice productivity gains realized in the post-Green Revolution period (1972-84). From these results, impact elasticities are measured (percent changes in yield from a unit-change in the genetic content variable). In the case of Indian rice plantations, the author argues that yields were 5.62% higher than they would have been if no new genetic resources beyond the original Green Revolution resources had been available to breeders. Assuming a 20 year average time lag between incurring costs and realising benefits, this represents an average annual yield increase of 0.5% over the period 1973-84.

In present value terms, the annual yield increase is worth only 0.061% assuming a 10% discount rate (0.027% at a 15% discount rate). Multiplying these numbers by the value of India's rice crop (the author states that it is approximately US\$10 billion, without specifying the year), the annual discounted benefit derived from the genetic resource is obtained: US\$50 million, with a present value of US\$6.1 million (10% discount rate) or US\$2.7 million (15% discount rate). The costs of maintaining the Indian rice germplasm collections are much lower (US\$0.3 million/year).

Since germplasm collections are exchanged internationally, a global calculation was also made using the same impact function estimated for India (0.5% increase in output per unit input 20 years from now).

The results again suggest that benefits (US\$74 millions at 10% discount rate or US\$32 millions at 15%) exceed costs (US\$20 millions).

**Valuation techniques used:** The production function approach was used to link the value of genetic material to increased rice output, reflecting the development of new rice varieties.

**Socio-economic groups affected:** Producers (farmers), centres of agricultural research and germplasm collections.

**Comments:** The study considers the costs of maintaining genetic collections but not the costs of adopting new varieties or increasing rice production. Using gross agricultural returns rather than net returns or value-added to determine the value of yield increases may thus over-state the value of genetic management. Nevertheless, the study is a potentially useful model for valuing forest biodiversity values. In the case of forests, however, there may be serious data constraints, as information on the extent of genetic variation in forest plant and animal species and potential commercial applications remains limited.

**Godoy, R. and T. Feaw. 1989. "The Profitability of Smallholder Rattan Cultivation in Central Borneo" in *Human Ecology*, 16(4): 397-420.**

**Type of assessment & main findings:** The paper presents a financial and economic CBA of smallholder rattan (*irit*) cultivation in Kalimantan, Indonesia, showing that economic returns to rattan production are about 12% less than financial (market) returns. The article includes some discussion of returns per hectare to rattan compared with rubber, rice and seasonal tropical fruit. Returns to labour in rattan cultivation are shown to compare favourably with other occupations.

**Empirical data:** Primary data gathered through individual and community level questioning in the village of Dadahup, along the Lower Barito basin in Central Kalimantan (South Borneo). However, a shortage of time precluded a representative, stratified random sample of farmers. Yield information was supplemented with data from Malaysia.

**Details of CBA:** The authors conduct a financial and economic CBA to estimate the profitability of green and processed rattan cane cultivation by smallholders. The CBA considers only direct use values. The farmgate returns to a representative one hectare plot of secondary forest and abandoned rubber stands over a 25 year period are calculated using a 10% real discount rate.

**Valuation techniques used:** Both market and shadow prices are used. Shadow prices are used to value rattan output and a shadow foreign exchange rate is used to adjust for over-valuation of the Indonesian currency, the Rupiah. For most smallholder inputs and outputs (i.e. land and labour), however, it was assumed that market prices were not significantly distorted. Financial (market) prices for green and processed cane at the farmgate were Rupiahs 350,000 per metric tonne (Rp/mt) and 1,776,191 Rp/mt, respectively. To determine the farmgate shadow price for processed rattan it was first necessary to estimate the shadow free on board (fob) price. Given that Indonesia was the major world producer of *irit* in 1988, when the government declared a ban on trade in processed rattan, prices on the international market were considered unreliable. (As the dominant producer Indonesia was able to influence world prices by controlling output.) The 1988 world market price of processed rattan was estimated instead by projecting pre-ban prices (1981-85) for processed rattan. This price was then adjusted to account for over-valuation of the exchange rate, using a conversion factor of 1.1 to derive the shadow fob price of processed rattan. Finally, marketing and transport costs, other fees and taxes were deducted from the shadow fob price to obtain the shadow farmgate price. Fuel costs were also adjusted using the exchange rate conversion factor. The shadow (economic) farmgate price of processed rattan was thus estimated at 1,897,291 Rp/mt. Estimating the shadow farmgate price for green cane was more problematic because exports of unprocessed cane were banned in the late 1970s. Instead, the percentage price difference between the financial and economic prices of processed cane was assumed to apply as well to green cane. In this way, the financial farmgate price of green cane was adjusted downward by about 5% to obtain a shadow (economic) farmgate price of 331,000 Rp/mt.

**Socio-economic groups affected:** Smallholder farmers.

**Comments:** The study is notable for its careful use of shadow prices to estimate the economic costs and benefits of rattan cultivation.

**Gunatilake, H.M, Senaratne, D.M.A.H. and P. Abeygunawardena. 1993. “Role of Non-Timber Forest Products in the Economy of Peripheral Communities of Knuckles National Wilderness Area of Sri Lanka: A Farming Systems Approach” in *Economic Botany*, 47(3): 275-281.**

**Type of assessment & main findings:** The authors estimate the economic benefits of forest-based activities of peripheral communities in the Knuckles National Wilderness Area in the Kandy and Matale districts of Sri Lanka. The study focuses on the identification, quantification and valuation of NTFP extraction and use. No attempt is made to estimate collection costs.

NTFPs (excluding grazing) are found to provide US\$253 per household per year, equal to 16.2% and 5.3% of total and cash income, respectively. Returns to land from NTFP extraction are about US\$92 per hectare per year, compared to \$399 and \$1,034 per ha/yr from shifting cultivation and cardamom production, respectively.

**Empirical data:** Data derive from a survey of 60 households (out of a population of 317) in three villages. Data reported include the main sources and income obtained from all household economic activities, the total quantity of NTFP's extracted, the number of collectors and the average value of products collected per household per year. A figure showing the relative importance of NTFPs for different income classes is also provided, indicating the expected decline in importance as household income rises. An appendix provides a list of 47 different forest plants commonly collected, grouped according to category of use.

**Economic values considered:** Direct use values of NTFPs were calculated, excluding illegal extraction of wildlife, poles and rattan or products collected irregularly.

**Valuation techniques used:** Market prices of products or prices of close substitutes are used to value the main NTFPs exploited by local communities. A farming systems approach was used to describe all of the economic activities of the community and to estimate net monetary and non-monetary income (without deducting the cost of family labour). Farm and forest gate prices of agricultural and forest products are used to estimate income, adjusted for transport costs where appropriate. Willingness to pay methods (unspecified) were used to value three medicinal plants.

**Comments:** The study compares returns per hectare per year from NTFP extraction to returns from shifting cultivation and cardamom production. It is not clear, however, whether the figures for shifting cultivation and cardamom are based on the total area required, including both cultivated and fallow land. If not, they may be overestimated.

**Hadker, N., Sharma, S., David, S. and T.R. Muraleedharan. 1997. “Willingness-to-pay for Borivli National Protected Area: evidence from a Contingent Valuation” in *Ecological Economics* 21: 105-122.**

**Type of assessment & main findings:** CVM is used to assess WTP of residents of Bombay (Mumbai) for conservation of the Borivli National Protected Area, which covers a fifth of the metropolitan area and is increasingly threatened by encroachment and deforestation. Average household WTP is estimated at US\$0.23 per month, or about US\$31.6 million in aggregate present value terms, which far exceeds the current budget of US\$520,000 to maintain the area.

**Empirical data:** Primary data were collected through a four-part survey administered to about 500 people. Information collected included:

- socio-economic data including age, gender, income, education, occupation, membership of environmental groups, etc.;
- environmental interests, i.e. whether respondents consider themselves “pro-environment”, “pragmatic” or “pro-development”;
- maximum WTP for the introduction of a management plan which will ensure protection of the area, as well as the preferred payment vehicle; and
- respondents’ willingness to volunteer time to help protect the area.

**Economic values considered:** The CVM was administered to both users and non-users of the park for its amenity, or non-consumptive, values. Values of individual components were not evaluated but are likely to include direct and indirect use values and non-use values. The main direct use value of the area is for recreation, with about 2.5 million visitors recorded each year. Indirect use values may be associated with the area’s role as a source of Bombay’s drinking water and as home to many endangered animals. Existence and bequest values may also be important.

**Valuation techniques used:** The CV survey used a double-bounded dichotomous choice formulation (where respondents are offered two bid amounts in sequence and the second bid amount depends on the first response), as well as open-ended questions, to elicit WTP for the implementation of a management plan to protect the area. Respondants were allowed to volunteer time rather than money. Where no payment (either monetary or in kind) is made the existing situation of gradual encroachment and degradation is assumed to continue. WTP is expressed as a monthly payment over a period of five years. Efforts to avoid bias included adoption of recommendations of the NOAA Panel (Arrow *et al.* 1993) to prevent part-whole bias, starting point bias, hypothetical bias and embedding effects. Statistical methods used to reduce bias include elimination of 133 “protest” bids.

**Socio-economic groups affected:** WTP results were analysed with respect to respondents’ age, gender, income, environmental interest, etc. Key determinants of “true” WTP include income, years of schooling, occupation, expressed preference for environmental activities, membership of an environmental group and frequency of visits to the site. Most variables affect WTP as expected, eg. higher income is associated with increased WTP. Interestingly, businessmen express higher average

WTP than professionals, even though businessmen are generally less educated than professionals and WTP increases with education.

**Hodgson, G. and Dixon, J.A. 1988. *Logging Versus Fisheries and Tourism in Palawan*. Occasional Paper No.7, East West Environment and Policy Institute: Honolulu.**

**Type of assessment & main findings:** The paper presents an economic CBA of a proposed logging ban in the Bacuit Bay coastal zone of Palawan, Philippines, in terms of impacts on the forestry, fisheries and tourism industries. The authors estimate total losses in tourism and fishing (US\$17.5-22.6 million) due to sedimentation associated with logging, and point out that these far outweigh the potential benefits from timber production (US\$9.7 million).

**Empirical data:** Data on logging, tourism and fishing are from secondary sources. Timber production is from inventory and yield records. Information on dive-based tourism includes average length of stay, average occupancy rates and advertised daily fee rates plus additional lump-sum fees. Information on fisheries includes catch volume, market prices and costs.

**Details of CBA:** On-site (logging) and off-site (tourism and fishing) benefits are assessed under two scenarios: with and without logging. Other off-site values beyond those captured by estimates of impacts on tourism and fishing are described in qualitative terms, eg. employment generation, job training, infrastructure development, flood protection and wildlife conservation. Costs are incomplete due to data constraints. The CBA assumes a 10 year time horizon (1987 to 1997). The NPV of timber production, using a 10% discount rate, is estimated at US\$9.7 million, falling to zero with a logging ban. Tourism benefits are assumed to be reduced by logging, due to soil erosion and sedimentation. The main tourist attraction for divers are the pristine coral reefs and clear water. The authors predict that in the case of continued logging in Bacuit Bay, tourism will decline by 10% per year due to degradation of seawater quality and marine life on which the diving resorts depend. The NPV from all dive-based tourism is thus estimated to decline from US\$25.5 million in 1987-91 to US\$6.3 million in 1992-96 (using a 10% discount rate). Fishing in Bacuit Bay is also assumed to be negatively affected by logging. The decline in the fish catch resulting from sedimentation is estimated through regression analysis, using information on coral cover, species diversity and fish biomass. Two scenarios are considered - with and without tuna - due to uncertainty about the impact of sedimentation on tuna fishing. The NPV of the fish catch is thus estimated to fall from US\$17 to US\$9 million (excluding tuna from the analysis) and from US\$28 to US\$15 million (including tuna) over the period 1987-96, assuming a 10% discount rate. Similar results using a 15% discount rate are also reported.

**Valuation techniques used:** Market prices are used to calculate logging revenues and impacts on tourism and fisheries. Log prices are assumed unaffected by changes in output associated with the two land use options. The production function approach was used to value forest watershed protection services, in terms of the estimated impact of sedimentation associated with logging on the revenues derived from dive-based tourism and marine fisheries.

**Socio-economic groups affected:** Issues such as income distribution, employment and job training under the different scenarios are considered.

**Comments:** The conclusions would be strengthened if the authors had estimated net benefits, rather than gross revenues, of different activities (logging, fishing, tourism). The links between logging, sedimentation and costs/revenues from tourism and fishing also require more detailed investigation.

**Howard, P. 1995. "The Economics of Protected Areas in Uganda: Costs, Benefits, and Policy Issues". Unpublished dissertation, U. of Edinburgh, summarised in Bagri, A., Blockhus, J., Grey, F. and F. Vorhies (eds.). 1998. *Economic Values of Protected Areas: A Guide for Protected Area Managers*. IUCN: Gland.**

**Type of assessment & main findings:** A financial and economic CBA is undertaken from the government's perspective with regard to Uganda's protected area system, including National Protected Areas, Game Reserves and Forest Reserves. While financial analysis yields a positive NPV of US\$37.20 per hectare, the economic CBA produces a negative NPV of US\$332.40 per hectare. The results highlight the misleading financial incentives facing the government and the large opportunity costs associated with protected areas in highly populated areas. Policy recommendations put forward concern how to ensure that welfare gains outweigh the costs of maintaining the protected areas.

**Empirical data:** Several sources of data are given. Values of marketed items are calculated from information on concession revenues, protected areas and gate receipts, permits and licenses, zoo entrance fees, softwood plantations and other revenues from forest department licenses for consumptive goods such as timber, charcoal and building poles. Non-marketed items are valued based on information collected from a survey of 84 households in six villages. Data includes the types of forest items consumed, volume extracted, extraction costs (eg. labour time) and prices received. The main goods valued include firewood, poles, timber, charcoal, thatch, meat, granary materials, food and water. Estimates of indirect benefits and option values are based on secondary data on fish production, afforestation costs, damage costs of carbon emissions and potential benefits from commercial uses of genetic material. Additional cost data is obtained from government expenditure figures and international financial contributions to protected areas. Opportunity costs are derived from estimates of net returns to agro-pastoral development.

**Details of CBA:** Both the financial and economic CBA use a 5% discount rate and assume a 25 year planning horizon. The financial CBA assesses the monetary flows associated with the protected area system, from the perspective of government. Total revenues earned by government (fees, taxes, etc.) from the protected areas are estimated at US\$1 million (in 1993/4). International donors contribute about US\$11 million per annum. By deducting the costs of maintaining protected areas (about US\$3 million per year) from total revenue, the government appears to gain US\$9 million a year, or a NPV of US\$121 million. This is equivalent to US\$37 per hectare.

For the economic CBA, non-marketed costs and benefits and the opportunity costs of protection are taken into account. Non-marketed benefits are divided between direct and indirect use values and option value. Direct use of wood and NTFPs by local communities is estimated (based on survey results) at about US\$74 million per year. Direct use benefits from tourism provide an additional US\$16 million per year. Indirect benefits from the forests' environmental services are calculated for carbon sequestration (US\$17 million per year) and watershed protection (US\$14 million per year). An option value of just over US\$2 million is added, based on estimated future spending by pharmaceutical and agro-chemical companies for the use of protected genetic material.

On the cost side, in addition to financial costs born by the government (US\$3 million a year), the annual opportunity cost of protection in terms of the forgone benefits from agricultural and pastoral activities (US\$111 million) and the direct costs of crop damage and loss of livestock (US\$76 million) are added. In addition, in the economic CBA donor spending must be treated as a cost. Taking all economic benefits and costs together, the authors estimate the total value of the protected area system to be *negative* US\$1.08 billion, or negative US\$332 per hectare.

**Valuation techniques used:** Market prices and costs were used for the financial CBA, eg. government license fees, domestically consumed timber and NTFPs. Indirect benefits and non-use benefits are estimated using a range of valuation techniques. The production function approach is used to estimate the value of forest watershed protection services. Since the watershed is a critical part of the hydrological system and regulates downstream water volumes and quality (eg. nutrient content), it provides critical support to the fishing industry. The value of the watershed protection service is assumed to be equal to the value of the share of the industry which depends on it. Forest carbon sequestration services are valued using two techniques: damage costs avoided and the replacement cost approach. Using the first approach, the service is valued at about US\$17 million per year. Using the replacement cost approach, the carbon fixing service is valued at US\$20 million per year. The former value is used in the economic CBA. Option value is estimated using an fixed annual figure for future pharmaceutical uses (US\$0.40/ha of rainforest and US\$0.20/ha of savannah and wetland) and for use of wild coffee genetic material (US\$1.5 million).

**Socio-economic groups affected:** The author highlights the issue of international equity and the fact that the Ugandan government is effectively bearing the opportunity cost of supporting global values such as carbon sequestration. Data collected for the study could be used to assess the domestic distribution of costs and benefits. For instance the author finds that local populations living around the parks lose about US\$135 per household per year. This compares with a range of benefits of US\$30 to \$136 per household per year. Off-site fishermen, on the other hand, bear none of the costs but benefit from significant watershed protection services.

**Comments:** The analysis is undertaken from a macro-perspective and it is likely that some protected areas are more easily justified in economic terms than others, eg. the forgone benefits of agriculture will be lower in relatively infertile or remote areas. Moreover, issues of sustainability do not appear to be addressed explicitly, either in the case of timber and NTFP extraction, or in the case of calculating the forgone benefits of agriculture or pastoralism. While excessive extraction of timber and NTFPs may not be an issue, soil degradation could be a concern if protected areas were converted to other uses, eg. agriculture. Other possible elaborations include sensitivity analysis to test the robustness of results given changes in key assumptions, shadow pricing of marketed items and the use of a social discount rate in the economic CBA, and consideration of other direct use (eg. future eco-tourism/recreation revenues) and indirect benefits (e.g. clean drinking water) of protected areas.

**Jonish, J. 1992. *Sustainable Development and Employment: Forestry in Malaysia*. Working Paper No. 234, International Labour Office: Geneva.**

**Type of assessment & main findings:** The paper presents a financial analysis of direct and indirect timber and employment effects of alternative natural forest management regimes in Malaysia, with a special focus on the State of Sarawak. The authors show that shifting to a sustained yield logging regime would have serious negative repercussions for employment.

**Empirical data:** Secondary data on forest resources in Malaysia, divided into Peninsular Malaysia, Sabah and Sarawak, is derived largely from ITTC (1990). From this the author develops a model of optimal rotation conditions and estimates sustainable annual timber yields for Sarawak and Malaysia as a whole. In Sarawak, the sustainable yield comes to around 6.0-8.2 million cubic meters per annum (MCM) given a 35 year cycle with harvesting of trees of 45 cm or more. This is about one-third of current annual harvests. For Malaysia as a whole, sustainable yields are estimated as 14.8 MCM, against recent annual coupes of 39.8 MCM. Information is also presented for selected years on total forest area (including actual depletion and forecasts of exhaustion of native forests), annual harvesting and production of logs and sawn timber, exports and employment in the timber and wood-based products industry (logging, sawmills, plywood/veneer, moulding, furniture).

**Economic values considered:** The evaluation focused on direct use values of timber and the employment impacts of moving from existing harvest levels to sustained yield. Comparisons of harvests and employment are made between alternative timber harvesting regimes. The Selective Management System uses a pre-harvest inventory to identify trees for cutting and allows re-harvesting in 25 to 35 years. On the other hand, the Malaysia Uniform System involves the removal of all trees in one felling with poison girdling of the remaining non-economic tree species, and requires more time (50 to 80 years) before the area may be re-harvested. The employment effects of moving to sustained yield management are dramatic. Adoption of sustained yield harvesting (37% of current yield) is estimated to reduce employment in logging from 69,000 to 25,000, while total employment in the domestic timber and wood-based products industry would decline from 150,000 to 57,000. Shifts into downstream processing and the use of supplemental sources of wood (eg. imports and plantation forests) would reduce the employment impact, but 35,000 to 55,000 jobs would be at risk in the near term.

**Valuation techniques used:** Market prices are used to value timber. Employment impacts are evaluated in terms of full-time equivalent jobs.

**Socio-economic groups affected:** The paper refers to effects on government (revenues from timber extraction), employment in extraction and processing industries, indigenous people and the commercial timber industry (both logging and processing).

**Key references:**

International Tropical Timber Council, 1990. *The Promotion of Sustainable Forest Management: A Case Study in Sarawak, Malaysia*. Mission Report to Eighth Session in Denpasar, Bali, Indonesia, May 16-23, 1990.

**Kramer, R., Munasinghe, M., Sharma, N., Mercer, E. and P. Shyamsundar. 1992. “Valuing a Protected Tropical Forest: A Case Study in Madagascar” paper presented at the IVth World Congress on National Parks and Protected Areas, 10-21 February, Caracas, Venezuela.**

**Type of assessment & main findings:** The study presents a CBA of alternative land uses in an area proposed for designation as the Mantadia National Park, in eastern Madagascar. The principal land use options considered are subsistence (shifting) cultivation, extraction of fuel wood and other non-timber products by local populations and tourism by foreigners. Further research (briefly described in an annex) examines local and regional watershed protection benefits and the international existence values associated with biodiversity conservation.

**Empirical data:** Data in the report derive primarily from interviews with local villagers and foreign tourists visiting Madagascar. A survey was conducted among 351 households (1,598 people) in 17 villages located within a 7.5 km radius of the park boundaries. Data include:

- land use practices (total farmland, planned forest clearance, land under rice, total rice yield, value and quantity marketed) with the number of observations for each variable, range and mean value per household; and
- forest product values (fuelwood, crayfish, crab, *tenreck* and frog) with the number of observations, total annual value for all villages and mean annual value per household.

Additional village-level data include wealth indicators, perceptions of forest values and willingness-to-accept (WTA) compensation for loss of access to the new park. A survey of tourists was administered to 94 respondents in 1991 but aborted as civil strife in Madagascar led to a temporary downturn in tourist traffic. Supplementary data were collected from tour operators in the US and Europe. Data are presented on total travel expenditure, income, age, educational attainment, country of origin, total trip length and time spent (in days) at the adjacent, smaller Perinet Forest Reserve. Total visits by foreign tourists to Perinet FR are given as 3,900 per year. Data are also presented on the willingness-to-pay (WTP) of foreign tourists for the new park.

**Details of CBA:** The analysis includes estimates of direct use values associated with potential subsistence and tourism benefits from the forest area. Estimated annual values per household are aggregated over the total local population. Estimated values per tourist trip are aggregated over the total number of trips per year to Perinet FR. Both estimates are discounted in perpetuity at 10% to obtain the net present value. The results are summarised below.

### **Estimated Costs and Benefits of Mantadia National Park, Madagascar**

(Net Present Values in 1991 US\$,  $r = 10\%$ )

	Opportunity cost	Travel cost	Contingent valuation
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Subsistence benefits foregone	758,446	-	451,400
Tourism benefits		936,000	2,535,000

While the authors pass over indirect and non-use values in this study, they refer to further research on these in Appendix A. In particular they describe an assessment of watershed protection benefits provided by the park (using a damage-cost-avoided approach) and a survey of 1,200 US residents carried out in 1992 to elicit WTP for tropical forest preservation (existence values). However, no results are presented in this report (see Kramer *et al.* 1995, below).

**Valuation techniques used:** Market prices are used to value agricultural and non-timber forest benefits foregone in the case of protection. The travel cost approach is used to estimate the value of potential tourism benefits and CVM is used to value both foregone subsistence and tourism benefits. Sources for market price data are not described in the report. The travel cost model used here is a standard random utility model which “examines the allocation of trip choices to Madagascar and other international nature tourism destinations as a function of travel costs, socioeconomic characteristics, and quality variables” (pg. 7). Predicted benefits to tourists, assuming that the Mantadia NP delivered a 10% increase in the quality of local guides, educational materials and facilities, are estimated at US\$24 per tourist per trip.

Contingent valuation involved two discrete-choice surveys, at the village level and as part of the tourist survey. In the former, respondents were asked their WTA compensation for loss of access to land taken for the Mantadia NP. Expressed in terms of an annual in-kind payment of rice, the mean WTA was 200 kg of rice per year per household (worth about US\$61). An alternative estimate of the opportunity cost of the park calculates agricultural and other subsistence benefits foregone at US\$120 per household per year, based on aerial photographs of land use patterns and household survey data.

In the tourist survey, CV was used to estimate WTP for the benefits provided by the new park. Respondents were asked how much more they would have been willing to pay to visit the new park during their trip to Madagascar, assuming similar attractions to those enjoyed at the Perinet FR. Using this approach, the mean WTP expressed by survey respondents was US\$65 per trip.

**Socio-economic groups affected:** The authors distinguish between impacts primarily affecting the poor and those affecting better off groups. Local subsistence farmers (mean annual income US\$190 per capita) would lose access to land taken for the park. Foreign tourists (mean annual income US\$59,000) would enjoy the additional attractions of the new park. The authors note that estimates of WTP or WTA inevitably reflect ability to pay and may discriminate against the poor. They stress that WTP is, in this case, a necessary but insufficient criteria for land use allocation and call for supplementary criteria to protect the “basic rights and needs” of local residents.

**Comments:** The study is a forerunner of Kramer *et al.* (1995), which is described in more detail below.

**Kramer, R.A., Sharma, N. and M. Munasinghe. 1995. *Valuing Tropical Forests: Methodology and Case Study of Madagascar*. Environment Paper No. 13, The World Bank: Washington D.C.**

**Type of assessment & main findings:** The paper summarises the results of four studies (see references below) which employ a range of techniques to estimate the direct use, indirect use and non-use values associated with creation of the Mantadia National Park in Madagascar. No overall CBA is presented, but the research illustrates the potentially significant WTP of foreigners for recreational benefits and for rainforest conservation.

**Empirical data:** The four source studies use information collected from both primary and secondary sources. The main data sources for each study are provided in the table below.

**Economic values considered:** Estimates are given for the following forest values:

- direct use values associated with forest use for timber and NTFPs and for shifting cultivation by local communities prior to the creation of the Park. These values reflect the forgone benefits, or opportunity cost, of the Park's creation;
- non-use values (e.g. cultural values) enjoyed by local communities;
- indirect use value to downstream rice farmers of reduced flooding. This is an important benefit which results from reduced deforestation associated with the new Park;
- direct use value associated with forest use for recreation by international tourists; and
- existence value placed on tropical forest protection by US residents.

#### *Forgone benefits to local households*

Two different approaches were used to estimate the benefits which local communities obtained from the Park before access was restricted: valuation of direct use benefits using market prices, and contingent valuation of local direct use, indirect use and non-use values.

The first approach focuses on fuelwood and agricultural benefits, although financial gains from extraction of other NTFPs are also included. Drawing on information collected through a household survey (community dependence on forest products and shifting cultivation) and data collected from secondary sources (prices etc.), the net returns to households from harvesting forest products and from shifting agriculture were estimated. Three separate cash flows were produced, reflecting different costs and benefits to three distinct groups around the Park (the affected area comprises a population of approximately 3,400 people). Based on these cash flows over a 20-year time horizon, an average annual net present value (NPV) of the forests to the communities was calculated. Note that the value estimated in this way represents only part of the opportunity cost to local communities of losing access to the Park, as it excludes non-use values, indirect use values and non-marketed direct use values foregone.

The second approach used to assess the value of benefits foregone by local residents from creation of the Park involved a CV survey, to elicit households' willingness to accept (WTA) compensation for loss of access to the park area. The survey presented households with a dichotomous choice question ("take

it or leave it”) offering a certain quantity of rice per year in return for their agreeing not to use the forests in the Park. The responses were used to estimate a mean WTA expressed in terms of bags of rice. On this basis, a quantity of rice worth US\$108 per household per year was estimated to be sufficient to leave the average household indifferent between having access to the Park and not having access. This figure may be compared with the mean estimate of US\$91 per household per year using the market value of output foregone. The difference (\$17) may reflect local WTA compensation for loss of indirect use and non-use values ignored under the first approach, or perhaps just inherent differences of measurement.

#### *Indirect use values for downstream farmers*

A separate valuation study used the production function approach to assess the benefits provided by the Park to nearby communities in terms of reduced flooding. The focus of the analysis was the impact of flooding on rice production. Other values associated with flooding such as destruction of infrastructure or water quality impacts were not considered.<sup>1</sup>

Using information on the rate of forest clearance without the Park (over an estimated 45 years), the impact of deforestation on local flooding, the impact of flooding on rice production, and the average net returns to rice cultivation, the authors develop a dose-response model linking deforestation to the value of rice production. By comparing rice production under the “with Park” scenario and a “without Park” scenario the authors estimate that the Park has saved farmers about US\$71,000 worth of rice. In other words, the net present value of the benefit attributable to the Park’s flood control function is US\$71,000. Note that this benefit accrues to farmers in the upper watershed who enjoy reduced flooding but *not* to those communities discussed in the previous section who lose access to forest land (i.e. they are different groups).

#### *Direct use values for international tourists*

The study used both travel cost, or recreational demand, models and CVM to estimate the value of the Park to tourists. The creation of the Park is expected to increase tourist visits to the area as a result of improved opportunities for accommodation and viewing wildlife. Data was collected through a survey of foreign visitors to the Perinet Special Reserve, located near the Park. The questionnaire was administered to almost 100 international visitors to the Reserve in 1991 (see Kramer *et al.* 1992, above). Two types of recreational demand models were estimated: a typical trip model and a random utility model. The trip model estimates an equation relating the *sum of the number of trips* that an individual has made or plans to make within the next five years, to eight different developing country destinations, to a range of explanatory factors. The latter include the cost of reaching those destinations, an index of their relative quality and several socio-economic variables.<sup>2</sup> The random utility model, on the other hand, defines a function relating the *probability of visiting each site* to a similar range of

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<sup>1</sup> It is often claimed that the off-site effects of upland forest clearing are significant even far downstream. In this particular case, the authors refer to earlier research finding no evidence of a relationship between forest cutting in headwaters and floods in the lower basin.

<sup>2</sup> The tourist surveys were used to select the seven most important destinations serving as alternatives to Madagascar. Cost and quality variables for these sites were constructed using an expert opinion survey administered to 27 US and European nature tour organisers.

explanatory factors. The authors note that the typical trip model may be more appropriate for situations in which visitors make numerous trips to a variety of sites over a shorter time period, such as residents of Madagascar who may visit the Park and other sites. The random utility model may be more appropriate for international tourists with a limited number of opportunities to undertake major trips. The CVM used the dichotomous choice method and asked whether the individual would be willing to pay a certain amount more for their trip if this included a visit to the new Park. All three models are used to estimate the WTP of tourists for the improved benefits of the Park. The recreational demand models estimate the mean benefits per tourist, in terms of the increase in consumer surplus due to increased quality of local guides, educational materials and facilities for interpreting natural areas. In addition, the CVM is thought to capture WTP for improved accommodation facilities and possibly some non-use, or existence values. By aggregating these benefits for the total number of tourists visiting the Perinet Reserve in 1990 and assuming this level of visitation is maintained in perpetuity, the authors obtain an estimate of the NPV of the Park for international tourists.

#### *Existence value for US residents*

This study involved a CV survey by mail of households living in the United States to assess the value that US residents place on tropical rainforest protection. While the results apply only to US residents and to rainforest protection in general, it is possible to view part of the estimated values as capturing WTP for initiatives such as the creation of the Mantadia National Park. A total of 542 mail surveys were returned with a stated WTP for the creation of parks and reserves to protect 45 million hectares (equal to about 5 per cent) of all remaining rainforests.<sup>3</sup> The data was used to estimate a model relating individual WTP to several socio-economic and attitudinal variables. The results indicate that WTP rises with income, an expected response for this type of environmental good. In addition, WTP was higher for those individuals that ranked tropical deforestation higher among a list of environmental issues. Based on the model a mean WTP of US\$24 - \$31 per household was estimated.<sup>4</sup> Aggregating across the US, and assuming that only households with income over US\$35,000 would actually donate the funds, total WTP was estimated at about US\$1 billion. As these figures apply to the conservation of approximately 45 million hectares of “generic” rainforest, as opposed to the 10,000 hectare Mantadia National Park, they cannot be compared directly to the results of the earlier sections. Moreover, these estimates are for US residents only and households in Europe, Japan and other high-income countries may also have substantial WTP for rainforest conservation. Nevertheless, the results suggest that global existence values for tropical rainforests such as the Mantadia National Park may be significant.

**Socio-economic groups affected:** Each valuation exercise considered values enjoyed by different groups of stakeholders. Direct use, indirect use and non-use benefits enjoyed by local communities which depend(ed) on the forests are valued separately from the indirect use value of flood control,

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<sup>3</sup> The final survey was based in part on the results of focus groups and a pretest. The payment vehicle was a hypothetical contribution to a “United Nations Save the RainForest Fund”; see Kramer *et al.* (1993) for details.

<sup>4</sup> Two payment vehicles were used, accounting for the two different values at either end of the mean 'range'.

which is captured by downstream farmers. Existence values and recreational values are also estimated separately for international stakeholders; the former for US residents who have not visited, and do not plan to visit, the Park and the latter for tourists who may make use of the Park's facilities. No direct comparison is made between the values captured by various groups.

**Valuation techniques used:** See table.

Values calculated	Valuation technique(s)	Estimated NPV	Data source	Source
Direct use value to local communities (timber and NTFPs, agriculture)	Market prices to estimate cash flow from extraction of timber and NTFPs, and from shifting agriculture.	US\$566,000 or US\$91/household/yr. (based on a 20 year time horizon, using a 10% discount rate).	secondary - government agricultural records, price surveys. primary - household survey for production volumes.	Shyamsundar <i>et al.</i> (1993); Kramer <i>et al.</i> (1994)
Direct use and non-use values to local communities (unspecified)	CVM to estimate willingness to accept compensation for loss of access to forest. Bags of rice used as method of payment.	US\$673,000 or US\$108/household/yr. (based on a 20 year time horizon, using a 10% discount rate).	primary - household survey.	Shyamsundar <i>et al.</i> (1993); Kramer <i>et al.</i> (1994)
Indirect use value to downstream rice farmers (flood control)	Production function approach to estimate rice crop losses from flooding associated with deforestation.	US\$71,000.	secondary - landsat images, topographical maps, aerial photos, hydrological experiments and data on past floods and lost rice crops.	Kramer <i>et al.</i> (1995)
Direct use value to international tourists (recreation)	TCM to estimate tourists' consumer surplus from forest recreation.	US\$936,000 using the random utility model; \$1.7 million using the typical trip model (in perpetuity, 10% discount rate).	primary - questionnaire administered to 100 visitors in 1991.	Mercer <i>et al.</i> (1993)
Direct use value to international tourists (recreation)	CVM to estimate tourists' willingness to pay for access to Mantadia National Park.	US\$2.53 million.	primary - questionnaire administered to 100 visitors in 1991.	Mercer <i>et al.</i> (1993)
Non-use value to US residents (rainforest conservation)	CVM to estimate willingness to pay for protection of tropical forests around the world (45 million hectares).	US\$1 billion.	primary - mail survey of US households; 542 completed.	Kramer <i>et al.</i> (1993)

**Comments:** The authors do not directly compare their estimates of different values or assess the implicit trade-offs among different stakeholder groups, although it is tempting to do so. Any such attempt, however, would require an effort to address difficult methodological and ethical issues involved in comparing changes in income of groups with widely varying levels of wealth. For example, to what extent can \$1 of forest benefits foregone by local residents be compared to \$1 of increased consumer surplus enjoyed by international tourists? An explicit attempt to grapple with this issue would have made the analysis even more penetrating. A more comprehensive CBA would also presumably include sensitivity analysis of various key parameters, such as the discount rates used and the time horizon chosen.

**Key references:**

Kramer, R.A., Sharma, N., Shyamsundar, P. and M. Munasinghe. 1994. *Cost and Compensation Issues in Protecting Tropical Rainforests: Case Study of Madagascar*. Environment Working Paper No. 62, Environment Department, The World Bank: Washington D.C.

Kramer, R.A., Mercer, E. and N. Sharma. 1993. *Valuing Tropical Rain Forest Protection as a Global Environmental Good*. Center for Resource and Environmental Policy Research, Duke University: Durham, North Carolina.

Mercer, D.E., Kramer, R.A. and N. Sharma. 1993. *Estimating the Nature Tourism Benefits of Establishing the Mantadia National Park in Madagascar*. Center for Resource and Environmental Policy Research, Duke University: Durham, North Carolina.

Shyamsundar, P., Kramer, R.A. and N. Sharma. 1993. *Estimating the Costs to Local Inhabitants of Establishing the Mantadia National Park in Madagascar*. Working Paper 93-1. Center for Resource and Environmental Policy Research, Duke University: Durham, North Carolina.

**Kumari, K. 1995a. *An Environmental and Economic Assessment of Forest Management Options: A Case Study in Malaysia*. Environmental Economics Series No. 26, Environment Department, The World Bank: Washington D.C.**

**Type of assessment & main findings:** The study evaluates the total economic value (TEV) of four options (one “unsustainable”, three “sustainable”) for logging a peat swamp forest in Peninsular Malaysia. All three sustainable options have higher net present values than the unsustainable option, for which a TEV of M\$10,238 (about US\$4,000) per hectare was calculated. Over 90% of TEV in all cases is made up of timber and carbon storage benefits.

**Empirical data:** A variety of secondary sources were used to calculate the component values included in the TEV. These are listed in the last column in Table 1, below.

**Economic values considered:** Estimates of the following forest benefits are presented:

- direct use values associated with extraction of timber and NTFPs (rattan and bamboo);
- indirect and direct use values associated with forest water regulation/purification services;
- direct use value associated with forest recreational benefits;
- indirect use value associated with forest carbon sequestration; and
- existence and option values associated with wildlife conservation.

**Valuation techniques used:** See Tables 1 and 2.

<b>Table 1. Goods and Services Valued</b>			
<b>Type of Forest Good/Service</b>	<b>Type of Value</b>	<b>Valuation Technique</b>	<b>Data Source/Approach</b>
Timber	Direct use	Market price	From forest harvest levels, mean annual increments, etc. National Forest Inventory.
NTFPs (rattan, bamboo)	Direct use	Market price	National Forest Inventory.
Hydrological - agricultural	Indirect use	PFA	Data on the hydrological disturbance in the swamps used to determine the effect on water shortage on the rice crop.
Hydrological - domestic	Direct use	Cost-based	Water abstracted from the canal to meet domestic requirements of residents living at the agricultural scheme.
Recreation	Direct use	TCM	Potential recreational value derived from information from existing visitor numbers to the nearby Kuala Selangor Nature Park, and from the results of TCM studies of other forest recreational sites in Malaysia.
Carbon sequestration	Indirect use	Damage cost avoided	Information on biomass and carbon stock in peat swamp forests used to determine the total carbon stored. Rates of carbon sequestration are established from biomass growth data and valued using marginal damage cost estimates from other studies.
Wildlife	Option and	CVM and	Contingent valuation estimates from other studies

Conservation (Sumatran Rhinoceros)	existence	opportunity cost	used to estimate the mean WTP of Malaysians for the population of rhinos at the site. Foregone timber benefits are calculated for the area set aside for wildlife conservation.
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Source: Kumari (1995), Table 2.

For each logging option, benefits are valued over a 100 year time horizon and discounted to present values using discount rates of 2% and 8%. The impact of logging damage to the residual timber stand on future benefits is assessed for each logging option using two different levels of damage (20% and 50% damage intensity).

In the final analysis, the benefits associated with each logging option are aggregated to allow a direct comparison. Results vary depending on the discount rate used and the assumptions made about damage to the residual stand. Table 2 presents some results using an 8% discount rate and plausible assumptions regarding stand damage for each option. The NPV is given for each of the forest benefits under the existing “unsustainable” system, along with the change in these values for the other land use options.

<b>Table 2. Summary Results (1990 prices, 8 per cent discount rate)</b>					
<b>Forest Good/Service</b>	<b>Base Case (unsustainable traxcavator and canal) (M\$/ha)</b>	<b>Percent of Total Economic Value (TEV)</b>	<b>Change from Base Case to:</b>		
			<b>Sustainable Traxcavator and Canal (M\$/ha)</b>	<b>Sustainable Traxcavator and Winch (M\$/ha)</b>	<b>Sustainable Winch and Tramline (M\$/ha)</b>
Timber	2,149	21.3	-696	-399	-873
Hydrological - agricultural	319	3.1	0	411	680
Wildlife conservation	454	4.4	35	20	44
Carbon sequestration	7,080	69.2	969	1,597	1,597
Rattan	22	0.2	88	172	192
Bamboo	98	1.0	0	-20	-20
Recreation	57	0.6	0	0	0
Domestic Water	30	0.3	0	0	0
Fish	29	0.3	0	0	0
Total Economic					

Value	10,238	100.0	396	1,782	1,620
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Source: Kumari (1995), Table 12.

**Socio-economic groups affected:** The author notes that the global community is the largest winner from moves to more sustainable logging practices, benefiting from forest carbon sequestration services and protection of endangered species. Together these values account for almost three quarters of TEV in the base case scenario and a large share of the increase in TEV for the three alternative options. This result is used to underline the need for innovative financial mechanisms, such as Global Environment Facility (GEF), to capture and convey the value of such global non-market benefits to local land owners. The study also highlights the unequal distribution of benefits between loggers and local communities. Loggers lose from a shift to more sustainable methods, while local communities enjoy the benefits of increased access to NTFPs and hydrological services.

**Comments:** The author stresses that the results should be seen as indicating orders of magnitude, rather than precise estimates of value. Various shortcomings are acknowledged, including lack of consistency in using net, as opposed to gross, measures of benefit. One innovative feature is the authors' use of confidence levels (low, medium and high) to assess the relative precision of benefit estimates. These are based on a qualitative evaluation of the reliability of the data used, the methods used to value different benefits, and the soundness of the assumptions made.

The author also attempts to identify those benefits whose loss would be harder to restore (a practical interpretation of irreversibility and the precautionary principle). This involves attaching a ranking (low, medium and high) to each benefit, which reflects the degree of risk aversion which must be exercised in order to ensure the health of underlying natural systems, or to maintain stocks of natural capital. These scores represent the author's own assessment of how critical the continued functioning of underlying natural systems are to the stability of wider ecosystems and to human welfare. Quantitative results are thus enriched by a subjective assessment of confidence and precaution. Underlining this point, the author notes that forest policy and management decisions should be based on value estimates for which there is a relatively high degree of confidence, and low risk of irreversible impacts.

**Kumari, K. 1995b. "Mainstreaming biodiversity conservation: a Peninsular Malaysian case" in *International Journal of Sustainable Development and World Ecology*. 2: 182-198.**

**Type of assessment & main findings:** The paper is in two parts; the first part develops a framework for evaluating forest biodiversity in Peninsular Malaysia. Emphasis is placed on the contribution of both managed and protected forests to biodiversity protection. The second part of the paper draws on earlier work by Pearce and Puroshothaman (1992) in an attempt to calculate the option value component of total biodiversity value (TBV). The approach used here links option value to the value of potential future forest-based pharmaceutical products. Different scenarios for drug development are considered, yielding a range of option values from an annualised US\$0.52 per hectare to US\$695.11 per hectare. Critical determinants of option value include the level of government rent capture, the final value of the drugs developed and the 'effective' forest area considered valuable as a store of biodiversity.

**Empirical data:** The author draws on Pearce and Puroshothaman (1992) to guide the theoretical discussion. Information on endemic species of trees and herbaceous plants and forest area is taken from official and academic sources, e.g. the 1989 tree flora inventory. Foreign sources are consulted for estimates of the probability of drug development, royalty rates, government rent capture (or appropriation) and the average value of future drugs.

**Economic values considered:** The author divides the TBV of forests into *protected area* biodiversity value and *production forest* biodiversity value. While the biodiversity value of timber-production forests is considered less than that of protected areas, both can make a significant contribution to biodiversity conservation. Moreover, the two types of biodiversity are closely related. Thus biodiversity in protected areas may be enhanced by proximity to production forests and vice versa, although the relationship is not easily evaluated. The author also notes the importance of distinguishing between the value of forest products and the value of biodiversity *per se*, i.e. the additional benefits which accrue from having a diverse range of genes, species and ecosystems.

**Valuation techniques used:** The author focuses on one benefit of biodiversity associated with the forests of Peninsular Malaysia, i.e. option value. A production function approach is used to link forest value to markets for pharmaceutical products, based on a model developed by Pearce and Puroshothaman (1992). This model identifies the main determinants of the medicinal value of one hectare of forest per year. These parameters and the values used are given below:

- number of species at risk - assumed equal to 2,826, or the total number of endemic species of trees and herbaceous plants in Peninsular Malaysia.
- probability of a plant species being developed as a drug - assumed to be 5 in 10,000 a middle value in the range identified by Principe (1989).
- royalty rate - a rate of 5% is used.
- appropriation rate - three rates are considered: 10%, 50% and 100%
- average value of drugs developed - three values are used: US\$390 million, \$1 billion and \$7 billion to represent low, medium and high possibilities.
- total area of forests - a range of values is considered to reflect different assumptions about the value of production and protection forests in terms of their contribution to biodiversity. Production forests

are considered less valuable, due to damage caused by logging. The relative importance of the two types of forests depends on the extraction method used. Estimates of stand damage due to logging in Peninsular Malaysia range from 30% to 70%. For the purposes of the study, maximum damage is assumed. The area of production forests is thus converted into 'effective' protected forest (for purposes of biodiversity conservation) by multiplying the former by 0.3. Adding these 'effective' protected forests to actual protected areas in Peninsular Malaysia yields a total 'effective' protected area of 2.1 million hectares.

### **Biodiversity value of Peninsular Malaysia using 'medicinal' plant value as a surrogate**

Scenario	Drug value		
	Low	Medium	High
<b>100% appropriation rate (\$/ha/yr)</b>			
protected area	38.73	99.30	695.11
protected area + production forests	5.16	13.23	92.61
'effective' protected area	13.12	33.64	235.50
(partial) biodiversity value (US\$ millions)	27.55	70.65	494.55
<b>50% appropriation rate (\$/ha/yr)</b>			
protected area	19.36	49.65	347.55
protected area + production forests	2.58	6.62	46.31
'effective' protected area	6.56	16.82	117.75
(partial) biodiversity value (US\$ millions)	13.78	35.33	247.28
<b>10% appropriation rate (\$/ha/yr)</b>			
protected area	3.87	9.93	69.51
protected area + production forests	0.52	1.32	9.26
'effective' protected area	1.31	3.36	23.55
(partial) biodiversity value (US\$ millions)	2.76	7.07	49.46

source: Kumari (1995)

In general, the higher the drug value and the appropriation rate the higher the option value of biodiversity conservation for Peninsular Malaysia. The results are also sensitive to the area of forest considered, given a fixed level of endemic species. The larger the area, the lower the value of each additional hectare. The author highlights significant values and the importance of maximising the appropriation rate. In the last row for each appropriation rate considered, the author calculates the present value of the option value.

#### **Key references:**

Pearce, D, and S. Puroshothaman. 1992. *Protecting Biological Diversity: The Economic Value of Pharmaceutical Plants*. Global Environmental Change Working Paper 92-27. CSERGE/UEA and UCL, London.

Principe, P. 1989. "The economic significance of plants and their constituents as drugs" in Wagner, H., Hikino, H. and N. Farnsworth. (eds.) *Economic and Medicinal Plant Research*. Vol. 3. pp. 1-17.

**Lal, J.B. 1990. "Economic Value of India's Forest Stock" in *Van Vigyan (Journal of the Society of Indian Foresters)*. 28(3): 63-72.**

**Type of assessment & main findings:** The paper estimates the total economic value (TEV) of India's forest stock including direct and indirect use values and non-use values. The total value given is 785.5 billion Rupees per year, or 27% of GNP (1987-88), an amount considerably larger than the contribution recorded in the national accounts (1.2% of the GNP). Assuming a discount rate of 5%, the net present worth of Indian forests is estimated at 15,910 billion Rupees.

**Empirical data:** Information from other sources is used to estimate forest values.

**Economic values considered:** Direct values (wood and non-wood products, grazing, recreation), indirect values (production of oxygen, soil conservation and maintenance of fertility, recycling of water and regulation of ambient humidity, control of air pollution, sheltering of fauna and flora), option and non-use values (conservation of biodiversity).

**Valuation techniques used:** Various methods are used but not all described in detail. Starting with direct use values, market prices are used in most cases. The value of timber and fuelwood is derived from the potential productivity of woody biomass, which is given as 36 million m<sup>3</sup> of timber and 54 million m<sup>3</sup> of firewood per year (Lal 1989). Assigning a stumpage value of 3000 Rupees/m<sup>3</sup> to timber and 200 Rupees/m<sup>3</sup> to firewood, the annual value of wood is 118.8 billion Rupees. Non-woody biomass was excluded because it is seasonal, perishable and negligible in comparison to the value of woody biomass. The value of animal fodder is based on 730 kg/year per cattle unit (assuming that grazing is limited to the carrying capacity) and is estimated at 22 billion Rupees. The potential annual revenue from all minor forest produce is estimated at 10.9 billion Rupees. The value of environmental services is obtained from the results of a previous study which estimated a figure for the total benefits of a medium-sized tree (which yields a biomass of 50 tonnes over a period of 50 years) using surrogate market techniques (Das 1980). These results are transformed to estimate the annual value of environmental services at 1,063 Rupees/tonne of biomass. The author multiplies this figure by the total biomass in four different kinds of forest in India (tropical, sub-tropical, temperate and alpine) to calculate a total annual value of 566.8 billion Rupees. The role of forests as harbours of genetic diversity is viewed as an option value, and is valued in terms of a hypothetical 'risk premium' paid to avoid not having something available which may be wanted in the future. The author assumes that the nation as a whole would be willing to spend 10% of gross national savings to avoid this risk, implying a value of 66 billion Rupees per year. Finally, forest recreational services are valued at 5% of the total recreational expenditure in the country, or 1 billion Rupees.

**Comments:** The author provides no information on how shadow prices were determined.

**Key references:**

Das, T.M. 1980. "The Value of a Tree". *Proceedings of the Indian Science Congress*.

Lal, J.B. 1989. *India's Forests - Myth & Reality*. Natraj Publishers, Dehra Dun.

**Loomis, J., Updike, D. and W. Unkel. 1989. “Consumptive and Nonconsumptive Values of a Game Animal: The Case of California Deer” in *Transactions of the 54th National Association of Wildlife and Natural Resources Conference*, pp. 640-50.**

**Type of assessment & main findings:** The article presents estimates of the economic benefits of deer hunting and viewing in California, using the contingent valuation method (CVM). The resulting figures are used to assess the opportunity costs of converting land to housing (building a subdivision), in terms of the loss of deer hunting and viewing opportunities. The value of forage for deer production is also estimated and found to be comparable to the value of forage for livestock production.

**Empirical data:** Primary data derive from a 1987 mail survey of hunters (15,300 purchasers of licences, 60% responded) and the general public (3,000 randomly selected, 44% responded). Data and the survey questionnaires are not provided in the paper. Secondary sources include USDA statistics on the value of forage.

**Details of CBA:** Survey data were used to estimate the average cost of deer hunting in 1987 for several areas in California. Total willingness-to-pay (WTP) for deer hunting was estimated using contingent valuation methods. Hunters were asked how much more they would be willing to pay for the same experience. They were also asked their marginal WTP for additional deer, a longer hunting season, fewer crowds, increased chances of bagging a four point buck, etc. The general public were surveyed at the same time in order to estimate their average WTP for viewing deer on trips made for other reasons and on trips made solely to look at deer. They were also asked their marginal WTP for additional deer.

The impacts of converting land to housing were expressed in terms of a loss of forage for deer, fewer hunting licenses or a shorter hunting season. The value of forage was estimated using a simple production function linking forage availability to the size of the deer population. WTP for deer hunting and viewing (based on the CV surveys) were expressed in present value terms and compared to the value of forage to ranchers (the latter based on USDA data). The resulting values were found to be comparable (\$10.40 versus \$11.00 per Annual Unit Month of forage).

**Valuation techniques used:** Three techniques are used:

- (i) market prices and expenditure (for spending on hunting and/or viewing trips);
- (ii) production function approach (for the link between forage and deer productivity); and
- (iii) CVM to elicit consumer willingness to pay (WTP) for deer hunting and viewing.

**Socio-economic groups affected:** In addition to estimating the benefits of wild deer to hunters and viewers, the authors also estimated total personal and business income generated in the State of California from deer hunting and viewing (using Commerce Department multipliers), as well as total employment.

**Key references:**

Loomis, J. Creel, M. and J. Cooper. 1989. *Economic benefits of deer in California: Hunting and viewing values*. Environmental Studies, UC Davis.

**Lynam, T.J.P, Campbell, B.M. and S.J. Vermeulen. 1994. “Contingent Valuation of Multipurpose Tree Resources in the Smallholder Farming Sector, Zimbabwe” in *Studies in Environmental Economics and Development*, 1994:8 (November), Gothenburg University: Gothenburg, Sweden.**

**Type of assessment & main findings:** The study presents an economic assessment of forest benefits to smallholder farmers in three agro-ecological zones in Zimbabwe (all are potentially *Miombo* woodland). A comparison is also made between the estimated value of locally gathered fuelwood, as revealed by CV, and the cost of production of fuelwood on eucalyptus plantations.

**Empirical data:** Based on a survey of about 360 smallholder farmers. Also uses manufacturers’ data on the costs of construction of hand-pump boreholes and improved pit latrines.

**Economic values considered:** Ten direct and indirect use values of forests are assessed including forage, building and household materials, fuel, food, cash income, inputs to crop production, shade, social aspects, health and ecological functions.

**Valuation techniques used:** The authors employed non-monetary ranking and scoring methods (participatory rural appraisal) to elicit the relative preferences of Zimbabwean smallholder farmers for ten categories of forest value. These non-monetary preferences were ‘anchored’ by simultaneously asking respondents to score a hand-pump borehole and a well-known type of pit latrine. In a second stage, respondents were asked their WTP and WTA for the borehole, as well as a series of dichotomous choice (DC) questions relating the borehole to five other commodities of known value. Information was also collected on the socio-economic status of each respondent.

Respondants’ relative preferences for tree commodities and for the pit latrine were expressed in terms of ‘borehole equivalents’ and thus as monetary values. The validity of WTP, WTA and DC estimates for boreholes (and indirectly WTP for latrines) was checked by comparison to actual construction costs (which were generally slightly higher). Results include preference ranking and estimated values of tree commodities. The top three commodities are fuel, farm/household materials and crop production inputs. The authors compared the present value of the annual benefit stream from trees to rural incomes (on and off-farm). They also compare estimated WTP for fuelwood benefits to the average cost of production of plantation-grown fuel. Differences in estimated WTP for key tree commodities in high versus low tree cover zones is assumed to reflect their relative scarcity.

**Socio-economic groups affected:** Smallholder farmers.

**Comments:** The study illustrates the use of non-monetary ranking and scoring methods as an adjunct of CVM. Such an approach may be most appropriate for rural populations with limited exposure to markets or monetary valuation. However, the conversion of non-monetary rankings into monetary values requires the strong assumption that the respective scales are comparable.

**Mattos, M. and C. Uhl. 1994. “Economic and ecological perspectives on ranching in the Eastern Amazon” in *World Development*, 22(2): 145-158.**

**Type of assessment & main findings:** The authors present a financial analysis of ranching in the Paragominas region of the Eastern Amazon (Brazil). The authors distinguish large, medium and small scale operations. The variables studied are annual income and direct costs, productivity under different management practices (extensive or semi-intensive, beef or dairy) and the capital requirements of shifting from extensive to semi-intensive management. All forms of ranching are found to be financially viable, but only because of an implicit environmental “subsidy”.

**Empirical data:** The study is based on interviews of a sample of 14 large properties (more than 6000 hectares), 13 medium properties (from 500 to 3600 hectares) and 22 small scale properties (all less than 100 hectare properties and located in a single community) all within 100 kilometres of the Paragominas municipal seat. A questionnaire was used with each property owner or ranch manager asking the property history, total herd size (numbers by age and sex), ranch operating costs (labour, maintenance of infrastructure, herd maintenance, taxes and transportation) and sources of capital for ranch maintenance. The paper presents data on:

- characteristics of each model of ranching (extensive, semi-intensive beef and semi-intensive beef and dairy) including stocking density, live weight production, milk production, total value of production, production costs and net profits;
- average area by type of use (pasture, degraded pasture, virgin forest, logged forest), average number of head and stocking density in extensive medium-sized and large-sized holdings;
- analysis of the costs and returns of a typical extensive, medium-sized beef cattle ranch;
- analysis of the costs and returns of a typical semi-intensive, small-scale dairy cattle ranch;
- characteristics of small-scale dairy-calf operations;
- costs per hectare to restore degraded pastures;
- costs and returns involved in pasture restoration over a fifteen-year period;
- net present value and return on investment (%) for large, medium and small scale ranches using extensive or semi-intensive practices.

**Details of CBA:** Cattle ranching is seen as financially viable, but only because ranchers benefit from hidden “natural subsidies”. Pastures on newly cleared land benefit from soil nutrients built up under natural forest, while the restoration of degraded pasture is often financed by sales of timber stocks on remaining uncleared land. Forest reserves are viewed by both small and large land holders as a source of capital with which to finance ranch improvements. Financial returns vary depending on the scale of the operation and management practices:

<b>Type of Ranching</b>	<b>Net Present Value (US\$/ha)</b>	<b>Return on Investment (%)</b>
Large scale, extensive	73.3	10.7
Medium scale, extensive	5.7	6.2
Large scale, semi-intensive	288	13.0
Medium scale, semi-intensive	291	14.2

Small scale, semi-intensive

541

16.2

Note: values are in US\$ (March 1991), PV is based on a discount rate of 6%.

**Valuation techniques used:** Market prices. The authors refer to the costs of soil nutrient losses and liberation of CO<sub>2</sub>, citing results published by Buschbacher *et al.* (1989) and Nordhaus (1991), but these are not incorporated into the CBA.

**Socio-economic groups affected:** Small and large scale ranchers.

**Comments:** The authors note a trend of increasing investment in improvement of forage quality, production techniques and management approaches, suggesting a movement from extensive to semi-intensive strategies. This may reflect increasing land scarcity in the study area.

**Key references:**

Nordhaus, W. 1991. *How Much Should We Invest In Preserving Our Current Climate?* Mimeo, Yale University: New Haven, CT.

**McDaniels, T. and C. Roessler. 1998. “Multiattribute elicitation of wilderness preservation benefits: a constructive approach” in *Ecological Economics* 27: 299-312.**

**Type of assessment & main findings:** The authors present a novel valuation method - multi-attribute value assessment (MVA) - which they claim is more accurate than CVM for eliciting values of unfamiliar goods such as environmental benefits. MVA is used to assess the views of two sets of stakeholders about potential losses of tax revenue to the provincial government if British Columbia's wilderness areas were doubled in size, from 6% of the total land area to 12%. Willingness to pay values are recorded for overall benefits and for the component benefits associated with expansion of wilderness areas.

**Empirical data:** Information was collected through two half-day workshops involving 28 people. The first workshop involved 13 graduates of the Faculty of Forestry at the University of British Columbia (BC). The second involved 15 graduates of the School of Planning.

**Economic values considered:** Workshop participants were asked to break down their valuation of a doubling of BC's wilderness area into three components: human demand values (these included marketed and non-marketed use values as well as existence and aesthetic values), human spiritual values (non-use values) and ecological values (indirect use values). In addition, respondents were asked to consider the relative importance of the three types of values for the present generation and for future generations.

**Valuation techniques used:** The study applies MVA techniques developed by Keeney *et al.* (1990) and called the 'public value forum'. The approach involved drawing together key stakeholder groups in a workshop-style meeting to discuss, learn about and ultimately articulate preferences and values for BC's wilderness area expansion plans. MVA differs from CVM in several ways. While contingent valuation surveys are administered to large random samples of individuals in a defined population, MVAs are administered to small non-random focus groups. CVM assumes that people know and can express their preferences for non-marketed goods and services, whereas MVA assumes that people do not always have well-defined values. MVA practitioners believe that participants must be provided with detailed background information and given an opportunity to discuss and revise their views. Moreover, MVA does not produce aggregate values for use in CBA, but instead aims to inform decision-makers of different values expressed by important stakeholder groups.

In this case study workshops were organised around six questions. The first question asked participants to state how much tax revenue they felt the provincial government should be prepared to forego in order to allow for the expansion of wilderness areas. (It was assumed that revenue would decline due to reduced economic activity in the forest products sector.) The following three questions then asked participants to disaggregate the potential tax revenue foregone into values they would assign to individual benefits associated with the expansion of wilderness areas, namely human demand values, human spiritual values and ecological values. The questions moved from asking participants to rank the individual wilderness area benefits, to asking them to assign weights indicating the relative importance of the different benefits and then asking them to value the benefits in terms of forgone tax revenue. Question four asked participants to state an acceptable decline in tax revenue to allow for an expansion

of wilderness areas on behalf of future generations. Question five asked participants to indicate how their valuations might change for smaller or larger expansions of wilderness areas. Question six asked participants to compare their initial response in question one to the result arrived at by aggregating responses to questions two through four and, if they wished, to revise their initial valuation.

One result of the study is the apparently high value placed on the ecological benefits of wilderness areas by both groups. These were valued at an average C\$88 million per year, somewhat more than human demand and spiritual benefits, which were valued at C\$72 million and C\$56 million per year, respectively. The study also illustrated the importance of learning during the workshop. In general, the sum of disaggregated values exceeded the initial overall value placed on benefits from wilderness areas. The most common response to question six was to revise values upwards, perhaps reflecting participants' belief that the disaggregated approach was more accurate. For instance, many participants noted that they had initially overlooked benefits to future generations.

**Comments:** The study attempts to address a fundamental weakness of CVM, namely the underlying assumption that individuals have a full set of values for non-marketed goods and services, which researchers can elicit with little or no opportunity for learning and revision of responses. On the other hand, it is not clear if constructive elicitation methods provide more accurate measures of 'true' value or simply introduce new sources of bias.

**Key references:**

Keeney, R.L., Von Winterfeldt, D. and T. Eppel. 1990. "Eliciting public values for complex policy decisions" in *Management Science* 36(9): 1011-1030.

**Niskanen, A. 1998. “Value of external environmental impacts of reforestation in Thailand” in *Ecological Economics* 26: 287-297.**

**Type of assessment & main findings:** The study presents a CBA of the environmental impacts of alternative reforestation options, as compared with the existing land use (grazing livestock) in northeast Thailand. The analysis considers reforestation with eucalyptus or teak in the form of industrial plantations, community plantations or agro-forestry. For all cases the environmental benefits appear to outweigh the costs, though this result is reversed if carbon sequestration benefits are excluded.

**Empirical data:** All data are from secondary sources. Growth and yield data for alternative plantation options came from various sources including official government documents. See below for more details.

**Details of CBA:** The CBA was undertaken to evaluate the net environmental impacts (indirect values) of alternative reforestation options as compared with maintaining the land for grazing. Six reforestation options considered were as follows:

- Industrial plantations of eucalyptus or teak;
- Community-based plantations of eucalyptus or teak;
- Agro-forestry-based plantations of eucalyptus or teak inter-cropped with cassava.

Global and local environmental impacts are valued for each reforestation option. The impacts considered are: the costs of increased water loss through transpiration and nutrient loss in harvesting, and the benefits of increased erosion control and carbon sequestration. Additional environmental impacts such as changes in the quality of drinking water, off-site impacts linked to run-off and sedimentation, land rehabilitation and shelter benefits are mentioned but not included in the analysis. A 10% discount rate is used throughout. In all cases except for teak and the cassava agro-forestry option, the net environmental impact of reforestation is found to be positive. This result is reversed, however, when carbon sequestration benefits are excluded. The largest environmental costs are associated with water loss due to transpiration.

To illustrate the magnitude of the net environmental benefits of different options, they are compared to economic production (market) benefits. The gains are highest for eucalyptus plantations (industrial and community) with net environmental benefits equivalent to 33% of production benefits. Net environmental benefits associated with industrial and community teak plantations were equivalent to 2 to 3% of the productive value. Of the agroforestry options, only eucalyptus yielded a net benefit, equal to 8% of the land's productive value.

The results of the CBA were tested for sensitivity to changes in key variables. The NPV of the alternative reforestation options are shown to be sensitive to changes in the value of transpiration costs and carbon sequestration benefits, the two most uncertain variables considered. The NPV of the eucalyptus options were more sensitive than the teak options. Increasing the discount rate to 14% caused the NPV of all options to fall, reflecting the fact that a large share of benefits arise in later years.

In the case of industrial teak plantations, the higher discount rate pushed the NPV into the red. A lower discount rate of 6% was also tested. While all estimated NPV increased, the change was most notable for teak industrial plantations for which the NPV rose over four-fold.

**Valuation techniques used:** The reduction in on-site soil erosion experienced as a result of reforestation is valued using the replacement cost technique. Soil nutrients losses without reforestation (based on figures from the Philippines, adjusted for lower rainfall and erosion) are valued in terms of the cost of commercial fertilisers needed to replace them. The loss of nutrients due to tree harvesting is valued in the same manner.

The principal transpiration costs associated with reforestation are linked to lost agricultural production due to lower water availability. The production function approach is used to value this impact, by comparing the value of agricultural output with and without plantations. Changes in water availability are estimated using two formulae: the first was developed by Calder *et al.* (1991) and links the rate of transpiration to the basal area of tree trunks. The second formula uses two different water use efficiency (WUE) ratios developed by Larcher (1980) and Jones (1992) to estimate the volume of water that is consumed by a plant during the growing season, per kilogram of dry matter produced. The basal-area approach of Calder *et al.* generated lower estimates of transpiration than the WUE formulae.

The benefits of carbon sequestration in trees are valued using an opportunity cost approach. If the trees were not planted, an equivalent amount of carbon fixation could be achieved through emission controls. The costs of these alternatives represent the savings achieved through planting, and the figure used is US\$25 per tonne of carbon, taken from Andersson and Williams (1994). The volume of carbon fixed through reforestation is estimated based on data for *Albizia* spp. plantations (Nabuurs and Mohren 1993), but adjusted for carbon emissions from the decomposition of detritus vegetation. Additional adjustments are made to account for the destination of output from the plantations, and the relative period of time during which carbon is immobilized in different wood products, including paper and fuelwood, before being released into the atmosphere. Carbon sequestered by grass- or shrub-lands (the alternative land use) is finally deducted from carbon storage by timber plantations in order to derive the net carbon benefit of reforestation.

**Socio-economic groups affected:** The author notes that a major part of the benefits of reforestation accrue to the global community, in the form of carbon sequestration, and that efforts to promote reforestation will make little headway without financial transfers to local landowners.

#### **Key references:**

Andersson, D. and R.H. Williams. 1994. *The cost-effectiveness of GEF projects*. UNDP/UNEP/The World Bank. Working Paper No. 6, 36 pp.

Nabuurs, G.J. and G.M.J. Mohren. 1993. *Carbon fixation through forestation activities*. Institute for Forestry and Nature Research, Wageningen, Netherlands, IBN Research Report No. 93/4, 205 pp.

**Paris, R. and I. Ruzicka. 1991. *Barking Up the Wrong Tree: The Role of Rent Appropriation in Sustainable Tropical Forest Management*. ADB Environmental Office, Occasional Paper No. 1. (May), Asian Development Bank: Manila.**

**Type of assessment & main findings:** An annex to the paper presents CBAs of alternative timber management practices for old growth forests in the Philippines. The calculations illustrate the divergence between the social and private costs of timber extraction. Financial analysis shows a net profit of US\$119/ha, while an economic evaluation yields net losses of US\$70 to US\$922 per hectare. The costs of forest stock depletion and offsite environmental damage are considered substantial and in the light of these results the authors recommend a halt to logging of old-growth forests in the Philippines.

**Empirical data:** Data are based on estimates prepared in 1990 as part of the Philippine Master Plan for Forestry Development.

**Details of CBA:** A financial CBA of logging activities in the Philippines, from a purely private perspective, is compared to the economic value of logging activities where old growth forest is: a) selectively logged and subsequently protected (model 1); or b) selectively logged and subsequently not protected (model 2). The economic analysis takes account of indirect values associated with the depletion of timber stocks as well as negative environmental externalities not considered in the financial analysis. It also uses shadow prices as opposed to market prices in the financial analysis. The results are presented in the table below.

For the financial analysis the authors assume that operations are legal and use existing selective logging systems. The direct benefits of logging activities are measured in terms of the market value of logs harvested. These are weighed against the direct costs of road building, harvesting and transportation costs to obtain the financial profit of \$119 per hectare per year.

The economic CBA of model 1 estimates the net economic gain from logging assuming the same level of timber extraction. In this case, however, downstream environmental impacts are included explicitly (estimated as a non-market cost of US\$223 ha/yr), as well as the financial costs of stand protection, improvement and enrichment planting to ensure sustainable timber production (estimated at US\$3.50 ha/yr). If off-site costs are excluded, this option appears to offer superior returns, with a net present value of US\$155 ha/yr. However, when the marginal cost of offsite damages to downstream activities is deducted, the result is a net economic loss of US\$70 ha/yr.

In Model 2, where no steps are taken to protect the forest after it has been logged, a significant economic loss of US\$944 ha/yr is estimated. In this scenario the benefits of logging include the market price of timber harvested plus the value of subsistence farming which would be possible on the deforested land. These benefits are weighed against the foregone potential revenue from sustainable timber production (an opportunity cost), and the loss of watershed protection values (estimated in terms of offsite damage costs), due to inadequate protection of the residual stand.

**Valuation techniques used:** Market prices are used for harvesting costs and a shadow price is used for logs in the economic analysis. The production function approach is used to estimate a value for watershed protection services in the economic CBA. The value is based on estimated off-site damages in the case of logging.

### Financial and Economic Analysis of Logging in the Philippines (1990 US\$ ha/yr)

	Financial Analysis	Economic Analysis	
		Model 1	Model 2
Volume Extracted (cum)	2.86	2.86	2.86
Market Price of Logs per cum (medium quality) <sup>a</sup>	71	78	78
Value of Log Harvest	204	225	224
Road Building, Harvesting and Transportation Costs	(85)	(67)	(67)
<b>Net Financial Benefit</b>	<b>119</b>		
Cost of Protection, Stand Improvement and Enrichment Planting		(3.5)	
Cost of Depletion <sup>b</sup>			(699)
Cost of Marginal Offsite Damage to Downstream Activities		(223)	(455)
Value of Subsistence Farming Crops			75
<b>Net Economic Benefit</b>		<b>(70)</b>	<b>(922)</b>

Notes: All values are in 1990 US\$ per hectare per year (exchange rate: Filipino \$28.00 to US\$1 from International Financial Statistics 1992).

**a/** For the economic analysis, the market price of logs is increased by 10% to account for low cost illegal supplies.

**b/** Calculated as the value of sustainable timber production on one hectare in perpetuity, i.e. US\$115.5 per annum discounted at 12%.

**Pearce, D.W. 1991. *Forestry Expansion - a study of technical, economic and ecological factors; Assessing the Returns to the Economy and Society for Investments in Forestry.* Occasional Paper No. 47, Forestry Commission: Edinburgh.**

**Type of assessment & main findings:** The paper presents a CBA of afforestation in the United Kingdom. NPVs and internal rates of return (IRR) are calculated for eight different forest types. The author concludes that, while under certain circumstances there is an economic justification for afforestation, in many cases it must be justified with reference to values not included in the CBA, e.g. biodiversity conservation.

**Empirical data:** Shadow prices and costs for 1989/90, secondary sources for market prices and estimates of carbon, recreational values and economic security values. Shadow prices used and sources for their estimation are listed in Table 1 below.

<b>Table 1: Shadow price calculation</b>	
<b>Item</b>	<b>Source</b>
Labour	67% of the market wage. Based on a survey of 100 farms carried out in Scotland (Dewar 1991).
Land	50% to 80% of the market value. Derived by removing trade and government distortions (e.g. subsidies) from the market price (this brings the price to 54% of the market value) and adding a premium for amenity and existence values attached to forested land. This premium varies by forest type.
Timber	Border price adjusted for benefits provided by economic security. These benefits are valued as a cost avoided in the case of interruption of timber imports, e.g. due to a trade embargo. This was estimated at between 0.2% and 1.8% of the shadow price of timber by Pearce <i>et al.</i> (1988). This study uses a premium of 1% of the shadow price of timber for all forest types.

**Details of CBA:** The CBA is undertaken from society’s perspective and shadow prices are used to value marketed benefits (timber) and costs (labour and land). Furthermore, the analysis attempts to include a range of non-marketed (direct and indirect) benefits and costs. Non-marketed benefits which are valued include:

- recreation (direct use value);
- carbon sequestration (indirect use value); and
- improved economic security of domestic timber supply (indirect use values).

Where benefits and costs cannot be valued, they are described qualitatively. This was the case for biodiversity, landscape values, community values (i.e. maintenance of a rural way of life) and various water resource functions. For instance, forests may increase local water acidity and aluminium content, but decrease air pollution. A 6% discount rate is used, which is the rate employed by government for evaluating public sector projects. Issues of risk and uncertainty are addressed through sensitivity analysis. Variations in estimates of land, labour and recreational values are considered, leading to numerous estimates of internal rate of return (IRR) for different options. With land values set at 80% of

the market price, labour at 67% and moderate recreational values, afforestation with Spruce in the uplands is seen to be the most desirable option (IRR of 6.0%). No other option has a positive NPV given these assumptions and a discount rate of 6%. Note that timber benefits are negative in every case, reflecting the fact that revenues are more than offset by the costs of production. Under different assumptions, other forest types achieve positive NPVs. Examples of the most viable options include:

- community forests where a very high recreational value is assumed;
- Spruce in uplands where land is valued at 50% of the market price;
- Fir, Spruce and Broadleaf forests in lowlands, where a high recreational value is used and land values are set at 80% of the market price; and
- Pine in lowlands where land is valued at 50% of the market price.

**Valuation techniques used:** See Table 2.

<b>Table 2: Valuation techniques used</b>		
<b>Forest benefit</b>	<b>Type of value</b>	<b>Valuation technique</b>
Timber	direct use	Shadow price - the border price adjusted for economic security benefits. Assumes constant prices.
Recreational use	direct use	Estimated consumer surplus based on Benson and Willis (1991). A range of values are given: low (£3/ha/yr), moderate (£30/ha/yr or £50/ha/yr), high (£220/ha/yr) and very high (£424/ha/yr). These are expected to increase by 1% per year based on Walsh (1986).
Carbon sequestration	indirect use	Damage costs avoided: Damage avoided is set at US\$13.3/tonne CO <sub>2</sub> , an intermediate value in a range of US\$3 to US\$25 per tonne suggested by Nordhaus (1990).

### **Key references:**

Benson, J. and K. Willis. 1991. *Forestry Expansion - a study of technical economic and ecological factors; The Demand for Forest Recreation*. Occasional Paper No. 39, Forestry Commission: Edinburgh.

Dewar, J. 1991. *Forestry Expansion - Forestry Expansion - a study of technical economic and ecological factors; New Planting Methods, Costs and Returns*. Occasional Paper No. 46, Forestry Commission: Edinburgh.

Pearce, D., A. Markandya, and I. Knight. 1988. *Economic Security Arguments for Afforestation*. Report to the Forestry Commission, Edinburgh.

Nordhaus, W. 1990. *To Slow or not to Slow: The Economics of Greenhouse Effect*. Unpublished mimeo, Yale University: New Haven, CT.

Walsh, R. 1986. *Recreation Economic Decisions: Comparing Benefits and Costs*. Unpublished mimeo, Venture State College, PA.

**Peters, C., Gentry, A. and R. Mendelsohn. 1989. "Valuation of an Amazonian Rainforest" in *Nature*, 339 (June): 655-656.**

**Type of assessment & main findings:** The authors present an economic CBA of subsistence and commercial exploitation of tropical moist forest for native fruit, latex and timber in Peru. These uses are compared to plantation forestry and cattle ranching. The authors conclude that periodic selective timber harvest combined with sustainable fruit and latex harvest is the most profitable land-use option.

**Empirical data:** The article contains data based on an original survey and supplemented by published statistics. Physical inventory of one hectare of natural forest land at Mishana, Rio Nanay, Peru, yielded the following data:

- number of tree species and number of stems greater than 10.0 cm diameter breast height;
- proportion of tree species and individuals yielding merchantable products (fruit and latex);
- fruit yield for four tree species.

The authors carried out monthly surveys in local markets to collect data on fruit prices in 1987. Timber prices were obtained from local mill operators. Interviews and observation of local forest users enabled the authors to obtain estimates of fruit yields for seven other tree species and of the labour inputs required to harvest fruit and latex. Primary data was supplemented with selected published information, including:

- the minimum wage in Peru in 1987;
- transport costs for fruit and latex products (estimated at 30% of market value);
- logging and transport costs for timber (30-50% of the market value of delivered timber);
- average latex yields;
- for timber tree species, mean annual diameter increment and the relation between diameter breast height and merchantable volume;
- NPV of timber and pulpwood obtained from a 1.0 ha plantation of *Gmelina arborea* in Brazilian Amazonia;
- gross revenues from fully stocked cattle pastures in Brazil (per annum and NPV).

Using these data, the authors generate estimates of:

- tree population, annual yield per tree, market price and total production value for 11 fruit tree species and one latex producing species occurring in one hectare of forest;
- tree population, merchantable volume, unit price at the mill and stumpage value for 60 species of commercial timber (grouped under 23 commercial names) in the same hectare of forest;
- maximum sustainable timber yield (estimated at 30 cubic meters per hectare every 20 years).

**Details of CBA:** The authors compare the NPV of three land use options: (i) sustainable fruit and latex extraction only, (ii) clear cutting of merchantable timber and (iii) periodic selective timber harvest combined with sustainable fruit and latex harvest. The preferred land-use is option (iii). Sustainable fruit

and latex are found to account for over 90% of the total value of tree resources in natural forest (excluding the value of medicinal plants, lianas and small palms which were not studied).

The best option is finally compared to the NPV of plantation forestry and of cattle ranching, under assumptions which appear to favour the latter scenarios. The authors conclude that sustainable multiple use of natural forest generates higher economic value (see table).

**Financial Returns to Non-Timber Products and Other Forest Uses in  
1 hectare of Natural Forest at Mishana, Rio Nanay, Peru**  
(Net Present Value, US\$/ha 1989, 5% Discount Rate)

1.	Non-Timber Harvesting	
	Fruit and latex	6,330
2.	Sustainable Timber Harvesting	
	Periodic selective cutting	490
<b>Total Natural Forest Value (1 + 2)</b>		<b>6,820</b>
3.	Clear-Cut Timber Harvesting	1,001
4.	Plantation Harvesting	
	Timber and pulpwood 1/	3,184
5.	Cattle Ranching 2/	2,960

Notes: 1/ 1.0 ha plantation of *Gmelina aborea* in the Brazilian Amazon.

2/ Gross revenues per hectare of fully stocked cattle pastures in the Brazilian Amazon (costs of weeding and fencing and animal care not deducted).

**Valuation techniques used:** Market (and official) prices and actual expenditure are used to value most items. The official minimum wage is used to estimate the opportunity cost (shadow price) of labour. These data are used to estimate gross and net revenues derived from fruit, latex and timber production on natural forest land.

**Socio-economic groups affected:** No formal analysis of distributional issues is conducted, but the authors note that non-timber products are primarily a concern of subsistence farmers, forest collectors, middlemen and shop-owners, hence less visible than timber.

**Comments:** The study is one of the most widely cited examples of an economic comparison of alternative forest land uses. However, while the analysis suggests that returns to non-timber products - in this case fruit and latex - compare favorably with clear-cutting of timber and forest conversion, the results should be interpreted with caution. Firstly, the estimated returns to fruit and latex extraction are *potential* returns. Actual returns might fall far short if local capacity for marketing, post-harvesting processing and/or export of NTFPs are weak. Secondly, the particular hectare of forest studied is

located near a village some 30 km distance from Iquitos, the town in which market price data were gathered. The results of the study cannot be extrapolated over a much wider forest area, as transport costs are likely to be higher and net returns proportionately lower. Moreover, any attempt to conduct a similar analysis at a regional or national level would need to account for limits to demand for NTFPs (i.e. consumers might not want or need all the fruit in the forest, even if it were made available). Finally, fruit and latex harvesting can be destructive if not managed carefully. In general, the record for harvesting non-timber forest products for commercial exploitation is not good, especially where harvesting is potentially destructive, such as in the case of tree barks and gum.

**Phillips, W., Adamowicz, W., Asafu-Adjaye, J. and P. Boxall. 1989. *An Economic Assessment of the Value of Wildlife Resources in Alberta*. Project Report No. 89-04, prepared for the Alberta Recreation, Parks and Wildlife Foundation by the Dept. of Rural Economy, Faculty of Agriculture & Forestry, U. Alberta, Edmonton, Canada.**

**Type of assessment & main findings:** The study presents a valuation of non-market benefits of wildlife in Alberta, Canada. The benefits considered are wildlife viewing and hunting.

**Empirical data:** The study presents data and analysis from two surveys conducted in 1988. Surveys were mailed to 2,590 randomly selected hunters (51% response rate) and 2,400 randomly selected households (30% response rate). The results include:

- socio-economic characteristics of respondents, including place of residence, age, gender, family size, years of schooling and income for both hunters and households;
- respondents' self-professed 'attitude' towards wildlife for both hunters and households;
- hunting experience of respondents, reasons for hunting and activities by type of game;
- hunting expenditures per person in 1987/88 (broken down by category of expenditure);
- nonconsumptive wildlife-related activities by type and frequency;
- species of wildlife used for nonconsumptive activities;
- expenditure on nonconsumptive activities;
- estimated economic benefits of hunting per person and in aggregate;
- preservation values per person by socio-economic strata;
- preservation benefits of wildlife to hunters and to the general population;
- total economic benefits of big game in Alberta;
- frequency distribution of bids for licenses to hunt grizzly bear under supply uncertainty and the empirical relation between option price (bid values) and supply uncertainty.

Appendices to the report include more detailed information on place of residence, family size, years of schooling and income for both hunters and households. For hunters only, data are provided on the reasons for hunting, the preservation values of wildlife and grizzly bears, and the economic value of big game and grizzly bear hunting. For households only, data are provided on the preservation value of wildlife.

**Economic values considered:** Direct use, indirect use and option value.

**Valuation techniques used:** CVM is used to estimate wildlife users' willingness to pay (WTP) for wildlife preservation. The questionnaire asked hunters how much more they would be WTP annually (over and above actual hunting expenses) to continue hunting, with separate values for big game and grizzly bear hunting. It also asked those who engage in hunting grizzly how much they would pay 'to a grizzly bear fund' in order to enjoy a specified probability (10%, 50% or 90%) of obtaining a license to hunt grizzly in the future (i.e. their option price). To derive a general option value, the questionnaire also asked households how much they would be willing to donate to a wildlife trust fund to preserve wildlife

in Alberta. Households were split into two groups to examine whether the method of payment (voluntary donation or increased income tax) influenced their WTP.

**Pinedo-Vasquez, M., Zarin, D. and P. Jipp. 1992. “Economic Returns from Forest Conversion in the Peruvian Amazon” in *Ecological Economics*, 6: 163-173.**

**Type of assessment & main findings:** The paper presents an economic CBA of timber extraction and swidden agriculture, compared to potential revenues from forest fruit and latex extraction in an 800 hectare reserve (60 year old secondary forest) near Iquitos, Peru. The authors conclude that the lack of secure land and resource tenure for individuals, and the absence of attractive alternative land uses, makes conversion of forested land to swidden agriculture a logical choice in the San Rafael region. The study results contradict those reported in Peters *et al.* (1989) for a nearby Peruvian village, Mishana.

**Empirical data:** The authors draw on unpublished data from a regional farmers’ union, combined with interviews and surveys conducted in San Rafael for information on costs and revenues for both timber and agricultural crops. Revenues from forest fruit and latex are re-estimated from data presented in Peters *et al.* (1989), on the assumption that only half of the 12 species inventoried in Mishana are found in San Rafael. An inventory of timber resources (stems > 25 cm in diameter for 29 species) was conducted in the San Rafael forest reserve.

**Details of CBA:** The benefits of NTFP extraction are compared to those of unsustainable commercial logging and swidden agriculture. Only direct use values are considered. No estimates are presented for sustainable management of timber, as the authors argue that it is unrealistic to compare the present value of potential returns from sustainable extractivism, when lack of secure tenure means that most farmers cannot afford to look more than about two years ahead. A more ‘realistic’ comparison is thought to be between timber extraction followed by swidden agriculture, and traditional extraction of forest fruit and latex. The CBA is conducted for one hectare of forested land over a 2-year period, assuming a 5% continuous discount rate. The results shows that the returns from one-time extraction of merchantable timber (US\$480.94) and conversion of forested land to swidden agriculture (US\$893.29) exceed the returns from extraction of fruits and latexes over the same period (US\$680.44 at Mishana; US\$42.93 at San Rafael). Returns are calculated for one rotation of swidden agriculture only. On this basis the authors reach a very different conclusion than that of Peters *et al.* (1989), who argued that sustainable management of the forest reserve in Mishana would be more profitable than logging or conversion. Sensitivity analysis to test higher discount rates of 10% and 15% does not alter the main conclusion.

**Valuation techniques used:** Market prices are used to value most costs and benefits.

**Socio-economic groups affected:** The focus is on the ‘ribereños’, the rural inhabitants of Peruvian Amazonia.

#### **Key references:**

Padoch, C. 1987. “The Economic Importance and Marketing of Forest and Fallow Products in the Iquitos Region” in *Advances in Economic Botany*, 5: 74-89.

Pinedo-Vasquez, M., Zarin, D. and P. Jipp. 1990. “Amazon land-use” in *Nature* pp. 348-397.

**Prasanthi Gunawardena, U.A.D., Edwards-Jones, G., McGregor, M.J. and P. Abeygunawardena. 1999. "A Contingent Valuation Approach for a Tropical Rainforest: A Case Study of Sinharaja Rainforest Reserve in Sri Lanka" in Roper, C.S. and A. Park (eds.) *The Living Forest: Non-Market Benefits of Forestry*. Proceedings of an International Symposium, Edinburgh 24-28 June 1996, Forestry Commission. H.M. Stationary Office: London, pp. 275-84.**

**Type of assessment & main findings:** The study presents estimates of use and non-use values associated with the Sinharaja Rainforest Reserve, covering about 9,000 hectares in the south-west lowlands of Sri Lanka. The authors conclude that the total economic value (TEV) of the Reserve depends critically on who participates in the survey.

**Empirical data:** A CV questionnaire was administered to three groups in 1994: rural and urban households (230 and 240 respectively), and people living near the Reserve (224 households). Open-ended willingness to pay (WTP) questions were posed with regards to both use values (collection of forest products, education, recreation) and non-use values (existence and bequest). Users were asked to express their WTP for both sets of values, while non-users were asked to state WTP for non-use values only. Socio-economic data was collected for econometric analyses linking household characteristics to WTP.

**Economic values considered:** Both use values and non-use values are calculated in an effort to estimate the TEV of the Reserve. Use values include direct benefits from the extraction of forest goods, non-consumptive uses such as recreation, and indirect benefits from the Reserve's environmental services, and were lumped together in a single WTP question. Existence and bequest values were treated separately. Option values were not considered explicitly, but may be part of individual's WTP for existence values.

**Valuation techniques used:** An open-ended CVM was used, consistent with guidelines given in Mitchell and Carson (1989) and Cummings *et al.* (1986).

**Socio-economic groups affected:** The distribution of benefits associated with the Reserve was not considered explicitly, although the authors note that WTP for different forest benefits varies among different groups. Local villagers (forest users) express the highest WTP, as a percentage of income, for the preservation of use values. Their estimated WTP is 0.52% of income, compared to 0.21% and 0.33% for rural communities and urban communities, respectively. Local villagers also express the highest WTP for bequest values, at 0.42% of their income, compared to 0.16% and 0.23% for rural and urban groups, respectively. WTP for existence values is similar for all three groups. Foreigners' WTP for non-use values is not estimated.

#### **Key references:**

Cummings, R.G., Brookshire, D.S. and W.D. Schultz. 1986. *Valuing environmental goods: a state of the art assessment of the contingent valuation method*. Rowman & Allenheld: Totowa.

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

**Type of assessment & main findings:** The report presents a CBA of conservation and development efforts in the proposed Korup National Park in Southwest Province, Cameroon. The analysis is complementary to a CBA of related efforts focusing on the adjacent Cross River National Parks Project (Oban Division), in Nigeria (**Ruitenbeek 1989b**). In both cases, project activities aimed to ensure conservation of an important area of tropical rainforest, relieve pressure from hunting and gathering activities and conversion of primary forest to farm land, while also supporting social and economic development in areas around the two parks. In this study, a ‘with project’ scenario was compared to a ‘without project’ scenario. Activities include establishing the park, enforcing park regulations, resettling six communities and implementing a complementary economic development plan for a defined management area around the park. In the ‘without project’ scenario, it was assumed that the forest would suffer continuing encroachment and eventual conversion to other uses. The author concludes that the Park offers significant net benefits at both national and project level.

**Empirical data:** The analysis is based on secondary data, incorporating the results of studies and surveys up to mid-1989.

**Details of CBA:** Base case results are presented in Table 1, showing that the net present value of the project as a whole is about UK£1 million, and for the Cameroon, about UK£7.5 million.

**Table 1. Cost Benefit Analysis of Korup National Park: Base Case Result**

(NPV in 1989 UK£ 000, r = 8%)

Direct Costs of Conservation		(11,913)
Opportunity Costs		(3,326)
- Lost stumpage value	(706)	
- Lost forest use	(2,620)	
Direct Benefits		11,995
- Sustained forest use	3,291	
- 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	
<b>NET BENEFIT - PROJECT</b>		<b>1,084</b>
Adjustments		6,462
- External trade credit	7,246	
- Uncaptured genetic value	(433)	

- Uncaptured watershed benefits  
**NET BENEFIT - CAMEROON**

(351)

**7,545**

The direct operating and capital costs of the Project are considered, as well as the opportunity costs of foregone timber earnings (lost stumpage value) and foregone production from six resettled villages (lost forest use). Against this are set direct project benefits in the form of sustained forest use beyond the year 2010, when the forest would otherwise have disappeared, replacement subsistence production of the resettled villages, tourism benefits, minimum expected genetic value of the forest in terms of pharmaceutical products, chemicals and agricultural crop improvements, etc., and environmental functions including watershed protection of fisheries, control of flooding and soil fertility maintenance. Carbon storage values are excluded.

**Valuation techniques used:** Market prices were used to value most project activities and impacts, including foregone timber benefits (valued at export prices). Labour inputs were shadow-priced at 50% of the market wage. Foregone forest use by local residents is valued based on survey data on the share of hunting and gathering in total household income, and the population affected. Replaced subsistence production for re-settled households is estimated at 25% of average national per capita income. Tourism benefits were valued on the basis of visitor projections and typical expenditures and itineraries at comparable locations.

Potential genetic benefits were based on the market value of patents for firms engaged in genetic research and various assumptions about the expected future value and number of research discoveries. A negative adjustment (uncaptured genetic value) was made to reflect the author's assumption that Cameroon will capture only 10% of total genetic value through existing licensing structures and institutions.

Watershed protection benefits are valued in terms of fisheries and flood control. In the first case, two different but equally crude approaches are used to estimate the gross value of on-shore and offshore fisheries, which are assumed to be entirely dependent on the forest. One estimate is based on the total capacity of the fishery, multiplied by the average market price, while the other is based on average national per capita income, multiplied by the total population engaged in fishing. A negative adjustment (uncaptured watershed benefits) indicates that some watershed protection benefits flow to Nigeria and not to Cameroon.

Forest flood control benefits were valued using rough estimates of expected losses from flooding, assuming the Korup forest were to disappear over the period 2010 to 2040. Soil fertility maintenance was expressed in terms of enhanced crop yields, valued at world market prices. Additional 'induced' benefits included expected increased agricultural productivity and new forestry production resulting from development initiatives in the buffer zone. An external trade credit shows a positive benefit to Cameroon in the form of external funding of the project.

All future costs and benefits were discounted to 1989. The base case was defined using an 8% discount rate and a shadow wage rate of 50% of the market wage. Sensitivity analysis considered a higher

discount rate (12%), increased labour costs and an alternative development scenario in which deforestation is delayed by 20 years. Even with these changes net benefits are positive.

**Socio-economic groups affected:** No special distributional considerations; thus implicitly assuming that the government placed the same welfare weights on benefits or costs accruing to people within the project area as they did to the rest of the country.

**Comments:** The valuation procedures are crude in some cases, but the study is an impressive early example of attempts to estimate the total economic value of tropical forest land.

**Ruitenbeek, H.J. 1989b. *Economic Analysis of Issues and Projects Relating to the Establishment of the Proposed Cross River National Park (Oban Division) and Support Zone. Prepared by the World Wide Fund for Nature for Cross River National Parks Project, Nigeria.***

**Type of assessment & main findings:** The report presents a CBA of conservation and development efforts in the Cross River National Parks Project (Oban Division), in Nigeria. The analysis is complementary to a CBA of related efforts focusing on the adjacent Korup National Park in Southwest Province, Cameroon (**Ruitenbeek 1989a**). In both cases, project activities aim to ensure conservation of an important area of tropical rainforest, relieve pressure from traditional hunting and gathering activities and the conversion of primary forest to farm land, while also supporting social and economic development in areas around the two parks. Land uses considered in this study include logging (both clear cutting and sustained yield management), tourism, agriculture (food and cash crops), hunting and gathering of forest products, exploitation of genetic resources, and watershed protection (for fisheries). The analysis suggests that it would be in Nigeria's economic interest to undertake the project only if the country could capture some of the genetic value that might be attributable to the resource.

**Empirical data:** Information is derived from three sources: reports prepared for the study by WWF consultants; econometric analysis of behavioural characteristics of villages previously surveyed for the Korup project in Cameroon (using only information judged relevant to the Nigerian context); discussions with Project and Government officials.

**Details of CBA:** Both direct and indirect use values are considered. On the cost side, the author considers the direct capital and operating costs of the project, the resettlement costs of displaced villagers, and the opportunity costs of forgone hunting, trapping and gathering activities and timber production. Against these costs are set the benefits of sustained forest use, revenue from agriculture and other development initiatives, tourism and watershed protection benefits (see table). At a 12% discount rate the net benefits of the project are negative with a social cost of ECU 12 M, assuming that Nigeria captures no other benefits. The author introduces the notion of a "*Rainforest Supply Price*", i.e. the amount that Nigeria must capture, either through genetic product development or direct transfers from the international community, in order to justify saving a particular rainforest. Calculations for Oban indicate a supply price of about ECU 12.1 M which works out to just under ECU 50 per hectare. The direct transfers proposed under this project have a value to Nigeria of ECU 12.5 M, just sufficient to give Nigeria an economic incentive to adopt the program.

**Valuation techniques used:** Market prices are used and all costs and revenues are expressed in 1989 ECU. Estimated values are judged to be reliable within plus or minus 25%.

**Socio-economic groups affected:** Distributional consequences are incorporated in terms of changes in the income of local populations. Hunting and farming are an important source of income and subsistence for 35-40,000 inhabitants surrounding the park. Various initiatives are proposed to mitigate the short-term negative impact which enforcement of park policies will have on local populations.

**Cross River/Oban Project Assumptions, Costs and Benefits**  
(NPV in millions of 1989 ECU)

**ASSUMPTIONS**

Discount rate = 12% : 90 years  
Standard Conversion Factor (SCF) = 0.85  
Shadow Wage Rate for Unskilled Labour = 1 \* SCF

**COSTS**

	<u>(38.30)</u>
Hunting, Trapping and Gathering Losses	(10.06)
Timber Losses	(15.29)
Capital and Operating Costs of CRMP <sup>a</sup>	(5.24)
Capital and Operating Costs of SZDP <sup>b</sup>	(3.12)
Capital and Operating Costs of CRBL <sup>c</sup> and Hotel	(1.47)
Capital and Operating Costs Agriculture and Aquaculture	(2.87)
Resettlement Costs	(0.25)

**BENEFITS**

	<u>26.20</u>
Sustained Forest Use (HTG)	2.46
Revenues from Agriculture & Development Initiatives	18.66
Other Revenues	1.57
Tourism	1.58
Appropriable Watershed Benefits	1.93

**NET BENEFITS PROJECT**

	<u>(12.10)</u>
INTERNAL ECONOMIC RATE OF RETURN	6.65%
INTERNAL FINANCIAL RATE OF RETURN (S.C.F.= 1)	7.15%

**FOREIGN INJECTIONS**

	<u>12.53</u>
RCF Capitalization (5 years)	0.63
VCR Payments (5 years)	2.26
Logging Concession Payout	0.73
Other Injections	8.91

**NET BENEFITS NIGERIA**

	<u>0.43</u>
INTERNAL ECONOMIC RATE OF RETURN	12.42%
INTERNAL FINANCIAL RATE OF RETURN (S.C.F.= 1)	15.42%

**SUPPLY PRICE ANALYSIS**

Area (ha)	250,000
LDC Rainforest Supply Price (ECU/ha)	48.41
Price Paid through Transfer Mechanism (ECU/ha)	50.14

Notes: a/ CRMP - conservation zone management programme  
b/ SZDP - support zone development programme

c/ CRBL - Cross River Bioresources Limited

**Ruitenbeek, H.J. 1992. *Mangrove Management: An Economic Analysis of Management Options with a focus on Bintuni Bay, Irian Jaya*. EMDI Environmental Report No. 8. Jakarta and Halifax.**

**Type of assessment & main findings:** The report presents a social and economic CBA of the protection of 300,000 hectares of mangrove in Bintuni Bay, Irian Jaya, in eastern Indonesia. The mangrove is under threat from cutting by woodchip exporters. The analysis considers six options for mangrove use, ranging from clear cutting to a total ban on felling. The best option depends on the assumptions made regarding the impact of cutting on the offshore shrimp fisheries. Where impacts are linear and immediate, a cutting ban is the preferred option. Where linkages are linear but delayed by 5 years, the optimal strategy involves 25% selective felling. Where no linkages exist, clear cutting yields the highest NPV.

**Empirical data:** Primary data was collected through a survey of 101 households, representing 3% of the local population. The survey gathered information on socio-economic factors, traditional mangrove uses and earnings. Based on this information the author estimates that 70% of total income to local households, on average, derives from use of the mangrove for fishing, hunting and gathering. Information on market prices, costs of production, commercial mangrove uses, agricultural production, and potential biodiversity values are from secondary sources including government statistics.

**Details of CBA:** The CBA is undertaken from the government’s perspective and uses economic prices, including a social discount rate of 7.5%. The analysis compares six mangrove-use options ranging from a cutting ban, through various selective cutting regimes, to a clear cut scenario. Cutting is undertaken for chipwood to feed the rapidly expanding export industry. It is assumed that a 80% selective cut is equivalent to the maximum sustainable yield under a 30 year rotation. A 90 year horizon is used to allow for 3 rotations. Most prices and costs are assumed constant in real terms for the period of the analysis. For each mangrove-use option the following values are estimated:

Value	Marketed?	Items
Direct use	marketed	timber (chipwood), sagu, offshore fisheries (shrimp and by-catch fish)
	non-marketed	traditional hunting, gathering, fishing
Indirect use	non-marketed	erosion control, biodiversity

Chipwood extraction over time is specified by the six options described above. Extraction rates for other benefits vary. Actual extraction is set to equal estimated sustainable extraction for sagu. Harvesting by shrimp fisheries (where no linkages exist) is assumed to increase by 15% from current levels to an estimated maximum sustainable yield of 5,500 tonnes per year. By-catch fish are assumed to grow in line with shrimp harvesting. Moreover, fish is assumed to become more valuable as commercial uses are developed. Traditional non-market uses are assumed to grow in line with population but this growth is slightly offset by reduced dependence on mangroves, which is expected to occur with rising incomes.

Estimation of indirect use values (erosion control and biodiversity benefits) are discussed below. Note that potential eco-tourism values were also considered, but excluded from the CBA due to the low

probability that such a use would generate significant profits in the near term. Option and existence values were not considered.

A key strength of the evaluation is the extensive use of sensitivity analysis. For each land-use option considered, costs and benefits are evaluated under different assumptions about the link between mangrove cutting and the productivity of offshore shrimp fisheries. Three main scenarios are developed, reflecting the alternative assumptions of a linear relationship between cutting and shrimp fisheries, a non-linear relationship, and no linkage at all. For the first two scenarios, delay parameters are used to account for the possible time lag between mangrove cutting and off-site impacts. Five and ten year delays are tested. The results are summarised in terms of the incremental benefit of shifting from one land-use option to another, as in the table below. The optimal strategy for each scenario is given in the last row.

Determinants of optimal mangrove management strategy, Bintuni Bay (NPV in billions of 1991 Rps)						
Option 1	Option 2	NPV (option 1) - NPV (option 2)				
		Linear linkage between cutting and shrimp fishery		Non-linear linkage between cutting and shrimp fishery		No linkage
		5 yr delay	10 yr delay	5 yr delay	10 yr delay	
25% cut	cutting ban	-50	<5	+80	+120	+170
40% cut	25% cut	-30	0	+50	+70	+100
80% cut	40% cut	-80	0	+110	+170	+270
Clear cut	80% cut	-120	-80	-40	0	+60
<b>Optimal strategy</b>		<b>Ban</b>	<b>25% cut</b>	<b>80% cut</b>	<b>80% cut</b>	<b>clear cut</b>

Alternative discount rates (5% and 10%) are also considered. In general, a lower discount rate increases the appeal of more conservative cutting strategies. Note that with a 5% discount rate, the clear cut option is never optimal. However, even with a high discount rate a cutting ban is preferred when the impact of cutting on the fishery is assumed to be strong.

**Valuation techniques used:** Shadow prices are used to adjust the market prices of both traded goods and domestic products, based on standard conversion factors for estimated policy distortions. Erosion control and fishery benefits are valued using a production function approach. Several possible relationships between mangrove cutting and fisheries are tested through alternative linkage scenarios. A simple one-to-one relationship links the value of erosion control to that of local agricultural output. Biodiversity was valued for the cash flow it is expected to generate in the future through bilateral grants, multilateral grants (e.g. the GEF) and NGO transfers linked to the protection of biodiversity. Based on previous research (Ruitenbeek 1990), capturable biodiversity value is estimated at US\$15 per hectare.

**Socio-economic groups affected:** Mangrove loss is found to affect poorer households disproportionately. While richer households benefit more in absolute terms from mangrove use, poorer households depend for a larger share of their income on traditional uses such as gathering, hunting and fishing. Moreover, as the formal sector has grown in importance in Bintuni Bay, poorer households have

benefited less than rich ones, while their dependence (in terms of contribution to total income) on the mangroves has increased.

**Key references:**

Ruitenbeek, H. J. 1990. *Evaluating economic policies for promoting rainforest conservation in developing countries*. Ph.D dissertation, London School of Economics: London.

**Saastamoinen, O. 1992. *Economic Evaluation of Biodiversity Values of Dipterocarp Forests in the Philippines*. Second Meeting of the International Society of Ecological Economics (ISEE), 3-6 August 1992. Stockholm University: Stockholm.**

**Type of assessment & main findings:** The paper presents a CBA of preserving Dipterocarp forests in the Philippines. It includes the net present (discounted) revenues from known and unknown minor forest products as benefits and the net present revenues from logging as (opportunity) costs. The results show that only with very low discount rates (1%, or 3% if timber harvest is permitted after 25 years) do the potential future benefits of preservation exceed the present value of harvesting the virgin forest over a period of 10 years.

**Empirical data:** The annual revenues derived from minor forest products are based on the Philippines Master Plan (1990).

**Details of CBA:** Direct use and option values are estimated to value benefits from forest preservation. Direct use values include existing harvests of NTFPs. An average annual value is assumed, based on the official Master Plan (1990) and equivalent to US\$65 per ha/yr, at an exchange rate of 23 Pesos/US\$. Option values refer to potential future values of undeveloped NTFPs and biological resources. These are thought to amount to US\$173 per ha/yr. There is also some consideration of existence value, but recreational and other amenity values are not included. Opportunity costs are valued in terms of the foregone net benefits of logging, and estimated at US\$350 per ha/yr over 10 years. The results are tested for their sensitivity to changes in the discount rate, using several different rates (1%, 3%, 5%, 10% and 15%).

**Valuation techniques used:** Market prices were used to value existing minor forest products, timber and option values. Estimation of option values required assumptions regarding future market prices, as well as the future production of lesser known products and biological resources. Lesser-known forest resources are assumed to reach a sustainable production level equal to two-thirds of the existing harvest of minor forest resources. This yield is assumed to be achieved after 10 years, at which point it is evaluated at US\$43 per ha/yr. Biological resource utilisation is assumed to be sustainable at twice the level of current harvests. This level is reached after 15 years, at which point it is evaluated at US\$130 per ha/yr. No details are presented to explain the difference between these categories.

**Schwartzman, S. 1989. "Extractive Reserves: The Rubber Tapper's Strategy for Sustainable Use of the Amazon Rainforest" in Browder, J.O. (ed.). *Fragile Lands of Latin America: Strategies for Sustainable Use of the Amazon Rainforest*, pp. 150-163, Westview Press: Boulder, Colorado.**

**Type of assessment & main findings:** The paper presents a financial CBA of rubber tapping and Brazil nut extraction in the Acre River Valley of western Amazonia (Brazil). The author finds that '*the fragile land use strategies of autonomous rubber tappers furnish ... an income that puts them above half of the economically active population of the region*' (pg. 161).

**Empirical data:** Primary data is obtained from a survey of 33 rubber collecting households in 'Serungal' (rubber state) Cachoeira, in the municipality of Xapuri (state of Acre, Brazil) in October and November of 1987. Average (per family/holding) data are presented on:

- (i) total holding size and area used for agriculture and pasture;
- (ii) annual production of rubber and Brazil nuts per holding (in kg and 1987 US dollars);
- (iii) labour time spent in rubber and Brazil nut production per year (preparing rubber trails, extracting latex, processing latex and collecting Brazil nuts).

Secondary data are presented on:

- (iv) area and population of proposed extractive reserves in Acre and Amazonas;
- (v) daily formal sector wage rate (in US\$) in the state capital (Rio Branco);
- (vi) rubber prices in domestic controlled markets and world market price, Brazilian Amazonian rubber production and natural rubber imports by Brazil (1980-1984).

**Details of CBA:** The analysis is undertaken from the perspective of rubber tappers and only considers direct use values from tapping, i.e. rubber and Brazil nuts. By extrapolating from estimated average gross revenues in Serungal Cachoeira (US\$960) to other reserves, the author estimates that gross returns come to US\$4.80 per hectare and per year. Cost estimates are based on labour demand. The number of person-days required to collect and process latex and gather Brazil nuts in a 200 hectare holding varies between 142 and 268, with an average value of 199 days. The daily wage rate was estimated at US\$2.60. This implies an average cost of US\$2.60 per hectare/year for both activities, bounded from US\$1.85 per ha/yr in the best case and US\$3.58 per ha/yr in the worst case.

**Valuation techniques used:** Market prices are used to value both outputs and labour inputs.

**Socio-economic groups affected:** Rubber collector households.

**Comments:** The author does not compare returns to rubber tapping and Brazil nut extraction to alternative land uses, e.g. agriculture. Policy distortions (import duties) affecting domestic rubber prices are not considered.

**Sedjo, R.A. 1988. *The Economics of Natural and Plantation Forests in Indonesia*. FAO: Rome.**

**Type of assessment & main findings:** The study uses CBA to rank eleven natural forest and plantation management options for timber production in Indonesia. The analysis neglects values thought to vary little under different regimes, e.g. ecological impacts. Comparison of the results indicates that the traditional selective cutting system is inferior to a range of alternative options, at least with respect to timber production values.

**Empirical data:** Data was gathered on wood prices, harvesting and management costs, and the opportunity cost of capital in Indonesia. Wood prices are forecast to remain constant in real terms for the purpose of the analysis.

**Details of CBA:** The study focuses on the direct use value of forests for timber production. In a brief discussion of environmental aspects, the author argues that the impact of different regimes on wildlife and genetic resource values, and on environmental services, will be small because the analysis considers only timber production, not protection forests.

The table below presents estimates of the discounted financial returns to six different timber regimes in Indonesia. (The remaining five management regimes considered represent minor adjustments to these six regimes.) TPI is the ‘ideal’ selective cutting system where minimum disruption to the natural forest ecosystem occurs. This is the officially approved management regime for production forests in Indonesia. CHR is ‘complete harvesting and regeneration’, i.e. harvesting of all marketable trees followed by natural regeneration and possibly enrichment planting. INTD is a newly developed system involving the establishment of intensively managed *Dipterocarp* plantations on cleared land. PULP is the establishment of fast-growing pulpwood plantations. SAW10 and SAW20 refer to saw timber plantations on 10 or 20 year rotations.

**Comparative Financial Returns of Alternative Timber Production Regimes, Indonesia**  
(Net Present Value, 1986 US\$/ha)

Discount Rate:		6%	10%
<b>Regime:</b>			
PULP	fast-growing pulpwood plantation	2,926	2,562
CHR	harvest all marketable trees; natural regeneration	2,593	2,553
INTD	intensively-managed <i>Dipterocarp</i> plantation	2,746	2,203
SAW20	saw timber plantation; 20 year rotation	2,419	2,278
TPI	officially approved ‘selective’ cutting system	2,409	2,177
SAW10	saw timber plantation; 10 year rotation	2,165	2,130

Note: all but TPI involve an initial harvest of all commercially valuable species. The costs of clearing remaining timber are not included in PULP, INTD, SAW20, and SAW10.

The analysis suggests that the official selective management regime (TPI) is less desirable than most plantation systems and than full commercial exploitation. However, while the PULP regime has the greatest financial returns, the author suggests that it may have limited applicability due to its heavy dependence on convenient access to a pulp mill. The author also notes that the INTD system requires further field trials before it can be applied widely. Uncertainty about sawtimber production reduces the appeal of SAW regimes, hence the author ultimately prefers the CHR regime (complete harvest of merchantable timber, followed by natural regeneration).

**Valuation techniques used:** Market prices are used to value all inputs and outputs.

**Comments:** Although CHR (along with most other options) appears to be preferable to TPI, this might not hold if the analysis had been extended to a total valuation of market and non-market costs and benefits. Several use and non-use values such as watershed protection functions, non-timber products, and existence values may be greater for a regime such as TPI, which maintains mixed-species, mixed-age forests composed of indigenous species. Given that the difference in the NPV of TPI and CHR is only around US\$200-400 per hectare, consideration of such values could easily tip the scales in favor of TPI or alternative selective cutting regimes.

**Sedjo, R. and M. Bowes. 1991. *Managing the Forest for Timber and Ecological Outputs on the Olympic Peninsula*. Resources for the Future: Washington, D.C.**

**Type of assessment & main findings:** The report presents a financial CBA of four alternative forest management regimes in the Olympic Peninsula (Washington, USA). The four regimes are conventional clear-cut and reforestation, and three ecological options including set-aside, green tree retention, and selection harvest. The study aims to identify the least-cost ecological regime by comparing the NPV of each alternative. In addition, the study examines the opportunity costs of moving an existing secondary mature forest onto one of the 'ecological' management paths. The authors conclude that the 15% set-aside regime is optimal in both respects.

**Empirical data:** Data on management regimes and financial returns from timber are provided by the Washington State DNR.

**Details of CBA:** Direct use values are considered in the first part of the study. Ecological benefits and non-use values are investigated secondly, using an implicit price approach.

**Valuation techniques used:** Market prices are used to evaluate all costs and benefits. The second part of the study attempts to calculate an implicit price for the ecological benefits achieved under the alternative, ecological management regimes. Environmental benefits are expressed in terms of the opportunity cost of moving an existing secondary mature forest onto one of the 'ecological' management pathways (versus the conventional clear-cut system). The authors suggest that decision-makers must value the benefits of ecological management at least as much as the costs of making the change (i.e. the foregone benefits of conventional forestry).

The authors calculate that, on a bare (logged) site, moving to an ecological regime would cost only US\$0.28 per acre more than conventional management. In the case of an existing forest, on the other hand, the opportunity cost of adopting an ecological regime is estimated at US\$466 per acre, for a 60-year old stand, and US\$1,026 per acre for a 110 year old timber stand. These higher values reflect the significant cost of forgoing immediate exploitation of mature stocks of timber. The question for policy-makers is whether the non-monetary benefits of an ecological regime are considered to be 'worth' this additional cost.

**Smith, J., Mourato, S. Veneklaas, E. Labarta, R. Reategui, K. and G. Sanchez. 1997.**  
*Willingness to Pay for Environmental Services Among Slash-and-Burn Farmers in the Peruvian Amazon: Implications for Deforestation and Global Environmental Markets.*  
CSERGE/CIAT/ICRAF Working Paper No. GEC97.

**Type of assessment & main findings:** The paper presents a contingent valuation (CV) study aimed at uncovering Peruvian farmers' willingness to accept (WTA) compensation for changing their land-use practices away from slash-and-burn agriculture towards forest preservation and 'multistrata agroforestry'. Farmers' willingness to pay (WTP) for the benefits associated with forest preservation was estimated separately. The results feed into an evaluation of cost-benefit ratios which compare the global benefits of forest preservation in terms of carbon sequestration to the costs of paying farmers to set aside forests or practice agroforestry. Potential welfare gains from increased forest preservation are shown to be significant. The results also indicate substantial cost savings can be achieved through carbon sequestration as opposed to emission reductions.

**Empirical data:** Primary data was collected by survey from over 200 farmers, including information on their socio-economic characteristics, e.g. education, income, housing, etc., and their WTA compensation for altering their land-use from traditional slash-and-burn to forest preservation and agroforestry. Farmers were also asked to state their WTP for the benefits arising from forest preservation. NOAA Panel recommendations regarding CV survey design were followed, except with respect to the elicitation method (see Arrow *et al.* 1993, Kopp and Smith 1993, for an overview of the Panel's recommendations). Farmers were asked open-ended questions about their WTA and WTP, rather than more conventional dichotomous choice questions. The latter are often preferred when conducting CVM in poor communities, but pre-tests favoured the open-ended WTA approach in this case.

Secondary data includes estimates of the global benefits of carbon sequestration (Fankhauser 1995), carbon storage in forests (Ricse *et al.* 1996; Schroeder and Winjun 1995; Schroeder 1994), and the costs of carbon emission reductions (Swisher and Masters 1992; Ridley 1997).

**Details of CBA:** A full CBA is not presented, but the authors compute benefit-cost ratios (BCRs) for carbon sequestration from a global perspective, and the cost effectiveness of carbon sequestration as opposed to emission reduction. In the former case, direct and indirect use and non-use values captured by local farmers under alternative land uses are included, as well as the global value of carbon sequestration. Benefits and costs are calculated over a 15 year time horizon and discounted to present values per hectare for a range of discount rates. Costs of carbon sequestration are born by local farmers and are discounted at 20% and 30%, reflecting farmers' high rate of time preference. Benefits to the global community are discounted at between 0.5% and 3%.

Cost data is from a survey which asked farmers their WTA compensation for changing land-use from slash-and-burn agriculture to forest preservation and multistrata agroforestry. The WTA reflects the loss in returns associated with slash and burn agriculture, over and above the expected benefits of forest preservation and agroforestry. Respondents were initially asked to ignore forest environmental services

when stating their WTA. Mean WTA values ranged from US\$138 per hectare per year, in the agroforestry scenario, to US\$218 per hectare per year in the forest preservation scenario. The forest preservation option is more costly as farmers are prevented from engaging in tree crop cultivation.

These WTA values represent the losses farmers expect to incur by abandoning slash-and-burn agriculture. Benefits to farmers from forest preservation, including improved environmental services (e.g. air purification) and improved access to forest products, were valued separately. The values that farmers place on forest benefits are revealed by their willingness to forgo part of the compensation they stated earlier. This value is interpreted by the authors as an annual WTP for forest benefits. Mean WTP ranged from US\$67/ha under the forest preservation scenario to US\$41/ha under the agroforestry scenario. Higher WTP for the forestry option reflects the higher environmental values associated with preserved forests as opposed to semi-cultivated forests in the second scenario.

The cost of carbon sequestration to the global community is assumed to equal farmers' WTA compensation to change land-use, minus their WTP for forest benefits, i.e. between US\$151 per hectare per year in the forest preservation scenario and US\$97 per hectare per year in the agroforestry scenario. The benefits of carbon sequestration are based on estimated damage costs avoided and the amount of carbon stored under competing land uses. Fankhauser (1995) estimates the benefits of carbon storage at US\$20.3 per tonne of Carbon (tC) for 1991-2000, and at US\$27.8 per tC for 2001-2030. Various sources are used to estimate the amount of carbon stored in the case study area under alternative land uses. An estimate of 180 tC per hectare from Ricse *et al.* (1996) is used for above ground biomass; Schroeder and Winjun's (1995) estimate of 50 tC per hectare is used for root biomass; and Schroeder's (1994) estimate of 10 tC per hectare is used for the agroforestry option. Using these figures, the authors calculate the present value of the net benefits per hectare of moving from slash-and-burn to forest preservation or to agroforestry.

Information on the benefits and costs of changing land uses are combined in BCRs. In addition to mean BCRs, upper and lower bounds are calculated reflecting uncertainty about cost estimates derived from the CVM. BCRs also vary with different discount rates. Overall, the benefits of carbon sequestration were estimated to be between 15 and 141 times greater than the costs to farmers of preserving forests.

The cost effectiveness analysis compares the costs of carbon sequestration born by local farmers to the costs of reducing carbon emissions. Carbon sequestration costs are based on the figures given above, expressed in US\$ per tC. A range of US\$0.65 to \$0.73 per tC is given for forest preservation, and from US\$1.17 to \$1.41 for agroforestry. Estimates of the costs of emission reduction are taken from several sources and range from US\$50 to \$429 per tC, indicating that carbon sequestration is a much cheaper option.

The analysis illustrates the significant potential welfare gains from promoting trade in carbon sequestration services. Not only would companies/countries faced with strict limits on carbon emissions save money by pursuing carbon sequestration in place of reduced emissions, but farmers could potentially gain from payments for protecting their forests. The authors note the relevance of their

findings for extending the Clean Development Mechanism set up under the Kyoto Protocol to cover trade in carbon sequestration.

**Socio-economic groups affected:** The central finding of the analysis is that all groups considered (local farmers and the global community) would benefit from a move towards forest protection if trade in carbon sequestration services were possible.

**Comments:** The use of CVM, and especially the WTA format, to estimate the opportunity costs of forest protection to local farmers is unusual in developing countries. Other studies typically calculate the costs of forest conservation (i.e. forgone economic output) using market and/or shadow prices. Use of CVM allows the authors to incorporate both these economic impacts and the non-market costs and benefits perceived by local people. The research suggests that Amazonian farmers are well aware of the environmental benefits provided by forests and are willing to pay to protect them. As a result the costs of compensating farmers for income lost by abandoning slash-and-burn agriculture is less than it might otherwise be and, in this case, substantially less than the lowest estimates of the benefits of carbon sequestration. One important omission is the failure to consider the transaction costs of making and enforcing contracts with small-holder farmers to modify their land use practices.

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Swisher, J. and G. Masters. 1992. "A Mechanism to Reconcile Equity and Efficiency in Global Climate Protection: International Carbon Emission Offsets" in *Ambio* 21(2): 154-159.



**Southgate, D. 1992. *The Economics of Agricultural Land Clearing in Northwestern Ecuador*. Mimeo, Instituto de Estrategias Agropecuarias: Quito, Ecuador.**

**Type of assessment & main findings:** The paper presents an economic CBA of three alternative land-uses (ranching with some shifting agriculture, agro-forestry and plantation forestry) in northwestern Ecuador. The estimated NPV of the three land use options are expressed as ‘annuity equivalents,’ i.e. as a constant annual income stream. The conclusion drawn is that forestry is competitive with prevailing land uses.

**Empirical data:** Results of a survey of 179 farmers in seven communities include summary statistics on household size and composition, educational attainment, geographic origin, property rights, land use and other economic activities. The average size of family holdings is under 30 hectares. 50% of holdings were purchased outright by their present owners. Typical land uses include forest (37%), pasture (50%) and cropland (13% of area).

**Details of CBA:** Direct use values considered are food, timber, cash income. Sensitivity analysis shows the effect of varying stumpage and coffee prices, wages and the discount rate. The author reports the hypothetical minimum ‘price’ at which farmers surveyed claim that they would be willing to sell their holding, when asked directly. The values are as follows:

price range (US\$/ha)	portion of the sample
< 100	29 percent
100 - 200	21
200 - 300	13
300 - 400	21
> 400	16

The report goes on to report the results of a financial analysis of three alternative land uses: laurel plantation, pachaco plantation (both for timber) and an improved agro-forestry option of coffee with laurel. Previously published data are used on input and output costs and timing to estimate the net present value of returns over a whole rotation.

**Valuation techniques used:** Market prices and wages are used for the financial analysis of forestry and agro-forestry options. The CVM is used to derive current land use practices and farmers’ asking price for their land. The latter is taken as a proxy for the NPV of financial returns under existing land use practices.

**Socio-economic groups affected:** Subsistence farmers/ranchers.

**Comments:** No details are given of returns to the current land use system (the author asserts that 31% of the sample reported a negative cash flow and that only 25% earned more than \$2,000 during the preceding year). The reported asking price for land may understate its true value and estimated returns

to forestry and improve agro-forestry may be optimistic. The author points out the advantage of agro-forestry, in terms of reduced need for credit, but also recognizes the greater vulnerability of this use to wage rate and coffee price fluctuations. The author also notes the recent purchase of nearby degraded land by a timber company for \$300-500 per hectare, for plantation under laurel, pachaco and other timber species.

**Tobias, D. and R. Mendelsohn. 1991. "Valuing Ecotourism in a Tropical Rain-Forest Reserve" in *Ambio* 20(2): 91-99.**

**Type of assessment & main findings:** The article presents estimates of eco-tourism values at a tropical rainforest site in Costa Rica, based on a travel cost model to examine the WTP of local tourists to visit the Monteverde Cloud Forest Reserve (MCFR). The authors conclude that the benefits of eco-tourism at the site exceed the price paid by the reserve to acquire new land, thereby providing justification for the expansion of protected areas near the reserve.

**Empirical data:** A survey of 755 park visitors was conducted in 1988. The sample taken was consistent in respect of point of origin with a smaller data set collected independently the year before, and was therefore assumed to be representative of the true domestic visitor population.

**Economic values considered:** Recreation value is the only benefit considered explicitly.

**Valuation techniques used:** A travel cost model is used to estimate forest eco-tourism value, based on a cross-sectional analysis of 81 cantons (provinces) in Costa Rica. Information on the number of visitors originating from different cantons is combined with data on the population of each canton to derive visitation rates per canton. Other data used include the distance between each canton and the MCFR, population density and literacy rates for each canton. A demand function for visits to the Reserve is estimated using two different specifications:

$$\begin{array}{l} \text{Visitation Rate} = 36.17 - 0.121 \text{ distance} + 0.006 \text{ density} \\ \text{(t statistics)} \quad (4.20) \quad (2.77) \quad (2.76) \end{array}$$

$$\begin{array}{l} \text{Visitation Rate} = 44.42 - 0.107 \text{ distance} + 0.006 \text{ density} + 0.001 \text{ illiteracy} \\ \text{(t statistics)} \quad (4.28) \quad (2.40) \quad (1.82) \quad (1.40) \end{array}$$

The results are used to predict visitation rates by the total domestic visiting population and to derive estimates of the park visitation demand function and consumer surplus. The values for consumer surplus for each canton are summed to obtain total annual consumer surplus, which was estimated at between US\$97,500 and US\$116,200. On this basis the NPV of the Reserve (for recreation) is estimated at between US\$2.4 and US\$2.9 million, assuming that the real value of recreational demand remains constant over time and applying a real discount rate of 4%. Given that there are about 3,000 domestic visitors annually, the site is valued at about \$35 per visit. The authors point out that their estimate of the value of ecotourism at MCFR is likely to under-estimate the true value of the site for three reasons:

- the real value of recreational visits to the site is assumed to remain constant over time, whereas the visitation rate had grown at 15% a year over the previous five years;
- the estimate represents the value of the site to domestic (national) visitors only, even though foreign visitors outnumber domestic visitors by four to one. If foreign visitors value the site *at least* as much as domestic visitors (at US\$35 per visit), an additional US\$400-500,000 should be added to the annual value of MCFR; and

- the recreational value of the site does not reflect other potential conservation values, such as sustainable harvesting of non-timber forest products, watershed protection values, protection of wildlife habitats and rare species, etc.

The authors also express the recreational value of the Reserve in per hectare terms. Given a net present value of domestic and international recreation of about \$12.5 million and a total Reserve area of 10,000 hectares, the authors calculate a mean recreational value of US\$1,250 per hectare. This value is compared to the market price of land surrounding the reserve, which ranges from US\$30 to \$100 per hectare. The authors thus assert that expansion of the reserve for eco-tourism would be economically warranted as a superior land use.

**Comments:** High estimates of eco-tourism value appear to justify expansion of the Reserve. However, it is not clear from the study whether the number of visitors or their WTP would increase with enlargement of the Reserve, sufficient to justify the purchase of adjacent land. The question is critical in this case, as the site is privately managed and any increased costs or investment would need to be covered by increased gate receipts or external subsidy. Simply increasing entrance fees to finance land acquisition could be counter-productive, if it resulted in a more than proportionate decline in visitor numbers. Moreover, higher entrance fees may alienate some visitors and undermine local support for the Reserve. Finally, it is not clear from the study whether land outside the Reserve exhibits the same biological diversity, natural beauty, or other ‘amenity’ values that are sought by ecotourists.

Veríssimo, A., Barreto, P., Mattos, M., Tarifa, R. and C. Uhl. 1992. “Logging impacts and prospects for sustainable forest management in an old Amazonian frontier: The case of Paragominas” in *Forest Ecology and Management*, 55: 169-199.

Uhl, C., Veríssimo, A., Barreto, P. and R. Tarifa. 1992. “A evolução da fronteira amazônica: oportunidades para um desenvolvimento sustentável”. (Title in English: The evolution of the Amazonian frontier: opportunities for sustainable development.) in *Pará Desenvolvimento*, IDESP, June (special edition): 13-31.

**Type of assessment & main findings:** The studies use CBA to analyse the logging industry and to assess the financial viability of managing forests for sustained yield of timber in the Brazilian State of Pará (eastern Amazon). The paper by Veríssimo *et al.* (1992) focuses on the costs and benefits of logging, while Uhl *et al.* (1992) presents a detailed analysis of forest management. The authors conclude that forest management is not financially viable, while conventional unsustainable logging is extremely profitable and likely to expand.

**Empirical data:** The study is based on interviews with sawmill owners and employees, and personal observations. The paper presents primary data on:

- the main features of the timber industry and of entrepreneurs (average output, costs and profits in extraction and processing, origin and previous activities of owners);
- socio-economic characteristics of employees and terms of employment in the industry (average wages, subsistence expenditures, origin and number of previous migrations);
- average volume, density and value of trees harvested per hectare;
- damage associated with timber extraction (in physical terms), including road building;
- volume of residual timber left in the forest;
- percentage of forest canopy area opened during extraction;
- rates of tree regeneration after logging;
- contribution to total sales of logs extracted from cattle ranches;
- price of virgin forest land and costs of reforming pastures;
- costs of forest management (timber inventory and climber cutting one year before harvest; stand enrichment by eliminating undesirable species 1, 10 and 20 years after harvest);
- benefits of forest management (increased timber harvest in physical and monetary terms).

**Details of the CBA:** The authors consider only the direct use values associated with timber extraction. Estimated revenues from unsustainable forestry range from US\$70 per hectare (the average price of a logging concession) to US\$200/ha (when extraction is conducted by the rancher). The authors note that timber revenues are an increasingly important source of investment capital for pasture reform (which costs US\$260/ha), compensating for a recent decline in subsidies to ranching from government.

The most profitable activity is sawmilling. Logging, transport and processing costs absorb 18%, 13% and 37% of the gross revenues of a typical sawmill in Paragominas, respectively. The resulting profit

margin (in cash terms) is about 32%. High profits are explained in large part by the low price of timber, with implicit stumpage prices ranging between US\$1 and US\$3 per cubic meter.

Analysis of forest management suggests that the expected returns are not sufficient to make this activity financially feasible. The investment cost of implementing improved management is estimated at US\$180/ha, of which US\$20/ha for inventory, US\$25/ha for cutting vines and US\$45/ha for each enrichment after harvest. The estimated benefit is an increase of about 32 m<sup>3</sup>/ha of timber, plus a reduction in the period between harvests from 50 to 35 years. The implied cost is US\$5 per m<sup>3</sup> of raw logs, which is not feasible in light of plentiful supplies of cheap logs from newly converted ranches. In conclusion, the authors propose three options to encourage improved forest management:

- legally mandated management practices. Sawmill and logging profits would decline, but would remain attractive activities; the additional costs of management represent only 7% of the total revenues of sawmills. Gross profit margins would decline to 24%.
- introduction of an 'ecological' tax of 7% on the price of timber products (sawlogs), with revenues recycled to loggers and sawmills, in order to finance forest management.
- reduction of value added tax (VAT) paid by sawmills from 12% to 5% for timber sales, combined with management mandates.

**Valuation techniques:** Market prices are used to value most items. In the case of stand damage, physical impacts are recorded.

**Socio-economic groups affected:** Loggers and millers (owners and workers), ranchers.

**Walsh, R.G., Bjonback, R.D., Aiken, R.A. and D.H. Rosenthal. 1990. "Estimating the Public Benefits of Protecting Forest Quality" in *Journal of Environmental Management*, 30: 175-189.**

**Type of assessment & main findings:** The paper presents a case study of the preservation benefits (including option, existence and bequest values) of intensively used forests in the state of Colorado, USA, including issues of decreasing quality. Values are calculated using CVM, and the results are tested for several possible influences or bias. The authors conclude that the general public in Colorado is willing to pay an average of US\$47 per annum for the protection of forest quality, and that CVM can be used to estimate the effect of changes in forest quality on social welfare.

**Empirical data:** The basic data are obtained from a household survey designed to represent the resident population of Colorado, but no information is given in the paper.

**Economic values considered:** Direct use values (recreation), option values, non-use values (existence and bequest values).

**Valuation techniques:** CVM is used to value various forest benefits. A survey sample of approximately 1% of the population was drawn from the current telephone directory for Fort Collins and surrounding rural areas during the first quarter of 1983. Personal interviews were also conducted in the homes of a subsample of 198 households. The questionnaire included questions about individual preferences for forest quality and its importance relative to the quality of other resources, the recreational demand for environmental resources and socio-economic variables (income, education, age, vacation days per year, etc. per household). With this data, a demand function was estimated (WTP<sub>ij</sub> per household *i* for forest quality *j*) using the following specification:

$$WTP_{ij} = B_0 + B_1RES_k + B_2USE_{ij} + B_3SOCIO_{ij} + B_4STRUC_{ij}$$

where RES<sub>k</sub> represents the demand for each other (than forest quality) environmental resource *k*, USE<sub>ij</sub> represents recreational use by household *i* of resource *j*, SOCIO<sub>ij</sub> are socio-economic variables and STRUC<sub>ij</sub> are categorical variables for alternative structures of the CVM procedure *h* (testing for possible influences or bias).

The results were tested in order to discover possible influences or bias due to the educational background of the interviewer, the starting point of the valuation, the incremental value of forest quality, the place of residence of the household and the presence of environmental substitutes. Where these influences were found to be significant (eg. educational background of the interviewer), the equation was adjusted and WTP was re-estimated.

The total annual WTP averaged US\$47 per household with a 95% confidence interval of US\$32 to US\$62. Public (non-use) preservation values represented nearly three-quarters of total benefits, and their inclusion increased the benefit estimation more than three and one-half times the estimate for

recreational use value alone. The authors also estimated total and marginal benefit equations (with and without public preservation benefits) using a quadratic function.

Finally, the results were compared to psychological preferences, which were estimated using both Thurston's method (paired comparisons) and the fractionization method (scale of 0-100 points ranking the relative importance of each program). A high similarity was observed in the results (high importance of the public preservation benefits), although some differences between the psychological and economic measures remained (not described in the paper).

**Comments:** The paper presents several ways of testing and adjusting CVM results for the effects of possible biases or influences. The accuracy of the results is related to operational conditions:

*“Respondents who are asked willingness to pay should understand the resource to be valued, have prior experience valuing it and choosing how much to consume under conditions of little uncertainty” (p.177).*

The main conclusion is that the general public is willing to pay for the protection of forest quality. However, this result may be influenced by the fact that the sample was restricted to the state of Colorado, which is recognized by the authors as a state characterised by intensive recreational use of its forests.

**Key references:** The paper is a companion piece to:

Walsh, R.G., Ward F.A. and J.P. Olienyk. 1989. “Recreation Demand Effects of Mountain Pine Beetle Damage to the Quality of Forest Recreation Resources in the Colorado Front Range” in *Journal of Environmental Management*, 28: 255-268.