Valuing Forests

A Review of Methods and Applications in Developing Countries

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Preface

Economic development is often associated with rising demand for environmental amenities. Forests are a particular focus of environmental concern; in many countries the value of non-timber forest benefits - many of them non-marketed - may be increasing faster than the prices of wood products. One result is that certain forest areas are increasingly valued more for the environmental benefits they provide than for their timber. Hence the "set-side" of timber-rich areas for wildlife conservation, and the increasing attention of public agencies to managing forests for recreational or aesthetic values.

Problems arise when policy-makers try to balance the twin objectives of timber production and environmental protection. When values conflict, what is the appropriate trade-off? What opportunities exist for "win-win" solutions, where timber and non-timber benefits are complementary? This report focuses on recent advances in the economic evaluation of forestry activities and, in particular, on how techniques for valuing non-timber forest benefits in monetary terms can assist the development of forest policy and management systems. The report considers the nature of non-market values and the need for valuation, as well as the different techniques used to estimate non-market forest benefits. It considers the use of valuation results in cost-benefit analysis and in forest policy and management. The report includes an extensive review of recent empirical studies of the economics of forest land use options in the developing world.

This report draws on and updates material presented previously in a publication entitled: *Economic Analysis of Tropical Forest Land Use Options: A Review of Methodology and Applications* (IIED 1994). Earlier work by IIED on the same topic was contained in an unpublished 1992 report to the UK Department for International Development (DFID, previously the Overseas Development Administration), as well as a more recent overview paper (Bishop 1998). The present report has been entirely re-organized and re-written, with many new examples from around the world. Support for this revision is gratefully acknowledged from DFID and The World Bank. This report forms part of the analytical work of the World Bank Forest Policy Implementation Review and Strategy (FPIRS). The views expressed in this report do not necessarily reflect those of DFID or the World Bank.

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Summary

All forest land uses can be characterized in economic terms, but until recently there was no satisfactory way to compare the market and non-market benefits of alternative forest land use options. Recent developments in environmental and resource economics have produced new methods to estimate non-market forest benefits, making more comprehensive assessment of land use options possible.

Forest provide many different economic benefits, both tangible and intangible. Forest benefits can be grouped into direct and indirect uses, option and non-use values. Only some of these values are reflected in market prices, due to widespread market imperfections and policy failures. Both private land users and public policy makers typically focus on tangible, marketed uses, and often neglect non-market environmental benefits, in particular. This results in excessive conversion of forest land to other uses, or excessive damage to non-market forest services in the process of extracting marketed timber and other goods.

A range of methods have been developed to estimate the total economic value of forests, including both marketed and non-marketed benefits. These include valuation using market prices, surrogate market approaches, the production function method, stated preference and cost-based techniques. Each method has its strengths and weaknesses, and certain methods are better suited to particular forest goods and services.

Valuation methods are particularly useful for extending the reach of cost-benefit analysis (CBA), in order to include non-market environmental impacts in the assessment of development projects or alternative forest land uses. CBA is not perfect, nor is it the only way to assess forest land uses, but it is useful for illuminating tradeoffs. Rigorous use of CBA, however, requires careful attention to questions of discounting, risk and uncertainty, price distortions, distributional concerns, and the sustainability of resource use.

Recent empirical work, particularly in temperate forest situations, has generated a large number of studies on the value of non-market forest benefits. This trend has been followed in the developing world. The literature review reveals however that the focus of interest in developing countries is somewhat different from that in wealthier regions. Most published economic studies of forest land use options in developing countries appear to concentrate on direct use values. While the methods used to value these benefits are relatively straightforward, usually involving market prices, data on quantities and inputs are often difficult to obtain. Relatively few of the studies reviewed attempted to calculate the net economic value of forest products.

Early case studies in developing countries concentrated on the value of non-timber forest products (NTFPs). This may reflect an assumption (or a hope) that the economic importance of NTFPs was sufficient to justify the conservation of forest land. In many cases, distributional concerns may also be reflected in this focus. Rural communities living in and around forest areas often rely heavily on NTFPs products for both subsistence and cash income. These groups are often among the poorest and most deprived members of society in developing countries. Where forests are perceived mainly as sources of growth for the timber industry, or as potential land for future agricultural expansion, attempts to estimate the value of other harvested forest products are one way to adjust the balance of perspective. A key question for future research is how the value of different NTFPs changes with urbanization and income growth.

The early concentration of developing country studies on NTFPs also reflects differences in forest values between developing and industrialized countries. Empirical research on non-market forest benefits in the latter case has focused on recreational and existence values held by urban consumers. This has spurred the development of non-market estimation techniques appropriate to such values, such as travel cost models (TCM) and contingent valuation (CVM). In developing countries, on the other hand, forest values related to production and subsistence remain relatively important, although this is changing in those regions characterized by rapid urbanization and income growth. In southeast Asia, for example, examples of TCM and CVM used to value forest recreational benefits have become increasingly common, particularly near urban areas. CVM may be more problematic in poor rural societies with different cultural perceptions. Nevertheless it appears to be the only means of eliciting existence values.

The concern of many citizens of industrialized countries about the loss of forests in rural and in developing regions is demonstrated in studies that estimate recreational and non-use values of such forests, which are mainly enjoyed by foreigners or by urban residents. These studies shed light on a key issue: how much do richer citizens of the world value forests, and how much are they willing to pay for forest conservation in rural areas or in developing countries? Difficulties with this type of research include ensuring that benefits are not overestimated by concentrating on only a single site, or extrapolating the results of an unrepresentative group of concerned individuals (e.g. eco-tourists) to a much larger and possibly more disinterested population (e.g. the entire United States). Another problem is the apparent conflict between rich and poor; the former seem to favor more forest conservation, and have the political clout and financial means to pay for it, while the latter prefer to use their forests to make a living, which until recently often meant extractive or destructive uses. The solution, of course, is to find new ways to recover non-use values from rich consumers and transfer funds to those with the will and the means to conserve forests in developing regions.

Interest in forest conservation in developing regions concerns not only their perceived recreational or non-use values, but also indirect use values. For example, the value of forests in developing countries for mitigating global warming by storing carbon has been included in several case studies. Most of these rely on recently improved estimates of the costs of global warming, and better scientific understanding of carbon flux in forests and deforested areas. Resulting estimates of carbon storage benefits provided by forests tend to dwarf all other benefits. As in the case of non-use benefits, the real question is when forest land owners in developing countries (or elsewhere) will be able to collect the money due.

Watershed protection is another indirect use benefit that has received attention in recent studies. In all cases a production function (or change in productivity) approach is used with varying levels of sophistication and precision. One obstacle to wider application of this technique is the difficulty of quantifying underlying ecological relationships. This may be one reason why the conclusions of case studies are so very mixed. Some suggest that logging or forest conversion has devastating effects downstream, while others maintain that negative effects tend to be short-lived and are offset by positive impacts, mainly increased water yield. Given the difficulties involved and heavy data requirements, existing studies have generally been limited to situations where the linkages are relatively clear. Future work on the value of watershed protection benefits will depend to a large extent on research by natural scientists on the underlying bio-physical relationships.

The value of forest biological diversity has been the focus of relatively few case studies. Initial estimates of the value of tropical forests as a source of new drugs and other bio-chemical products were very optimistic. Subsequent more rigorous studies indicate that genetic and other biological information contained in wild forest species does have economic value, but not enough by itself to justify forest conservation on a massive scale. On the other hand, the recent rapid growth of the bio-chemistry industry suggests that demand for forest biodiversity may not have peaked by any means. For forest biodiversity, as well as for other non-timber and non-market forest values, there is need for better information on spatial and temporal variation in willingness-to-pay, and the underlying factors which determine the magnitude of non-timber values in different forest areas.

Overall, the literature review suggests that non-timber and non-market values of forests in developing countries are often significant, when compared to the market value of forest land for timber extraction and agricultural production. Information on the economic significance of non-timber forest benefits can and should be incorporated in private property rights, forestry regulations and pricing policy. This potential has not yet been realized, however, largely due to political and institutional barriers but also because of the lack of regular, reliable information on the use of (and changes in) non-timber benefits.

An important priority is thus to develop routine systems for monitoring and evaluating non-timber forest benefits on a national and local scale. The bigger challenge, however, is finding ways to “internalize” non-market forest values in local, national and international decision-making. Economists need to focus more attention on the institutional requirements and transaction costs of bringing non-market forest values into the market-place, including efforts to estimate the marginal costs to forest land-users of shifting from their current behavior to more environmentally-friendly land use practices. In conclusion, the challenge faced by forest managers and policy-makers is:

- to assess the current and expected future economic importance of non-timber benefits at the level of the forest site, region and nation, and under different land use and management regimes;

- to make informed trade-offs between the marketed and non-marketed benefits of forestry activities, both at the level of national or regional land use planning and in the management of particular forest sites; and

- to devise regulations and incentives which lead forest managers and land users to account more fully for non-market benefits in their decision-making. Where non-timber values are held mainly by foreigners, this may imply the need for innovative mechanisms for international financial transfers for environmental benefits.

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1 Introduction

Forests have been central to human survival for as long as we have inhabited the earth. How people use and value forests at a particular place and time, however, depends in large part on their scarcity or abundance relative to changing human needs. Historical patterns of forest land use reflected the cumulative effect of centuries of individual or small group decisions about where to hunt, where to settle, what land to clear for agriculture and what land to preserve for religious or other purposes.

In recent years, human population growth, migration and industrialisation, and other socio-economic changes have had a dramatic impact on the world's forest resources.[1] Traditional forest land uses in the tropics have been joined and in some cases displaced by large-scale commercial activities, such as industrial logging, plantation forestry and cattle ranches. Even where forests are not cleared outright, they are often modified by the use of fire or other practices which favour particular plant and animal species.

Deforestation in tropical regions is now widely acknowledged as a global problem, as is the decline in mature or "old-growth" forests in all countries (Barbier *et al.* 1994; Brown and Pearce 1994; Dudley *et al.* 1995; Sharma 1992). The recent increase in secondary forests in temperate regions, while less well-known, will also have a profound effect on the global supply of forest goods and services (Arnold 1991; FAO 1995; Sedjo and Lyon 1990). Meanwhile, human demands on forests are changing rapidly, as we become more aware of the important environmental benefits they provide.

All of these trends can be characterised in economic terms, as forest land users have always been concerned with the relative costs and benefits of alternative ways and places to make a living. In the past, however, trial and error or rough rules of thumb were adequate means of determining which land to use and how. Until very recently there was little *formal* economic analysis of what type of land use is best in a particular area, or how to manage that use for maximum benefit.

In the past few decades, the increasing scarcity of "natural" forest on a global scale, together with concern that opportunities for economic development should not be wasted, have led government agencies and private firms to rationalise their decision-making with respect to the use of forest lands. New tools have been developed to evaluate alternatives, both at the level of specific sites and projects, and on a regional scale. Methods of appraisal include physical approaches, such as land suitability classification, as well as financial and economic methods such as cost-benefit analysis and forest sector models. Many of these methods have been developed in the industrial nations, and subsequently adapted for use in developing regions.

Even more recently, there has been growing awareness and concern about the potential adverse social and environmental consequences of land use change. These impacts may be significant, yet because they are generally non-marketed or imperfectly reflected in markets, environmental values in particular tended to be ignored in past decisions about forest land use. In response, many public agencies and private firms now try to ensure that project and policy reviews - from *ex ante* appraisal to *ex post* evaluation - account for social and environmental impacts as well as economic effects. In the forestry sector as elsewhere, new multi-disciplinary procedures have been developed for impact assessment, land use evaluation, project appraisal and policy analysis.

As part of this effort, environmental and resource economists have elaborated new concepts of value, which include the social and environmental costs and benefits of economic activity. They have also developed new ways to measure these non-market impacts. These include a range of methods to estimate the economic significance of *non-timber forest benefits*, both in aggregate terms and in terms of their value to particular stakeholder groups. The results of these efforts are seen in a growing record of attempts to evaluate the social, economic and environmental

[1] Forests currently cover about one quarter of the earth's land surface and are concentrated in the developing countries, although the balance is shifting due to deforestation in the developing world combined with growing forests in the developed regions (FAO 1995).

trade-offs of alternative forest land uses in monetary terms. This report provides an overview of the new methods and recent applications, focusing on forest land use in the developing world.

1.1 Aims of the report

The report aims to review and illustrate the new concepts and methods used to evaluate the environmental benefits and distributional consequences of alternative forest land use options, with a focus on *non-timber benefits in developing countries*. The report presents a general framework for identifying, estimating and comparing forest values, within the context of cost-benefit analysis. We review the different valuation techniques used in such assessments and illustrate their application with examples drawn from the empirical literature. The report includes detailed summaries of over 50 economic case studies of forest land use values.[2] It also includes a brief discussion of how the results of valuation studies can contribute to improved forest policy and multiple-use management, and identifies a set of critical issues and research priorities in the valuation of forest land, as a contribution to on-going research efforts.

In compiling this report, we were conscious of the many existing publications which go beyond case studies of specific countries or forest areas, and likewise attempt to address the economics of multiple-use forestry in broader terms. These include a wealth of literature reviews, theoretical think pieces, original policy analysis, training manuals and guidelines for practitioners, as well as "state-of-the-art" compilations of new research.[3] The discussion of theory and method presented briefly here can be found elsewhere, and in much more detail. What distinguishes this report, we hope, is the extensive review of recent case studies carried out in the developing world, which to our knowledge have not been compiled previously in any other publication.[4]

The report concentrates on the application of *cost-benefit analysis* (CBA), which is widely used in the appraisal of development projects, to forest land use decisions in the developing world. Other appraisal methods are also briefly reviewed, including methods designed to assist decision-making where the information available does not permit a full CBA, as well as methods designed to compensate for perceived weaknesses of CBA. While the focus throughout is on the use of forests in developing countries, many of the issues and methods discussed here are equally relevant in other contexts.

A major part of the report is devoted to the use of different valuation techniques for estimating willingness to pay (WTP) for non-timber benefits provided by forests.[5] We do not attempt to provide a "cook book" for valuing non-market benefits, however, as such methods are described in a number of existing publications. The economics of timber production receives no particular attention, although logging is included as one of many possible uses of forest land. The report is thus intended as a supplement to existing manuals on the economic analysis of development projects,[6] the economics of forest management for timber,[7] and the valuation of environmental impacts.[8]

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[2] Most case studies discussed here are from developing countries and focus on tropical forests. No case studies were identified from the Transition Economies, although this gap in the literature will surely be filled soon.

[3] Among many, many others see: Adamowicz *et al.* (1996); Bann (1998); Barbier and Burgess (1997); De Beer and McDermott (1996); Godoy *et al*. (1993); Gregerson *et al*. (1995); Gunton (1991); Lampietti and Dixon (1995); Lee *et al*. (1998); Parks *et al.* (1998); Prins *et al.* (1990); Roper and Clark (1999); Southgate (1998); Wibe (1995).

[4] Almost all of the material reviewed for this report was published in English. No attempt was made to review material published in other languages, although we are aware of some relevant research on the topic.

[5] Willingness to pay (WTP) is a term used to express the level of demand felt by consumers for a particular good or service. Normally used in reference to goods and services that are not traded in markets, and for which no price can be observed directly, WTP is analogous to price in the sense that it expresses a monetary value which may be compared to other priced or un-priced goods and services. A related concept is willingness to accept (WTA), which refers to the amount of money that consumers demand in compensation to give up a particular good or service. See Freeman (1993) for a fuller explanation.

[6] See for example: Gittinger (1984), Little and Mirrlees (1974), Squire and van der Tak (1975), Winpenny (1988).

[7] See for example: Bowes and Krutilla (1989); Hyde and Newman (1991); Repetto and Gillis (1988).

Readers seeking more detailed treatment of CBA and valuation techniques (some of which form the subject of entire volumes) will find plenty of references to get them started.[9] The report is offered as a resource for land use planners and forest policy makers. We hope it will inspire some readers to attempt (and others to insist upon) more comprehensive evaluations of the environmental impacts and distributional implications of tropical forest land use options. The extensive review of applications may also be helpful to students and researchers.

1.2 Structure of the Report

The report is in two parts. *Part I* provides a general framework for identifying, estimating and comparing forest values. Chapter 2 introduces the range of goods and services provided by forests, drawing on the concept of Total Economic Value. The chapter goes on to draw a distinction between those forest benefits which are traded in markets, and those which are non-marketed or only imperfectly reflected in markets. There follows a brief discussion of why certain forest benefits are more likely to be ignored or under-valued by the market, and the adverse consequences that result for both the environment and the economy as a whole.

Chapter 3 then reviews the different valuation methods which can be used to express non-market forest goods and services in monetary terms. These include relatively sophisticated techniques such as travel cost models, hedonic pricing and the contingent valuation method, which were developed in the context of industrialised economies, where environmental amenities have assumed greater significance in recent years. Chapter 3 also considers alternative methods such as cost-based valuation and the production function approach, which have emerged from the experience of appraising investment activities in developing countries, where non-marketed goods and services often have greater importance in production processes.

Chapter 4 presents an extended cost-benefit analysis framework, showing how the forest values discussed in preceding chapters can be included in an economic assessment of forest projects and programmes. The chapter considers various criticisms of valuation, and offers justification for continuing efforts to place monetary values on non-market forest benefits. We also provide some practical guidelines for preparing an assessment and discuss key methodological issues in cost-benefit analysis. Particular emphasis is put on the distinction between a financial perspective and an economic analysis which incorporates both distributional and sustainability concerns. Chapter 4 includes references to relevant case studies in developing countries, as well as additional references on the theory and application of valuation techniques and cost-benefit analysis.

Finally, chapter 5 contains a brief overview of the potential uses of forest valuation results. This includes a discussion of the implications of valuation for land use planning, forest property rights, forestry regulation and forest pricing or tax policy.

Part II of the report reviews the recent experience of valuing forests in developing countries. Chapter 6 provides an introduction and overview of the literature, focusing on which forest benefits are most often valued, using which methods. An attempt is made to identify general lessons about the potential and limitations of forest valuation in developing countries. Some suggestions for further research in this area are also put forward.

The remainder (and bulk) of Part II comprises summaries and commentary on more than 50 case studies containing economic appraisals of forest land use options. The purpose of the summaries is to provide further information on a representative selection of case studies of different forest land use options, market and non-market values, countries and approaches. References included here are those which we think illustrate most clearly the environmental costs of forest land use, the trade-offs among alternative uses and socio-economic groups, and the methods available to

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[8] See for example: Abelson (1996), Cummings *et al.* (1986); Dixon *et al*. (1994), Freeman (1993); Hearne (1996); Hufschmidt *et al.* (1983); Kopp and Smith (1993); Mitchell and Carson (1989); Munasinghe and Lutz (1993); Vincent *et al*. (1990); Winpenny (1991).

[9] See also the Environmental Valuation Reference Inventory, recently published on the World Wide Web at http://www.evri.ec.gc.ca (an initiative of Environment Canada).

value non-marketed forest costs and benefits. References relating to temperate forest land use are included only if they are particularly relevant from a methodological viewpoint.

A complete bibliography appears at the very end of the report. This includes references consulted for both Parts I and II. All references printed in **bold type** are summarised in Part II of the report. Additional key references cited in Part II (e.g. sources of secondary data for case studies) are also included in this list, although not all have been reviewed by IIED.

Part I

Forest Values and Valuation

2 Forest Goods and Services

Economic development is often associated with rising demand for environmental amenities.[10] Forests are a particular focus of environmental concern; in many countries the demand for non-timber forest benefits may be increasing faster than demand for many wood products. One result is that certain forest areas are increasingly valued, by the public as well as their political representatives, more for the environmental benefits these forests provide than for their timber. Hence the set-side of large areas of timber-rich forest for wildlife conservation. Hence also the increasing attention of public agencies to managing forests for recreational or aesthetic values.

Problems arise, however, when policy-makers try to balance the twin objectives of production and environmental protection. When different values conflict, what is the appropriate trade-off? What opportunities exist for "win-win" solutions, where timber and non-timber benefits are complementary? The first step in answering such questions is to identify clearly the different forest values that are at stake. Hence this chapter begins by reviewing the components of forest value. We briefly consider the distinction between market and non-market costs and benefits, and consider why the market tends to ignore certain forest values.

2.1 Identifying Forest Benefits

It is increasingly recognized that forests provide a range of goods and services, some of which have significant economic value.[11] These include fertile soil and timber, of course, but also non-timber products, recreation, landscape value and a wide range of environmental benefits such as climate regulation, watershed protection and the conservation of biodiversity. Forest benefits may be grouped into general categories, as in Table 2.1. This follows a typology introduced by Pearce *et al*. (1989), which recognises three types of environmental value:

- *direct use* value, e.g. the benefit of using forest resources as input to production or as a consumption good;
- *indirect use* value, comprising the indirect support and protection provided to economic activity and property by natural forest functions, or forest "environmental" services; and
- *non-use* value, including all other benefits which cannot be characterised in terms of a current or future physical interaction between the forest and consumers.

Direct uses of forests include both commercial and non-commercial activities. Commercial uses such as timber production may be significant in both domestic and international markets. Non-commercial direct uses, on the other hand, are often mainly local but can be very important for the subsistence needs of rural populations and poorer groups, e.g. fuelwood, game, edible and medicinal plants (FAO 1990). Direct uses also include important services such as forest recreation, education and research, which are often conducted on a non-commercial basis.

Table 2.1 Types of Forest Value

[10] This does not necessarily imply that demand for environmental quality increases faster than income (see Kristrom and Riera 1996; McConnell 1997).
[11] See FAO (1999) for alternative definitions of forest land.

Use Values			Non-Use Values
1. Direct Use	**2. Indirect Use**	**3. Option**	**4. Existence**
Wood products (timber, fuel) Non-wood products (food, medicine, genetic material) Educational, recreational & cultural uses Human habitat Amenities (landscape)	Watershed protection Nutrient cycling Air pollution reduction Micro-climatic regulation Carbon storage	Future direct and indirect uses	Biodiversity (wildlife) Culture, heritage Intrinsic worth Bequest value

Source: adapted from Barbier (1991).

Indirect use values comprise the many ecological functions of forests. Their value derives from supporting or protecting economic activities that have directly measurable market benefits. For example, some forest may have indirect use value through controlling sedimentation and flood damage that affects downstream agriculture, fishing, water supplies and other economic activities (**Aylward *et al.* 1999**). Likewise the micro-climatic function of certain forests may have indirect use value by maintaining or enhancing the productivity of crop cultivation in neighbouring areas (Lopez 1997). Another important indirect use value associated with forests is the storage or "sequestration" of carbon in trees, offsetting the atmospheric accumulation of so-called "greenhouse" gases that are implicated in global warming.

Some authors distinguish a further sub-category of *option value*, referring to potential direct and indirect use values which might be realised in the future. According to this view, there may be a premium on preserving forest eco-systems for future uses, particularly if people are uncertain about potential future values but believe they may be high, or if the effects of exploitation or conversion are considered irreversible. For example, forest resources may be under-utilised today but may have high future value in terms of scientific, educational, commercial and other economic uses. Similarly, the environmental regulatory functions of a forest ecosystem may become more important over time as economic activities develop and spread in neighbouring areas.

Finally, there are *non-use* values. These refer to the intangible benefits derived from the mere existence of forests, above and beyond any direct or indirect use value that people may enjoy. Non-use values include both *existence value* and *bequest value*. An example of the former is the value which people attach to the continued existence of certain species of wildlife found in particular forest areas (e.g. bears or tigers). Such values may be most apparent among those who do not live near or use the products of forests directly themselves, and perhaps benefit only very slightly from indirect uses, but who nevertheless wish to see such forests preserved in their own right. *Bequest values* arise when people place a value on the conservation of particular resources for posterity (future generations). Bequest values may be high among local populations using or inhabiting a forest area, to the extent that they wish to see a way of life and culture that has "co-evolved" with the forest passed on to their heirs. By the same token, those who live far from forests may wish to ensure that their descendants have an opportunity to visit and enjoy them.

The *Total Economic Value* (TEV) of a forest system refers to the sum of (compatible) values: i.e. direct and indirect use (and their associated option values), plus non-use values. Different forest land use options will be characterised by a different combination of direct, indirect and non-use values, and thus a different total economic value. Only part of this value is reflected in market prices, however, creating a risk that forest planners and land users will ignore or under-state certain important forest benefits. We now turn to why this happens.

2.2 Market and Non-Market Values of Forests

Only some of the forest benefits listed above are traded in markets and have a directly observable price. In general, direct use values are most likely to be reflected in market prices. Indirect use values may be reflected in the prices of certain goods and services which depend heavily on the underlying environmental benefit, while non-use values are rarely reflected in market prices or decision-making. Clearly, however, the absence of a market price does not mean that a thing has no economic value.[12]

Most forest land owners are aware of the many environmental benefits they provide, in addition to supplying timber or other commodities to the market. Public agencies in many countries, some of them responsible for managing millions of hectares of forest land, often make special efforts to provide non-timber benefits. This includes restricting logging in areas of exceptional natural beauty for the sake of recreational uses, or on steep slopes so as to protect water quality and reduce the risk of flooding downstream. Similarly, some companies provide access to their land to hikers, hunters and fishermen on a voluntary basis.

While such efforts are welcome they are usually limited in scope and often inadequate relative to public demand. The reason is that forest land owners and managers in most countries get little or no material advantage from providing environmental benefits. Both in the private and the public sectors, land owners and managers tend to focus on the direct costs and tangible benefits of their activities. Thus foresters produce timber because they can sell it, while farmers convert forest land because they can cultivate it for profit or subsistence.

Many non-timber forest benefits, on the other hand, cannot easily be bought and sold (e.g. biodiversity, watershed protection, carbon storage). Others generate little or no revenue for the land owner, although they may have significant value to the general public (e.g. aesthetic values). Where non-timber forest benefits are also non-marketed, private land owners will have little motivation to produce them unless compelled to do so. Similarly, public forest agencies may under-estimate the importance of such benefits, which are often less visible than the revenue, taxes and jobs generated by the timber and agriculture industries.

Even where forest benefits are partly or informally traded, they often escape notice. In many developing countries, for example, rural populations exploit non-timber forest products such as vines and edible fruit for both subsistence and sale, but this activity is rarely recorded and is thus easily ignored by forest authorities. Similarly, in the developed world, entry fees to forest recreational areas often grossly under-value the true willingness-to-pay of visitors and thus the full value of recreational benefits.

Demand for traditional forest products - timber and pulp - is certain to increase with economic growth (FAO 1997; Sedjo and Lyon 1990). Timber prices are also expected to rise in many developing countries, due to the increasing scarcity of easily accessible, mature stands of timber, although price increases will be moderated by new forest plantations and supplies from other parts of the world (Perez-Garcia and Lippke 1993; Sohngen *et al.* 1999). At the same time, demand for forest recreation and landscape amenity values can also be expected to grow rapidly in many developing countries, due to urbanization and rising incomes, whereas the demand for certain non-timber forest products may fall. For example, higher rural incomes can lead to decline in both the range and volume of forest products used for subsistence, but this may be offset for certain products by increased commercial exploitation and sales in urban markets. Recent work on the consumption of an edible forest fruit in Malaysia has found that urban consumption has increased at almost the same rate as incomes (Woon and Poh 1998).

[12] Economists distinguish financial from economic values. The former refer to market prices, while economic values ("efficiency prices") are estimates of the prices which would prevail in a competitive market, free of any market imperfections (e.g. monopolies) or policy distortions (e.g. taxes or barriers to trade). Efficiency prices are considered a more accurate reflection of the contribution of a good or service to social welfare.

The fact that many non-timber forest benefits are not traded or do not have a directly observable market price is not a problem in itself. However, the use of forests to produce tradable commodities such as timber or agricultural crops often reduces the availability of non-timber goods and services, with the result that non-market, environmental values are lost. If the latter are significant, forest resources will be used inefficiently, both in terms of the area devoted to timber or converted to agriculture, and in terms of the technology of production, i.e. management. We now turn to why the market often fails to account for non-timber benefits, even when they are important in economic (as opposed to financial) terms.

2.3 Non-Timber Benefits and Market Failure

In principle, markets will allocate resources efficiently if prices reflect both the full marginal costs of production and the full marginal benefits of consumption, including all components of total economic value.[13] Where prices do not reflect all costs and benefits, however, the so-called "invisible hand" of the market does not work and resources may be used inefficiently, resulting in a loss of human welfare (Baumol and Oates 1988). Economists have identified various reasons why and how market prices fail to reflect environmental costs and benefits. Two of the most important reasons for market failure in forestry are the prevalence of "public goods" and "externalities".

Public goods are characterized by the fact that: (i) no one can be effectively excluded from consuming them and (ii) increased consumption of the good by one individual does not reduce availability to others. For example, no one traveling on a public thoroughfare can be charged for enjoying a pretty view, even if the land in question is privately owned. Nor does one person's enjoyment of the view detract from that of another (provided there is no crowding!). Such aesthetic value is among many public goods provided by forests, along with carbon storage and biodiversity conservation. Economic theory explains why the free market will systematically under-provide such goods, and why collective action, typically by the government, is usually required to ensure their adequate provision.

Externalities are uncompensated costs or benefits arising from economic activity. A classic example in forestry is the decline in availability of game or other non-timber forest products due to logging. Unless the logging company (or land owner) pays compensation to hunters and gatherers for their loss of livelihood, the full economic cost of extracting timber will not have been paid. If similar conditions prevail elsewhere, market prices of timber products will tend to understate true economic costs and consumers will use timber relatively inefficiently.

In addition to public goods and externalities, markets may fail to reflect non-timber forest benefits due to lack of information about their contribution to economic welfare, distortions in prices arising from public policy and regulations, lack of clear or secure property rights over forest lands, and other factors. In such cases, the question arises as to how decision-makers can compensate for market failure, and ensure that non-timber forest benefits are given sufficient weight in land use planning and management.

There are many ways to internalize non-market values in the behavior of producers and consumers, ranging from the introduction of strict environmental standards to ecological tax reform, and from facilitating environmental damage claims in the courts to the promotion of trade in environmental services or "pollution permits". An extensive literature describes the economics of different approaches to environmental protection (Baumol and Oates 1988; Cropper and Oates 1992; OECD 1989; Portney 1990).

A full review of environmental policy is beyond the scope of this paper. Nevertheless, it is clear that information on the significance of non-market environmental impacts, and the trade-offs between market and non-market values, is an essential input to rational environmental policy-making. Without such information, it is difficult to see how one can determine the urgency, stringency and scope of intervention required. One promising approach is to express

[13] The marginal benefit (or cost) of a good refers to the incremental change in consumer welfare (or producer cost) resulting from an incremental change in the quantity of the good consumed (or supplied). In a competitive market the level of output is determined by prices, which will tend to equilibrate at the point where marginal benefit equals marginal cost and social welfare is maximized. This is the "efficient" level of output, for a given distribution of income (Henderson and Quandt, 1958).

non-market environmental costs and benefits in monetary terms, so they can be compared directly with the value of marketed commodities. The following chapter describes the various methods available for this purpose.

3 Methods for Valuing Forest Benefits

To help private firms and government policy-makers make more informed decisions about activities with significant environmental impacts, economists have devoted considerable effort in recent years to developing and applying methods for valuing non-market benefits in monetary terms (Freeman 1993). All of the methods attempt to express consumer demand, i.e. the willingness-to-pay (WTP) of consumers for a particular non-marketed benefit in monetary terms, or their willingness-to-accept (WTA) monetary compensation for the loss of the same. In short, these valuation methods attempt to express the utility derived from non-market goods and services in the metric of the market, which is considered to provide an accurate reflection of the relative preferences of producers and consumers for different goods and services. (Just how "accurate" is discussed below.) The resulting values may be used in cost-benefit analysis or as input to more elaborate economic models.

Techniques for estimating non-market or non-timber forest values vary in their theoretical validity and acceptance among economists, their data requirements and ease of use, and the extent to which they have been applied in (and perhaps their relevance to) different countries (Munasinghe and Lutz 1993). For convenience, we have divided the different techniques into five broad groups:[14]

- *market price* valuation, including estimating the benefits of subsistence production and consumption;
- *surrogate market* approaches, including travel cost models, hedonic pricing and the substitute goods approach;
- *production function* approaches, which focus on bio-physical relationships between forest functions and market activities;
- *stated preference* approaches, mainly the contingent valuation method and variants; and
- *cost-based* approaches, including replacement cost and defensive expenditure.

The remainder of this section reviews the different methods, illustrated with examples from case studies of forest land use evaluation in developing countries. A summary table (3.1) is provided at the end of the chapter, showing the main valuation methods, the forest benefits for which they are most suited, and their respective strengths and weaknesses.

3.1 Valuation Using Market Prices

The simplest valuation methods are those which rely on market prices. Many goods and services from tropical forest land uses are traded, either in local markets or internationally, including wood products (timber and fuel), non-wood forest products (food, medicine and utensils), crops and livestock products, wildlife (meat and fish) and recreation. For those products that are commercially traded, market prices can be used to construct financial accounts to compare the costs and benefits of alternative forest land use options. In some cases, it may be necessary to adjust market prices to account for market or policy failures. The latter step, also sometimes called "shadow pricing", is discussed further in Chapter 4 where we address various methodological issues in cost-benefit analysis.

Prices are derived within the market place through interaction between consumers and producers over the demand and supply of goods and services. In an "efficient" market goods and services will be priced at their marginal value

[14] These categories overlap to some degree, and alternative groupings of valuation methods may be used. Certain authors emphasise the distinction between methods which elicit direct statements of willingness-to-pay (e.g. contingent valuation) and those which rely on indirect indicators or "revealed preference" (including market prices and most other valuation methods). See Freeman (1993) and Maler (1992) for further discussion.

product and reflect the full opportunity costs of resource use.[15] Where available, efficient market prices are usually the first choice for comparing the costs and benefits of any activities. For many NTFPs, researchers are able to find prices in local or more distant markets. Despite questions regarding their efficiency, there is often little choice but to rely on these as proxies since elaborate modelling techniques for determining efficiency, or shadow prices are not justifiable.

When using market prices for the purpose of financial valuation it is important to determine the *appropriate* market price for the various goods and services of the alternative forest land uses. There may be a variety of ways to obtain the relevant market prices, including existing economic and social studies, published or privately held statistics, socio-economic surveys and consultation with agricultural extension officers, forestry service personnel, government market specialists and statisticians. In many cases, it will be necessary to carry out new market surveys to collect the prices of so-called minor non-timber forest products, which may be traded on a small-scale or occasionally, and which are typically neglected by official economic statistics. It may also be necessary to take account of seasonal variations that lead to fluctuations in market prices.

Using information derived from such sources it should be possible to derive prices that reflect the prevailing market value of the goods and services of forest land uses. The farmgate price, or stumpage price, is what the farmer/forester receives when he or she sells products or buys inputs from the boundary of his or her farm/timber stand - that is the price without any transport or marketing costs included. Domestic market prices will reflect any transport and marketing costs involved in getting the product to the local market and may also reflect the costs of processing the product before it reaches the market. Similarly, the border prices of traded goods will reflect transport, marketing and processing costs, and is given by the f.o.b. (free on board) price for exports and the c.i.f. (cost, insurance, freight) price for imports. The choice of which price to use in the analysis depends on whether the good is traded or non-traded, the level and type of analysis and the project boundary.[16] Gittinger (1984) provides a manual for cost-benefit analysis of projects, concentrating on situations where all benefits and costs are evaluated using price data obtained from markets and adjusted as necessary for policy distortions. Dixon *et al*. (1994) provide an overview of the use of market prices for valuing environmentally-related impacts.

In a well-known example of forest valuation, **Peters *et al.* (1989)** analyse alternative forest uses in Mishana, Rio Nanay, Peru. They compare the financial benefits of maximum sustainable extraction of wild fruits and latex to the potential returns from forest conversion for timber harvesting. Their estimates of sustainable fruit and latex yields for a one hectare (ha) plot of forest are based on field analysis, interviews with collectors and existing literature. Using average retail prices for forest fruits, based on monthly surveys of the Iquitos produce market, and rubber prices (which are controlled by the Peruvian government) from the agrarian bank office, the value of the harvest was derived by multiplying yields by market prices. By deducting from market prices the estimated harvesting and marketing costs (using data on labour inputs, prevailing wage rates and transport costs), the net revenue from a single year's harvest of fruit and latex production was estimated at US$422/ha. Assuming that this amount can be obtained in perpetuity, constant real prices and a discount rate of 5%, the authors calculate the net present value (NPV) of the forest for sustainable fruit and latex production at US$6,330/ha.

Much effort can be devoted to assessing the efficiency of market prices and correcting for policy interventions. However, the majority of studies reviewed in Part II that use price and expenditure information to value NTFPs appear to have experienced more difficulty in collecting data on quantities and inputs. Markets for NTFPs are often very thin, seasonal and localised. In many situations, a large proportion of NTFPs are consumed by the harvesters or their family. Thus, official statistics on harvesting and trade are usually not available, with the notable exception of some

[15] An efficient market also normally requires that many buyers and sellers compete and none of them are able to exercise significant market power (influence over prices) by virtue of their size or access to information.
[16] Following the conventional definition, a non-tradable good has a domestic supply price, at the given level of local demand, that exceeds the f.o.b. price of exports but falls below the c.i.f. price of imports. This may include perishable goods or goods that are difficult to transport. Traded goods include those goods for which, if exports, the domestic costs of production are less than the f.o.b., and if imports, the domestic cost of production exceed the c.i.f. price.

commercially important species, such as rattan or bamboo in some areas. The harvest of animal products may be officially prohibited, making people reluctant to provide information.

The main cost of harvesting NTFPs is typically household labour (processing and transport to market may require other inputs). Pricing labour inputs in rural areas of developing countries can be problematic, due to thin labour markets and seasonal changes in work opportunities. Estimating the amount of time involved in harvesting can also be difficult, due to the complementarity between harvesting NTFPs and other activities (e.g. agriculture). Several of the case studies reviewed use information on labour inputs and wages to estimate the production costs of NTFP extraction, including: **Alcorn (1989); Anderson and Jardim (1989); Godoy and Feaw (1989); Howard (1995); Kramer *et al.* (1992, 1995); Pearce (1991); Peters *et al.* (1989); Pinedo-Vasquez *et al.* (1992); Ruitenbeek (1989a, 1989b);** and **Schwartzman (1989)**.

3.2 Surrogate Market Approaches

A second group of methods rely on the fact that certain non-market values may be reflected indirectly in consumer expenditure, in the prices of marketed goods and services, or in the level of productivity of certain market activities. These techniques statistically sophisticated methods, such as travel cost models and hedonic pricing, as well as simpler techniques such as the substitute goods method. The theoretical basis for all of these approaches is the household production function, which describes how households attempt to maximize their well-being by allocating time and resources to different activities.

3.2.1 Travel Cost Method

The travel cost method (TCM) is based on the assumption that consumers value the experience of a particular forest site at no less than the cost of getting there, including all direct transport costs as well as the opportunity cost of time spent traveling to the site (i.e. foregone earnings). This survey-based method has been used extensively, especially in richer countries, to estimate environmental benefits at recreational sites (including wildlife reserves, special trekking areas and beaches). TCM has recently been applied in several developing countries, particularly where higher incomes and rapidly developing markets have been associated with growing demand for amenities such as scenic views and recreational areas.[17]

Three basic steps are involved in travel cost models. First, it is necessary to undertake a survey of a sample of individuals visiting the site to determine their costs incurred in visiting the site. These costs include travel time, any financial expenditure involved in getting to and from the site, along with entrance (or parking) fees. In addition, information on the place of origin for the journey, and basic socio-economic factors such as income and education of the individual is required.

The resulting data is manipulated to derive a demand equation for the site. This relates the number of visits to the site to the costs per visit. The third step is to derive the value of a *change* in environmental conditions. For this, it is necessary to determine how willingness to pay for what the site has to offer alters with changes in the features of the site. By comparing the willingness to pay for sites with different facilities it is possible to determine how the total benefits derived from the site change as the facilities of the site change.

Since the earliest applications of the travel cost method in the USA in the late 1950s, the technique has been steadily improved and a number of theoretical and empirical issues have been tackled (see Bockstael *et al*. 1991 for a thorough review). In spite of these improvements, the usefulness of this technique to value forest recreational uses in developing regions is constrained by the large amount of data required. Increasingly, surveys for the travel cost method are being combined with contingent valuation surveys leading to more robust results, as well as potential estimates of option and non-use values.

[17] TCM has also been used to value the benefits of alternative water supply and sanitation systems in the developing world (see for example: Wittington *et al*. 1990, 1991).

In an application of the travel cost method in Costa Rica, **Tobias and Mendelsohn (1991)** estimate the eco-tourism value to domestic users of the Monteverde Cloud Forest Biological Reserve. They derive a national recreational value of the site of approximately $100,000 per year. Other examples of TCM used to value forests in the developing world include: **Adger *et al.* (1995), Kramer *et al.* (1995)** and Willis *et al*. (1998).

3.2.2 Hedonic Pricing

Another valuation technique is the hedonic pricing method, which attempts to isolate the specific influence of an environmental amenity or risk on the market price of a good or service. The most common applications of this technique are the *property value* approach and the *wage differential* approach, which are used to value environmental amenities and dis-amenities. Hedonic pricing is based on the assumption that the market value of land or labour is related to the stream of net benefits derived from it. This stream of net benefits includes a range of factors, including environmental amenities. Therefore, the value of the environmental amenity can be imputed from the observed land or labour market.

Application of the hedonic pricing approach to property values involves observing systematic differences in the value of properties between locations and isolating the effect of environmental quality on these values. The market value of a residential property, for example, is affected by many variables including its size, location, construction materials, and also the quality of the surrounding environment. With sufficient data on property values and characteristics it may be possible to control for size, location, construction materials and other factors, such that any residual price differential may be imputed to differences in environmental quality. The hedonic pricing method requires large data sets, in order to account for and eliminate the influence of all other variables which affect market prices. The approach also assumes that markets for land are competitive, and that both buyers and sellers are fully informed of the environmental amenity or hazard.

Hedonic pricing has been used in developed countries to estimate the negative impact of air and noise pollution, or the presence of waste disposal facilities, on the market prices of residential property and, conversely, the positive impact of proximity to water or public green space (Garrod and Willis 1992).[18] We found no examples of hedonic pricing used to assess the environmental amenity value (or any other value) of forests in developing countries. One constraint on use of the technique in developing countries is that private property markets are often thin, uncompetitive and poorly documented. This is a particular problem at the frontier of forested areas, where formal title to land may be missing and where land is often essentially an open access resource.

This situation will probably change as incomes grow and land markets in developing countries become more efficient and discriminating (and as land transactions are better documented). It may already be possible to apply the hedonic pricing method to residential property markets in and around high-growth cities in developing countries, especially where new residential housing developments provide home buyers with the opportunity to reside in greener, forested areas, away from the smog and congestion of the city centre.

3.2.3 Substitute Goods Approach

For those forest resources which are non-marketed or which are used directly by the harvester (e.g. fuelwood), value may be approximated by the market price of *similar goods* (e.g. fuelwood sold in other areas) or the value of the next best *alternative or substitute good* (e.g. charcoal). The extent to which the value of the alternative marketed good reflects the value of the non-market good in question depends, to a large extent, on the degree of similarity or substitution between them. That is, if the two goods are perfect substitutes then their economic values should be very close. As the level of substitution decreases so does the extent to which the value of the marketed good can be taken as an indication of the value of the non-marketed forest good.

Examples of the substitute goods approach used to value forest benefits in a developing country context focus on NTFPs. **Adger *et al.* (1995)** and **Gunatilake *et al.* (1993)** use the technique to supplement market price data for

[18] The wage differential approach has been used to evaluate the impact of occupational hazards or other environmental factors on wages, based on the assumption that the supply of labour varies with local living and working conditions (see Freeman 1993 for a thorough discussion).

NTFPs in Mexico and Sri Lanka, respectively. **Chopra (1993)** uses the approach as an alternative to labour cost analysis for valuing fuelwood, in a study of deciduous forests in India. No examples were found of the substitute goods approach being used to estimate other forest values.

In some circumstances, a substitute good may be non-marketed as well, but it may still be possible to infer a price for the good in question. In a cost-benefit analysis of a management programme for two forested watersheds in Nepal (Fleming 1981, cited in Dixon *et al*. 1994), fuelwood was valued in terms of the alternative uses of its closest substitute, that is cattle dung which can be dried and burned when wood is unavailable. The opportunity cost of using cattle dung as fuel rather than as fertiliser is estimated in terms of losses in food grain resulting from lower dung inputs into agricultural production. Thus this approach involves two stages: first, estimating a conversion factor for equating the two substitutes (in this case, the energy value of dung and wood); and second, estimating the marginal effect on output, and thus profits, of a change in the use of the substitute (in this case cow dung).

3.3 Production Function Approaches

A third type of valuation method is variously called the *change-in-production* technique, the *input-output* or *dose-response* method, or the *production function* approach (the latter term is used here). Whatever the name used, all involve an attempt to relate human well-being (or more narrowly, the incremental output of a marketed good or service) to a measurable change in the quality or quantity of a natural resource (Maler 1992).[19] The production function approach may be used to estimate the indirect use value of ecological functions of forests, through their contribution to market activities. The approach is referred to as the production function method because many studies estimate impacts on economic production. However, the same approach can be used to estimate consumption losses directly, e.g. siltation of bathing areas.[20]

Use of this approach involves a two-step procedure. Firstly, the physical effects of changes in the environment on economic activity are determined. This may be done through laboratory or field research, observation or controlled experiments, or statistical techniques. The second step consists of valuing the resulting changes in production or consumption, usually using market prices. In this way the monetary value of the ecological function is derived indirectly.

The production function approach has been used extensively in both developed and developing regions to estimate the impacts of changes in environmental quality (e.g. deforestation, soil erosion, air and water pollution) on productivity in agriculture, forestry and fisheries, on human health, and on the useful life span or costs of maintaining economic infrastructure.[21] An essential requirement of the approach is good information on the physical relationship between the state of the environmental resource and the economic activity or asset it supports. In addition, market conditions and policy distortions affecting production decisions need to be taken into account.

An example of the production function approach is provided in a study by **Hodgson and Dixon (1988)**, who conducted an evaluation of alternative development plans for a coastal zone in the Philippines. The study used a production function approach to estimate the impact of the ecological effects of coastal logging on terrestrial and marine ecosystems, and thus on tourism and marine fisheries. A reduction in the fish catch resulting from increased sedimentation due to logging was estimated through regression analysis, using information on coral cover, species diversity and fish biomass. Similar analyses of the relation between mangrove conversion and the productivity of

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[19] Maler (1992) subsumes all valuation methods except stated preference techniques into the production function approach. For this discussion we focus on Maler's first sub-category, i.e. where output is measurable.
[20] In this case, it may be necessary to use other valuation methods to estimate the change in consumption benefits.
[21] Sometimes the benefits of an environmental resource are expressed in terms of *damage costs avoided*, e.g. when the carbon content of a forest is valued in terms of the potential economic losses which would occur if that amount of carbon were released into the atmosphere and exacerbated global warming (Fankhauser 1995). The value of the environmental service consists in reducing the amount of other (marketed) inputs needed to sustain economic activity and assets. Variants include some cost-based methods (see section 3.5).

tropical marine fisheries can be found in cases studies of El Salvador (Gammage 1997), Mexico (Barbier and Strand 1998), Indonesia (**Ruitenbeek 1992**), and the Philippines (Janssen and Padilla 1997; Nickerson 1999).

Another common application of the production function approach is to evaluate the impact of forest disturbance on hydro-electric power generation and fresh water supply. **Aylward *et al.* (1999)**, for example, use the production function approach (along with other methods) to value the hydrological impacts of forest conversion in upland areas, in a case study of the Arenal watershed, in Costa Rica. Other case studies of the downstream hydrological impacts of logging or forest conversion in the developing world include research in Bolivia (Richards 1997), Peninsular Malaysia (Mohd. Shahwahid *et al*. 1998) and Thailand (Johnson and Kolvalli 1984).

The production function approach is relatively straightforward in the case of *single use systems*, i.e. forest areas in which the main non-market value is a single ecological function as described above. In the case of *multiple use systems*, i.e. where a single forest regulatory function supports several economic activities, or where there is more than one non-market ecological function of economic value, applications of the production function approach are more problematic.[22] In particular, assumptions concerning the relationship between the various uses must be carefully constructed. One difficulty is the risk of "double counting" when estimating the total economic value of a forest area from various sub-component values (Aylward and Barbier 1992).

3.4 Stated Preference Approaches

Price-based, surrogate market and production function approaches all rely on the use of market prices (revealed preference) to estimate the value of forest goods and services. An alternative is to ask consumers to state their preferences directly, in terms of hypothetical markets or payments. In this approach, information on the value of an environmental benefit is obtained by posing direct questions to consumers about their willingness to pay for it or, alternatively, their willingness to accept cash compensation for losing the benefit. The most widely used and well-developed stated preference technique is the contingent valuation method (CV or CVM). Alternative but less widely used stated preference methods include choice experiments (CE) and the use of participatory or "focus group" approaches to elicit preferences.

3.4.1 Contingent Valuation

CV elicits individual expressions of value from respondents for specified increases or decreases in the quantity or quality of a non-market good. Most CV studies use data from interviews or postal surveys (Mitchell and Carson 1989). Valuations produced by CVM are "contingent" because value estimates are derived from an hypothetical situation that is presented by the researcher to the respondent. The two main variants of CV are open-ended and dichotomous choice (DC) formats. The former involves letting respondents determine their "bids" freely, while the latter format presents respondents with two alternatives among which they are asked to choose. Open-ended CVM formats typically generate lower estimates of WTP than DC designs (Bateman *et al*. 1995).

Proponents of CVM (e.g. Carson 1991) argue that its theoretical foundations are firmer than those of other valuation techniques, because it directly measures Hicksian welfare measures, or true WTP (or WTA).[23] Moreover, CV is the only generally-accepted method for estimating non-use values, which are not traded in markets and for which there are no traded substitutes, complements or surrogate goods which can be used to impute values.

On the other hand, because no payment is made in most cases, some observers question the validity of stated preference techniques. Critics argue that CVM fails to measure preferences accurately and does not provide useful information for policy (Diamond and Hausmann 1994). Even practitioners accept that poorly designed or badly implemented CV surveys can influence and distort responses, leading to results that bear little resemblance to the

[22] **Ruitenbeek (1992)** explicitly incorporates the possible ecological linkages between direct and indirect use values in his analysis of mangrove wetlands of Bintuni Bay, Irian Jaya, Indonesia.
[23] Other techniques such as travel cost models measure Marshallian consumer surplus. The degree to which they approximate true WTP (or WTA) relies on the strength of assumptions regarding the form of the utility function. See Braden and Kolstead (1991) for a technical discussion, and Carson *et al*. (1996) for a comparison of estimates.

relevant population's true WTP. Much recent attention has focused on overcoming potential sources of bias in CVM studies.[24] Resolving these difficulties involves careful design and pre-testing of questionnaires, rigorous survey administration, and sophisticated econometric analysis to detect and eliminate biased data. While CVM is accepted by the US legal system as a basis for assessing environmental damages, the procedural requirements for using CV estimates in court cases are very strict (Arrow *et al*. 1993).

The use of CVM for valuing environmental resources originated and was largely developed in North America. In forestry, CVM has been used to value wildlife and recreational benefits of protected areas. Several recent studies have demonstrated the feasibility of applying CVM to forest land use in the developing world. For example, in a case study of forest recreation in Costa Rica, Echeverría, Hanrahan and Solórzano (1995) used a "take-it-or-leave-it" personal interview survey of eco-tourists to estimate WTP for the Monteverde Cloud Forest Preserve. In another example, Willis *et al*. (1998) used CVM together with an Individual Travel Cost Model to estimate consumer demand for forest recreational sites in Peninsular Malaysia. They found that the two methods generated comparable estimates, and that the aggregate benefits of forest recreational areas exceed the (direct) costs of their provision. Additional examples of CVM used to estimate WTP for forest recreation and non-use benefits in developing countries include: **Adger *et al.* (1995)**, **Dixon and Sherman (1990)**, **Hadker *et al.* (1997)**, **Kumari (1995a)**, and **Prasanthi Gunawardena *et al.* (1999)**.

In a slightly different vein, **Smith *et al.* (1997)** use a CV survey to assess Peruvian farmers' willingness-to-accept (WTA) compensation for adopting alternative land use practices which store more carbon (as a mitigation strategy for global warming), and farmers' WTP for forest use benefits. The resulting estimates cover a wide range of direct, indirect use and non-use values. Similarly, **Kramer *et al.* (1992, 1995)** use CV to evaluate the direct use benefits to rural communities' from harvesting NTFPs and using forest areas for agriculture and residential space, near the Mantadia National Park, in Madagascar. Their estimates may also capture non-use existence or cultural values placed on the forest by local residents. As in the Peru study, the results of the CV are subsequently used to estimate farmers' WTA compensation for loss of access to forests in the park. The survey data revealed an annual mean value per household of US$108 and an aggregate net present value for the affected population (about 3,400 people) of US$673,000. Price-based assessment of foregone forest income yielded comparable estimates of US$91 per household and US$566,000 in aggregate present value terms.[25]

The Madagascar case study demonstrates how CVM can be used to value the direct use benefits of forests, such as non-timber forest products, in terms of local people's WTA compensation for loss of access to these benefits. Similarly, the study in Peru illustrates how CVM can be used to determine the cost of maintaining forest environmental services, such as carbon storage, in terms of local people's WTA compensation for adopting "ecologically sound" land use practices. On the other hand, CVM may be less appropriate for estimating the benefits (as opposed to the costs) of forest environmental services. This is because the relation between alternative forest land uses and the degree of protection or support afforded to off-site market activities (e.g. fisheries) is not well understood by consumers, or indeed by scientists!

3.4.2 Contingent Ranking

A variant of contingent valuation, this method involves asking respondents to rank a series of alternative non-market goods (Foster and Mourato 1997). One advantage of contingent ranking is that monetary bids may or may not be used. Some have suggested that the use of hypothetical cash payments in CVM may be inappropriate in remote rural communities in the developing world, where people may have relatively little exposure to the market economy (**Lynam *et al.* 1994; Emerton 1996**). In such cases monetary values can be assigned indirectly, by including in the contingent ranking one or more "anchor" goods with known market values.

[24] Bias is any aspect of a study that consistently skews responses in one direction, thereby leading to results that diverge from the true WTP of the population. Bias may arise in any of the four steps in survey design and implementation: construction of the market scenario; development and application of the method and vehicle for eliciting responses; sample design and implementation; and drawing inferences from the results.

[25] **Hadker *et al.* (1997)** and **Prasanthi Gunawardena *et al.* (1999)** also use CVM to estimate direct use (and other) values, although in these cases it is not possible to validate the resulting estimates with reference to other methods.

An illustration of contingent ranking is provided by **Lynam *et al.* (1994)**, who use the method to value multi-purpose tree resources in Zimbabwe. The authors asked smallholder farmers to rank and score ten categories of benefits obtained from trees. These non-monetary preferences were "anchored" by simultaneously asking respondents to score a hand-pump borehole and a well-known type of pit latrine. Respondents were then asked for their WTP for the borehole and latrine in order to provide a monetary benchmark from which to impute the value of the non-market forest products and services. The results indicated that forest products consumed directly by households scored the highest, with production inputs and forest-related services following lower down the scale. In a similar vein, **Emerton (1996)** uses contingent ranking to value a range of direct use benefits of forests (timber, fuelwood, grazing, etc.) to rural households in Kenya, including the use of several monetary "anchors" (a radio, bicycle or milk cow).

The contingent ranking method is conceptually simple, easy to administer and able to generate rough estimates of value for a number of forest goods and services at once, without conducting separate WTP surveys for each use and non-use value. On the other hand, contingent ranking may not provide accurate estimates of WTP. A fundamental question is whether the scores generated by contingent ranking reflect an ordinal ranking of relative preference (i.e. first, second, third, etc.) as opposed to cardinal measurements of value (i.e. one, two, three...). In the former case, it may not be valid to use the cost/price of marketed "anchors" to impute monetary values to non-market goods and services, because they are on different (incommensurate) scales.

3.4.3 Choice Experiments

Another stated preference method for valuing environmental goods is the use of choice experiments (CE). This approach involves asking individual respondents to chose among alternative bundles of non-market goods, which are described in terms of their attributes, including an hypothetical price (Hanley *et al.* 1998; Adamowicz *et al.* 1998a). In the case of forests, for example, a CE survey may present respondents with alternative landscapes (in the form of images), which vary by species mix, age diversity, percentage of open area, the presence of roads and the hypothetical price (given a particular payment vehicle) to the individual. CE shares many features with Dichotomous Choice CV models and the results should be directly comparable with estimates based on DC/CV models. A particular strength of CE is the ability to estimate characteristic values for environmental goods.

CE has been used in North America to estimate recreational values (Adamowicz *et al*. 1994; Boxall *et al*. 1996) and, more recently, to estimate non-use benefits (Adamowicz *et al.* 1998b). Hanley *et al.* (1998) use CE to estimate both use (recreation) and non-use values of alternative forest landscapes in the UK. They find comparable results to using open-ended CVM. No examples of CE used in the developing world were found in the literature, although there is no reason in principle why the approach could not be used to estimate a wide range of forest values.

3.4.4 Participatory Methods

CVM and CE rely on interviews or questionnaire surveys to collect data on individual WTP for environmental benefits. Contingent ranking may also involve individual interviews. Survey design and administration has been a major focus of concern in all of these methods, with the aim of minimizing biased or strategic responses (Hanemann 1996). Some researchers argue that the use of participatory or "focus group" techniques in both data collection and analysis can reduce bias and generate more accurate information.[26] These and related concerns have led researchers to develop variants of CVM which use participatory survey techniques. While such methods have not been widely used, a few examples were identified in the literature review.

One illustration is provided by **McDaniels and Roessler (1998)**, who propose a method of multi-attribute value assessment and use it to estimate the value of wilderness conservation in British Columbia, Canada. In their approach, values are elicited from groups rather than from individuals, with plenty of opportunity for discussion and revision of "bids". The technique is less demanding than CV, in terms of the statistical manipulation of data required, but it is not clear whether bias is minimized or increased when a group of respondents is asked to rank and score a

[26] Participatory methods come in guises, including Participatory Rural Appraisal (PRA), Rapid Rural Appraisal (RRA), Participatory Learning and Action (PLA), etc.

range of environmental amenities together. In a comparison of participatory techniques and household surveys for valuing forest benefits in Zimbabwe, **Davies *et al.* (1999)** found that participatory methods were better at generating qualitative information, but not as good at generating quantitative data (and were also more time consuming for local respondents).

3.5 Cost-based Valuation

In addition to the methods described above for estimating WTP or WTA for non-market forest benefits, some other cost-based approaches may be used to shed light on the costs of maintaining non-market forest benefits, or trade-offs with market values. Three alternative methods focus on the costs of providing, maintaining or restoring environmental goods and services.[27] A thorough discussion of cost-based valuation can be found in Dixon *et al*. (1994). The most common methods are:

- *replacement cost* methods, which measures environmental values by examining the costs of reproducing the original level of benefits;

- *preventive expenditure* methods, which estimate the cost of preventing or defending against degradation of the environment; and

- *opportunity cost* approaches, which use estimated production costs as a rough proxy for the value of non-market benefits.

Cost-based techniques are commonly used where there is limited time and resources for more rigorous estimation of environmental benefits. However, such techniques must be used with care, with particular attention to ensure that non-market *benefits* and *costs* are not confused. Because cost-based techniques do not directly measure WTP for environmental goods and services, the resulting estimates may over- or under-estimate forest benefits by a large margin. Problems arise when potential rather than actual expenditures are used, as it is not always clear that the environmental benefit in question justifies the costs of replacement, relocation, etc. On the other hand, while cost-based methods are inexact, they may be the only practical alternative in some cases, given resource and time constraints. Where such methods are used, key assumptions about the relationship between estimated costs and associated benefits should be stated clearly.

3.5.1 Replacement Cost

The replacement cost technique generates a value for the benefits of an environmental good or service by estimating the cost of replacing the benefits with an alternative good or service.[28] For example, where logging or road construction in upland forest areas leads to increased runoff and sedimentation, some studies use information on the costs of dredging or flood control as a rough estimate of the non-market benefit of watershed protection. The technique rests on the availability of such an alternative, which should - as nearly as possible - produce the same type and level of benefits as supplied by the resource or environmental function being valued. When developing a replacement cost scenario, it is normal practice to select the least cost option among all possible technologies, so as not to over-estimate the value of the environmental benefit.

Relatively few examples of the replacement cost method were found in the literature review. One application to valuing forest benefits is to estimate the value of soil nutrients lost due to increased erosion associated with logging

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[27] As noted above, some cost-based methods overlap with other non-market valuation techniques. An attempt is made to signal such overlaps in the discussion that follows.

[28] The replacement cost method is very similar to the *substitute goods* technique, which was described above under Surrogate Market approaches. The relevant question in both cases is to what extent the original non-marketed environmental benefit can be replaced or substituted by some alternative, marketed good or service. Another variant is the *restoration cost* technique, which is based on estimates of the cost of recreating the original environmental good or service. In the case of natural forests, complete restoration of all benefits following logging, burning or conversion can take centuries, which limits the relevance of the technique.

or deforestation in terms of the cost of manufactured fertilizer needed to replace the eroded nutrients (**Chopra 1993; Niskanen 1998**). Another example is provided by **Aylward *et al.* (1999)**, who value changes in runoff water yield for hydro-electric power generation, under different land uses, in terms of the marginal opportunity cost of alternative (thermal) sources of electric power.

3.5.2 Preventive Expenditure

The preventive expenditure approach (also sometimes called "mitigation" or "defensive" expenditure) places a value on environmental goods and services by estimating the costs of preventing a reduction in the level of those benefits derived from a particular area. This approach may be most applicable for assessing the indirect use values of forests.

No case studies using preventive expenditure were found in the literature review. However, an hypothetical example can illustrate how the technique could be used to estimate non-market forest values. For instance, projected expenditures on soil conservation measures aimed at halting or reversing soil degradation could be used as a rough proxy for the benefits generated by the natural nutrient cycling and watershed protection functions of forests. In the case of logging, the watershed protection benefits that might be diminished by building roads for the extraction of timber could be valued by examining the incremental cost of adopting less damaging extraction methods, such as non-mechanised extraction, helicopter logging, or alternative road layouts. As always, it is important to ensure that the benefits of the preventive expenditure match those originally provided by the environmental function, in order to obtain a realistic cost estimate.

The preventive expenditure method is sometimes confused with a variant of the production function approach known as "damage costs avoided". The difference is that the latter approach uses information on the costs of making good or repairing damages incurred as a result of some environmental change, whereas the preventive expenditure approach focuses on the costs of avoiding or mitigating damages before they occur. Where alternative valuation techniques yield different estimates of a particular forest benefit, it is generally preferable to use the lowest estimate so as not to over-estimate the non-market benefit in question.

3.5.3 Opportunity Cost of Labor

Another valuation approach focuses on the employment opportunities foregone in order to secure or protect a particular non-market benefit. As with other cost-based approaches, the focus is on the costs of providing a non-market benefit, rather than the magnitude of the benefit *per se*. The basic idea is that a non-market benefit is worth at least as much as the return that could be obtained by private producers if they were to devote the same effort (i.e. the labour used to secure the non-market benefit) in some alternative use.[29]

The opportunity cost approach is most often used to value the subsistence benefits of NTFP collection, where labour is the main input and prices are not available because all or most output is consumed directly by producers. In such cases, the implicit assumption is that a producer's decision to spend time collecting non-timber forest products is weighed against alternative uses of household labour. The opportunity cost of time spent harvesting NTFPs is thus taken as a proxy for the value of the product(s) in question.[30] The only data required are the amount of time spent on the harvest, the resulting yield and the prevailing (rural) wage rate.

Nevertheless, care must be exercised when using rural wage rates. Firstly, it is important to ensure that the effort involved in harvesting a non-timber forest product is commensurate with the effort associated with the prevailing wage rate. For example, one day of a child's time spent collecting wild foods should not be valued at the same level as the wage received by an adult for physically-demanding agricultural work. In such cases, it may be appropriate to adjust the wage rate used. Similarly, seasonal variations in rural wages should be considered, as the harvesting of

[29] Use of the opportunity cost of labour to value non-market forest benefits may be distinguished from the more general concept of the "opportunity cost" of a particular forest land use. The latter typically refers to market values foregone as a result of forest conservation or the adoption of sustainable management (see Chapter 4).

[30] If we assume rational behaviour, the benefits of collecting the good will be at least equal to the costs. Collection costs are thus a minimum estimate of the benefits derived from the good. The intuition is less appealing in the case of public expenditure, where the ratio of benefits to costs may not be a relevant criterion for decision-makers.

NTFPs may be concentrated in periods of slack labour demand, when wages are lower. Thirdly, gathering forest products is often combined with agricultural activities, for example when walking to or from the fields. This must also be taken into account when deciding how much labour time to include in NTFP harvesting costs.

Of the case studies reviewed, most of those which estimated NTFP benefits used labour cost data to estimate production costs. These were deducted from the market value of products (for which prices were available) to calculate the net benefits of NTFP extraction (see section 3.1). In a few cases, however, market prices were apparently missing and rural wages were used directly to value NTFPs themselves (**Browder *et al.* 1996; Chopra 1993)**. No examples were found of using other inputs to estimate non-market forest benefits.

Table 3.1 Methods for valuing forests

Valuation method	Relevant forest benefits	Strengths and weaknesses
Market prices: Use data from surveys of producers and consumers, adjusted if necessary to account for seasonal variation, value-added processing and/or public policy distortions.	Price-based valuation is commonly applied to non-timber forest products which are partly or informally traded, in order to estimate subsistence and/or unrecorded consumption.	Market prices clearly reflect consumer preferences, but often need adjustment to account for public policy distortions or market failures. Aggregation or extrapolation of values based on potential production is not valid unless account is taken of likely price effects (elasticity of demand).
Surrogate markets: Travel cost - use survey data on direct costs (e.g. fares, accommodation) and, in some cases, opportunity costs of time spent travelling to and from a site, evaluated at some fraction of the average wage rate. Hedonic pricing - use statistical methods to correlate variation in the price of a marketed good to changes in the level of a related, non-marketed environmental amenity. Substitute goods - use market prices of substitutes for non-marketed benefits.	Travel cost is often used to estimate demand for forest recreation at specific locations. Related methods used mainly in developing countries estimate the value of non-marketed, non-timber forest products in terms of the opportunity cost of time spent collecting and/or processing them. Hedonic pricing is used to estimate the impact of proximity to forested land and/or logging on the prices of residential and commercial property. Substitute goods approaches may be used wherever close market substitutes for non-timber benefits exist.	Provided the relation between the benefit being valued and the surrogate market is correctly specified, and prices in the surrogate market are not very distorted (e.g. by policy intervention), such methods are generally reliable. Travel cost estimates may need to account for various objectives (benefits) in a single trip. Hedonic pricing requires large data sets, in order to isolate the influence of a non-market benefit on market price, relative to other factors.
Production function: Change in production method - uses data on the physical relation between level (or quality) of a non-market benefit and level (or quality) of output of a marketed good/service.	Change in production (or “input-output” or “dose-response”) methods are used to estimate both on- and off-site impacts of land use change, e.g. the effect of logging on hunting, downstream water users, fisheries, climate.	Change in production methods require good data on biophysical relationships (dose-response).
Stated preference Contingent valuation method - use consumer surveys to elicit hypothetical individual willingness-to-pay for a benefit, or willingness-to-accept compensation for the loss of that benefit. Contingent ranking / focus groups - use participatory techniques in group setting to elicit preferences for non-market benefits, either in relative terms (ranking) or in monetary terms.	Recreational values are often estimated using contingent valuation. Stated preference methods such as CVM are the only generally accepted way to estimate non-use values, e.g. landscape or biodiversity values, for which price data do not exist and/or links to marketed goods cannot easily be established. Contingent ranking may be used where target groups are unfamiliar with cash valuation.	Contingent valuation estimates are generally considered reliable if strict procedural rules are followed. Participatory techniques are more experimental and not widely used to estimate non-market forest benefits. They are good at eliciting qualitative or “contextual” information, but there are doubts about their reliability for estimating willingness to pay.

Cost-based approaches: Uses data on the costs of measures taken to secure, maintain and/or replace forest goods and services.	Cost-based approaches include replacement/relocation cost, defensive expenditure and opportunity cost analysis; may be used (with caution) to value any type of forest benefit.	Cost-based approaches are usually considered less reliable than other methods. One test of validity is evidence that people are prepared to incur costs to secure relevant benefits.

4 Cost-Benefit Analysis of Forest Land Use Options

Chapter 2 described the range of values and uses of forests, including non-market benefits, while chapter 3 reviewed the methods used to estimate different forest values. A rigorous economic assessment of forest land use ought, ideally, to include an evaluation of all the benefits and costs associated with each relevant land use option. This chapter presents a general framework for assessing the net economic benefits of alternative forest land use options. In particular, we show how these values can be incorporated into cost-benefit analysis (CBA), which provides a useful means of highlighting trade-offs between different development options.

The following section 4.1 describes an extended cost-benefit analysis framework and how it may be used to evaluate alternative forest land use options. Section 4.2 goes on to discuss the concept of economic opportunity cost and its relation to CBA. Of course, CBA is not without its weaknesses and thus section 4.3 briefly reviews some major criticism of valuation, CBA and economic methods generally. Section 4.4 describes some alternative assessment methods which may be used when CBA is considered unfeasible or inappropriate. Section 4.5 then discusses a number methodological issues which arise when applying CBA to issues of forest management. Section 4.6 concludes the chapter with a summary and brief checklist of the key steps involved in undertaking an economic assessment of forest land use options.

4.1 Cost Benefit Analysis

Cost-benefit analysis (CBA) is a standard tool for evaluating the economic merit of investment or development projects, and is widely used to assess forest land use options. When applied correctly, CBA results in a systematic listing of the advantages (benefits) and disadvantages (costs) of any project or land use option. This section does not explain CBA in detail, as there are many excellent texts on the subject.[31] Rather the focus here is on extensions of CBA to incorporate the range of benefits and costs associated with forest land use decisions.

A strength of CBA is the use of explicit and directly comparable decision criteria. The underlying logic of CBA is that, for any set of alternative activities (e.g. land use options), the net benefits of each should be compared, where the net benefits (NB) of a given option are simply the sum of benefits (B) less the total costs (C):[32]

$$NB = B - C \qquad (4.1)$$

These benefits and costs are identified for each time period - usually one year - over some time horizon chosen by the analyst. Using the technique of discounting, net benefits over time can be combined into a single aggregate figure, or net present value (see section 4.3.2).[33] Thus, for any two alternative forest land uses, A and B, the net benefits of A (NB^A) must *exceed* the net benefits of B (NB^B), if A is to be the preferred land use option on purely economic grounds, hence:

$$NB^A - NB^B > 0 \qquad (4.2)$$

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[31] See Gittinger (1984) for a practical manual on the use of CBA. Dixon et al. (1994) provide an overview of CBA for environmental analysis. For more technical treatments on CBA and its use in evaluating public investment, see Dasgupta *et al.* (1972), Little and Mirrlees (1974), Squire and van der Tak (1975).

[32] Net benefits may be distinguished from Total Economic Value (TEV), which makes no deduction for costs. For a detailed discussion of the theory underlying this methodology see Barbier and Burgess (1997).

[33] Benefits and costs may also be adjusted to account for their relative probability, for policy interventions which distort market prices, or for the distribution of costs and benefits among different stakeholder groups (see section 4.3).

The net benefits of a given land use option will comprise both *direct* and *indirect* net benefits, (respectively, NB_D and NB_I). Direct net benefits include the benefits and costs involved in producing marketed output, such as the revenues from timber extraction and associated forest management costs. Indirect net benefits cover the range of environmental goods and services discussed in the previous chapter, less any associated costs. Thus, we may re-write (4.2) as:

$$(NB_D^A + NB_I^A) - (NB_D^B + NB_I^B) > 0 \qquad (4.3)$$

For example, if land use option A involves clearing the forest for agriculture, not only should the direct costs of conversion (e.g. clearing and burning the forest, establishing crops) be included as part of the analysis of this option but so also must the *foregone* values of the forest that has been converted, which could have been conserved closer to its natural state through some alternative use, such as limited and sustainable use of forest resources (option B).[34] These may include both the loss of important *environmental functions* (e.g. watershed protection, carbon storage) and *resources* (e.g., commercial hardwood, non-timber products, recreational amenities).

While CBA is often used to compare alternative land uses, it can also be used to evaluate the net benefits of a single land use option. In the latter case, the question posed in CBA is whether the benefits of a particular land use exceed the costs, and if so, by how much. In other words, is an investment (in that land use option) justified, in economic terms? Of course, even where the net benefits of a given land use are positive, i.e. benefits exceed costs, there may be other land use options which would generate even greater returns. Hence the attraction of comparing several alternative land use options.[35]

Many of the case studies reviewed for this report present estimates of the benefits of a single land use or a single forest value. Moreover, some studies fail to account even for the direct costs of the forest benefit in question, let alone the opportunity cost of foregoing alternative land use options (see below). Of those studies which compare the net benefits of two or more land uses, many confine themselves to analysing closely related options in fairly narrow terms. For example, some studies use CBA to assess the net returns to alternative models of forestry for timber production (e.g. **Sedjo 1988; Veríssimo *et al.* 1992; Uhl *et al.* 1992**). Relatively few studies compare broad categories of land use (e.g. agriculture versus forestry), and only a handful make any serious attempt to consider the full range of forest values (i.e. direct and indirect uses, option and non-use values).

Probably the most well-known CBA of alternative forest land use options in the developing world is a case study by **Peters *et al.* (1989)**. Their study estimates the financial costs and benefits of sustainable extraction of wild fruit, latex and timber in the Peruvian Amazon, and compares them to the potential net financial returns from one-off "clear-cut" extraction of timber, plantation forestry and cattle ranching. Non-market forest values are not considered, but the authors nevertheless conclude that the net present value (NPV) of the "sustainable" land use option exceeds that of all three alternatives. While this case study has been criticised for several of its assumptions (see for example **Pinedo-Vasquez *et al.* 1992**), it represents one of the earliest and most influential attempts to compare alternative forest land use options using cost benefit analysis.

Since the publication of **Peters *et al.* (1989)**, many other studies have appeared which find that traditional, "sustainable" or otherwise environmentally-benign uses of forest land generate greater returns than conventional land use practices (e.g. clear-cut logging, plantation forestry or ranching). In some cases, this conclusion depends upon an assumption that new market opportunities such as eco-tourism or pharmaceutical prospecting will quickly generate large financial flows, and that these flows can be "captured" by forest land owners. In other cases, the argument depends on an appeal to entirely non-market forest benefits. For example, in a comparison of alternative

[34] Option B may be considered a base case scenario against which alternatives, such as A, should be compared.
[35] There may be other reasons to prefer certain land uses, even if they have relatively low net benefits, such as lower initial investment required, greater local employment impact, less prone to risk, etc. (see section 4.3).

forest management systems in Malaysia, **Kumari (1995a)** concludes that adopting more sustainable methods of timber extraction from peat swamp forest is preferable in economic terms. Although shifting to a sustainable harvesting system reduces the net benefits of timber harvesting, the case study suggests that this is more than offset by increased non-market benefits, primarily hydrological and carbon storage values. The problem, of course, is that in most cases such non-market benefits do not generate any financial returns, and may never do so.

4.2 Opportunity Cost and CBA

CBA may be used to assess the costs and benefits of a single forest land use, or to compare the net benefits of alternative land use options. In the latter case, reference is often made to the *opportunity cost* of choosing a particular land use, in terms of potential market opportunities foregone.[36] In other words, by choosing a particular land use and set of forest values in a given area, it may be necessary to forgo some other, incompatible forest land uses or values.

Several case studies reviewed for this report present estimates of the opportunity costs of forest conservation, or the opportunity costs of adopting more "sustainable" land use practices. Often this forms part of a Total Economic Valuation of a particular land use, or a CBA of alternative land uses. For example, **Dixon and Sherman (1990)** estimate the opportunity cost of the Khao Yai National Park in northern Thailand, in terms of the loss of alternative land uses including hunting, logging and gathering of forest products. **Emerton (1996)** uses contingent ranking to estimate the opportunity cost of restricting access to protected forests in Kenya, in terms of timber and non-timber values foregone by local residents. **Hodgson and Dixon (1988**) estimate one of the non-market opportunity costs of logging in upland areas, i.e. the potential loss of fisheries and other watershed benefits downstream. **Howard (1995)** estimates the aggregate opportunity cost of protected areas to Uganda, in terms of foregone forestry and agricultural land uses, as part of a broader CBA of protected areas. **Jonish (1992)** evaluates the opportunity cost of adopting sustainable forest management in Malaysia, in terms of potential job losses in the timber industry. **Kramer *et al.* (1992, 1995)** use both market prices and contingent valuation methods to assess the foregone benefits of subsistence (shifting) cultivation, extraction of fuel wood and other non-timber products by local populations due to the creation of the Mantadia National Park, in eastern Madagascar. **Loomis *et al.* (1989)** assess the opportunity costs of converting land to housing in California (building a subdivision), in terms of the loss of deer hunting and viewing opportunities. **Ruitenbeek (1989a, 1989b)** estimates the opportunity cost of foregone timber and agricultural production in and around two protected areas in Cameroon and Nigeria, as part of an analysis of two national park support projects. And **Saastamoinen (1992)** estimates the foregone logging benefits of forest preservation in the Philippines.

4.3 Criticism of CBA and Valuation

Cost-benefit analysis, valuation of non-market impacts and the concept of opportunity cost are all fundamental components of any economic comparison of alternative forest land use options. And yet many people reject the notion of comparing market costs and benefits with non-market social and environmental values. Others take issue with the assumptions of cost-benefit analysis, or the methods of estimating non-market values. This section reviews some of common criticism of CBA, monetary valuation and economic approaches to forest land use decisions generally. We defend the role of economics in forest land use planning, while acknowledging some of the weaknesses of economic approaches. The following section then discusses other land use assessment frameworks, which may be used in place of CBA or in conjunction with it.

Critics of economic evaluation of forest land use options raise various objections, ranging from minor methodological quibbles to sweeping rejection of economic modes of thought. Starting with the most fundamental criticism, some argue that it is not only impossible but ultimately illegitimate to attempt to reduce the range of fundamentally different values to a single measure such as net economic benefit. Many people believe that certain forest values are effectively "priceless", notably the preservation of endangered species of wildlife. Extreme versions of this view

[36] Similarly, the opportunity cost of inputs may be used to estimate specific non-market benefits, although this is rare (see Chapter 3).

consider any economic approach to environmental decision-making to be tainted by association with market forces, which are identified as the root cause of all environmental problems. From this perspective, any attempt to express non-market benefits in monetary terms implies a "slide down the slippery slope" of reducing all concepts of value to an economic bottom-line.

The view put forward in this report is that it is both possible and often desirable to estimate non-market values in monetary terms, as a contribution to rationale debate about the relative advantages and disadvantages of alternative courses of action. Trade-offs among widely divergent concerns are inevitable. A variety of methods must be found to reconcile these differences. Economics cannot claim to be the final arbiter of value, but it can contribute to political and other decision-making processes by providing a consistent and transparent accounting framework. Economic valuation makes trade-offs comparable and intelligible, by expressing different costs and benefits in terms of a single *numeraire*, i.e. monetary value. In this way we can directly compare, for example, the value of marketed timber or crop production that must be foregone in order to preserve certain environmental benefits.

Another common complaint is that valuation of non-market benefits is too costly. It is true that rigorous estimation of non-market values is often expensive, mainly because the data required are not readily available. Critics forget the enormous effort continually invested by public institutions, private firms and individuals to keep detailed accounts of financial and market transactions. This cost is simply accepted, and yet when more modest efforts are made to gather information on non-market phenomena, some people complain about the expense. Attempts to address this concern include recent research on "benefits transfer" - the idea that estimates of non-market value from one context may be applied to other situations (**Bateman *et al.* 1996**). Provided that the underlying determinants of variation in non-market value are understood, this can be a fruitful approach.

Even among those who accept economic approaches to decision-making, there may be concern about the methods used to estimate non-market values. As noted in Chapter 3, a major focus of debate is whether stated preference techniques provide accurate estimates of willingness-to-pay. Particular attention has been paid to the potential bias in how people respond to surveys, including the frequency of "protest bids" in contingent valuation studies and indications that many people prefer to rely on moral judgement or a rights-based approach, when asked to consider certain environmental benefits (Hanley and Milne 1996). While it is true that non-market valuation methods are imperfect (and improving all the time), the same could be said of most other decision-making processes. The appropriate response is to acknowledge the weak components or gaps in an evaluation, not to give up altogether.

Another frequently noted problem is that monetary estimates fail to account for distributional considerations, i.e. the relative importance of non-market values to different groups of people (this problem is not, of course, confined to non-market valuation studies but affects much economic analysis). In some cases this leads to arguments for social weights to favour the poor, or altogether different criteria for land use decisions, e.g. historical precedence.

Others refer to the poor record of valuation studies in influencing public policy (again a problem which afflicts several branches of applied economics). And some make the further point that valuation by itself may be meaningless, if there is no mechanism to capture and convey consumers' willingness-to-pay for non-market values to the people who, by their actions, can either fulfil or frustrate that demand.

While many of these criticisms of valuation are valid, the problem remains that environmental protection is often incompatible with other social and economic objectives. In forestry as in other spheres, people must often choose between incompatible alternatives, e.g. preservation, timber production or conversion to agriculture. Moreover, the view taken here is that many if not most land use decisions will inevitably have a strong economic basis, and that factors which are not quantified risk being ignored. We must acknowledge, however, that economic valuation of forest benefits can provide only part of the total picture, and that economic efficiency must be considered alongside other criteria such as social and cultural value, historical claims, distributional impacts and other factors. Alternative assessment methods which may help in this regard are discussed in the next section.

4.4 Alternative Methods of Land Use Assessment

The CBA framework is appropriate for making relatively small-scale decisions. The technique is generally based on the assumption that the project or initiative being considered is not so large as to alter prices or the structure of the wider economy. Yet many decisions concerning forest land use are made on a much larger scale. An obvious example is the classification of entire forest estates into zones which are assigned particular uses, such as recreation or timber production. Another is reform of timber concession fees throughout an entire economy. This report has not dealt with other evaluation frameworks, such as land use planning or sector modeling techniques, which are better suited to assessing the impact of such large-scale decisions. But these decision-making tools can also be extended to incorporate estimates of a range of forest benefits, in either physical or monetary terms.

Other evaluation methods can help resolve particular weaknesses or difficulties of CBA. These include variants of CBA as well as very different decision-making approaches. This section briefly describes some alternative methods for assessing forest land use options.

In many cases it is not practical to estimate non-market benefits in monetary terms, or to conduct a full-blown CBA. One alternative to estimating non-marketed benefits explicitly is to ask how much it would cost to ensure their preservation by various means. The aim of *cost-effectiveness analysis* (CEA) is to determine the most economical or cost-effective means to achieve a specified objective, where the latter has previously been justified using some other criteria (Dixon *et al*. 1994).

This approach is illustrated by **Sedjo and Bowes (1991)**, who compared alternative management regimes on forest sites of different maturities in the Pacific Northwest (USA). The authors calculate the NPV of logging (per acre) under conventional clear-cut harvesting as well as three “ecological” options. The aim of the exercise was to identify the least-cost ecological regime and to estimate the additional cost of moving from conventional forest management practices to such a regime. The authors estimated that it would cost no more than US$0.28 per acre to switch from the traditional clear-cut to a 15% set-aside regime when starting from bare ground. However, the cost of switching to such an ecological regime rises sharply for older stands, reflecting the opportunity cost of leaving valuable old-growth timber standing.

When the objectives of alternative projects or land use options are more varied, or involve different units of measurement, CEA may be difficult. In such circumstances, *multi-criteria analysis* (MCA) provides a systematic way for evaluating trade-offs in reaching multiple objectives. An example of this approach is provided by a case study of the social, economic and environmental trade-offs among mangrove conservation, commercial forestry and fishpond development in the Philippines (Janssen and Padilla 1997). The authors used both CBA and MCA to explore the preferences of various stakeholder groups, including fishpond owners, local and national government, social and environmental agencies, and the global community. Using a financial CBA, they found that the opportunity costs of mangrove conservation (in terms of the foregone benefits of acquaculture) were very high, over US$6,500 per hectare. They then develop an MCA, in which a range of environmental and social effects are given equal weight with financial outcomes. They find very high trade-offs between equity and economic efficiency, moderate trade-offs between economic and environmental objectives, and relatively little conflict between equity and environmental objectives. On this basis, the authors conclude that commercial forestry offers the best prospect of meeting multiple objectives (social, economic and environmental), while semi-intensive acquaculture dominates in strictly economic terms.

Other assessment approaches focus on issues of risk. Many projects and land use options involve risky events which may affect human welfare. *Risk-benefit analysis* (RBA) evaluates the benefits associated with a land use option in comparison with major risks, such as flooding, landslides, etc. On the other hand, in *decision analysis*, which is an extension of rather than an alternative to CBA, for each action or land use a range of possible outcomes is specified, depending on what conditions or “state of nature” prevail. If possible, these outcomes are assigned probabilities or the impact of varying probabilities is assessed using sensitivity analysis. Where relevant, non-market benefits can be incorporated into such techniques, just as in CBA.

All of the methods described above (CBA, CEA, MCA, RBA, decision analysis) are quantitative tools which rely (at least in part) on economic information. Non-economic criteria also have an important role to play in forest land use planning. CEA and MCA, for example, use other types of information to assess trade-offs between economic and other (social or environmental) objectives. Non-economic information can also be used on its own, for example to define the ecological suitability or physical carrying capacity of forest lands for particular uses. Physical indicators are essential when certain forest goods and services evade monetary valuation.

One of the most widely-used non-economic frameworks for assessing development projects is *environmental impact assessment* (EIA). EIA involves the prediction of environmental impacts, either adverse or beneficial, of any proposed action. Like cost-benefit analysis, EIA has become a standard tool for project design and appraisal. Although EIA usually has no economic content, it may be well-suited to forest planning, not only because the environmental implications of many land use options are numerous, long-term (or even irreversible) and far-reaching, but also because many of the benefits (or values) provided by forests fall outside of the market. EIA can be seen as a complement, even as a necessary foundation for proper CBA, by specifying the impacts which CBA should attempt to evaluate. In general, it is not practical to value all of the impacts identified through an EIA. On the other hand, awareness of the range of forest goods and services, as well as how they can be valued, may be incorporated into EIA.

4.5 Methodological Issues in Conducting CBA

Some of the assessment methods described in the preceding section were developed to address specific weaknesses of CBA, or as alternatives when comprehensive economic analysis is not possible. For those who are prepared to undertake the rigors of CBA, a number of methodological challenges must be resolved. This section discusses key issues involved in conducting a CBA, including the treatment of time and discounting, risk and uncertainty, financial versus economic analysis, distributional concerns, and the sustainability of resource exploitation.

4.5.1 Time and Discounting

CBA entails identifying all the costs and benefits of a proposed activity, as well as when they are expected to occur. With many forest land use options, some benefits and costs may occur over relatively long time periods, reflecting the pace of natural processes. Setting an appropriate time horizon for land use appraisal is therefore a significant issue.

In the case of agricultural uses, for example, this may be a relatively short period of a few years, corresponding to one complete crop rotation (including fallow where relevant). In the case of forestry, normal practice is to consider the entire cycle of tree growth and maturation. For certain environmental or aesthetic benefits, however, even a 50 year timber rotation may not be enough time to reflect all of the consequences of a change in land use. Changes in soil fertility, hydrology or climate, for example, may not be revealed for decades. The aesthetic value of certain old-growth forest ecosystems may reflect centuries of growth, decay and natural adaptation.

On the other hand, any attempt to account for costs and benefits beyond a few years hence can seem naive in the face of rapidly changing tastes and technology. Thus there is no hard and fast rule for fixing a time horizon for forest land use appraisal. The appropriate time horizon may be determined by the nature of the problem being evaluated. What is important is to ensure that all relevant costs and benefits are included in the analysis, whenever (and wherever) they occur, and that alternative land uses are compared over the same time frame.

The question then is how to compare costs and benefits which occur at different points in time. The conventional answer is *discounting*, which involves weighting costs and benefits differently, depending on the period in which they occur. There are two fundamental justifications for discounting: firstly the fact that most people prefer to receive benefits as soon as possible and to postpone costs (*pure time preference*); and secondly, the fact that alternative investment opportunities - including forest land uses - must compete for scarce savings (*opportunity cost of capital*). The cost of capital is normally measured by the market *rate of interest* or the cost of funds to the decision-making agency. Pure time preference is not so easily measured, but it is implicit in people’s behaviour. The economic rationale for discounting and its implications for environmental management in developing countries are extensively discussed in the literature.[37]

Conventional discounting procedures are alleged to discriminate against environmental quality and resource conservation as a consequence of:

- reducing the negative impacts to society of long lived effects, such as global warming or species extinction;
- discriminating against investments with long gestation periods, such as reforestation or afforestation with slower growing indigenous species; and
- accelerating the depletion of natural resources generally - the higher the discount rate the more likely is extinction of biological resources and the greater the rate of extraction of non-renewable resources.[38]

The relation between the market rate of interest and the use of forest land is not always clear. Certain environmentally benign projects, such as sustainable harvesting of high value timber species, may satisfy the requirement of a high rate of return and use of a market rate of interest may not discriminate against them. Moreover, because high rates of interest discourage private investment and economic activity generally, they may retard the pace of development of forestry and agriculture and can therefore indirectly slow the pace of deforestation. On the other hand, a high interest rate may encourage more rapid extraction of timber and other resources, by making it financially unattractive to hold natural resource assets for long periods of time.

A related problem arises from the widespread assumption that individual firms and households have a higher rate of time preference, and thus employ higher discount rates, than society as a whole. The argument is that society can more effectively minimise risk by diversifying its investments; and of course society "lives" forever while private firms and households do not. High rates of private time preference may be associated with extreme poverty, when immediate subsistence is uncertain. Tenure problems and inappropriate concession terms can also engender high rates of private time preference, wherever insecure or short-term use rights or shared access to scarce resources discourage private investment and prudent management. The divergence between public and private rates of time preference leads the private sector to discount future costs and benefits excessively and thus to consume assets that society as a whole would choose to conserve (Markandya and Pearce 1991). According to this argument, a socially optimal rate of logging and forest clearance will fall below the level chosen by private concession-holders and farmers.

Thus the discount rate remains a matter of concern. Some environmentally desirable land use options may not satisfy a high discount rate criterion. As a result, the allocation of forest land according to such a criterion may not be optimal. There are essentially two ways around this problem. One is to adopt a lower, *social* rate of discount where environmental concerns are paramount. This, however, raises the problem of how to choose which projects or land use options will benefit from the lower rate, given that all forest land use options have environmental effects. Another alternative is to impose a *sustainability criterion* on projects with environmental impacts. This would require that the total environmental benefits provided by forest lands do not diminish over the long run. Such a condition would imply the need for *compensatory projects* to ensure that total environmental benefits were maintained, although such projects may not have to show a specific rate of return (Pearce *et al*. 1990).[39]

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[37] See, for example, Markandya and Pearce (1991) and Pearce *et al*. (1990).

[38] High discount rates imply a greater opportunity cost to leaving resources "in the forest". If the market rate of interest is greater than the rate of growth of a biological resource (plus the expected rate of increase in prices), it may make financial sense for the owner to liquidate the resource and put the proceeds in the bank. In the case of non-renewable resources, e.g. mineral deposits, the relevant criteria is simply expected growth in prices. If natural resources are taxed differently than financial assets, this also needs to be taken into account.

[39] A basic assumption of this approach is that the compensatory project effectively replaces the benefits destroyed by the original activity. An application of this idea currently in vogue is to compensate for industrial contributions to global warming by initiating "carbon storage" projects - principally forest plantations in developing countries.

For the analyst attempting to provide useful information to decision-makers, a practical approach is to investigate the impact of alternative discount rates, by means of sensitivity analysis. For example, in the study by **Kumari (1995a)** of a Malaysian peat swamp forest, two discount rates are used: 8 per cent (taken as a "conventional" or market rate) and a lower rate of 2 per cent. Even with a discount rate of 8%, the analysis favours a shift from timber extraction using traxcavators and canals to a less environmentally-damaging method, using traxcavators and winches. With a 2% rate an even less damaging system, using winch and tramlines, is the preferred option. Sensitivity analysis is also useful where certain benefits or costs are highly uncertain, as discussed below.

4.5.2 Risk and Uncertainty

All forestry projects and policies entail some element of risk and uncertainty. For instance, in a production-oriented development project, future prices and expected yields will be subject to uncertainty. For watershed conservation projects, the rates of soil erosion and/or their off-site effects both with and without the project may be unknown. Natural events such as drought, windstorm and plant/animal diseases may also seriously affect project outcomes.

The most common way of dealing with risk and uncertainty is to use *expected values* for those variables whose precise values cannot be known in advance. In this way uncertainty (where the probabilities of different outcomes are not known) is transformed into risk (where probabilities can be assigned to the likelihood of occurrence of various outcomes). Each potential outcome is weighted by the probability of its occurrence and the weighted outcomes are then summed to arrive at a mean, or expected value.

Sensitivity analysis is another means of dealing with risk and uncertainty. This entails examining the effect of different assumptions about key input variables on key outputs. Using optimistic and pessimistic values for different variables can indicate which ones have the most pronounced effect on benefits and costs. While sensitivity analysis need not reflect the probability of occurrence of the upper or lower values, it is useful for determining which variables are most important to the success or failure of a project. On the other hand, some argue that sensitivity analysis is not a substitute for proper risk assessment, especially where environmental impacts are concerned.

Another alternative, when risk cannot be quantified, is to make a subjective assessment of the confidence which can be placed on certain values in a CBA. This may be appropriate where there are many non-market benefits, all of them estimated using the valuation techniques described above. **Kumari (1995a)** assigns one of three confidence levels (low, medium and high) to each of the forest benefits estimated in that case. Rather than the precise numeric confidence intervals of statistical analysis, this approach requires the analyst to assess his/her confidence in the results, based on the source of data, valuation methods used and the plausibility of any assumptions made. **Ruitenbeek (1992)** proposes a similar approach, in this case using confidence categories to define data needs, based on the practice of engineering cost analysis. Interpretation of an economic analysis involving estimates of non-marketed benefits or costs is much easier when the analyst provides some assessment of how confident he/she is that the stated results fall within a given range. Unfortunately, few other studies reviewed here included this type of information.

4.5.3 Financial versus Economic Analysis

Financial analysis is usually the first step in assessing the economic costs and benefits of projects or land use options. The aim is to measure private profits accruing to households or firms, based on market (financial) costs and benefits. Financial analysis can be invaluable in illustrating the motivations of the private sector. Only by looking at costs and benefits as perceived by different social and economic groups can we begin to understand how they will respond to government policies and programmes.

Economic analysis, on the other hand, measures the effect of a project or land use on the welfare of society as a whole. This usually requires various adjustments to financial prices, in order to correct for market imperfections, policy distortions and (in some cases) distributional inequities. In the context of a single project, these adjustments involve the estimation of *shadow prices*.[40]

As discussed in Chapter 2, market prices will not reflect true economic values when there are significant market failures or policy interventions.[41] *Market failures* include the absence of secure tenure (e.g. forests subject to "open access" exploitation), the presence of public goods (i.e. non-rivalrous and non-exclusive forest environmental services such as carbon storage), externalities (e.g. downstream siltation and flooding due to logging), incomplete information (e.g. ignorance of the potential future benefits of biodiversity) and imperfect competition (e.g. monopolies). *Policy failure* occurs when government interventions necessary to correct market failures are absent or inadequate (e.g. ineffective regulation of access to public forests). They also occur when government decisions or policies are themselves responsible for distorting market prices, such as exchange rate controls, price ceilings or supports, subsidies or taxes that create incentives for unsustainable forest use.

Empirical methods to account for market and policy distortions in CBA are available. The literature on CBA has concentrated on policy distortions.[42] Recent efforts by environmental economists have concentrated on market failures, leading to the development of non-market valuation techniques as well as new policy instruments to correct for environmental market failures.[43]

Economic analysis extends financial analysis by substituting economic values, or shadow prices, in place of financial prices. In addition, non-market costs and benefits are estimated and included where possible. Caution should be exercised in the use of shadow prices, due to the sometimes arbitrary and imperfect manner in which they are calculated. A recent review of experience at the World Bank, for example, found that shadow prices for conventional (as opposed to environmentally-related) policy failures were rarely used in project appraisals (Little and Mirrlees 1990). In many cases the market price is taken as a rough proxy of the real economic value of a good or service, on the grounds that the effects of policy on prices are trivial, or simply due to lack of data or expertise to estimate accurate shadow prices! In practice, analysts often limit themselves to adjusting for the most visible policy distortions, such as those created by government intervention in foreign exchange markets, taxes and direct financial subsidies.

Few of the case studies reviewed for this report attempt to make adjustments to financial prices, perhaps because the focus is on estimating the value of non-market forest benefits. Yet the use of economic prices can easily change the conclusions of a CBA. **Godoy and Feaw (1989)** provide a relevant illustration of the use of shadow prices in a CBA involving non-timber forest products. Their analysis of the profitability of smallholder rattan (*irit*) cultivation in Central Kalimantan, Indonesia, estimates the farmgate shadow price of rattan by accounting for an over-valued exchange rate as well as marketing and transport costs (including related fees and taxes). The results indicate that the economic return to rattan production is about 12 per cent lower than the financial return. Similarly, studies by **Browder (1985, 1988)** show how deforestation in Brazil was stimulated by subsidies to cattle ranching.

4.5.4 Distributional Concerns

The main objective of economic appraisal is to evaluate the costs and benefits of alternative activities in terms of aggregate economic efficiency, i.e. irrespective of the distribution of costs and benefits among different groups of people. Most policy-makers, of course, are concerned about distributional impacts, and we may expect alternative forest land use options to impose costs and confer benefits to varying degrees on different social and economic groups.

For example, the designation of forests as protected areas can be seen as a means by which certain interest groups (typically not the poor) secure recreational, amenity or non-use values. This may result in significant loss to another

[40] For a larger scale activity, such as land use appraisal at a national level, a more complicated procedure involving the estimation of marginal social cost and benefit curves is required (i.e. when potential changes in output are large relative to market demand, prices can no longer be assumed to remain constant).
[41] See Baumol and Oates (1988) for a general introduction to the theory of market and policy failures.
[42] Gittinger (1984) provides a good introduction.
[43] Attention has focused on methods to estimate non-market public goods and externalities.

group, e.g. subsistence farmers who rely on forest land for extraction of non-timber forest products, or for shifting agriculture. Where the values of domestic and foreign consumers differ widely the resulting conflict may be international in scale, as shown by recent heated debates about tropical forestry and timber trade policy in global fora.

Similarly, efficiency and equity objectives in forest land use often conflict. Cost benefit analysis may lend weight to certain values and associated land use options which are unavailable to poorer groups, due to their limited access to capital and information. These groups must therefore confine themselves to "inferior" uses. For example, a study of a new national park in Madagascar estimated the value of additional benefits to international tourists at two to three times the loss, in terms of lost agricultural land, incurred by local villagers, despite measures allowing them access to buffer zones (**Kramer *et al*. 1995**). While such a change in land use may be economically efficient, since the potential for compensation exists, it will aggravate poverty where compensation is absent or inadequate.

Distributional concerns may be incorporated in an economic appraisal of forest land use options in at least three ways:

- the *distributional consequences* of land use options can be made explicit by assigning costs and benefits to specific groups;

- *distributional weights* can be used in the economic analysis to adjust the benefits and costs according to which groups enjoys or bears them; and

- the *entitlements* (use and access rights) of particular groups with respect to certain forest resources or benefits may be protected by defining minimum standards or guarantees.

To some extent the first approach is a prerequisite of the second and third. Unless the costs and benefits of a project or land use option can be linked to specific groups there is no way to know where distributional weights should be attached or what rights need to be protected. Therefore, the first step in any distributional analysis is to identify the different *stake-holders* in alternative forest land use options. Depending on the region and the particular land uses in question, this may include:

- indigenous hunter/gatherer populations
- subsistence farmers
- commercial farmers
- small-scale traders
- industrial firms (owners and employees)
- local, state and national government agencies
- domestic and foreign consumers

The next step is to determine which groups are affected by the various impacts of alternative land use options. Some costs and benefits may be spread widely among a number of groups, while in other cases the impact on certain stakeholders will be more concentrated. For example, the benefits of timber harvesting will be spread among the owners of logging companies and their employees, as well as firms involved in providing equipment, wood processing, transport, distribution and sales. It may not be possible to single out every industry (let alone every firm) which benefits from a particular forest land use option. However, it is usually possible to distinguish impacts on broad sectors of the economy and on different categories of labour (e.g. skilled versus unskilled).

Finally, the link between costs and benefits and different groups needs to be quantified, if possible, to show the magnitude of the distributional impact. Ideally this will be in monetary terms, although if certain costs and benefits have not been measured or monetized it may be necessary to describe their impact on different stakeholders in physical or qualitative terms. Costs and benefits may be expressed in financial terms, using market prices, or in economic terms, with adjustments made to account for market imperfections and/or policy distortions.

It may be more difficult to trace the distribution of *non-marketed* costs and benefits, although the techniques used to value these items can often be extended to distinguish different groups. For example, in the case of watershed protection benefits provided by an upland forest, it may be possible to identify those who stand to lose if these services are disrupted, e.g. land-owners and residents of the downstream flood plain, the regional water or irrigation management authority controlling a downstream reservoir subject to sedimentation, etc.

Only a few studies of land use options attempt to quantify the distribution of costs and benefits among different groups. But even where particular groups are not singled out, the distribution of costs and benefits is often implicit. The case study of the creation of a national park in Madagascar, by **Kramer *et al.* (1992, 1995)**, examines the benefits and costs to various groups, including those residing within or around the protected area, other agricultural communities in the same watershed, domestic and foreign tourists, and foreign populations. In this case communities around the park bear much of the cost of its establishment, in terms of loss of access to forest products and land, while all other groups gain. Likewise **Kumari (1995a)** concludes her case study of alternative management systems for peat swamp forests in Malaysia by noting that the largest benefit to be gained from more sustainable exploitation will accrue to the global community, in the form of carbon storage and reduced global warming. These examples highlight the range of groups who are increasingly claiming a stake in the future of tropical forests. Trading off the gains and losses of various groups with wide-ranging levels of income and wealth can raise difficult ethical questions.

Concems about the equity of distributional impacts can be integrated into CBA formally, by using distribution weights. The underlying justification for doing so is that prevailing market prices reflect the *existing* distribution of income and wealth and are therefore "distorted" with respect to social equity objectives. The usual practice is to define a multiplier which is applied to some or all costs and benefits accruing to the target group(s).[44] This results in a number of *socially-adjusted prices*. Despite strong theoretical arguments, distribution weights, like full shadow pricing, are rarely used in economic analysis. To some observers the approach seems too subjective. No examples of the use of distribution weights were found in our review of case studies of forest land use options.

Another way to ensure that land use decisions do not adversely affect certain groups is to define certain rights or minimum standards as absolute targets or limits. This approach is similar to cost-effectiveness analysis (CEA) in that the analysis proceeds from certain "givens", for instance the requirement that indigenous populations retain their traditional rights of access to particular forest areas. Such entitlements thus define the feasible set of land use options. Like distribution weights, such rights or limits cannot be determined objectively but are the product of a political or ethical judgement.[45] Thus, the basis for assigning them should be made clear. However, this approach is more prescriptive than analytical and is essentially non-economic, to the extent that trade-offs are not made explicit.

4.5.5 Sustainability and the Depletion of Resources

Many forest areas in developing countries are currently exploited under an *open access* regime, or are public property and sold at prices below their true opportunity cost (e.g. wildlife, fuelwood, timber). As a result, the prevailing rates of extraction may be inefficient, in economic terms, or unsustainable in ecological terms. In such cases, simply multiplying the current periodic harvest by the price (even when an efficient price is used) will grossly overstate the net benefit of the resource or land use. Hence the need, noted above, to adopt a time horizon sufficiently long to allow for the potential degradation or depletion of the resource over the long run.

When comparing alternative land use options, however, it may be more appropriate to define an optimal or sustainable rate of exploitation. A conventional method for renewable resources is to define the harvest in purely

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[44] For a detailed explanation of how to derive distributional weights and calculate socially-oriented shadow prices see, for example, Ray (1984) and Squire and van der Tak (1975).

[45] Normally rights or entitlements are defined with respect to human beings, although some conservationists insist that plant and animal species also have a "right" to exist. Laws on wildlife protection have been used in this way, for example in the United States. If this principle were generally applied in the developing world it would of course imply an immediate halt to further encroachment on natural forest lands, where conversion poses the greatest threat of species extinction.

biological terms and to estimate the *maximum sustainable yield* (MSY), as demonstrated by **Peters *et al*. (1989)**. When comparing alternative land use options, it may be possible to compare two or more *sustainable* management regimes, e.g. maximum sustainable wildlife harvest or maximum sustainable yield agriculture. The physical output in each case is given by the zoologist or the agronomist, based on models that relate animal population growth or crop productivity to fundamental ecological constraints. The value of the sustainable harvest is then calculated directly, by multiplying the estimated harvest by the appropriate efficiency price.[46]

Alternatively, the analyst may attempt to estimate the efficient or “optimal” rate of exploitation in *economic* terms, i.e. the rate of harvest which maximises profit rather than physical output (see Tietenberg 1988 for a detailed discussion).[47] The procedure used to estimate net benefit, however, would remain the same, i.e. gross revenue less total cost, where the latter is the sum of direct costs and any indirect or environmental costs.

In many cases, however, the sustainable or economically efficient harvest rate is not known and cannot be estimated directly. The analyst may then simply rely on *sensitivity analysis* to illustrate differences in net benefits under different assumptions about physical output or impact (see for example **Ruitenbeek 1992**). The compensatory project approach may also be helpful in this situation, as a way of accounting for the loss of benefits due to excessive levels of resource exploitation (see the earlier section on time and discounting).

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[46] Note that even when market prices for forest benefits exist and are not distorted by public policy, they may understate the full economic value of the resource if the bulk of market supply comes from land over which there are no clear property rights or other restrictions on harvest levels. The reason is that in such cases, market prices will fail to reflect *user costs* (e.g. the stumpage value of standing timber). Any off-site impacts would also need to be considered. See section 4.5.3 for more details.

[47] The optimal economic rate of harvest for a renewable resource is normally less than MSY but is heavily dependent on the choice of the discount rate (see Pearce *et al*. 1990).

5 Conclusion: The Uses of Forest Valuation

Chapters 2 to 4 have described the range of benefits provided by forests, the methods available to estimate market and non-market forest values, and alternative decision frameworks for assessing the trade-offs among competing forest values and land uses. Part II of the report (including chapter 6) provides a review of empirical research in this area, along with detailed summaries of selected case studies. The question remains, however, what is it all for? Why undertake the effort and expense of evaluating alternative forest land use options? Who can use the results, and how?

This chapter focuses on potential applications of forest valuation results. In contrast to the considerable advances made in valuing non-timber forest benefits, there appears to be relatively little progress in applying the results of valuation studies to forest policy and management. This is probably due to political and institutional barriers rather than a reflection of the quality or relevance of valuation studies. Despite the discouraging record to date, a number of potential applications can be identified.

The integration of forest values in policy is a crucial step. Forest land users and managers are often reluctant to modify their management practices, even where they acknowledge the importance of environmental benefits, due to the constant pressure to increase revenue and reduce costs. Careful design of forestry regulations, concessions and tax policy can encourage forest managers and land users to account for non-market benefits in their own interests (Richards 1999). This in turn can reduce the need for and costs of supervision by regulatory agencies, while achieving a more efficient mix of market and non-market benefits.

Information on the economic value of non-timber forest benefits can be applied at different geographic scales: in determining the appropriate extent and type of forest cover (i.e. for land use planning); and in deciding how individual forest stands should be managed. In both cases the scope for improving policies runs the gamut from zoning and property rights to regulation and pricing schemes.

5.1 How much forest is needed, of what type and where?

Virtually all forests have some positive non-market value. This implies that the value of keeping land under forest is almost always greater than the amount which can be realised by private firms producing for the market. This, in turn, means that private land owners will systematically under-provide forested land.

Similarly, valuation studies suggest that the general public prefers forested landscapes composed of mixed species and varying ages. For recreational purposes (e.g. trekking, camping) the public generally prefers mature forests with little undergrowth, high canopies and relatively few stems, to younger, denser stands. Both of these preferences run counter to the usual aims of industrial forestry, which in turn implies that private firms will tend to under-supply older and more diverse forest landscapes.

The traditional solution to this problem is for the state to provide recreational and amenity forests on publicly owned land, in which industrial uses are strictly limited or forbidden. An alternative to public provision is to introduce land use zoning or other restrictions on the use of private land, to ensure greater forest cover and/or more diverse forests in areas of relatively high demand.

One interesting implication of travel cost and other valuation studies is that many forests may be misplaced. In effect, there should be more (and more diverse) forests near population centers. On the other hand, existing land use restrictions in some areas may already provide an appropriate level of forest cover with respect to recreational, landscape and other non-market values. This applies particularly to blanket restrictions on farming or logging of slopes above a certain steepness, irrespective of opportunity costs or actual downstream water uses and flood risk.

5.2 Non-timber values and private property rights

Economists often argue that a fundamental cause of the under-supply of non-market benefits (and the over-supply of non-market costs or "externalities") is the lack of exclusive property rights. The notion is that private property, where it is enforceable, creates an opportunity for profitable exchange and thus an incentive for more careful management. As a rule, therefore, economists tend to favour the creation of property rights over regulation or price policy. One advantage of such an approach is that government need not concern itself with the difficult task of setting prices but can devote its efforts to enforcing property rights and contracts.

Promising areas for property rights-based solutions to the under-supply of non-timber forestry benefits include concessions for non-timber forest products and for recreational uses.[48] These may overlap with timber concessions, requiring logging companies (or land owners) to make proper compensation for loss of non-timber benefits. Constraints on the viability of private concessions include the difficulty of excluding poachers and/or free-loaders, and competition from publicly-owned lands, where access to comparable benefits may be free or below cost.

5.3 Non-timber values and forestry regulations

Where private property rights are not feasible[49], it may be possible to account directly for the value of non-timber benefits in forestry regulations. In fact, many public agencies already account for environmental values either explicitly or implicitly. Timber cutting limits and rotation length, careful road layout, mandatory low-impact logging methods, stream-side buffer strips and wildlife corridors, etc. are all increasingly standard practice and can help to mitigate damage or loss of non-timber benefits due to logging.

The weakness of such regulatory approaches is their insensitivity to differences in the costs and benefits of compliance at different forest sites. Many forestry regulations are applied uniformly to all areas in the same way, regardless of the type of forest involved or its location. And yet evidence from valuation studies suggests that demand for many non-timber benefits varies widely from place to place, mainly as a function of the proximity and density of human populations but also as a function of forest characteristics (e.g. age and species composition, topography and accessibility, presence or absence of streams and water falls). This in turn implies a need for greater flexibility and sensitivity of forestry regulations to the effective demand for non-timber benefits at particular sites. Valuation studies can help by demonstrating the relation between key characteristics and WTP for non-timber benefits.

5.4 Non-timber benefits and forest pricing policy

Land owners are clearly sensitive to taxes in their choice of land use. Similarly, timber concession holders and logging firms are sensitive to royalties, taxes and other fees. The results of valuation studies may be incorporated in such policies and can be expected to induce changes in land use and logging practices.[50]

For example, the sale price of timber concessions on public forest land can be adjusted to account for the relative importance of non-timber benefits in different areas and the impact of timber harvesting on them (positive or negative). This can apply whether the price of timber concessions is fixed administratively or by auction. At the margin, higher (or lower) prices will lead firms to lose (increase) interest in harvesting timber from certain areas altogether (i.e. forests which are less accessible or less densely stocked with mature commercial timber species). Similarly, on private land, rates of tax may be adjusted up or down according to the level of provision and the importance of non-

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[48] The results of valuation studies may provide a bench mark or reserve price for auctioning concessions.

[49] For example, an exclusive right to the carbon storage benefits of a particular forest is a ridiculous notion: firstly, because one person's enjoyment of the climate benefits secured thereby does not detract from another's, and, secondly, because it is impossible for the "owner" of the right to prevent others from enjoying the benefit.

[50] Industry often argues that such measures erode their competitive position. However, there is some evidence which suggests the reverse, namely that the adoption of environmentally sensitive production methods, if combined with appropriate marketing efforts, can confer a "green" market advantage and improve profitability.

timber forest benefits in that area. Of course, both measures require detailed knowledge of local conditions and thus may be best administered by local government.

Finally, the results of recreational demand studies (using travel cost and/or contingent valuation) can be and often are used to set entry and license fees for forest recreational areas, including day trippers, campers and hunters.

Part II

Forest Valuation in the Developing World

6 Applications of Forest Valuation in Developing Countries

The empirical literature on valuing non-timber forest benefits and land use options is large and growing fast. Good examples can now be found for virtually all types of forest benefits and most valuation methods, even if one restricts attention to studies conducted in the developing world. It is hardly feasible, nor particularly helpful, to attempt an exhaustive inventory of published studies. Any review must therefore be selective, and this is no exception.

The aim of this chapter is to review some of the more complete and/or influential case studies of non-timber forest benefits and forest land use options published during the past ten years. Several examples were provided in the Part I, as part of the review of valuation methods and discussion of practical issues in conducting CBA. Additional illustrations are presented below, organised here in terms of the main categories of forest value as defined in Chapter 2 - i.e. *direct* and *indirect use* value, *option* value, and *non-use* value. Examples of *total economic valuation* are considered separately. Suggestions for future research are offered where appropriate. This is followed by more detailed summaries and commentary on over 50 case studies, which were selected from among a larger number of studies reviewed.

6.1 Direct Forest Land Uses

The type of forest benefits most commonly estimated are direct use values, including timber and non-timber forest *products* (NTFPs or "extractive" benefits), as well as certain forest *services* (notably recreation and "passive" uses such as landscape or amenity values). Some case studies also compare forest benefits with the value of alternative uses of forest land, e.g. agriculture. In general, the value of marketed products and services of forest land is easier to estimate than the value of non-marketed or subsistence uses. This is one reason why many private land owners and public policy makers often fail to consider non-market forest values in their land use and development decisions.[51]

6.1.1 Timber and Non-Timber Forest Products

Valuation of timber and most NTFPs is relatively straightforward. It can usually be undertaken using market prices or the prices of substitute goods, as opposed to more sophisticated non-market valuation techniques. However, while the valuation of timber and NTFPs presents few analytical difficulties, for many of the latter there is little publicly-available information on the quantities harvested, consumed and sold or the costs incurred, including tools as well as non-priced inputs such as household labor. This is due in part to the perceived "minor" significance of NTFPs and their concentration in informal or subsistence economies (FAO 1990).

The economic importance of NTFPs in subsistence agriculture is probably underestimated. These products are widely used in most rural communities throughout the developing world, and in some cases even in urban areas. Edible forest plants and animals are often important as dietary supplements, as seasonal supplements - most often when cultivated food supplies are in short supply at the end of the crop season - and as emergency supplies during wars and famines. Unfortunately, lack of systematic monitoring and information systems means that it is often necessary to collect this data from scratch, using surveys.

[51] There are also powerful institutional reasons for this failure, including widespread lack of secure or exclusive property rights over many non-timber forest benefits, which means that land users cannot control access to or demand payment for their provision (see Chapter 2).

Case studies reviewed here which provide estimates of the value of both timber and non-timber forest products include: **Emerton (1996); Howard (1995); Kumari (1995a); Peters *et al.* (1989); Pinedo-Vasquez *et al.* (1992); Ruitenbeek (1989a, 1989b, 1992); and Saastamoinen (1992)**. Several other case studies estimate the value of NTFPs (and in some cases other forest benefits) but do not consider timber values. These include: **Appasamy (1993); Chopra (1993); Davies *et al.* (1999); Godoy and Feaw (1989); Gunatilake *et al.* (1993); Kramer *et al.* (1992, 1995); Lynam *et al.* (1994); and Schwartzman (1989)**.[52] Finally, a few case studies consider timber values alone: **Jonish (1992); Sedjo (1988); Sedjo and Bowes (1991); Veríssimo *et al.* (1992); and Uhl *et al.* (1992)**. Case studies which estimate timber values alongside other land use options (e.g. agriculture) are discussed below.

Most of the studies reviewed use market prices to estimated the value of forest products. Some studies simply estimate the gross value of extracted products, while others attempt to calculate net returns by deducting the costs of harvesting, processing, transport and marketing margins. Some include the opportunity cost of capital (especially important in industrial timber production), while others do not. The resulting estimates cover a range of different products and are expressed in various ways: as average annual returns per hectare, per household or per firm; in gross terms or net of production costs; using "forest-gate" prices for unprocessed product or using prices of semi-processed products in nearby markets; in annual or net present value terms; etc.

Unfortunately, the use of inconsistent methods and data from different periods to estimate timber and NTFP values makes it difficult to compare the results of different studies. In addition, real returns would be expected to vary dramatically depending on the location of the case study. Thus, for example, the net returns to timber estimated in the studies reviewed here range from just US$12 per hectare in Brazil (NPV of "extensive" timber extraction, using a discount rate of 12%, reported by **Almeida and Uhl 1995**), up to $3,184 per hectare, also in Brazil (NPV of *Gmelina arborea* plantation, using a discount rate of 5%, reported by **Peters *et al.* 1989**). Reported returns to NTFP extraction also vary widely, from as little as $1.22 per hectare per year (net returns to extraction of rubber and Brazil nuts, reported by **Schwartzman 1989**) up to about $350 per ha/yr. (net returns to fruit and latex extraction in Peru, reported by **Peters *et al.* 1989**). Widespread adoption by researchers of common accounting methods and assumptions would make it easier to compare the estimates of different studies (Godoy *et al*. 1993). Moreover, methodological consistency would also help focus attention on the underlying factors that determine the relative returns to alternative forest land uses, such as access to markets, population density, land capability for agriculture, etc.

NTFP values seem to have lost prominence as a focus of valuation research in recent years, perhaps due to disillusion with the apparently modest returns to management of forests for their extraction (Southgate 1998). And yet we know that extractivism can be competitive in certain circumstances, e.g. harvest of wild mushrooms in southern Europe and the US Pacific NW, maple syrup extraction in New England and eastern Canada, etc. Questions for future research in this area include:

- which NTFPs retain or increase in value with urbanization and rising incomes, and why?
- Can we predict which types of NTFP will maintain or increase in value with development, and which ones will decline?
- How should forest planners monitor and respond to shifting NTFP values?

6.1.2 Alternative Land Uses

A few of the case studies reviewed estimate the returns to several different uses of forest land, as part of a comparison of alternative land use options. In most cases, the studies compare forest conservation or "sustainable" management with conventional (unsustainable) timber extraction and/or conversion to agriculture. Many studies find that environmentally-friendly land use options are superior, in economic terms, but only when indirect use and non-use forest values are included in the CBA.

[52] Other examples of NTFP valuation can be found in: Anderson and Ioris (1992); Balick and Mendelsohn (1992); Bann (1997a, 1997b); De Beer and McDermott (1996); Dixon and Sherman (1990); Emerton (1996); Gammage (1997); Kramer *et al*. (1994); Kumari *et al*. (1998); Padoch (1987); and Woon and Poh (1998), among many others.

Case studies reviewed here which estimate returns to alternative forest and non-forest land uses include: **Almeida and Uhl (1995); Aylward *et al.* (1999); Bennett and Reynolds (1993); Browder (1988); Dixon and Sherman (1990); Gunatilake *et al.* (1993); Hodgson and Dixon (1988); Howard (1995); Kramer *et al.* (1992, 1995); Kumari (1995a); Paris and Ruzicka (1991); Peters *et al.* (1989); Pinedo-Vasquez *et al.* (1992); Ruitenbeek (1992); Smith *et al.* (1997);** and **Southgate (1992).** As in the case of forest products, estimated returns to non-forest land uses are calculated and expressed in different ways and the results vary widely. Thus for example we observe estimates of financial returns to traditional "slash-and-burn" farming ranging from as little as $75 per ha/yr. in the Philippines (**Paris and Ruzicka 1991)** up to about $450 per ha/yr. (**Pinedo-Vasquez *et al.* 1992)**. Likewise estimates of the NPV of cattle ranching vary from as low as *negative* $279/ha in Brazil (**Almeida and Uhl 1995**) up to *positive* $8,700 in Costa Rica (including social and environmental benefits, net of foregone direct use values of forestry, reported by **Aylward *et al.* 1999**).

6.1.3 Forest Recreation

The direct use value of forests for recreation in developing countries has received more attention lately, with a growing number of researchers applying travel cost and contingent valuation methods. Travel cost and CV studies have proved useful for setting and revising fees charged to recreational visitors to forest or park land, for determining the government's "reserve price" when negotiating concessions to private operators seeking to offer recreational services on public land, or simply to justify public designation of, and expenditure on, protected areas.

Significant examples reviewed here include: **Dixon and Sherman (1990); Hadker *et al.* (1997); Kramer *et al.* (1992, 1995); Prasanthi Gunawardena *et al.* (1999); and Tobias and Mendelsohn (1991)**.[53] Estimated values are usually expressed as a marginal WTP in US$ per visit, or as a total value for a particular forest area. In a few cases estimates are expressed as a NPV per hectare. Average reported values for those studies which undertook original surveys are on the order of US$30-40 per visit.

To some extent, the recent interest of researchers in recreational values probably reflects increased familiarity with travel cost models and contingent valuation methods. It may also reflect the growth of international tourism to forest areas in developing countries, along with increased domestic demand for recreational experiences in natural areas in some countries, notably those characterized by significant urbanization and rapid income growth.[54] Note also that a substantial portion of this value is potentially recoverable, e.g. through park entrance or concession fees, leading both public and private land owners to commission valuation studies of recreational benefits as part of their price-setting and budget procedures.

Nevertheless, forest recreational values remain controversial. This is not so much out of concern for the methods used to estimate them (although many still distrust CVM), but rather because of the conflict between recreational and other more "local" forest uses (e.g. grazing, extractivism, agriculture, logging). In the developing world, the problem is exacerbated by the unequal political and economic power of recreational (primarily urban, upper income) and local (rural) forest users.

6.1.4 Amenity/Landscape Values

The amenity value of forested landscapes may be considered a direct use value to the extent that consumers take advantage of it, even if it is by enjoying the view only.[55] Various techniques can be used to estimate this benefit, including TCM, CVM and hedonic pricing models. Studies of forest recreation in developing countries using TCM or CVM probably include landscape value, although it may not always be possible to distinguish this benefit from the rest of the recreational experience.

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[53] Other developing countries examples include: Echeverría *et al*. (1995); Mercer *et al*. (1993); Willis *et al*. (1998).

[54] Note that WTP for forest recreation rises with ability to pay (income), but not necessarily at the same rate (Kristrom and Riera 1996). There is a consistent bias in all monetary valuation methods towards those forest uses which are of relatively greater interest to richer groups in society (see section 4.5.4).

[55] Where landscape values are unrelated to any direct contact with or experience of the forest area in question, they may be characterised as non-use values (see section 6.4 below).

One way to isolate landscape value is to apply hedonic pricing models, using data from residential property markets. An illustration of the latter approach used to value forests in the UK is provided by Garrod and Willis (1992). No examples of this approach were found in developing countries, perhaps due to relatively poorly developed and/or badly documented housing markets. Such studies may become more feasible in future years, particularly in peri-urban areas of middle-income countries, where more and better data on private property transactions should permit robust econometric analyses of the effects of proximity to different types of forest on residential house prices. Such research might help to justify preservation of "green space" in and around rapidly-growing southern cities, and would also shed light on the distributional impacts of land use planning restrictions (since the rich are more often able to afford the higher cost of property located near greenery).

6.2 Indirect Forest Uses

Case studies of the indirect use benefits of forests are less common in the literature than studies of direct uses such as NTFPs. Important forest environmental functions such as protection of watersheds and coastal marine resources, biodiversity conservation and carbon storage are usually non-marketed, financially un-rewarded and only indirectly connected to economic activities.[56] They are also difficult to measure, as the indirect use value of a environmental function may only become apparent when there is a change in the market value of one or more activities or properties that can be attributed to a change in the nature, intensity, duration or extent of the function itself. For this reason, the production function approach is often used to value indirect uses, although other methods can also be used (Aylward and Barbier 1992).

Two indirect use benefit which have received the most attention in forest valuation studies are watershed/fisheries protection and, more recently, carbon storage. We found just one published case study which estimates the benefits of micro-climate regulation (Lopez 1997). None of the studies reviewed attempted to estimate the benefits of forests in terms of soil nutrient cycling or air pollution reduction. This may be because, in the latter cases, the underlying ecological relationships are still not well understood and thus not amenable to economic analysis.

6.2.1 Watershed/Fisheries Protection

The benefits that forests provide by protecting watersheds and fisheries, including the regulation of both the quality and quantity of water runoff, are considered especially significant in hilly tropical areas subject to intense and heavy rainfall. Likewise, tropical mangrove forests are considered to play a key role in maintaining the productivity of near- and off-shore fisheries (among other benefits). Unfortunately, in most developing regions little data is available on the relationships between forest disturbance and downstream or off-site economic activities.

The evidence with respect to watershed and fisheries protection values is mixed. Some studies suggest that the off-site hydrological impacts of logging or forest conversion are mainly negative (e.g. **Bennett and Reynolds 1993; Hodgson and Dixon 1988; Kumari 1995a; Paris and Ruzicka 1991; Ruitenbeek 1989a, 1992)**. These and other authors refer to:

- increased risk or magnitude of drought or flood damages;
- increased turbidity and sedimentation of rivers, reservoirs, harbors, irrigation channels, etc. resulting in higher water treatment and dredging costs, or reduced capacity and life span of economic infrastructure (e.g. pumps, turbines, etc.);
- reduced recreational value of lakes, streams, rivers and off-shore coral reefs;
- reduced diversity or productivity of inland- and near-shore fisheries,
- reduced soil nutrient cycling and/or soil formation, etc.

Such arguments should, of course, be based on careful estimation and/or measurement to determine the impact of forest disturbance on one or more downstream activities. The benefit of maintaining forest areas, or of adopting low-

[56] Estimates of biodiversity conservation benefits are discussed along with other option values in section 1.3, on the grounds that most cases studies to date have looked at *potential* rather than actual benefits.

impact logging methods, for example, would then be expressed in terms of the net value of downstream activities that would otherwise be lost, using the production function approach (see Chapter 3).

Unfortunately, many studies do not undertake detailed estimation or measurement of the off-site impacts of forest disturbance, but simply assume a damage function. For example, **Bennett and Reynolds (1993)** argue in their case study that the entire near-shore fishing industry in the Kuching Division of Sarawak, East Malaysia, is "at risk" from mangrove conversion. While this may be true, more rigorous documentation of the links between forests and fisheries is needed to support recommendations of forest conservation or other land use restrictions.

Some detailed studies present a more nuanced picture. For example, in their study of the Arenal watershed in Costa Rica, **Aylward *et al.* (1999)** conclude that the impacts of forest conversion on hydroelectric power production are broadly positive. Although increased sedimentation due to forest conversion does slightly reduce the capacity of the Arenal reservoir to hold water for electric power generation (and for irrigated agriculture), the authors find that the benefits of increased water run-off, in terms of additional electric power generating capacity, are far more significant. Similarly, **Niskanen (1998)** concludes that reforestation imposes a significant cost through reduced water availability for irrigated agriculture.

These findings are supported by other studies which show that deforestation leads to increased runoff from upland areas (due to lower evapo-transpiration). In other words, the removal of forest cover may enhance supplies of fresh water, albeit with increased sedimentation and higher risk of flooding in some cases (Bruijnzeel 1990; Hamilton 1983; Calder 1992). Clearly, much depends on local terrain and hydrological conditions, the type of land use in upland areas, the type of land and water uses in downstream areas, and the links between them.

A priority for future research in this area is to enable land use planners to move beyond existing, crude decision rules for upland forest management (e.g. bans on logging or agriculture above X☜ slope or Y meters elevation; minimum riparian buffer strips of N meters width, etc.). Where there is high demand for water, for example, it may make little sense to maintain upland areas under forests which consume large quantities of fresh water, even if water treatment costs rise slightly.[57] Conversely, where upland forests protect existing communities and infrastructure against the risk of flooding, continued forest conservation may be justified. Of course, some watershed protection services may become apparent only when they are lost, but this is probably a reason for proceeding cautiously rather than not at all.

Closely related to the need for more detailed valuations of watershed protection services themselves, research is also needed on the institutional requirements and transaction costs of watershed protection. As with other off-site forest benefits, the development of markets for watershed protection services is likely to be constrained above all by institutional factors, e.g. the costs of conferring property rights, making contracts, and enforcing liability for damages incurred (Hyde *et al*. 1996). A useful area for future research would be to assess the costs of coordinating forest use and/or enforcing property rights over non-timber benefits. Where are these costs prohibitive and why? Are these costs rising or declining, in real terms?

6.2.2 Carbon Storage

The benefits of forest cover for slowing down global warming by storing carbon in trees and other vegetation have been incorporated recently into several studies. While this is clearly an indirect use value, the nature of carbon storage makes it unique in comparison to other forest benefits. Firstly, the mitigation of climate change is a global benefit and thus benefits the entire world population.[58] Secondly, the benefits of storing a ton of carbon do not appear to depend on the type of forest or where it is located. As a result, a "global" estimate of the value of carbon storage can be used virtually anywhere.

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[57] Obviously one would want to consider other non-timber forest values before deciding to log or convert upland forests. High demand for water is not sufficient reason on its own!

[58] Certain regions of the world are likely to suffer more than others under continued global warming. However, because of the variety of interests involved and the high degree of uncertainty, slowing global warming is usually considered to be a global benefit.

Recent research has concentrated on assessing the magnitude of carbon storage benefits. The approach has concentrated on estimating the marginal damages caused by releasing additional carbon dioxide into the atmosphere. Thus the benefit of carbon storage is defined in terms of the damage costs avoided. Published estimates range from as little as US$0.3 up to US$221 per ton of carbon, in net present value terms, with the wide range attributable to a variety of different assumptions. Recent research has narrowed this range considerably (e.g. Cline 1992). Fankhauser (1995) reviews previous research and adds his own analysis in order to propose a "central" or benchmark figure of US$20 per ton. Fankhauser's analysis refines previous work by modeling the impacts of climate change on separate regions of the world (rather than simply extrapolating from the US economy).[59]

Using these estimates, several recent case studies calculate the carbon storage value of forests in a developing country setting. With the unit value of the benefit taken as given, the researcher simply needs to determine the amount of carbon stored or released under alternative land use scenarios, for a particular region. For example, in a case study of a Malaysian peat swamp forest, **Kumari (1995a)** estimates the change in carbon stored per hectare under a range of management options. These changes are valued at US$14 per ton, corresponding to the more conservative estimates available prior to the publication of Fankhauser's paper. Nevertheless, under a base case scenario involving unsustainable timber harvesting, carbon storage accounts for almost 70 per cent of the economic benefits measured, far more than timber or any other non-timber benefit estimated in the study. Other case studies reviewed here which estimate the carbon storage benefits of forests include: **Adger *et al*. (1995), Niskanen (1998)** and **Smith *et al.* (1997)**. Some case studies quantify carbon storage or emissions in physical terms, but do not ascribe monetary values (e.g. **Almeida and Uhl 1995**). In general, because of the high carbon content of forests and the potentially large damages of global warming, estimates of carbon storage values tend to swamp all other forest benefits, often including timber.[60] Estimates reported in the case studies reviewed here range from US$650 to $3,500 per hectare, in net present value terms.

Despite the apparent magnitude of carbon storage benefits, until recently there was no mechanism for recovering this value. The challenge is to persuade the "consumers" of carbon storage (effectively everyone) to pay forest land owners for carbon storage services rendered. Even today, despite the emergence of carbon trading and commercial sequestration services in response to national commitments made at Kyoto in 1997, most forest land owners cannot turn their carbon "assets" into cash as readily as they can timber and other forest products. Moreover, most developing countries have made no formal commitment to reduce carbon emissions, and for many developing country governments carbon storage remains a relatively low priority. When valuing carbon storage benefits, therefore, some judgment must be made about the likelihood of financial compensation from abroad, and the importance of carbon storage from a national perspective.

It remains to be seen whether carbon values will be realized on a large scale in developing countries, and if they are, whether the resulting financial transfers will have a significant impact on the pace or nature of land use change in those regions which have experienced rapid deforestation in the recent past. Additional case studies of the carbon profile of alternative forest land uses would add little, at this stage. Far more pressing is a better understanding of the marginal cost of switching to more "climate-friendly" land uses, i.e. what does it take to persuade land users to modify their practices? (e.g. **Smith *et al*. 1997**) Other research needs include determining which types of forest and forest user will benefit most from markets for carbon storage, and how to ensure that small-scale land users (who are often implicated in tropical deforestation) benefit from the sale of carbon storage services.

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[59] Fankhauser's model incorporates uncertainty by using random variables for several parameters, such as the sensitivity of climate to a doubling of atmospheric concentrations of carbon dioxide and the magnitude of estimated damages.

[60] See Fankhauser (1995) for more detail on the economics of carbon storage and the greenhouse effect. Methods for estimating carbon storage and emissions from forest land are described in Brown *et al.* (1997).

6.3 Option Values (Biodiversity)

Assessment of option values related to future use of forests is particularly challenging, as it requires fairly strong assumptions about future incomes and preferences, as well as technological change. One area where progress has been made is in estimating the potential future value of genetic information and organic compounds derived from wild plant and animal species found in tropical forests. These may be used as "raw material" for the development of new crop cultivars, pharmaceutical products and pesticides, among other uses.

Adger *et al.* (1995) and **Kumari (1995b)**, for example, use a technique developed by Pearce and Puroshothaman (1992) and Pearce and Moran (1994), which in turn build on earlier work by **Ruitenbeek (1989a)**. The approach estimates the production value of plant-based drugs as a function of many variables including the number of plant species in forests, the probability of a species providing a commercial drug (i.e. the "hit rate"), the royalty rate paid to prospecting companies, the proportion of this paid to the country where the plant is found and the average value of drugs. Unfortunately, little information on these parameters is available for developing countries; hence the resulting estimates of biodiversity values vary wildly. Depending on the assumptions made, reported annual values range from just US$0.20/ha (minimum estimate reported in **Howard 1995)** up to $695/ha (maximum estimate reported in **Kumari 1995b)**.

Another case study reported by Barbier and Aylward (1996) assesses the value of genetic information from wildlife on public forest land in Costa Rica for the development of new drugs. In this case, detailed information on hit rates and research and development costs were used to estimate the net value of the wild product, rather than simply applying the market value of the final product, as in some previous studies. The authors conclude that the economic value of biodiversity for such "pharmaceutical prospecting" can be locally significant, but is probably not sufficient by itself to justify forest conservation in the face of alternative land use options.

Finally, a case study by **Evenson (1990)** takes a slightly different approach to estimate the benefits of using genetic material from wild rice stocks to improve the yield of cultivated rice. The study used data on varietal improvements in rice and changes in productivity from the period 1959-84. (The resulting estimate of US$74 million in present value terms is perhaps more accurately described as an indirect use value, as the benefits were real rather than potential). Note that while this study does not focus on forests *per se*, wild rice may be found in forest areas and the methodology could be used to value the benefits of using wild genetic material from other species to improve the yield, disease resistance or other characteristics of commercial crops.

Initial optimism about the commercial value of biological diversity, as a motive for conserving tropical forests, seems to have diminished in recent years. The latest estimates of the benefits of using genetic information from wild species for pharmaceutical, agro-chemical and other commercial purposes have declined dramatically from early projections (Simpson *et al.* 1996). More modest estimates of biodiversity value reflect in turn a better understanding of the difficulty of finding commercially useful genetic information or chemical compounds from wild organisms (i.e. the low "hit rate" of screening efforts), as well as the realization that only a small part of the market value of a new drug or product can be attributed to the natural environment (most value is added further down the product pipeline, in the process of testing, refining, seeking regulatory approval, production and marketing). Finally, technical innovation quickly reduces the value of material in the wild, once the genetic or chemical information it contains has been isolated (often at very low cost). Modern chemical, industrial and agricultural processes allow firms and farmers to produce additional material (on farm, in the laboratory or factory) without recourse to the wild (Aylward 1993). This is good news, in the sense that there is less risk of over-exploiting wild resources, but it also limits the value that can be attributed to biodiversity in its natural state.

On the other hand, the bio-engineering industry continues to grow in importance, while genetically-modified organisms become more and more common in the market place (notwithstanding a recent consumer backlash in Europe). These trends suggest that the storehouse of genetic information contained in forests, particularly in the more diverse humid tropics, will continue to yield new riches. Previously published estimates of the "hit rate" for bio-chemical prospecting may be low, particularly if they have been taken from single-purpose studies (e.g. the search for a cure for a particular form of cancer).

Recent experience with carbon storage may be relevant. Only a few years ago there seemed to be little prospect of selling carbon storage services through forestry. Today, in the aftermath of Kyoto, several firms are competing for carbon storage contracts around the world. While the prospects of an international financial support framework for biodiversity conservation (i.e. a Kyoto Protocol or Clean Development Mechanism for biodiversity) are more problematic than for carbon, not least due to problems of measurement, it may be premature to dismiss biodiversity values altogether. A useful focus for future economic research will be to identify the most cost-effective strategies for shifting to "biodiversity-friendly" land uses (**Smith *et al.* 1997** is a useful model; see also Lippke and Bishop 1999).

6.4 Non-Use Values

Existence and bequest values are among the most difficult forest benefits to estimate in monetary terms. Stated preference techniques are usually considered the only way to estimate them.[61] In the case of bequest values, respondents must make assumptions about the preferences of their descendants, while in the case of existence values respondents must make subjective valuations unrelated to either their own or others' use, whether current or future.

Despite these difficulties, the non-use values of forests have been a focus of research effort in the developed world, mainly using CVM. Likewise, several researchers have attempted to estimate the non-use values of forests in developing countries. Examples in the literature reviewed for this report include: **Davies *et al.* (1999); Hadker *et al.* (1997); Kramer *et al.* (1995); McDaniels and Roessler (1998); Prasanthi *et al.* Gunawardena (1999); and Smith *et al.* (1997)**.

In many cases it is not possible to isolate non-use benefits from other forest values in reported estimates of WTP. One case study which did attempt to isolate bequest value from other forest use values found them to be roughly comparable in magnitude, although the absolute values were small in both cases (less than 1% of average household income among urban and rural communities in Sri Lanka, see **Prasanthi Gunawardena *et al.* 1999)**. This may be compared with estimates from the USA suggesting WTP for the non-use value of "rainforest conservation" or "protection of forest quality" ranging from US$24 to $47 per capita per annum (**Kramer *et al.* 1995; Walsh *et al.* 1990)**. The latter figures are also well under 1% of average per capita income in the US.

6.5 Total Economic Valuation

Finally, some of the most ambitious case studies reviewed attempt to synthesis information on a wide range of forest values, in order to calculate the Total Economic Value (TEV) of a particular forest area or national forest estate. Often this forms part of an analysis of several alternative forest land use options.

Among the case studies reviewed, some of the most comprehensive evaluations of market and non-market forest benefits include: **Howard (1995); Kumari (1995a);** and **Ruitenbeek (1989a, 1989b, 1992)**. **Adger *et al.* (1995)** estimate several non-timber forest benefits, but do not include timber values in their analysis. **Kramer *et al.* (1995)** estimate a wide range of forest benefits, but stop short of conducting a full-blown CBA. While it is difficult to generalize from the results of these very different studies, some issues and findings recur:

- the largest non-market values seem, ironically, to be those which forest owners are least able to "capture" (**Adger *et al.* 1995**). The benefits of carbon sequestration, biodiversity conservation (for pharmaceutical prospecting) and existence values often exceed direct and indirect use values by a wide margin. Carbon storage in particular dominates other non-timber values, and often exceeds timber values (**Kumari 1995a**).

[61] Some authors suggest that donations to "rainforest conservation" organisations are a rough indicator of consumers' revealed preference for non-use forest values. However, estimates based on such donations may under-estimate true WTP, as they ignore "free-riders" who enjoy non-use benefits provided by others but do not pay for them.

- non-timber forest values are often assumed to be compatible (complementary) with each other, whereas timber (and of course agriculture) are assumed to be incompatible with non-timber values in most cases (**Kumari 1995a**). Few case studies explore the potential complementarities between timber and non-timber benefits (e.g. Woon and Poh 1998).

- many of the case study results suggest that forest conservation or the adoption of more "sustainable" forest management regimes is economically justifiable, because non-timber benefits exceed the foregone value of timber or land conversion (**Kramer *et al.* 1995; Kumari 1995a; Ruitenbeek 1989a, 1989b, 1992**). Often this reflects low returns to timber or agriculture, and may be very site specific.

- several case studies emphasize the significant opportunity cost of forest conversion or sustainable management to local land users in developing countries, underscoring the need for better compensation mechanisms to win support for forest conservation (**Howard 1995; Kramer *et al.* 1995; Ruitenbeek 1989b**).

Note that the most comprehensive case studies, in terms of the number of different forest benefits estimated, often rely heavily on fairly crude assumptions or secondary sources of data. This is not surprising, given the considerable effort and information required to estimate even a single forest benefit. In some cases, however, it also means that detailed information on estimation procedures and primary data sources are not provided, making it difficult to judge the validity of the results.

7 Summaries of Selected Case Studies of Forest Benefits

This section contains summaries and commentary on over 50 case studies of the economics of forest benefits. The main criteria used to select studies for this section were as follows:

- published or widely available;
- present original data and analysis;
- focus on developing countries;
- good use of valuation methods; and/or
- detailed analysis of cost-benefit trade-offs.

For articles singled out on this basis, a standard outline was used to prepare a brief summary and assessment. The outline is presented below, followed by summaries of the selected articles.

1. Type of assessment and main findings
- cost-benefit analysis of alternative land uses
- total economic valuation of a specific land use
- valuation of specific non-timber forest benefits

2. Empirical data
- source(s)
- type (time-series, cross-sectional)
- coverage

3. Details of CBA (where relevant)
- financial versus economic (shadow-price) analysis
- perspective (government, individual, household, company, community)
- time horizon and discount rate(s) used
- treatment of risk and uncertainty
- analysis of sustainability/depletion of resources

4. Economic values considered (where relevant)
- direct use
- indirect use
- option
- non-use

5. Valuation techniques used
- market (and shadow) prices
- surrogate market (travel cost, hedonic prices, substitute goods)
- production function
- stated preference (contingent valuation and variants)
- cost-based (replacement, defensive, opportunity cost)

6. Socio-economic groups affected
- government, political elites
- subsistence forest dwellers
- commercial forest-based industry
- other forest land-users
- domestic, global communities

7. Comments (where relevant)

8. Key references (e.g. for secondary data)