

Economic Valuation and Market Capture of Forest Functions in Developing Countries

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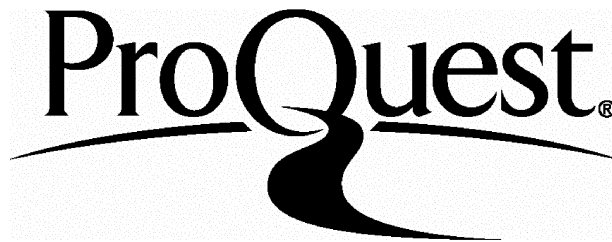
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ABSTRACT

This thesis illustrates through case study examples how the two-stage approach of economic valuation and capture design can greatly contribute to the optimal management of forests in low and middle-income countries. The thesis is orientated towards forest and mangrove land use in Cambodia, Malaysia and Turkey. The case studies from Cambodia represent the first natural resource valuation exercises in this country and highlight the research challenges faced in a poor country at the early stages of recovery from a protracted civil war. The case studies employ a range of valuation approaches (e.g., the production function approach, contingent valuation and cost based approaches) to estimate key forest functions which are then employed in a cost benefit analysis of competing management / land use options for the concerned sites. Attention is paid to the distributional impacts of competing land uses. The thesis discusses how a country's development status affects both the practical aspects of carrying out valuation studies and the potential to act on research findings. The institutions necessary to 'capture' natural values are more likely to be, or can more readily be, established in countries at a more advanced stage social, political and economic development.

Based on the case study findings and literature reviews the thesis concludes that if forests are to be better managed, their demonstrated value needs to be translated into resource flows to stakeholders. To date however, natural resource values are not widely incorporated in private property rights, regulations and pricing policy largely due to political and institutional barriers. Furthermore, the case studies show global values to be highly relevant to the conservation argument however, most international capture mechanisms (e.g., the Kyoto Protocol) require a greater commitment by the international community if the desired conservation objectives are to be achieved.

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CB

For Simon

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1 Introduction

1.1 Objectives of Thesis

This thesis sets out to show how economic valuation methodology can be used to estimate the value of environmental conservation in developing countries, and further, how these demonstrated values can be ‘captured’ (i.e., how these estimated values can be translated into actual benefits for stakeholders).

While valuation of natural resources such as forests is a necessary first step in that it provides important information to decision makers and the general public on the magnitude of these assets, it does not ensure that areas of high conservation value will be protected. This is because, in reality, such ‘paper’ values rarely have any influence on development decisions. A very different outcome is possible however if the values demonstrated through economic studies can be translated into cash benefits. This requires creating appropriate mechanisms for translating non-marketed resource values into financial flows to stakeholders. The two-step ‘valuation-capture approach’ is a powerful environmental management tool. It is increasingly apparent that unless the conservation of forest resources can compete financially with the returns to converting land to less diverse uses, these natural resources will continue to decline.

The thesis is orientated towards forest and mangrove land use in developing and middle-income economies. It is based on case studies undertaken in Cambodia, Malaysia and Turkey. The case studies from Cambodia represent the first natural resource valuation studies in this country and highlight the research challenges faced in a poor country at the early stages of recovery from a protracted civil war. These studies are compared with similar studies undertaken in the middle-income countries of Turkey and Malaysia. A country’s development status affects both the practical aspects of carrying out valuation studies and the potential to act on research findings. The institutions necessary to ‘capture’ natural values are more likely to be, or can more readily be, established in countries at a more advanced stage of social, political and economic development.

In summary, the objectives of this thesis are to illustrate through case study examples:

- The nature of forest economic values
- The practical relevance of economic valuation in a land use context
- The demonstration-capture paradigm
- How values can be captured through institutional design
- How estimation and the capture of resource values are affected by a country's development status.

1.2 The Role of Economic Estimation in Forest Conservation

For many developing countries, tropical forests and mangroves represent an important resource base for economic development. If managed wisely, these natural resources have the capacity to provide a perpetual stream of income and subsistence products, while supporting other economic activities (such as fisheries and agriculture) through their ecological services and functions. Despite their multiple benefits forests are disappearing. According to the Global Forest Resource Assessment 2000 the global deforestation rate in the nineties was 14.6 million ha (i.e., 0.2%) per annum. There are currently an estimated 3,870 million ha of forest worldwide (FAO, 2001).

In reality forest land must compete with a number of alternative commercial land uses. For example, tropical forest land may be utilised for commercial timber extraction, or it may be converted for commercial agriculture such as oil palm or rubber plantations. It may also be used for traditional subsistence activities (e.g., traditional agricultural practices such as shifting cultivation, and/or the extraction of non-timber forest products (NTFP)), or it may be afforded various levels of 'protection' through the establishment of a Protected Area, a National Park or Wildlife Sanctuary (IIED, 1994). The possible uses of tropical forest land are summarised in Table 1.1.

Table 1.1. A Taxonomy of Tropical Forest Land Use Options

TIMBER PRODUCTION
Natural Forest - clear cutting, or sustained yield
Plantation or silviculture
COMMERCIAL AGRICULTURE
Plantation agriculture
Agro-forestry
Cattle ranching
SUBSISTENCE AGRICULTURE
Shifting cultivation
COLLECTION OF NON TIMBER FOREST PRODUCTS
(for subsistence and / or commercial purposes)
CONSERVATION
National park
Wildlife reserve
Protected area
ECOTOURISM
OTHER
Human habitat

Note: Not all these uses are mutually exclusive.

Mangroves cover a surface area of approximately 181,000 km². They line about one-quarter of the world's tropical coastlines. It is estimated that one half of the world's mangroves have already been destroyed or severely degraded by human activities such as logging, road construction, drainage operations, hydroelectric development, or conversion to aquaculture (World Resources Institute, 2002). Possible land uses for mangrove areas are summarised in Table 1.2.

Table 1.2. Possible Uses of Mangrove Land

PROTECTION
FORESTRY
Sustainable subsistence forestry
Sustainable commercial forestry
AQUACULTURE
Aquasilviculture – conversion of a portion of the mangrove area to fishponds while some portion remains forested
Semi or intensive aquaculture production
CONVERSION
Conversion of mangrove for urban, industrial or tourism development

Note: Not all these uses are mutually exclusive.

In order to make sustainable land use decisions more reliable information on the environmental, social, and economic value of forests and mangroves both in their own right and relative to other land uses is urgently needed. A problem is that project evaluation procedures do not typically incorporate the full range of environmental and social costs associated with different land use options. Due to this omission, decisions on land use have been biased in favour of development options, some of which have been shown to be economically unjustifiable once the relevant environmental costs are accounted for. While the benefits of development options are easily identifiable as they often comprise marketable outputs (e.g., timber revenue and agricultural income) many values of the natural or managed forest have no market, and thus are generally ignored in land use decisions. For example, the market value of land converted to agriculture often fails to reflect lost environmental benefits such as watershed protection, which may be highly significant. However, if owners had to pay for the full social cost of developing forested land (i.e., the environmental and

social costs that typically remain outside of the decision framework) less land would be converted or over-exploited¹.

One reason for this shortcoming has been a lack of understanding of, and expertise in, the monetary evaluation of environmental impacts such that they can be included in the appraisal process. In response to the need to value environmental goods and services (the majority of which are non-market), economists have developed a range of new valuation techniques (see Chapter 2). Meaningful assignment of monetary values to environmental goods and services, once considered to be unquantifiable, is therefore now possible. There has also been a change in perceptions. What were once considered relatively unimportant intangibles such as improved recreation and visual amenities, or were in the past virtually unrecognised (e.g., the loss of biodiversity and the preservation of endangered species and unique ecological systems) are now significant sources of value and/or central issues in the analysis of policy choices (Freeman, 1993).

A key objective of economic valuation of the environment is therefore the integration of environmental concerns into the conventional economic decision making process in order to furnish policy analysts and decision makers with better information upon which to base decisions. A social cost-benefit analysis (CBA), which incorporates all the gains and losses associated with each land use option, is the most common framework for undertaking such an analysis².

¹ In certain circumstances land conversion might be the best option. For example, Aylward *et al* (1999) show that the benefits of ranching plus associated downstream hydrological effects in Costa Rica significantly outweigh expected returns from reforestation and forest regeneration.

² Economic valuation has many applications, for example: Cost Benefit Analysis (CBA) of policies, projects and programmes, benefit analysis, damage analysis; establishing the basis for an environmental tax or charge; and 'Green' national accounting. The focus here is its use in the CBA of alternative land use and management options for forests and mangroves.

The CBA framework defines the 'best' land use option based on economic efficiency³. Importantly, other concerns such as equity, intergenerational effects, the sustainability of resource systems, or social risk aversion often need to be factored into the decision making process. CBA is therefore one important tool for meeting the objective of sustainable management that is best complimented by other analytical procedures. The distributional implications of alternative land use options are stressed throughout this thesis.

1.3 Summary of Case Studies

A tropical forest and mangrove study was undertaken in Cambodia, which is among the group of twenty poorest countries in the world. Two middle-income countries were studied – Turkey (forests) and Malaysia (mangroves). A summary of the case studies detailed in Chapters 4-8 is presented in Table 1.3.

³ CBA is a method of judging projects and policy proposals according to the size of their net economic benefits.

Table 1.3. Summary of Case Studies

Case Study	Development Status of Country GNI per capita¹ / HDI rank²	Feature of Study
Cambodia - Ratanakiri Tropical Forest	Low Income GNI per capita- \$260 HDI rank- 121	First CBA of tropical forest in Cambodia Survey based in remote area Compares benefits of traditional forest use with commercial logging Focus on NTFP
Turkey Temperate Forest	Middle Income GNI per capita - \$3,100 HDI rank- 82	Estimates forest components values for all of Turkey's forest Analysis of institutional setting
Cambodia - Koh Kong Mangrove	Low Income GNI per capita - \$260 HDI rank - 121	First CBA of mangrove area in Cambodia Survey based in remote area Compares traditional use of mangroves with commercial aquaculture
Malaysia - Johor Bahru Mangrove	Middle Income GNI per capita - \$3,380 HDI rank - 56	Valuation of 17 mangroves sites in Johor state. Contingent valuation (CV) study of local communities and non-Malaysians on mangrove biodiversity

Note: 1/ Development status based on World Bank criteria for classifying economies according to Gross National Income (GNI) per capita (2001): low-income – \$745 or less; lower-middle income - \$746-2,975; upper-middle income - \$2,976-\$9,205; high income - \$9,206 or more. GNI estimates from World Development Indicators Database (2001); 2/ Human Development Index (HDI) rank based on Human Development Report, 2001, The United Nations Development Programme (UNDP). Cambodia, Turkey and Malaysia are all classified as having medium human development, although Cambodia borders the low human development category.

1.4 Layout of Thesis

This thesis is organised as follows. Part I summarises the theory of valuation (Chapter 2) and presents an overview of capture mechanisms (Chapter 3). Part II presents the four valuation case study examples (Chapter 4-8). Part III discusses the key findings of the case studies and compares the results of the case studies with findings in the literature. Possible capture mechanisms that might be applied to realise the values demonstrated in the case studies are highlighted (Chapter 9). Chapter 10 concludes.

**PART I: An Overview of Valuation Techniques and Capture
Mechanisms**

2 The Theory of Economic Valuation – An Overview

2.1 Introduction

The usefulness of deriving monetary estimates of natural resources is, as discussed in Chapter 1, compelling. This Chapter outlines the theoretical underpinning to economic value and the range of techniques that have been refined over the past 30 years or so for estimating environmental goods and services⁴. A summary of the valuation techniques applied in the case studies is provided. The Chapter concludes with a framework for assessing the costs and benefits of land conversion.

2.2 Economic Valuation, Economic Efficiency and CBA

Economic valuation of the environment has its foundation in neo-classical welfare economics. Welfare economics is based on the premise that the purpose of economic activity is to increase the well-being of individuals, and that individuals are the best judge of their welfare. Well-being is then based on what people prefer. Since these preferences are regularly revealed in the market place, there is a logical link from preferences to *willingness to pay* (WTP). WTP can be shown to be a measure of preference satisfaction and hence a measure of well-being.

Benefits and costs are defined in terms of individuals' preferences measured in terms of money. The measure of benefit is WTP, while the measure of cost is willingness to accept (WTA). Both measures are based on the assumption of substitutability in preferences, but they adopt different reference points for well-being (Table 2.1).

⁴ The theory of economic valuation is well developed in the literature and is not recreated here (see for example Freeman, 1993, and Johansson, 1994).

Table 2.1. WTP and WTA as Measures of Preferences.

	WTP	WTA
Definition	The maximum sum of money the individual would be WTP rather than do without an increase in some good such as an environmental amenity.	The minimum sum of money the individual would require to voluntarily forego an improvement that would otherwise be experienced
Assumption of substitutability	The amount of money that would make an individual indifferent between paying for the improvement and foregoing the improvement while keeping the money to spend on other things	The amount of money that would make the person indifferent between having the improvement and foregoing the improvement while getting extra money.
Reference point	The absence of improvement	The presence of the improvement

These measures of benefit and cost underlie the principle of economic efficiency. The economic efficiency criteria implies that scarce resources should be used to maximise benefits from them, net of the costs of using them in each case. Economic efficiency increases if (in principle) the gainers could compensate the losers without becoming losers themselves. This efficiency criterion (or compensation test) is adopted by CBA to appraise specific proposals⁵. CBA is particularly useful in situations where markets do not exist, or where they are economically inefficient, for example where policy is concerned with public goods⁶. Many environmental goods, such as biodiversity are classic examples of public goods.

⁵ That is, following the Kaldor Hicks criteria, A is preferable to B even if compensation does not actually take place.

⁶ A good is public to the extent that consumption of it is *non-rival*, i.e., one person's consuming it does not reduce the amount available to others, and *non-excludable*, i.e., it is not possible to supply the good only to those who choose to pay for it, and to exclude everyone else (Bateman *et al*, 2002).

WTP is formally related to the demand curve. The correct measure of value is the individual's maximum WTP to prevent environmental damage or realise an environmental benefit. This is represented by the entire area under the demand curve. A basic formula is then - Total WTP = Market Price + Consumer Surplus. Consumer surplus indicates the excess of what the consumer would have been WTP over what he actually has paid. This concept is particularly important when estimating the benefits of environmental goods and services that have a low, or no market price. In such case, the entire area under the demand curve represents the benefit of the good.

Typically we are interested in how individuals will be affected as a result of some change in (environmental) policy or quality. The classic measure of such welfare changes is consumer surplus. Ordinary consumer surplus, associated with the Marshallian demand curve does not measure any of the theoretical definitions of welfare. It is not an index of utility change, except under special conditions, or a measure of gain or loss that can be employed in a potential compensation test (Freeman, 1993). It is therefore more accurate to estimate consumer surplus based on the Hicks-compensated demand function which shows the quantities consumed at various prices assuming that income is adjusted (compensated), so that the utility is held constant. The Hicksian demand function is obtained by taking the partial derivative of the expenditure function with respect to price⁷.

Consumer surplus can be measured using the equivalent variation (EV) or the compensating variation (CV). These two measures are set out below (Varian, 1994).

⁷ The expenditure function is the inverse of the indirect utility function and gives the minimum amount of expenditure (cost) necessary for achieving a pre-specified level of utility. The partial derivatives of the cost function with respect to price are the cost minimising demand functions known as the Hicksian compensated demand function. The indirect utility function gives us the maximum utility achievable at given prices and incomes.

$$EV = e(p^0, u') - e(p', u') = \int_{p'}^{p^0} h(p, u') dp$$

$$CV = e(p^0, u^0) - e(p', u^0) = \int_{p'}^{p^0} h(p, u^0) dp$$

where:

$e(p, u)$ = expenditure function

p^0, u^0 = prices, utility at the status quo

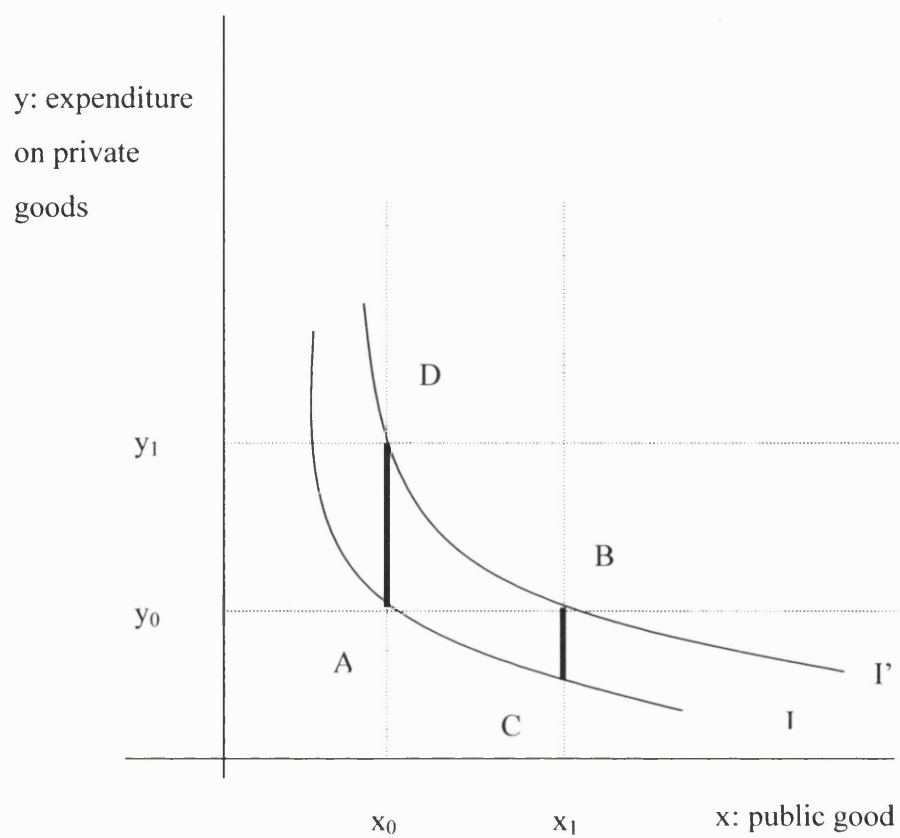
p', u' = prices, utility at the policy change

$h(p, u)$ = the Hicksian demand function

It follows from these expressions that the correct measure of welfare is an integral of the Hicksian demand curve. The CV is the integral of the Hicksian demand curve associated with the initial level of utility, while the EV is the integral of the Hicksian demand curve associated with the final level of utility (Varian, 1994). Which welfare measure to use depends on the nature of the analysis. The four measures of welfare change associated with the Hicks-compensated demand curve are explained in Table 2.2 with reference to Figure 2.1, which illustrates the preferences of a given individual using indifference curves⁸.

⁸ In Figure 2.1, I and I' are indifference curves showing the combinations of the two goods (x and y) between which the individual is indifferent. Each curve corresponds to a level of welfare or utility (I' correspond to a higher level of utility than I).

Figure 2.1. Measures of Change in Human Welfare



Source: Bateman *et al*, 2002

Table 2.2. Welfare Measures

Measure	Comments
Compensating Variation (CV) for increase in good WTP to secure a benefit	The CV asks what compensating payment (i.e., offsetting change in income) is necessary to make the individual indifferent between the initial situation and the new situation. If the quality of the public good improves it is interpreted as the maximum amount that the individual would be WTP to secure the benefit. In Figure 2.2 consider the value to the individual of an <i>increase</i> in the quantity of the public good from x_0 to x_1. Suppose that initially the individual has y_0 private consumption, and so is at A. At C the individual can enjoy x_1 of the public good but his private consumption is less by the amount BC. We can therefore infer that his WTP for the increase in the public good is BC. The loss of BC in private consumption exactly compensates for the increase in the public good.
Compensating Variation for reduction in good WTA for reduction in good	If the quality/quantity of the public good deteriorates, CV is the minimum amount of money that must be given to an individual to compensate him for the loss so as to leave him as well off as he was prior to the change. In Figure 2.2 consider an individual at position B who faces a <i>decrease</i> in the public good from x_1 to x_0. Compare point D. At D, the individual enjoys only x_0 of the public good, but his private consumption is greater by DA. Since B and D are on the same indifference curve I', we can infer that his WTA for the reduction in the public good is DA.
Equivalent Variation (EV) for increase in public good WTA to forgo a benefit	The EV is the minimum amount that someone who gains from a particular change would be WTA to forgo the particular change. In Figure 2.2 suppose that the individual starts off at A. What additional amount of private consumption would be just as preferable as an increase in the public good to x_1? Since D is on the same indifference curve as B, equivalent gain is equal to DA.
Equivalent Variation for a decrease in a good WTP to prevent a loss	If environmental quality deteriorates, EV is the maximum the household is WTP to prevent that deterioration. In Figure 2.2 suppose the individual starts off at B. What loss of private consumption would be just as preferable as a decrease in the public good to x_0? Since C and A are on the same indifference curve, equivalent loss is equal to BC.

Source: Based on Bateman *et al*, 2002.

2.3 Total Economic Value

A common framework used for the valuation of natural resources is Total Economic Value (TEV). TEV comprises three main types of values - direct use values, indirect use values and non-use values. Direct use values relate to direct use or interaction with the resource in question. For example, for a tropical forest or mangrove area direct values might include NTFP, or a visit to a national park. Indirect use value relates to the indirect support and protection provided to economic activity and property by a natural resource's natural functions, or regulatory 'environmental' services. For example, the watershed protection function of a tropical forest may have indirect use value through controlling water flow that affects downstream agriculture and water supplies. Possible use can also be important since people may be WTP to maintain a good in existence in order to preserve the *option* of using it in the future. *Option value* thus becomes a form of use value.

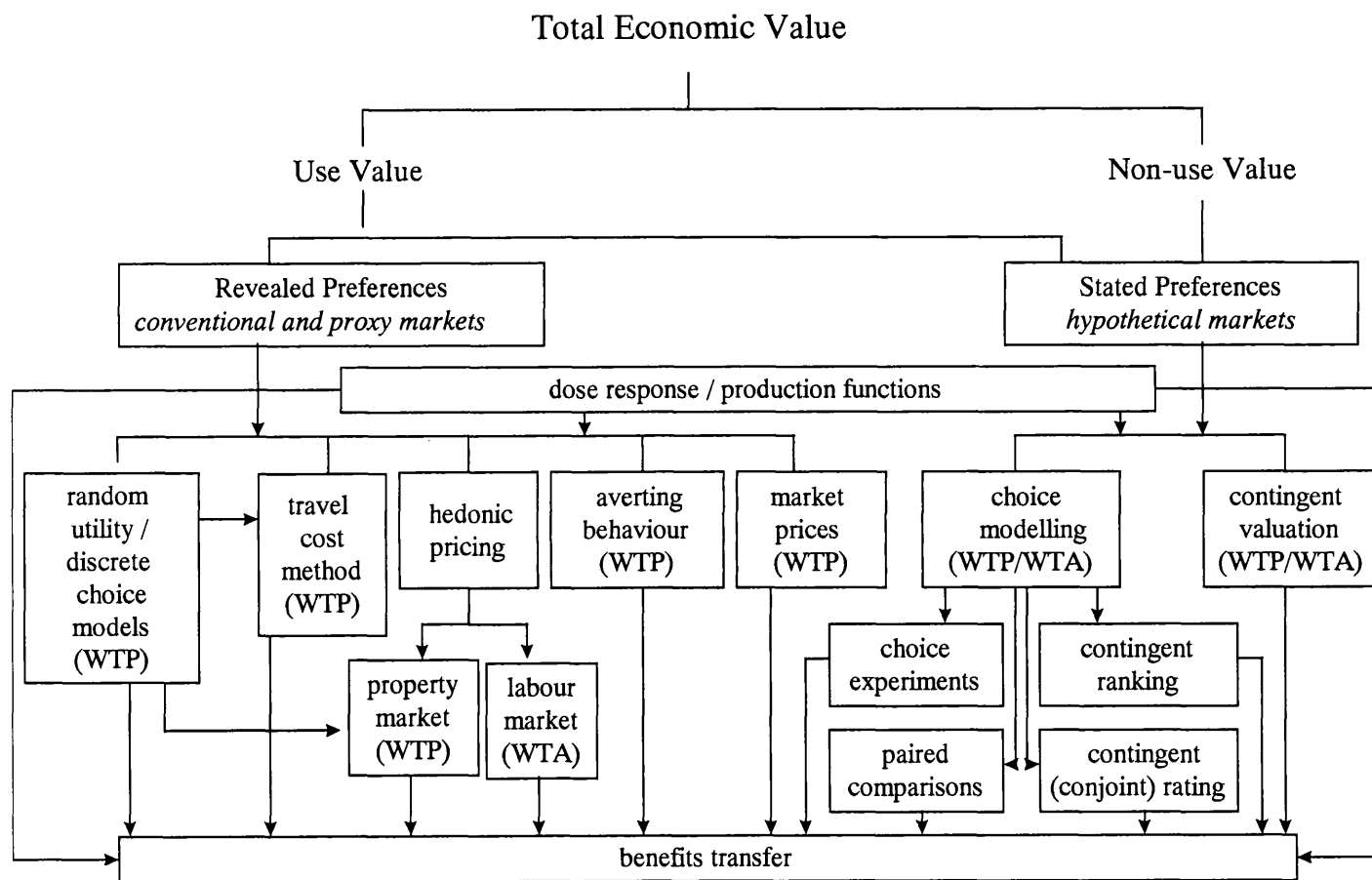
Non-use value refers to WTP to maintain some good in existence even though there is no actual or planned use. Types of non-use value include existence value, altruistic value and bequest value. Existence value might be motivated by a feeling of concern for the asset itself (e.g. a threatened species) or a 'stewardship' motive whereby the valuer feels some responsibility for the asset. Altruistic value might arise when the individual is concerned that the good in question should be available to others. Bequest value relates to a concern that the next and future generations should have the option to make use of the good. The TEV framework is adopted in this thesis (see Chapters 4-8).

2.4 Monetary Estimation of Environmental Costs and Benefits

A range of techniques are available for the estimation of natural resource values. These are categorised in Figure 2.2. Direct use values are relatively straightforward to measure, and usually involve the market value of production gains. Since environmental functions are rarely exchanged in markets, measurement of indirect use values typically entail the use of more complex techniques such as the change in productivity approach, travel cost method, and hedonic pricing method. Non-use values can only be defined from surveys of people's preference about their WTP (e.g., Contingent Valuation).

Figure 2.2 broadly categorises valuation approaches into revealed preference approaches and stated preference approaches. Revealed preference valuation techniques seek to determine preferences for the environment from actual, observed market based information. Often, when no market price exists for an environmental good or service, people's preferences for the environment can be 'revealed' *indirectly* by examining their behaviour in markets that are *linked* to the environment. Some goods and services are complements to environmental quality, others are proxies, surrogates or substitutes for it. They leave what may be called a 'behavioural trail'. Therefore, by examining the prices paid in environment-related markets, people's environmental preferences can be uncovered (Pearce and Moran, 1994). An advantage of these techniques is that they rely on actual choices rather than on the creation of an hypothetical market to uncover the value of the environmental good or service in question as stated preference approaches do.

Figure 2.2. Economic Valuation Techniques



Source: Pearce and Ozdemiroglu *et al.* 2002

2.5 Valuation Techniques

The valuation approaches employed in the case studies are summarised in Table 2.3 and outlined below⁹. Typically market prices have been used in the analysis. Valuation methodologies capable of estimating demand curves such as the travel cost method (TCM) and hedonic pricing were not employed due to data and resource constraints. The hedonic pricing method depends on well functioning markets and its application to forest resources in developing countries is minimal. The travel cost method has however been widely and successfully used to measure the benefits of tourism associated with national parks (see Chapter 9).

⁹ See Johansson 1994 and 1993, Freeman 1993, Bann 1998a and Pearce 1983 for a more detailed exposition of valuation approaches and CBA.

Table 2.3. Summary of Valuation Approaches Applied in Case Studies

Valuation Approach	Case Study	Value component
Market Prices	1/ Ratanakiri / Forest (Chapter 4) 2/ Turkey / Forest (Chapter 5) 3/ Koh Kong / Mangroves (Chapter 6) 4/ Johor / Mangroves (Chapter 7)	1/ NTFP (fuelwood, malva nuts, rattan, bamboo, traditional baskets, manufactured products, wildlife, fish) timber 2/NTFP (medicinal and ornamental plants, fruits nuts and resins), fodder, wildlife, tourism, recreation. 3/ Charcoal, housing, fish, shrimp 4/ Poles, fuelwood, fish, aquaculture
Direct Substitution Approach	1/ Ratanakiri / Forest (Chapter 4) 2/ Koh Kong / Mangroves (Chapter 6)	1/ Housing, medicine 2/ Fuelwood
Change in productivity approach	1/ Ratanakiri / Forest (Chapter 4) 2/ Turkey / Forest (Chapter 5) 3/ Johor / Mangroves (Chapter 7)	1/ Watershed benefits (change in agricultural productivity) 2/ Watershed benefits (foregone production) 3/ Shoreline protection (change in crop productivity)
Contingent Valuation	1/ Benut / mangroves (Chapter 8)	1/ Biodiversity
Benefits Transfer	1/ Ratanakiri / Forest (Chapter 4) 2/ Turkey / Forest (Chapter 5)	1/ Biodiversity, carbon storage 2/ Carbon storage (damage cost avoided), pharmaceuticals (rent capture approach)
Damage Cost Avoided	1/ Koh Kong / Mangroves (Chapter 6)	1/ Storm protection (property)

2.5.1 Market Prices

Many natural resource products have market prices that can be used in the valuation exercise. Strictly speaking efficient prices should be used, i.e., they should account for any distortions such as externalities, taxes and subsidies. Values used should be net of production costs. They should also be based on optimal harvesting levels, and take account of seasonal changes in production and prices. Market analysis may also be necessary to understand the likely effects of market expansion, shifts in demand and international price fluctuations.

2.5.2 Related Goods Approach

The related goods approach consists of three similar valuation techniques: barter exchange approach; direct substitute approach; and indirect substitute approach. These relatively simple, intuitive approaches are useful for estimating forest products in developing countries that are largely used by rural communities for subsistence purposes or traded informally. These approaches are based on the fact that often a non-marketed good or service is related to a marketed good or service. By using information about this relationship and the price of the marketed product the analyst may be able to infer the value of the non-marketed product. For example, the direct substitute approach bases the value of a non-marketed good such as fuelwood, on the price of its closest marketed substitute (e.g., charcoal) and the rates of exchange between them in terms of energy equivalence.

2.5.3 The Production Function Approach

The production function approach is a common economic technique which relates output to different levels of inputs of the so-called factors of production (land, labour, capital, raw materials). It is often thought of as the most straightforward way to value the environment¹⁰.

¹⁰ Various called the change in production approach, the input-output or dose response approach. All involve an attempt to relate the incremental output of a marketed good of service to a measurable change in the quality and quantity of a natural resource (Maler, 1992).

More formally, the production function for a single output may be given by:

$$y = F(X, Z)$$

where X is a set of inputs (e.g., land, capital), Z is the input of the unpriced environmental resource and y is the output that can be measured using market prices. If prices of inputs X are not expected to change when supply of the environmental resource (Z) changes, then the economic value of the change in the supply of Z is the value of the production change associated with the change in Z at constant inputs of the other factors (X) (Pearce and Moran, 1994)¹¹.

For example, consider a tropical forest that supports downstream fisheries by ensuring a regular flow of clean water to streams important as spawning grounds for fish and nurseries for fry. The forest area in the watershed (S) may therefore have a direct influence on the catch of some fish species dependant on the area, Q , which is independent from the standard inputs of commercial fishery, $X_1...X_k$. Including forest watershed area as a determinant of fish catch may therefore capture some element of the economic contribution of this ecological support function (Barbier 1992).

$$Q = F(X_1...X_k, S)$$

The approach is most appropriate where: the environmental change directly causes an increase or decrease in the output of a good (or service) which is marketed; the effect is clear and can be observed, or tested empirically; and, markets function well, so that price is a good indicator of economic value (OECD, 1995). Specifying the physical effect of a change in environmental quality, and the resulting impact of the physical effect on the economic activities can be difficult and data intensive in practice. These functions may be estimated or derived from existing literature, but ideally expert studies are required by epidemiologists, clinicians and technologists. Also, where environmental change has a sizeable effect on markets, a more complex view needs to be taken of the market structure, elasticities, and supply and demand responses. Consumer and producer behaviour needs to be introduced into the analysis as

¹¹ This approach can also be applied to output which is not marketed but where an actual market exists for similar /substitutes goods (e.g., health production functions).

behaviour may change in response to changes in the environment. In addition, the impacts of market conditions and regulatory policies affecting production decisions need to be taken into account. Unless these factors are accounted for the production function approach may produce unreliable information. Freeman, 1993 concludes 'The conditions under which a naïve damage function model will yield conceptually correct measures of value and welfare changes are quite restrictive'. Nevertheless, the production function approach has strong intuitive and practical appeal and has been used frequently in developing regions to estimate the impact of deforestation on soil erosion and on water production and quality.

2.5.4 Stated Preference Approaches

Stated preference techniques (SP) refer here to any questionnaire-based technique that seeks to discover individuals' preferences. Perhaps the most well known approach under this category is the Contingent Valuation Method (CVM)¹². A detailed account of a contingent valuation (CV) study is presented in Chapter 8.

The CVM uses survey techniques to ask people directly what their environmental preferences are. It is therefore a form of market research, where the 'product' in question is a change in environment quality. A hypothetical market is constructed and consumers are asked what they would be WTP for a hypothetical environmental improvement or to prevent a deterioration, or what they would be WTA in compensation to tolerate a loss. A hypothetical market includes not just the good itself (an improved view, better water quality, *etc.*), but also the institutional context in which it would be provided, and the way in which it would be financed. Answers to questionnaires are intended to *simulate* the behaviour of individuals in the market place. A great deal of care is needed to ensure that questionnaires mimic the relevant features of the market place, and that potential biases in responses are controlled for.

SP techniques become necessary when the WTP information that is needed cannot be inferred from markets. They are therefore extremely applicable to the valuation of

¹² See, for example, Bateman *et al*, 2002, and Mitchell and Carson, 1989 for more detail on methodology.

public goods for which no markets exist. CVM is technically applicable to all circumstances and is the only practical method for uncovering existence values (e.g., preservation of rare species, biodiversity for its own sake).¹³ Carson (1998) argues that CV techniques are directly relevant to forest valuation, while others, such as Rolfe *et al.*, (2000), suggest that choice modelling techniques are more likely to capture the rich array of value components in a rainforest.¹⁴

2.5.5 Benefits Transfer

Benefits transfer (BT) involves ‘transferring’ economic benefit estimates from a site where a study has already been done (the ‘study site’) to the site of policy interest (the ‘policy site’). If BT is a valid procedure, then the need for ‘primary’ studies is greatly reduced. However, the current consensus, based on ongoing research, appears to be that BT is unreliable (Brower, 1988; Bateman *et al.*, 1999). Results tend to differ by up to 75% if outliers are excluded, and by up to 450% if they are included. This margin of error may be acceptable for some project and policy applications, and uncertainty can be addressed through sensitivity analysis.

Benefits transfer is most appropriate when: funds, time, or personnel are insufficient to undertake a satisfactory new study; the study site is similar to the policy site; the issues (e.g., proposed policy change, or nature of the project) are similar in the two case; and, the original valuation procedures are theoretically sound (OECD, 1995). These ‘borrowed’ unit values can represent order of magnitude estimates for the environmental goods and services of interest. However, primary data collection and analysis may be unavoidable for large projects, projects with potentially large (and

¹³ Other valuation techniques are not aimed at capturing non-use values. While it may be possible to infer estimates of existence values from market behaviour - such as donations to philanthropic pursuits - it is almost impossible to separate out use and existence values revealed in such markets.

¹⁴ Choice modelling, sometimes somewhat confusingly referred to as stated preference or stated choice (Louviere *et al.*, 2000), involves a rating or ranking of options each of which contains a varying set of characteristics, including a money price or cost. Respondents are not asked any WTP questions. Rather WTP is inferred from the stated choices.

irreversible) consequences, or for particularly complicated or politically sensitive projects.

It is possible to transfer an average WTP estimate from one study site, or to transfer a WTP function from the study and apply it to the policy site, or to transfer WTP estimates from meta-analysis.¹⁵ If values are transferred ‘unadjusted’ the credibility of the policy site estimates are questionable. Possible differences that should be accounted for include: baseline conditions and/or the magnitude of the economic impact (i.e., change from baseline); study methodology; researchers judgement in the selection of sample size; socio-economic characteristics of the relevant population; determinants of WTP; market conditions applying to the sites (e.g., variations in the availability of substitutes); and econometric specifications.

2.5.6 Cost Based Valuation

Cost based valuation techniques assess the costs of different measures that would ensure the maintenance of the benefits provided by the environmental good or service being valued. These cost estimates are then used as proxies for the non-market environmental benefit in question. Cost based valuation approaches include: opportunity cost based approaches; approaches which measure environmental values by examining the costs of reproducing the original level of benefits (e.g., the replacement, restoration and relocation cost methods); and, the preventative expenditure approach, which examines the up front payments paid in order to prevent environmental degradation.¹⁶

¹⁵ Meta-analysis explains the variations in WTP taken from a number of studies. This should enable better transfer of values since we can find out what WTP depends on. In the meta-analysis case, whole functions, based on the collected studies, are transferred rather than average values.

¹⁶ The preventative expenditure approach is also referred to as the ‘defensive expenditure approach’ ‘mitigation approach’ or ‘avertive behaviour approach’. There are two different approaches to this type of analysis and only one of them is truly a cost-based valuation technique. If estimates of what people are WTP to prevent damage to the environment or themselves are elicited through the use of constructed markets, or by the examination of past events in similar circumstances through the use of

Cost based valuation techniques must be used carefully as they are inherently measuring values, or benefits, by looking at costs. There are a number of problems associated with this. A practical difficulty is ensuring that the cost of maintenance will provide a benefit equivalent to the benefit of the original good. A potential cause of overestimation occurs if the benefits of maintenance do not exceed the costs of maintenance. If this is the case, then the investment is not a profitable use of economic resources and the cost of maintenance activities may be larger than the WTP for the original environmental benefits¹⁷. Conversely, if the benefits generated by the maintenance activity exceed that of the original environmental benefits, then the costs of maintenance activity may exceed the WTP for the original environmental benefits. Further, because they bear no relation to demand or WTP for environmental goods and services, cost estimates do not reflect consumer surplus thus tending to underestimate environmental values.

It is argued that the replacement cost approach is only valid if three conditions are met (Bockstael *et al* (2000)): 1) the human-engineered system provides functions that are equivalent in quality and magnitude to the natural function; 2) the human-engineered solution is the least cost alternative way of performing the function; and, 3) individuals in aggregate would be willing to incur these costs if the natural function were no longer available. These conditions are rarely achieved, hence the replacement cost approach is rarely accurate. Due to the inaccuracies inherent in cost based valuation approaches they are generally regarded as *second best valuation techniques*. However, they can be extremely useful when there are limitations on the time and resources for detailed research or when data sets are so questionable as to reduce the advantages of using more exact but costly techniques.

revealed preferences exhibited through actual or surrogate markets, *first based estimates* of value will be derived.

¹⁷ In certain cases, such as estimating the costs of relocating communities affected by land use changes, satisfying this condition may not be critical. Concerns over equity (ensuring just compensation) may override any economic criteria being placed on the cost of relocation.

2.6 A Framework for Assessing the Costs and Benefits of Land Conversion

The economics of land use can be assessed from the point of view of the individual land user (financial analysis) and from the point of view of society (economic analysis). A decision whether to conserve or develop (convert) land can be rationally based on the net benefits (benefits minus costs) of competing options within a CBA framework (Moran and Pearce, 2000).

The Individual Land User

Consider a rational economic agent trying to decide whether to conserve or develop for agriculture an area of tropical forest he owns or rents. Economic rationality suggests that the decision will be determined by the relative profitability, or *rate of return*, of the two options. Within the conservation option we include *sustainable use* of the forest for say agro-forestry or for NTFP such as fuelwood and medicinal plants. On this analysis the relevant rates of return are those that accrue to the land-owner or tenant, no account is taken of any returns to society. In this simplified situation the decision to conserve the land will be the right one if:

$$\text{Rate of Return from SU} > \text{Rate of Return from Development}$$

where SU is the sustainable use of the forest, i.e., the conservation option.

$$B(\text{SU}) - C(\text{SU}) > B(\text{DEV}) - C(\text{DEV}) \dots(1)$$

or

$$B(\text{SU}) - C(\text{SU}) - [B(\text{DEV}) - C(\text{DEV})] > 0 \dots(2)$$

where

$B(\text{SU})$ = the benefits of sustainable use of the forest;

$B(\text{DEV})$ = the benefits of traditional development of the land for, say, agriculture or forestry or industry;

$C(\text{SU})$ = the costs of the sustainable use option;

$C(\text{DEV})$ = the costs of the development option;

Rule (1) or (2) says that the net benefits from sustainable use should exceed the net benefits from development if conservation is to be the preferred option. The benefits and costs here are all *private costs and benefits*. Typically, the landowner will prefer benefits now rather than later, and costs later rather than now. To allow for this we have to introduce discounting which permits us to compare gains and losses that occur over different time periods. Allowing for time, rule (2) can be restated in terms of *present values*:

$$PV[B(SU) - C(SU)] - PV[B(DEV) - C(DEV)] > 0 \dots(3)$$

where

$PV(B) = \sum B_t / (1+r)^t$, and similarly for costs.

r = discount rate

t = time

As many of the benefits of SU are often not marketed (e.g., watershed protection functions of the forest, carbon storage functions and existence value) the individual landowner has no incentive to account of them. Conversely, the benefits from development are typically tangible and easily observed. When conservation values are not valued in monetary terms and thereby not reflected in the CBA framework, there is a bias in favour of development options. This can result in economically inefficient land use decision. The returns from clearance may simply be higher than the returns from conservation because the latter may consist of a range of unmeasured non-market benefits and/or benefits that accrue to people other than the landowner (external benefits).

Society's View and Global Values

From the standpoint of society we need to redefine the benefits and costs in equation (3) to account for the TEV of conservation (the full range of use and non-use values). A second adjustment arises from the fact that both use and non-use values can reside

in the host nation or globally (where globally means all nations other than the host nation).

$$TEV(SU) = UV + NUV = DUV + IUV + OV + BV + XV \dots(4)$$

and

$$TEV(SU) = UV_n + UV_g + OV_n + OV_g + BV_n + BV_g + XV_n + XV_g \dots(5)$$

Where:

UV	=	use value
NUV	=	non use value
DUV	=	direct use value
IUV	=	indirect use value
OV	=	option value
BV	=	bequest value
XV	=	existence value
n	=	national
g	=	global

The expression for the cost-benefit rule, then, is that sustainable use will be preferred if:

$$PV [TEV(SU) - C(SU)] - PV[B(DEV) - C(DEV)] > 0 \dots(6)$$

Equation (6) sets the requirements for the comparison of sustainable land use and its opportunity cost, namely the foregone development values. Equation (6) indicates what would be needed for sustainable use to be preferred over traditional development land use if a national host country standpoint is taken, and if that country seeks to secure the biggest gains in national efficiency. It tells us that conservation is preferred if the *national* gains are greater than the costs, and that those national gains will be

larger still if the country can 'capture' some of the global use and non-use values. If the individual land user does not get part of the national gains from conservation, or part of the global gains, then he has no incentive to act in accordance with equation (6). He will simply operate according to his own private gains and losses. This divergence between global, social and private returns does much to explain continuing habitat loss.

2.7 Distributional Equity

The CBA framework defines the 'best' land use option on the basis of economic efficiency. In theory, it makes no difference if one group is made significantly worse off so long as another group is made better off by a larger amount as the winners could fully compensate the losers and still be ahead. In practice compensation rarely takes place. Distributional concerns are rarely incorporated into the economic evaluation framework despite that fact that they are often of paramount concern, especially in poor countries¹⁸. Unfair outcomes are unsatisfactory both from an ethical and practical point of view. Invariably they lead to a breakdown in natural resource management due to the disincentives created for key stakeholders. An important consideration is then identifying who receives the benefits and who pays the costs of potential option. The case studies have sought to identify the stakeholders associated with possible land use and management options, and to determine how they might be impacted by alternative land use decisions.

¹⁸ In the 1970s it was common practice to include utility weights in CBA carried out in developing countries but this is not true now.

3 The Capture of Economic Values

3.1 Introduction

Demonstrating that a forest area is of high economic value through the valuation approaches outlined in Chapter 2 may well be meaningless in policy terms unless ways of converting at least part of the value into monetary benefits for the stakeholders are also determined. Such tangible returns provide an incentive for sustainable resource management and conservation. Effectively then, 'capture' becomes a way of financing conservation and the two terms can be used synonymously.

This Chapter provides an overview of capture mechanisms. There is currently much enthusiasm and activity among International Organisations (IOs), Governments, Non-Governmental Organisations (NGOs) and the private sector in the development of new and innovative approaches for financing natural resource conservation. The introduction and adoption of new initiatives makes this an exciting and important research area as approaches are fine-tuned and seek to develop credibility. While this Chapter attempts to include all key initiatives it does not claim to be exhaustive¹⁹. 'Domestic' mechanisms can go a long way to securing important resource values and thus to promoting sustainable resource management. However, the most challenging area is the design of workable international mechanisms for the capture of global values. Global values can account for a significant proportion of TEV and are therefore highly relevant to the conservation argument (e.g., see Chapters 5 and 7). For this reason some emphasis has been placed on examining approaches in use or under consideration for capturing global externalities.

3.2 Overview of Capture Mechanisms

Capture mechanisms range from local taxes and user fees targeted at local resource values, to global conventions and internationally tradeable emissions permits designed

¹⁹ See Landell-Mills and Porras for a recent review of markets for forest environmental services.

to capture global benefits. A classification of capture mechanisms is provided in Table 3.1.

Table 3.1. Classification of Natural Resource Management Capture Mechanisms

Property rights	Market creation	Fiscal instruments	Charge systems	Financial instruments	Liability systems	Bonds
Ownership rights (land titles, water rights)	Tradeable emissions/ effluent permits	Pollution taxes (effluent / emissions)	Pollution charges	Financial subsidies	Legal liability (e.g., non-compliance charges)	Environmental performance bonds
Use rights (stewardship, licensing, concession bidding)	Tradeable catch quota	Input taxes	User charges	Soft loans		Land reclamation bonds
Development rights (patents, prospecting rights)	Tradeable development quotas / rights	Product taxes	Betterment charges	Grants	Natural resource damage liability	Waste delivery bonds
Coaseian bargains	Tradeable water shares	Export taxes	Impact fees	Location / relocation incentives	Liability insurance	Environmental accident bonds
	Tradeable land permits	Import tariffs	Access fees	Subsidised interest	Enforcement incentives	Forest management bonds
	Tradeable offsets/ credits	Tax differentiation	Road tolls	Hard currency at below equilibrium exchange rate		
	Transferable	Royalties and resources taxes	Administrative charges	Revolving funds		
		Land use taxes	Resource protection charges	Sectoral funds		
		Investment tax credits	Collection charges	Ecofunds/		
		Accelerated				

Property rights	Market creation	Fiscal instruments	Charge systems	Financial instruments	Liability systems	Bonds
	development rights	depreciation Subsidies Property taxes Capital gains tax		Environmental funds Green funds		

Source: derived from Panayotou, 1998

Pearce *et al*'s categorisation suggests an order according to which mechanisms might be introduced (Table 3.2).

Table 3.2. Types of Financing Mechanisms

Category / Step	Description	Forms of Financing / Pricing
1/ Capturing surplus value where property rights are absent	Ill defined or absent property rights result in surplus rents to individual resource users, but costs to society.	Establish property rights to enable pricing.
2/ Capturing surplus values where ownership exists	Where ownership exists but prices are set below revenue maximising level revenue capture is not optimal	Maximise revenues through price revisions. e.g., taxes and charges
3/ Capturing global incremental benefits	Charging for unmarketed benefits to reflect the full social value of an asset	Compensating flows of funds for external global benefits.

Source: derived from Pearce *et al* 1999(a).

Defining property rights is a logical first step in improving sustainable management of resources.²⁰ Secure property rights act to internalise social costs by making the owner directly affected by the depletion and environmental externalities associated with the use of the environmental resource. Where traditional, customary or communal rights exist, the best policy might be the recognition and strengthening of these rights rather than replacing them with private property rights, especially if the latter is alien to local culture. This is shown to be an important consideration in Ratanakiri, Cambodia

²⁰ Property rights may take the form of: (i) ownership rights, such as land titles and water rights; (ii) use rights, such as licences with geographical designation, concession bidding, usufruct certificates and access rights (e.g., to roads, parks); or, (iii) development rights. They may be private, communal or public (State).

(see Chapter 4). A number of countries have over the past few decades undertaken reforms giving local people greater rights and responsibility over forest. A recent study however (Edmunds and Wollenburg, 2002) concludes that while reforms have been good for forest, poor people have gained less than originally hoped, with local elites continuing to capture the lion share of the benefits.

The second stage is to determine prices that will maximise revenue. Often prices are set too low (e.g., forestry rents and tourism charges) because countries do not know the full revenue potential of their natural assets locally and internationally.²¹ The third stage is focussed on charging for un-marketed benefits, e.g., non-use values. In this case, funds may be provided to countries to compensate them for the global external benefits provided.

In this Chapter capture mechanisms have been classified according to forest component. An advantage of this is that some mechanisms are aimed at capturing the value of a specific forest component. A summary of relevant stakeholders, market development and potential capture mechanisms by forest category is provided in Table 3.3 and described in more detail in the following Sections.

²¹ Valuation techniques that derive demand curves, such as the TCM and CVM, can be used to identify consumer surplus and therefore to set entry and license fees for tourism sites.

Table 3.3. Capture Mechanisms by Forest Component

Good or service	Key Stakeholders	Market	Capture Mechanisms
Timber	Concessionaire	Markets exist but often inefficient	Fees, taxes, Property rights, concession bidding / pricing, environmental bonds
Fuelwood	Local communities/ urban centres	Usually none or local sales	Property rights, fees, taxes
NTFP	Local community	Usually none or local sales	Property rights, fees, taxes
Genetic information for pharmaceuticals / agriculture	Plant breeders Drug companies	Markets exist	Intellectual property rights fee, bioprospecting fees / royalties
Tourism/ Recreation	Visitors Tourism companies	Markets exist, but countries often fail to capture sizeable value due to underpricing and leakages	Entrance fees / charges Tradeable development quotas
Watershed benefits	Regional inhabitants	Markets emerging	Self organised private deals; trading schemes; public payment schemes
Climate benefits	Global community	Markets emerging	Joint implementation, Clean Development Mechanism, tradeable carbon permit system, spontaneous trades, prototype carbon fund, Forest Against Carbon Emission (FACE), Peugeot-Pro-Natura; Trees for travel ¹
Biodiversity (other than genetics)	Local and global communities	No market	Debt for Nature, conservation concessions, Purchase of Nature, Donations, 'Exotic carbon', Fiscal incentives.

Good or service	Key Stakeholders	Market	Capture Mechanisms
Amenity	Local residents	No market	Values capitalised in land and property prices
Non-use values	Local, national and global communities	No market	Environmental funds, debt for nature, Global Environment Facility (GEF), donations
Bundles of goods	Local, national and global communities	Markets emerging	Environmental shares ² , tradeable reforestation tax credits

Notes: 1/ FACE was set up by electricity generators in the Netherlands in the 1990 to plant trees to offset CO₂ emitted by electricity. It is now a foundation assisting third parties. Peugeot has a scheme with Pro-Natura that is putting money into reforestation. Trees for travel is a voluntary private sector scheme operating in different countries. 2/ A pilot project is underway in Columbia (see Robledao, 2002)

3.3 Timber and NTFP

Table 3.4 summarises some potential mechanisms for capturing timber and NTFP values.

Table 3.4. Examples of Mechanism for Capturing Timber and NTFP Values

Mechanism	Comments	Example (where available)
Communal tenure	May prevent deforestation more effectively than either state or private ownership if it provides entitlement and secure tenure to groups that benefit from a forest's sustainable use.	PNG – as much as 97% of the land remains communal; Philippines have granted 25 year communal forest leases through a Community Forest Stewardship Agreement between communities and the Forest Management Bureau; Vietnam – ‘People’s forestry’ begun in 1994, with the transfer of management authority for forest land from the State to households.
Property rights for NTFB	Concessions for NTFP and for recreational use may overlap with timber concessions, requiring logging companies (or land owners) to make proper compensation for loss of non-timber forest benefits (NTFB).	
Concession bidding	Where there is sufficient competition, bidding ensures that concessions go to the most efficient and productive operator and that maximum rents are extracted. The bidding price also provides a market based indicator for adjusting forest fees.	Congo, Ivory Coast, Ghana
Forest Pricing Policy	The sale price of timber concessions can be adjusted to account for NTFB and the impact of timber harvesting on them (positive and negative).	

Mechanism	Comments	Example (where available)
Forest fees and timber-taxes	Forest fees and taxes are generally too low to capture timber rents and to internalise the negative externalities of logging. Often forest taxes result in perverse effects, e.g., logging taxes based on the quantity of merchantable timber removed (rather than the timber on the site) thus encouraging high grading and damage to remaining trees.	Central African Republic levies a 'deforestation tax' on land clearing in public forest ranging from \$170-500 / ha depending on the type of public forest land. To the extent that the deforestation tax reflects the foregone non-timber values from logging, it acts as an economic incentive to reduce deforestation (Grut <i>et al</i>, 1991). Cameroon – fixed and variable taxes on land and amount of timber harvested. Brazil – 'deforestation tax' for unsustainable forest use.
Environmental bonds	Ensure that resource extracting companies and potential polluters take adequate measures to minimise environmental damage caused by their activities.	Employed in West and Central Africa and the Philippines (Forest Guarantee Bond) to promote sustainable forest management. Chile requires forest concessionaires to acquire insurance policies to cover potential environmental damage.
Economic incentives to support the regulation and management of concessions	Economic incentives such as performance or compliance concessions or deposits of refundable performance bonds may weed out speculators acquiring large concessions without making the necessary investments in forest inventory and efficient harvesting, processing, and regeneration.	The 'interim concession license' (Lettre d'Intention) introduced in Zaire in 1984 requires the satisfactory completion of 20 elements (specified in the application file) within 3 years before it can be converted into a full concession licence. Otherwise the interim licence is cancelled.
Forestry regulation	Timber cutting limits and rotation length, careful road layout, mandatory low impact logging methods, stream side buffer strips and wildlife corridors can be incorporated into forestry regulations.	

3.4 Hydrological Functions

There is considerable potential for, and interest in, using financial incentives to encourage the conservation of forest watersheds. This is due to the immense size of the global water market and the fact that investments in sustainable watershed management can be significantly cheaper than investments in new water supply and treatment facilities. Furthermore, regulatory approaches and/or subsidies to encourage soil conservation techniques have been ineffective.

Table 3.5 lists the main hydrological benefits of forests and opportunities for market based instruments (MBIs). In some watersheds opportunities for MBIs do not yet exist or are extremely limited. This is especially true in remote, very large, or sparsely settled watersheds and in countries with ineffective legal and regulatory frameworks. In other places the opportunity is there but its development is hindered by a lack of information about the source of the ecosystem service and who exactly benefits from it. Even where this is known, the beneficiaries of the service may have little interest in paying for a service they now believe they are getting for free.

Table 3.5. Water-Related Ecosystem Services from Forests

Benefit	Beneficiaries	Opportunities for MBIs
Water quality	Rural and urban domestic water users; industrial water users (distilleries, water and soft drink bottlers)	Highest application in watersheds serving relatively large populations
Flow regulation ¹ (surface and ground water)	Farmers, agricultural markets, property owners in flood plains, taxpayers, insurance companies, government agencies	Highest application in watersheds where chronic or catastrophic damages have cause major economic losses
Water Supply	Irrigators, municipal water utilities, electric utilities, and large industrial water users that require adequate water supplies during the dry season	Regions with annual dry seasons or frequent droughts where base flow demands meet or exceed supply
Aquatic Productivity	Sport and commercial fishermen, fishery management agencies, and tourism industry	Watersheds with high value fisheries

Source: Johnson *et al*, 2002

Note: 1/ Although forests generally reduce total annual water flow, in some cases they can increase minimum flows during the dry season (base flow).

A typology of incentive mechanisms according to the degree of government intervention in the administration of the mechanism is presented in Table 3.6.

Table 3.6. Capturing Forest Hydrological Services

Country	Self organised private deals
France	Perrier-Vittel's water sources are in heavily farmed watersheds where nutrient runoff and pesticides threaten the aquifers. Perrier-Vittel has found that reforesting sensitive infiltration zones, financing farmers to build modern facilities, and switching to organic farming practices are cheaper than building filtration plants.
Columbia	Water users' associations charge large-scale agricultural producers in the Cauca Valley fees to finance watershed management practices in upland areas. These practices include reforestation, erosion control on steep slopes, land purchases and protection agreements for springs and stream buffers, and economic development in upland communities. The objective is to improve base flows and reduce sedimentation in irrigation canals.
Costa Rica	Since 1988, a private hydroelectric power company has paid \$10/ha/year to the conservation organisation of Monteverde to maintain regular water flow for hydrological generation in the Penas Blancas watershed. The service is provided by private upstream owners of forest land (payments to landowners are supplemented by government funds).
Philippines	A hydroelectric power company provides incentives to local communities for reforestation activities (Mero, 2002).
	Trading Schemes
USA	Regulated factories (point sources) that must spend large sums on pollution control technologies to comply with their limits on nitrogen and other organic pollutants pay unregulated farmers (non-point sources) to reduce their emissions (Faeth, 2000).
Australia	Irrigation farmers purchase transpiration credits from State Forests which plant trees on state land upstream (State Forest of NSW). The next step in establishing this trading scheme would be for the government to establish forest cover targets for individual landowners or watershed areas.
	Public Payment Schemes

USA	New York City watershed management program is an alliance between federal, state and municipal governments to protect water quality in the Croton and Catskills watersheds
Brazil	The state of Parana uses a public redistribution mechanism to finance payments to those municipalities that take action either on their own or in cooperation with private land owners to protect watersheds. Allocation of the transfer payments is on a competitive basis; municipalities that protect more watershed area receive a larger allocation of the tax funds.
South Africa	The public works scheme 'Working for Water Program' is aimed at the removal of alien tree species and the restoration of native vegetation. These actions result in improved water supply at a fraction of the cost of water delivered through diversion or reservoir projects. Following the National Water Act (Act 36, 1998), land uses such as commercial forestry have been designated as Stream Flow Reduction Activities (SFRA) and land owners will be charged in accordance with the estimated flow reduction that these land uses charge (Hope <i>et al</i>, 2002).
Ecuador	Municipal authorities allocate part of their revenues to finance protection activities in watersheds from which they receive drinking water. The municipal authorities of Quito and Pimampiro created water funds by charging levies on drinking water (Hofstede and Alban, 2002). In Quito, the revenues of the water taxes are planned to be complemented by voluntary payments by major agricultural and industrial water consumers, and to be invested in nature conservation activities in upland areas. In Pimampiro, the fund was set up with the help of an environmental NGO and results in direct payments to forest owners. The municipal water company of Cuenca invested revenues from water into the purchase of upstream nature areas for strict conservation areas.

Source: Based on Powell and White, 2001 and Perrot-Maitre and Davis, 2001 with additional information added.

Transfer payments from downstream water uses to upstream stakeholders for ecosystem conservation are the most common mechanism being used. Self-organised private deals are most appropriate when the water services provided are related to private goods (bottled water, electricity, agricultural products) and where a strong link between land use and the watershed service is evident. These deals will take place

only if monitoring and transaction costs can be covered. Trading schemes are rare, but growing with private sector participation motivated by large cost savings opportunities. The complexity of designing and maintaining the financial mechanisms increases with scale due to the fact that the cost of collective action grows as more actors are involved and because the uncertainty surrounding the biophysical relationships between land use and hydrology increases with size. For this reason, it is most likely that private deals will focus on smaller watersheds, while publicly initiated systems will dominate in larger systems where watershed protection is desired for public reasons (Perrot-Maitre and Davis, 2001).

3.5 Capturing Global Values

Most global environmental values reside in the poorer countries of the world. They have a rich biodiversity, forests important for maintaining the balance of the global climate and for biodiversity habitat, and natural assets of recreational, educational and scientific value. What the poorer countries do not have is the financial means of conserving and managing these resources. Aside from the economic efficiency gains evident from global co-operation, it seems fair that the richer countries should pay their share for the benefits such global assets provide. Conservation of resources of global significance requires international funding.

The cost of implementing Agenda 21 (1993-2000) was estimated at an additional \$125 billion per year (1% of the North's GNP), plus \$500m per year additional expenditure from the South. More recently the Zedillo Panel on financing and development estimated the additional annual cost of achieving the 2015 International Development Targets would be approximately \$50 billion per annum, plus \$20 billion a year on Global Public Goods (GPGs) (UN General Assembly, 2001). Such estimates are considerably greater than the funds that have been made available in the post-Rio years. In 2000, official development assistance fell to its lowest level ever, declining to \$53 billion from \$56 billion a year earlier (OECD press release). The aid level in 2000 represents only 0.22% of the GNP of the developed countries, less than a third of the UN target of 0.7%. The situation is exacerbated by the debt servicing costs faced by the developing countries estimated at \$60-70 billion annually (Pearce

et al, 1999a). Muthoo 2002, notes that the 27 countries that between them account for 97% of the remaining tropical forests owe some \$670,000 million.

Not only have official resource flows from the North to the South shrunk, but they are now also expected to cover more tasks. The World Bank and UNDP estimate that at least 15% of ODA is now being spent on providing GPGs rather than for development assistance in the narrower sense (World Bank, 2001, UN General Assembly, 2001)²². Raffer, 1999 suggests the figure is at least 40%. It is argued that GPGs ought to be financed by new and additional means that are referred to separately from ODA statistics, as stated in the Rio conventions. It is widely acknowledged that conventional sources of international development financing are inadequate and that a range of 'new and innovative' financing options are needed to help meet financial targets²³. Key approaches for internalising global values are summarised below.

3.6 International Tourism Use Values

A straightforward way of capturing international use values is to set higher entrance fees for foreigners to sites of international significance. Such an approach may be considered equitable insofar as foreigners receive far greater benefits than they are currently being asked to pay for, they do not pay taxes to support the park, and they do not bear the opportunity costs of not using the land for agriculture, logging or other activities (Linderberg 1991, Chase *et al*, 1998).

Demand for well-known tourism sites is often highly inelastic. For example, in 1989 the Department of Wildlife and National Parks in Botswana raised park entry fees for non-residents by 500-900% (from \$1.20 to \$7 or \$11.50). The fee increase did not affect foreign visitor numbers and monthly park revenues increased by some 890%

²² GPGs include the protection of rainforest, the seas and the ozone layer, staving off global financial crises and promoting international security

²³ An innovative financing mechanism (IFM) may be defined as an institutional arrangement that results in the transfer of new or increased financial resources from those WTP for sustainably produced goods and / or forest ecological services, to those willing to provide those goods and services (Verweij, 2002).

(Barnes, 1996).²⁴ A further step towards maximising revenues is price differentiation between parks (adopted by many countries for non-residents and non-national residents). Demand for protected areas within a country is highly dependent on site specific characteristics such as ecosystem type, vegetation, wildlife diversity/density, possible recreational activities, tourism infrastructure, the park's accessibility and price. Depending on the own price elasticities of demand for parks and cross-price elasticities between parks (their substitutability), one can use differential pricing to influence visitation rates and hence maximise revenues²⁵. Such an approach might be useful in Turkey which has a diverse national parks system (see Chapter 5).

3.7 Biodiversity Conservation

'Biological diversity' (biodiversity) is an umbrella term used to describe the number, variety and variability of living organisms in a given assemblage. Biodiversity may be described in terms of genes, species and ecosystems, relating to the three fundamental and hierarchically-related levels of biological organisation.

3.7.1 Conservation Concessions

Conservation International (CI) has developed the concept of 'conservation concessions' (CCs) under which a government or local resource user agrees to protect a natural ecosystem in exchange for a steady stream of structured compensation (Rice, 2002). The opportunity cost of foregoing natural resource exploitation, including lost employment and government revenue for taxes, serves as a basis for determining the amount of payment. Payments also reflect the cost of government administration and enforcement. CCs are operating in Guyana, Guatemala and Peru, and are under consideration in Cameroon, Indonesia and Madagascar. CCs are opening up a market

²⁴ However, there were some substitution effects with a drop in visitations from neighbouring African countries and a further increase of visitations from overseas.

²⁵ Chase *et al* (1998) calculated revenue maximising entry fees for three national parks in Costa Rica using a contingent behaviour methodology. They conclude that current parks fees are not optimal in terms of revenue maximisation and that differentiated park entrance fees are needed.

where tropical countries have a comparative advantage, namely biodiversity conservation. They also involve local communities and preserve national sovereignty.

3.7.2 Purchase of Nature

The Netherlands Committee for the International Union for the Conservation of Nature (NC - IUCN) operates a small grants program for the purchase of nature. The program provides financial support to NGOs for the strategic purchase of relatively small but critical natural areas that are at risk in developing countries (Blom *et al*, 2002). The National Postcode Lottery funds the program to the amount of 453,800 Euros per year. A strict condition of the programme is that the legal system of the country involved should allow purchase of nature by NGOs. To date, Poland, Costa Rica and Ecuador have been assigned a grant.

3.7.3 Fiscal Incentives

An innovative tax revenue sharing scheme designed to promote the conservation and management of protected areas - ICMS Ecological, has been introduced in a number of states in Brazil. The Scheme aims to compensate municipal governments for the loss of potential tax revenue from the designation of protected areas (mainly by the State and federal government). It is also intended to have an incentive effect, encouraging both better management of existing protected areas as well as the designation of new conservation areas (Greg-Gran, 2000).

Box 3.1. The United Nations Convention on Biological Diversity (UNCBD)

The UNCBD has 168 signatories and 181 parties. Malaysia ratified the convention in 1994, Turkey in 1997, while Cambodia acceded to the convention in 1995²⁶. The objective of the CBD is: 'The conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilisation of genetic resources, including the appropriate access to genetic resources and by the appropriate transfer of relevant technologies'. The Convention stresses the importance of international, regional and global cooperation among nations, IOs and the NGO sector, and the principle of burden sharing. The CBD acknowledges that substantial investments are required to conserve biological resources and that current sources and channels of funds are far from adequate. As such, financial institutions need to augment their conventional facilities as well as identify new and innovative ways for attracting additional financial resources. Article 11 recognises that the preservation of environmental resources is intimately linked to the provision of economic incentives for individuals, groups and nations. It has provided support for both the fair and equitable sharing of benefits derived from genetic resources and the recognition of rights over these resources.

3.7.4 Bioprospecting and Benefit Sharing

Biodiversity prospecting, or bioprospecting, is the process of gathering information from the biosphere on the molecular content of natural resources (i.e., natural products) for the development of new commercial products (Zilinskas and Lundin, 1993). Biodiversity has historically been treated as a global common property resource. This means that bioprospectors could develop valuable pharmaceutical products from material taken from the wild, without any requirement to return any part of the gain to the source country. The benefit sharing question addresses the division of returns between host countries who own the resource and countries utilising the resources. Central to this is the form of contract that binds the user to compensate the supplier. A good contract sets up an incentive system that is mutually beneficial in terms of capturing and sharing global values in a way that conserves the resource base by influencing the incentives for stakeholders. Such a requirement is difficult to achieve in practice due to the problems of moral hazard, adverse selection,

²⁶ Accession (Article 35) requires Cambodia to declare the extent of their competence with respect to the matters governed by the Convention and to inform the Depository of any relevant modifications.

monitoring costs, expectations of contract renewal and aversion to risk (Pearce *et al*, 1999a²⁷). Pearce *et al* conclude that in practice because of the asymmetry contracts are never totally efficient. A dynamic combination of incentives is the second best approximation often working within the confines of a multitude of area-specific cultural norms and beliefs governing the use of local products. While no single contractual form predominates on bioprospecting agreements, some features appear to be standard. Host countries and communities are risk adverse, and most contracts acknowledge this by providing some form of up-front payment. Most contracts also include a provision for royalties. In 1999 four types of contracts were found to be in use, these are summarised in Table 3.7.

²⁷ Moral hazard describes a situation where the security of payment for a contract leads the agent to provide a sub-standard level of service performance, e.g., in providing the agent with an agreed number of wild samples. Adverse selection arises when one party holds information at the time of negotiation that affects the value to the other party, e.g., a country accepting a contract in an area it knows to hold little value.

Table 3.7. Characteristics of Bioprospecting Contracts

Company:	INBio/Merck	Biotics	Shaman	ICGB/Surinam¹
Parties	National <i>Biodiversity</i> Institute of Costa Rica (INBio), Ministry of Environment and Mines (MINAE) Costa Rica. Merck & Co (pharmaceutical firm).	Various	Various	Various
Comments	INBio to supply Merck with samples for pharmaceutical screening over 2 year period.	Biotics Ltd, a private company, acts as an intermediary between pharmaceutical companies and supplies of plant samples from developing countries.	Emphasis on indigenous ethno- botanical knowledge.	CI and Missouri Botanic Garden to conduct local inventory, Bristol Myers Squibb Pharmaceuticals provide training and equipment to local pharmaceutical company.
Advance payments	Monetary (\$1 million)	No	20% of field research budget used to finance local projects.	Inventory of biodiversity
Sample fees	Yes	Yes Initial payment of £25	No	No

Company:	INBio/Merck	Biotics	Shaman	ICGB/Surinam¹
Royalties to collectors	Yes	Yes 50% of any royalties received by Biotics.	Yes	Yes
Royalties for information	No	No	Yes	Yes
Technology transfer including overseas education	Yes	No	Yes	Yes
Funds for conservation	Yes INBio invest 10% of any payments and 50% of royalties into conservation areas.	Maybe	Yes	Yes 50% of royalties go to 'Forest People's Fund' for the indigenous people of Suriname.

Source: Adapted from Pearce *et al*, 1999a

Notes: 1/ The ICBG program was established by four US agencies, the National Institute of Health (NIH), the National Science Foundation and the US Agency for International Development (USAID). The aim was to build a partnership between science and industry in the United States and host countries, there are currently 5 projects that cost about \$500,000. Other ICBG projects are located in Peru, Costa Rica, Argentina, Chile, Mexico, Cameroon and Nigeria. Corporate involvement includes the Monsanto Company, BMS, Sharman, and American Cyanamid.

Given that some 40-90% of the world's species live in tropical forest, mega-diverse developing countries can be expected to secure most of the bioprospecting market. However, while the CBD seeks to establish intellectual property rights in genetic material, facilitating further trade in bioprospecting, a number of recent studies suggest that bioprospecting has a very low return (see Section 9.3).

3.8 Financing Carbon Sequestration

All forests are of value for their carbon storage function. The clearing and burning of forest releases carbon dioxide into the atmosphere which contributes to the greenhouse effect and hence to global warming.

Box 3.2. The UN Framework Convention on Climate Change (FCCC) and the 1997 Kyoto Protocol.

The FCCC has been ratified by 175 countries and is the centrepiece of global efforts to combat global warming. Adopted in 1992 at the Rio Earth Summit, its ultimate objective is the 'stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system'. The Convention sets guiding principles such as the principle of 'common but differentiated responsibility' of states, which assigns the lead in combating climate change to developed countries. Other principles deal with the special needs of the developing countries and the importance of promoting sustainable development.

The FCCC pledged the OECD plus the states of Central and Eastern Europe, known as Annex 1 countries, to adopt policies and measures aimed at stabilising their Green House Gas Emissions (GHG) to 1990 levels by the year 2000. They were also expected to provide 'new and additional financial resources' to fund the costs incurred by developing countries in submitting their national communications, and to facilitate technology transfer. Only two countries honoured these targets, arguably as a result of fulfilling other primary objectives - Britain through electricity privatisation and Germany through the absorption of East Germany.

In December 1997, the Conference of the Parties (COP) adopted the Kyoto Protocol.²⁸ It sets new reduction targets - Quantified Emission Limitation and Reduction Objectives (QELROs) for the Annex 1 countries (listed as Annex B in the Protocol). These countries are legally bound to reduce their collective GHGs by at least 5% compared to 1990 levels by the period 2008-2012. The European Union (EU) has ratified the Kyoto Protocol but the US, the biggest emitter of CO₂, remains opposed to it and the Bush Administration has devised a US Climate policy separate from Kyoto, based on reducing GHG intensity.

Barrett, 2001 argues that the Protocol provides poor incentives for participation and compliance, and

²⁸ The COP comprises all states that have ratified the Convention. Its role is to promote and review the implementation of the Convention.

that as designed will have little effect on the climate. The minimum requirement is set at such low levels that the agreement can enter into force while limiting the emissions of less than a third of the global total. At Bonn 2001, countries agreed on a compliance mechanism. This requires that countries that fail to meet their emission ceiling in the first control period (2008-2012) make up for the short fall and reduce its emission by an additional 30% of this amount in the next control period (2013-2017). This is a defective proposal because: 1/ It cannot be binding in the first period. 2/ It relies on every party punishing itself for failing to comply. 3/ Emission limits for the second control period have yet to be negotiated (a country may then hold out for easy targets in the second control period). Barrett believes that there is no ideal remedy for global climate change because of the problems with international governance.

3.8.1 Trading Under the FCCC

The Kyoto protocol enables countries with mandatory GHG reduction commitments to offset some of their domestic emissions by emission reductions and enhancement in sinks in other countries. The protocol considers 3 types of 'offsets' or 'trades'.

- (i) Joint implementation (JI) between Annex 2 countries (Article 4)
- (ii) A form of joint implementation between Annex 1 and non-Annex 1 countries known as the Clean Development Mechanism (CDM) (Article 12).
- (iii) Global emission trading Article 17 states that parties listed in Annex B (i.e., countries with mandatory quantitative targets) 'may participate in emission trading'. Such trading must be 'supplemental to domestic actions' to meet stated target.

JI and CDM are a form of credit trading. Anyone securing a reduction in emission (or an increase in sequestration) over and above some baseline is awarded some credit for doing so. In a fully tradeable system, those credits could be sold on to others. These credits can be set against the QUELRO of the country acquiring the credits. Emissions trading on the other hand is a form of allowance trading. Each emitter is given an allowance, the maximum emissions that it is allowed to have up to some point in the future. Any emission less than this allowance produce another form of credit that can be stored ('banked') or sold to others. Both CDM and JI can proceed

piecemeal and have the potential to operate quickly, whereas emission trading will involve complex collective agreements about the assignment of allowances and may therefore be some years away.

One way of looking at the potential size of the market is to assume that about one billion tonnes of carbon emissions must be reduced per year during the commitment period of 2008-2012 in order for the industrialised countries to meet their obligations of a 5% reduction in their 1990 level of emissions. If half this volume of reductions is to occur through trade and the price range is \$20-40 per ton of carbon emissions, the trade volume is in the range of \$10-20 billion per year. Because developing countries have opportunities to achieve their carbon emissions reductions at around this price, a significant proportion of the trade is likely to occur between them and the industrialised countries under the CDM (www.prototypecarbonfund.org). However, sink related activities can only be used to offset up to 1% of the carbon emissions of an Annex 1 country (UNDP, 2001).

Joint Implementation

Under the JI concept country 'A' secures a benefit by reducing emissions or undertaking conservation in country B. Since the costs of emissions reduction / conservation differ across locations, the benefit to A is the possibility of securing least cost credits under some global environmental agreement for meeting its obligations to improve the environment (or it may be that A simply seeks a good global 'green image')²⁹. The gain to B is that A pays for the reduction and in doing so transfers modern technology to B, or generally provides a benefit to B, perhaps in the form of employment or local environmental improvements.

Under the FCCC Annex 1 countries are enabled to trade among themselves to secure emissions reductions units (ERUs). Trades cover emission sources, such as the burning of fossil fuels, and sinks. Sinks refer to the growing of biomass (trees and

²⁹ The first 'joint implementation' agreement was reached between Mexico, Norway and Poland through the GEF. Under this agreement, Norway agrees to create additional financing (through the revenues from its own carbon tax) for GEF carbon-reducing project in Mexico (energy efficient lighting) and Poland (converting from coal burning to natural gas).

other vegetation) which absorbs, or fixes carbon dioxides from the atmosphere at a faster rate than it emits it. These trades must be additional, i.e., over and above what would happen without the project, and must be supplemental to domestic actions, implying that despite trading, the emphasis must be on domestic reduction activities. More than 150 JI trades have already been reported to the Secretariat of the FCCC as 'Activities Implemented Jointly' (AIJ). AIJ was initiated by the COP with the aim of learning how JI would work. AIJ projects cannot secure credits against the 2008/10 Kyoto targets, so they understate the potential of the trading.

JI trades may be between governments and / or the private sector and can be an important source of additional financial flows with both local and global environmental benefits, provided it is incremental to existing flows and does not distort the host countries' development priorities.

The Clean Development Mechanism

The CDM is similar in concept to JI, but relates to trade between to Annex 1 and developing countries rather than to intra-Annex 1 trades. CDM trades must contribute to the sustainable development of the developing country. The CDM seeks to assist non-Annex 1 countries to achieve sustainable development, while assisting Annex 1 countries to meet their emission reduction commitments. The units of credits under the CDM are 'certified emissions reductions' (CERs). During the pilot phase a wide range of activities were funded, including forest conservation, restoration and management. The carbon sequestration costs were variable, but far below theoretical estimates of its economic value of between \$10-50. Concrete carbon sequestration prices depend on the type of forest ecosystem, the proposed activities, and the method used.

CDM was expected to become a substantial source of finance for tropical forest management, however the Bonn COP6, July 2001 set important restrictions to this application, discussed in Section 3.8.2 (Skutsch, 2002). Arguably, the 'adverse effects' and adaptation' funds of the climate treaties provide better opportunities for sustainable forestry than the CDM. These funds are not intended to save carbon, but to support projects or programs that counteract the adverse effects of climate change, particularly in the more vulnerable countries. An Adaptation Fund is to be financed

by a levy of 2% of the value of carbon savings on all CDM projects. At Bonn two new funds were set up under the UNFCCC - a special Climate Change Fund and a fund for Least Developed Countries. The EU, Switzerland and Canada have pledged to donate \$420 million per year to these funds from 2005. Contributions to these funds are entirely voluntary.

An alternative route for CDM financing might be to manage forest for bio-energy. Forests would then qualify not as sinks *per se* but rather as a form of alternative fuel supply. Developing countries might even argue that the sustainable management of forest for fuelwood production and other benefits could in itself represent an effective means of carbon mitigation. At least 2 billion people use firewood or charcoal as their primary cooking fuels (Skutsch, 2002).

The Prototype Carbon Fund (PCF)

The World Bank's PCF is a new product that aims to demonstrate how project-based emissions transactions can mitigate climate change with the objective of stimulating a global emission reductions market. The Bank will generate knowledge on how public and private entities can participate in the global market for project-based emission reductions in the framework of the Kyoto Protocol. The PCF aims to invest in 20 or so projects, covering a range of technologies and countries, under both JI and CDM. A central objective of the Fund is to demonstrate how the CDM can be an effective vehicle in helping developing countries to meet their sustainable development objectives. The Bank does not intend to remain a player in the market once the private sector confidence has been established and the market is open and functioning.

3.8.2 The Kyoto Protocol and Forest Conservation

The principle of including terrestrial carbon sinks, such as forest ecosystems, as a means of offsetting emission of carbon from fossil fuel combustion, remains one of the more controversial elements of the Kyoto Protocol.

The potential for such activities is significant. The IPCC TAR (Intergovernmental Panel on Climate Change, Third Assessment Report) estimates a biological sink potential of up to 100 Gts over the next 50-100 years. This could capture 10-20% of

the anticipated net fossil fuel emission between now and 2050. However, there are a lot of unresolved issues, for example:

- (i) Forestry carbon accounting and registration systems are still to be developed.
- (ii) The rules and regulations as to how a project can qualify for CDM are scheduled to be worked out at COP9 in 2003. However, the decision of COP7, Marrakech 2001, allows the immediate start of CDM projects, provided that these will meet with the technical requirements to be decided upon in 2003.
- (iii) Article 3.3 is restricted to plantations and projects that involve a clear land use change, such as from non-forest use to forest, or from deforested areas back to forest. These definitions leave room for multiple interpretations.
- (iv) Projects involving improved management of existing / natural forest areas are at present not eligible for CDM status, as they are categorised as 'additional activities' (Article 3.4 in the Kyoto protocol). This means that an existing forest managed by a local community, for example, would not qualify for CDM funding even though the benefits to the local population were significantly higher than a plantation scheme. In some cases, plantation projects have led to the total exclusion of local people from the forest area in order to safe guard the carbon stock (Skutsch, 2002). There is further the risk that the Annex 1 countries will focus on the price of carbon (i.e., the cheapest) as their top investment criterion, while in terms of social justice other considerations should be considered (e.g., impacts on local community and biodiversity benefits). This makes it unlikely that many ARD projects will measure up to the standards for sustainable forest management under the CDM proposed by CIFOR (2000).
- (v) There is some concern that the cost of sinks is in fact much higher than the supposed \$5. Aside from the cost of planting, carbon sequestration costs include monitoring and transaction costs, business plan development and risk mitigation. This is likely to put carbon sequestration beyond the means of local communities.
- (vi) The availability of funds for CDM is unclear given that the development of the market for CDM is hard to predict and the USA's non-involvement in the Kyoto Protocol.

A fundamental issue regarding the sequestering carbon in forests as opposed to reducing GHG from fossil fuels is that of permanence – can we assume that the sequestered carbon will remain ‘locked up’? As a means of addressing this issue, Sedjo *et al* (2002) suggest a rental contract for potentially ‘non permanent’ emissions credits³⁰. Such an approach establishes continuous responsibility for the sequestered carbon; credit would be assigned when carbon is sequestered and debits would accrue when carbon is emitted. Such a system recognises that stocks and flows can be alternative descriptions of the same phenomenon, and that a stock may not exist in perpetuity to have an equivalent flow. Under such an approach it is essential to establish liability, i.e., who is responsible if and when the CO₂ is released to the atmosphere³¹. This approach links in well with the need to define sustainable sinks. The creation of carbon ‘cemeteries’ where carbon is locked up for a 100 years does not appear to be realistic. Trees that could be sustainably harvested would rot within this timeframe.

A market in GHG emissions reductions (carbon) is emerging in the EU. The UK, Denmark, The Netherlands, Italy, and Germany are setting up emission allowances, crediting or trading schemes and the EC wide trading system is due to start in 2005. However, forestry-based carbon investment must wait until 2008 to be included under the Kyoto protocol and is excluded from the proposed EC-wide carbon trading system. The early carbon market is then likely to be ‘locked in’ on energy sector to the exclusion of forestry carbon.

³⁰ The Government of Columbia, 2000, proposed a similar approach.

³¹ An alternative solution to the permanence issue is the ton-year approach in which activities would accrue credits for each year that a ton of carbon is withheld from the atmosphere and some quantity of ton year would be equated with a permanent ton.

3.9 Financing a Combination of Services

3.9.1 Global Environment Facility

The GEF was created in 1991 to be the financing mechanism for the UN Framework Convention on Climate Change, the UN Framework Convention on Biological Diversity and the Montreal protocol on ozone depleting substances³². The GEF only funds the agreed incremental costs of projects that will achieve global environmental benefits. 'Incremental cost' refers to the costs that countries would have to bear if they were to modify their developmental plans so as to ensure that global benefits are taken into account. The rationale is that if there is a global external benefit from conservation then the 'user' of that benefit, i.e., the global community, should pay for it. Without this provision, the host country is unlikely to act in the global interest. Financing from the GEF can therefore be seen as a charge by the host country to the rest of the world for the external benefits it has created. As of June 2000, the UNDP-GEF portfolio totalled \$1.045 billion. Funds have remained at a very modest level for the past 10 years, and for the period 1998-2002, the GEF has a mere \$2.75 billion at its disposal.

3.9.2 Environmental Funds

Environmental Funds (EF) are specialised funds or institutions (e.g., trust funds, foundations, endowments, revolving funds) designed for managing money and disbursing it to people or projects that help protect the environment. Since the 1990s, more than 100 such funds have been established around the world. Funds are generally single or multi-issue. Single-issue funds have a very specific mission (e.g., in Uganda an EF helps finance the Mgahinga National Park and the Bwindi Impenetrable Forest National park). Multi-issue funds have a broad mission such as 'the protection of biological diversity' or the 'achievement of sustainable development' (e.g., The Indonesian Biodiversity Foundation and the Fondo Mexicano Para la Conservacion de la Naturaleza). They vary greatly in terms of their funding,

³² The GEF addresses four general environmental concerns: biological diversity and ecosystem protection, ozone depletion, climate change, and the improvement of international waters.

governance, structure, purpose and funding priorities, and may operate at the local, regional or national level. Some of the key issues associated with EF are summarised in Box 3.3.

Box 3.3. Environmental Funds

- (i) **The sources of funds:** Major capital funding for EFs has come from national government payments resulting from debt for nature swaps, and from other bilateral or multilateral sources such as the GEF. However, environmental funds are also increasingly focusing on harnessing in-country resources (such as user fees, taxes and levies, income from privatisation and donations) to ensure long term financial stability.
- (ii) **The Fund's long term plan:** Funds with clear plans and with specific criteria governing the use of funds tend to be most successful.
- (iii) **Fund Governance:** EF may be structured and governed as government or government majority funds, NGO majority funds, or joint government – NGO funds. The most successful funds tend to be those created in the private domain involving both governments and NGOs.
- (iv) **Asset management:** the long term viability of the fund is strongly dependent upon the way in which the money is managed, the rate of return on investment, and the use of the fund's capital base.
- (v) **Grant making criteria:** Typically both the public and private partners involved in the fund jointly establish the criteria by which projects will be chosen for funding. Local participation should be built into the project preparation assessment.
- (vi) **Fund Monitoring and Evaluation:** Mechanisms should be established before the projects are funded.
- (vii) **Legal Status:** The legal status of EFs can take several forms: foundation; non-profit corporation; common law trust; or a trust established by act of a national legislature.

Source: Bayon *et al.* 1988

Box 3.4. National Environmental Funds

National environmental funds (NEF)– national in scope and created by people and organisations committed to developing innovative, participatory, long term approaches to the conservation of natural resources – are part of a movement to create a local solution to environmental challenges and provide an alternative to the short term projects undertaken by financing institutions. NEF collect and disperse public money in support of national environmental strategy, environmental action plans or environmental policy. They are usually funded or capitalised from pollution charges, fees and fines, budgetary contributions, debt for nature swaps or contributions from donor agencies. Funds in effect disburse subsidies (through grants, reduced interest payments, direct loans, loan guarantees, equity investments and co-financing with commercial banks, public financial institutions, private enterprises and NGOs) in order to achieve environmental policy goals.

In developing countries NEF tend to be more specific and, because environmental taxation is not as well developed as in transition economies, they rely on external sources or other fees for their funds. Pearce *et al* (1977) reports that in Algeria the main source of the fund is a tax on airline tickets, and in Costa Rica a tax on petrol, while Brazil's municipal environmental funds are financed by World Bank loans. The Protected Areas Conservation Trust (PACT), Belize, was created in 1996 to provide a sustainable source of funds for the conservation and management of the country's protected areas. It is financed from a 'conservation fee' of \$3.75 charged to foreign tourists as they leave the country, together with 20% of the revenues collected through park entry fees, concession fees, permit and licence fees, and cruise ship passenger fees. In Costa Rica, a program of Payment of Environmental Services (PES) includes monetary compensation by the Costa Rican Society to private landowners either for maintenance of primary forest, establishment of forestry plantations, or forest management (Reyes *et al.*, 2002). The National Forestry Finance Fund (FONAFIFO) takes care of these area-based payments. FONAFIFO is financed with funds provided by the national government, from taxes on fossil fuel consumption, for example. From 1997-2000, the PES program included more than 250,000 hectares of private landowners (4.9% of Costa Rican territory). Of this land, 85% corresponds to forest protection, 9% to forest management systems and 6% to plantations.

A key to future success is more efficient management, reduced administration costs and use of rigorous cost-benefit analysis of projects as the principal criterion for disbursing funds.

3.9.3 Debt Conversion

Debt conversion deals can be structured to relieve the debt burden of developing countries and provide local currency for the purposes of conservation. The debt for nature swap was the first type used. Variation on the debt conversion approach such

as debt for equity conversions, debt rescheduling, debt for policy reforms or debt for sustainable development may also hold promise.

A debt for nature swap involves an indebted country exchanging its foreign debt for a newly created domestic obligation, which typically involves local currency payments into a fund to finance conservation activities. There are potential gains for all parties involved³³. Swaps to date have relied on donations of private debt or purchases on the secondary market by NGOs. Since the first debt for nature swap in 1987, some \$1billion has been leveraged at the global level for conservation (Keipi, 2002) – small compared with the international debt burden of some \$1.3 trillion. Nonetheless, the NGOs that negotiate such arrangements receive substantial funds for natural resource conservation.

Debt swaps have typically involved bilateral or commercial debts. For various reasons (such as concern about credit ratings) multilateral creditors, who hold the lion's share of outstanding debts in many developing countries, have been opposed to such debt 'forgiveness'. This is changing with the multi-donor supported Highly Indebted Poor Country Initiative (HIPC) on debt.

3.9.4 Transferable Development Rights

Transferable (tradeable) development rights (TDRs) distinguish between development and ownership rights and provide a route for side-stepping the sensitive issue of ownership. Ownership of an area of public importance is not altered but development of the site is prohibited. However, property owners can transfer to other sites or sell their development rights to others and thereby recover their full market value. TDRs have been used in the conservation of historical buildings, archaeological sites, cultural heritage, wetlands and coastal areas (e.g., Puerto Rico), and is under

³³ If the foreign debt is acquired at a good discount the swap may be attractive to the debtor government. The commercial bank is able to regain some cash for the developing country's non-performing note and is able to clear its book. The central bank that redeems the note for local currency is relieved of a portion of its debt. The donor gets more impact for its grant money through a better rate of exchange for its donation for conservation.

consideration by a number of countries as an instrument in the conservation of greenbelts, forest and biodiversity.

In principle, TDRs could be used internationally as an instrument of payment by the North for conservation and supply of environmental services in the South. Tropical countries could set aside habitats for biodiversity conservation and divide each habitat into a number of TDRs, corresponding to an area, for example a hectare. The TDR would state the location, condition and diversity and degree of protection of the habitat and any special rights it conveys on the buyer/holder. TDR could then be offered for sale both locally and internationally at an initial offer price that covers fully the opportunity costs of the corresponding land unit. Costa Rica is experimenting with international tradeable development rights.

3.9.5 Tradeable Reforestation Tax Credits

In Costa Rica, landowners who protect natural forest or reforest their land receive payments of about \$50/ha /year financed from energy taxes, the sale of carbon offset, and international donations for biodiversity conservation. A transferable tax credit system was introduced to benefit small land holders who can sell their tax credit to wealthier taxpayers to offset their high taxes.

3.9.6 International Environment Taxation

Taxing activities that impose global negative externalities could raise significant funds for conservation. A number of international taxes have been proposed including an international carbon tax on energy fuels and an international air transport tax. Politically however, global taxation is unpopular as it requires nations to yield their sovereign powers to a supra national authority. They would necessitate alternative institutional arrangements which assured the minimum possible delegation of tax authority. Possible solutions include the harmonisation of national taxes through international agreements, and non-sovereign international taxes along the lines of the European Union taxes that involve a minimum delegation of sovereignty and allow member states to keep a percentage of the tax revenue for their own use.

3.10 The Role of the Private Sector

While aid from OECD countries to the developing world has been falling, the flow of private capital (portfolio investment and foreign direct investment) has been increasing rapidly. According to the World Bank (WB) private investment in and lending to developing countries increased from \$44 billion in 1990 to \$244 billion in 1996. This raises the question of whether private capital flows could become a major source of funding for sustainable land use in developing countries. This possibility is promoted by a number of international development bodies.

Governments, bilateral aid agencies and multilateral institutions (such as the WB and the GEF) are trying various ways of leveraging private funds for investment in the environment. Private enterprises are attracted to more risky projects (technologically or financially) by financial incentives (grant, co-financing, lower interest payments). The WB and International Finance Corporation (IFC) are exploring ways to set up joint venture capital funds for biodiversity. Other publicly sponsored venture capital funds for biological diversity include: the Global Environment Emerging Markets Fund (US Government sponsored), the Nordic Environmental Finance Corporation (sponsored by Nordic countries and the North America Environmental Fund (partly sponsored by the Japanese Overseas Economic Co-operation Fund)³⁴. Another potential source of funding is ecological funds. These funds are a business response to growing environmental concerns and a desire to cash in on a new and more eco-friendly corporate image. It is estimated that socially screened and actively used portfolios now account for 10% of portfolios internationally.

Of concern is the fact that private capital rarely reaches the lowest income countries. It tends to flow to countries whose economies are relatively healthy – i.e., ‘middle income’, ‘newly industrialised’ or ‘emerging’ countries such as Brazil, Mexico, China, Malaysia, Thailand and Indonesia. Africa attracts very little investment, most of it for oil exploration and extraction. A study of the potential of UK portfolio investors to finance sustainable tropical forestry found that the greatest obstacles were

³⁴ See CBD COP 2 – Study of the Availability of Additional Financial Resources: Commercial and Investment Banking Institutions.

the small size of tropical forestry companies and the fact that they were not publicly listed. Again, the geographical location is an important factor. Emerging market and fund managers favour South East Asia followed by Latin America and Africa. All investors surveyed were willing to invest in Malaysia as a selected emerging market (Gullison *et al*, 1998).

The private sector is paying a catalytic role in the development of emerging markets in environmental services. There is a growing enthusiasm, for example, among fund managers, insurers, private companies in the emerging carbon market. Many corporations are moving ahead on carbon initiatives, as they know they are going to face a carbon liable future and recognise the benefit of planning for it. This is happening in the USA despite President Bush's position on climate change.

3.11 Selecting the Right Instrument

The choice of capture mechanisms will be influenced by a site's characteristics and will be guided by considerations of its environmental and cost effectiveness, flexibility, ease of introduction, monitoring and enforcement, and acceptability. There are pros and cons associated with most funding mechanisms (see Table 3.8 for summary). A difficulty is that since many of these approaches have yet to be tested, there is little real life experience with which to direct and inform the development of such capture mechanisms. This situation is gradually changing however.

Table 3.8. Advantages and Disadvantages of Capture Mechanisms

Funding mechanism	Advantages	Disadvantages
INTERNATIONAL CO-OPERATION		
Kyoto Protocol – Joint implementation / CDM	Potentially large amounts of funds Potential government - private sector collaboration	Requires unprecedented levels of co-operation and agreement Impact on sustainable forest management limited. Natural forest excluded Equity concerns Sustainable sink system that realised carbon and timber values not yet defined Lack of emphasis on fossil fuel reduction and benefits of avoided deforestation
International taxation	Potentially vast amounts of funds Can influence policies to be more supportive of conservation	May not be GATT compatible; requires political will Fund may be diverted to purposes unrelated to conservation.
Funds from trade in tropical timber	Could raise \$1.5 billion per year, with no effect on final product prices Provides incentive for improved forest management	Consumer countries forgo significant tax revenues Needs internationally agreed monitoring and enforcement
GEF	Additional funds for protection of global environment	Modest amount of funds available

Funding mechanism	Advantages	Disadvantages
Prototype Carbon Fund	Confidence building of carbon emissions market	
GOVERNMENTS		
Taxes and charges	Can generate significant funds Can build on 'polluter pays' and 'beneficiary pays principle' 'Green taxes' can change consumer behaviour in favour of conservation without increasing the total tax burden	Taxpayer resistance Conservation rich areas often distant from sources of funding Monitoring / enforcement costs can be high
Tradeable permits	Can generate funding in the billions of dollars Can change behaviour Specifies opportunity costs and provides mechanism for beneficiaries to pay for them	Administratively demanding Difficult to translate to international level
Property rights	Gives responsibilities to those living closest to the resource	Difficulty of government monitoring of resource management in remote areas Privatisation can destroy effective community based management systems
Debt related measures	Can generate funds in national currencies and reduce (slightly) debt burdens	Some resentment of conditionality
PRIVATE/ PUBLIC SECTOR		
Trading Schemes (hydrological functions)	Potential cost savings	

Funding mechanism	Advantages	Disadvantages
Environmental funds	Flexible Can be structured to ensure long term financial stability	
PRIVATE SECTOR		
Private Water deals	Effective management of private goods	High transaction / monitoring costs
Transfer of development rights	Respects sovereignty	
Prospecting rights and biological royalties	Funds can be generated by discoveries of new drugs or other substances from nature	Needs effective international agreement on intellectual property rights and royalties Long lead time Difficult to get CBD compliant deals Difficult to ensure local communities are involved Low interest from companies Bureaucratic complications may lead to over regulation which stifles innovation and exploration
Green interests (Green Venture Capital funds)	Private sector invests in order to bolster public image or for strategic reasons	Weak capacity in some countries to regulate private sector Poorest countries excluded Requires appropriate incentives from Government

Funding mechanism	Advantages	Disadvantages
NGOs		
Conservation Concessions	Developing a market in biodiversity; local involvement; protects sovereignty	
Purchase of Nature	Grants to conserve high risk / biodiversity rich areas	Legal system must allow purchase by NGO
'Debt for nature' swaps	Generates significant funds in national currency Can be used to endow trust funds for long term investment	Discounted debts now less available Can be inflationary
Targeted fund raising	Allows public willingness to pay to be tapped in support of conservation Can build strong alliance among NGO, public sector and private sector	Requires significant investment in fund raising Needs sympathetic government regulations such as tax deductions.

Source: adapted from McNeely, 1997.

PART II: Case Studies

4 Appraising Tropical Forest Land Use Options in Cambodia

4.1 Introduction³⁵

Ratanakiri is a remote, sparsely populated province in the extreme northeast of Cambodia. The province covers an area of 11,673 km² and is richly forested. Forest land in Ratanakiri represents an extremely valuable natural resource, but the area faces a number of destructive commercial development activities. Given the fact that local communities in Ratanakiri are totally dependent on the forest and in view of the rapid rate of deforestation evident throughout Cambodia, equity concerns suggest that sustainable forest management options urgently need to be identified for the area³⁶. Over 85% of the population (79,533) of Ratanakiri belong to ethnic minorities sometimes referred to as 'Highlanders'³⁷. For centuries the Highlanders have made their living in and around the forest, clearing the forest for farming and collecting subsistence products such as fuelwood, medicine, food and construction materials from the forest³⁸. Villages are based within locally recognised boundaries. However, families have no legal rights to the land.

Despite current commercial pressures on the area, management plans for Ratanakiri's forest land are yet to be developed. Furthermore, there is no clear interpretation of the law on protected areas, illegal logging is evident, and the user rights over forest and agricultural land under Cambodian law are ambiguous and not enforced. Unless development of the province is carefully planned and managed, irreversible damage to

³⁵ A longer version of this Chapter has appeared as an EEPSEA working paper, see Bann 1997a.

³⁶ The Asian Development Bank forecasts that at present rates of logging there will be no commercial species left in Cambodia within the next 5-10 years (ADB, 2000).

³⁷ The total ethnic breakdown of the province is estimated as follows: Tampuan 26%; Jorai 19%; Kreung 19%; Khmer 13%; Lao 10%; Brao 7%; Kachok 3%; Kavet 2%; Cham, Chinese, Lun, Phnong and Vietnamese 1% (White, 1996).

³⁸ This situation may be gradually changing as more opportunities arise, especially near district centres and new commercial agricultural ventures.

the natural environment is set to occur, which would have an adverse impact on the subsistence and self-reliance of the population as well as on the wider aim of sustainable economic development for the province. For the development process to be successful, the rights and freedoms of the ethnic minorities need to be respected. An assessment of the costs and benefits (including distributional concerns) of alternative forest land uses can greatly facilitate the design of forest management plans by indicating which forest land use option will maximise the economic and social returns to local communities over the long term.

4.2 Background

Ratanakiri Province is quite distinct from the provinces of the Mekong Delta. It is characterised by high forest cover, areas of fertile volcanic soils, low population density and a unique demography. It borders Lao PDR to the north and Vietnam to the east, and has national boundaries with Stung Treng to the west and Mondulkiri to the north. As a border area Ratanakiri is of political importance. It is also of great economic potential on account of its valuable natural resources. Natural forest cover for the province is estimated to be 70-80%. Forest cover varies from the dense impenetrable forest in the northern reaches that are still rich in wildlife, to the drier and more sparse forest, composed mainly of dipterocarps, found in the southwest. The ethnic mix brings a wide variety of cultural traditions, beliefs and languages. While lowland groups such as ethnic Lao, Chinese and Khmer have migrated to Ratanakiri within the last 200 years, there are at least twelve highland minorities whose settlement predates the Angkor period by centuries and who may be thought of as 'original' inhabitants.

4.2.1 Forest Land Use

Forest land in Ratanakiri is used in a variety of ways. It has long served as the subsistence base for the majority of people. Most of Ratanakiri's indigenous peoples have for centuries cleared forest land for agriculture, and in addition have profited by drawing from the forest a wealth of subsistence products. Until quite recently, the highlanders were observed coming to markets only once a year to buy salt and metal for their knives. Ratanakiri contains part of the Lomphat Wildlife Sanctuary with an

area of 250,000 hectares straddling Ratanakiri, Mondulkiri and Kratie provinces. The Sanctuary is home to a number of wild animals such as buffalo, tiger, wild pig and bear. Virachey National Park covers 332, 500 hectares and is located in Ratanakiri and Stung Treng provinces, and is part of an international park system as its borders adjoin national parks in Lao PDR and Vietnam.

Foreign and national commercial interest in the forest is so intense that some areas have been set aside more than once for the development of soyabean, rubber, coffee and cashew nut plantations. A concession of 9,000 hectares has been granted for oil palm production in O'Yadao district despite questions about the suitability of the soil, topography and climate for oil palm production in the area. Local people whose land fell within the oil palm concession were reportedly paid \$36 per hectare to clear their own land and were then allocated half a hectare of land along highway 19 (which is not enough to practice swidden agriculture). Furthermore, commercial cash crop plantations are said to be exacerbating environmental problems by further diminishing land cover and the natural genetic pool of the area (Himel, 1997). In addition, much of the province has been allocated to a commercial timber concession, Macro-Panin. This concession covers over 1.4 million hectares in Stung Treng, Ratanakiri and Mondulkiri Provinces. Other logging company are reportedly operating illegally in the area (see Chapter 9).

Of great concern is that current concession areas encompass many of the traditional and currently farmed lands of the Highlanders. Despite this, consultation with local people over the development of the area has been minimal. On the whole the local people do not want to give up their ancestral lands or to work for other people. There is a real risk that the highland people will lose and/or become marginalised on their own land unless their rights can be protected. Faced with the current threats to their land, local people in Poey (Chan) Commune have taken the initiative to set up a Forest Conservation Association to gain concession (not title) of their customary forest. Customary forests are those forest areas that are used *de facto* by local communities. If the Association could gain legal recognition, the customary forests would represent an exclusion zone from the current and future outside concessions. Such recognition would also legitimise the process, such that other villages

throughout Ratanakiri could form similar Associations to gain the right to manage their community's forest³⁹.

4.2.2 Economic Analysis of Tropical Forest Land Use Options

Each land use decision for a forested area has its own economic costs and benefits. For example, when forests are logged, important environmental functions and resources are lost, perhaps irreversibly, such as NTFP, the watershed functions of a tropical forest and biodiversity. Conversely, conservation incurs costs such as the cost of managing the area and the revenue forgone from timber extraction. It is important that account is taken of all the benefits and costs of each land use option, so that the best use of a given forest area may be determined. This requires a comprehensive social cost benefit analysis which takes into account the full range of benefits and costs, social and environmental, associated with each land use option (Bann, 1998a, IIED, 1994). In addition, the impact of alternative land uses on the welfare of local communities (i.e., the distributive incidence) should be a central factor in investment decisions. A classification of the total economic value (TEV) of a tropical forest is presented in Table 4.1.

³⁹ Based on personal communications with Gordon Paterson and Sara Colm, and Colm 1997.

Table 4.1. Classification of the TEV of Tropical Forests

Use Values			Non Use Values
Direct Value (1)	Indirect Value (2)	Option Value (3)	
Timber	Watershed protection	Future Use as per (1) and (2)	Existence Value
Non timber forest products	Nutrient cycling		
Recreation and tourism	Air pollution reduction		
Medicine	Micro climatic functions		
Plant genetics	Carbon store		
Education	Biodiversity		
Human habitat	Ecological resilience		

4.2.3 Project Design and Approach⁴⁰

In comparing alternative forest land use options one would, ideally, measure the TEV of the forest for the various land uses and/or management regimes under consideration. There are few practical examples of such a comprehensive approach, which in any event is out of the question for an area like Ratanakiri, where physical data on environmental functions are virtually non-existent, and where the vast majority of the population has little or no interaction with markets. Furthermore, evaluation of certain key values of the forest is often sufficient to demonstrate the benefit of supporting one land use over other possible uses of the land. With this in mind, the survey work focused on five key categories of NTFP - fuelwood, rattan and

⁴⁰ The survey team was trained by the author in survey techniques and in the basics of environmental economics. Detailed survey results are provided in Bann, 1997a.

bamboo, medicine, wildlife and malva nuts. These products were selected following a review of existing survey work, discussions with agencies working in the villages, and pilot surveys.

Following initial survey work in a Lao village - Itub, and a Kreung village - Kancheung (February 1996), Tapean forest was selected as the study site. Tapean forest is used extensively by at least five villages for the collection of NTFP. It also contains timber of commercial value, is an important habitat for malva nut trees (an important source of income for villagers), acts as an important watershed and has potential as an ecotourism site. Key productive uses and ecological services for the study area are identified in Table 4.2. This classification was based on a survey of available information and consultation with resource users, local government and researchers working in the area.

Table 4.2. Key Productive Uses and Ecological Services of Tapean Forest

Key Productive Uses and Ecological Services	Value			
	High	Medium	Low	Unknown
Sustainable timber	X			
Food	X			
Medicine	X			
Fuelwood	X			
Structural materials	X			
Animal products	X			
Recreation and tourism		X		
Education	X			
Human habitat	X			
Watershed protection	X			
Nutrient cycling				X
Air pollution reduction				X
Micro climatic functions				X
Carbon store	X			
Biodiversity	X			
Cultural heritage	X			
Existence value	X			

4.3 Forest Inventory

A forestry inventory was undertaken in March 1996 covering a representative half hectare of Tapean Forest. Ten transects (100m times 50m) were randomly selected⁴¹. The forest inventory identified 189 types of tree and 320 species of ground flora and saplings. Of the 189 types of tree, 100 are used by the villages for a range of purposes. The main uses (with the number of types of trees used for this purpose in parenthesis) are food (47), house construction (32), fuelwood (2), manufacture (10), and medicine (2). Products manufactured from tree species include weaving instruments, earrings, and coffins. Some tree species have more than one use. Of the 320 ground flora and saplings identified, over 201 have traditional uses. The main uses (with the number of flora and sapling species used for this purpose in parenthesis) are food (81), medicine (42), house construction (18), fuelwood (16), and manufacture (12). Types of products manufactured include cooking instruments, axe handles and toys. Other uses of ground flora and saplings include pig feed, fish poison, dye, rope, boat construction and ceremonial uses. Elders from Kancheung village greatly assisted with species identification.

A comparison of mature and immature trees over the half hectare study area and for individual transects (block by block analysis) provides an insight into possible harvesting practices and regeneration capabilities for some species. From the survey results, certain species appear to have good regeneration capabilities, for example (traditional use in parenthesis): aing koch (fuelwood); kreung (house construction); kray (house construction); mao (fruit); sa nge (fuelwood); ra pe (manufacture); and skorr (fuelwood). One tree species worthy of greater analysis is *Sterculia Lychnophora*, from which malva nuts (samrong) are collected. From the inventory results this species seems to be regenerating well. However, cursory interpretation of the results suggests significant cutting of trees in some areas. Without proper

⁴¹ The following information is available for each transect: diagrammatic interpretation of forest; a comparison of mature and immature trees for each 10m * 5 m block; comparison of mature and immature trees for sample area as a whole; tree diversity, abundance and species richness; comparison of ground flora and saplings for each 10 times 5 meter block; and comparison of number of ground flora and saplings in the study area as a whole.

management, it is conceivable that the sustainability of malva nuts could be threatened in the future as market influences increase and population grows.

Aerial photographs were interpreted, with the assistance of the Integrated Resource Information Centre (IRIC), in order to determine the total area of Tapean forest and the different land uses within the area. The land use statistics for the forest are presented in Table 4.3. The total area of Tapean forest is estimated to be 1,824 hectares.

Table 4.3. Land Use / Cover in Tapean Forest

Description	Hectare (ha)
Urban / Built-up Areas	0
Agriculture	0
Swidden Lands	
Active	0
Recently fallow	0
Secondary growth	0
<i>Subclasses</i>	
Shrubland (0-2m)	7
Bushland (2-6m)	4
Forest cover (6-10m)	497
Forest Cover	
Broadleaf evergreen	1,271
Broadleaf deciduous	23
Mixed deciduous / evergreen	13
Bamboo forest	9
TOTAL	1,824

Source: Integrated Resource Information Centre, Phnom Penh (IRIC)

4.4 Household Survey

In order to assess the importance of the forest for traditional uses and to value key NTFP, 42 households were surveyed in four villages known to use Tapean Forest for

the collection of NTFP. Available population statistics for the four study villages, Kancheung, Mas, Koy and Tangaich, are presented in Table 4.4.

Table 4.4. Population Statistics for Study Villages

Name of village	No. of families	Population			Aged over 15 years		
		Total	Female	Male	Total	Female	Male
Kancheung	48	235	133	102	127	74	53
Mas	28	117	76	41	n.a	n.a	n.a
Tangaich	27	112	56	56	69	39	30
Koy	46	n.a	n.a	n.a	n.a	n.a	n.a

Note: n.a. - not available

All villagers are farmers who practise swidden agriculture, and collect NTFP. Alternative employment opportunities for people living in the village are very limited⁴². The villages lack many basic goods, such as medicine, food (including rice), clothes and seeds for farming. All households recognise their dependence on the forest for food, medicine, fuelwood, house construction materials and, importantly, as a land resource for farming. They also appreciate the importance of the forest as a habitat for wildlife, and for its watershed protection functions. The most important products collected from the forest are malva nuts, rattan, bamboo, wood, wildlife and fruit. The main forest products sold are malva nuts and wildlife (turtles and

⁴² In Koy Village 27% of households have one family member in paid employment (e.g., district teacher earning 36,000 riel (\$13) per month. In Tangaich village an estimated 33% of households have one family member in paid employment (e.g., provincial military paid 71,000 riel (\$26) per month). The exchange rate used throughout this chapter is \$1 = 2,700 riel (1996).

monkeys). Use of the forest is extensive in all villages.⁴³ All villagers feel that it is becoming more difficult to collect forest products (especially wildlife). Reasons given for this include: increased forest clearance for farm land; population increases; and the over-exploitation of wildlife. The clearance of forest for farm land is considered to be the most important environmental threat to the area. Suggested ways to conserve the forest are: to look for flat land to plant rice; to prohibit commercial forestry; for the government to support forest protection through legislation; and for outsiders to be prohibited from cutting trees and clearing the forest for farms.

Limited purchases are made by most highlanders, either from travelling traders or at the market place. Regular purchases include salt, monosodium glutamate (MSG), tobacco and *prahok* (fish sauce). More occasional purchases include medicine, clothes, sandals, cheese, flints for lighters, mosquito nets and blankets, and cooking utensils (pots, kettles, plates, bowls and spoons). Expenditure patterns are similar in the three villages studied ranging from \$56 - 62 per household a year – roughly \$9 - 11.50 per person. Barter exchange is widely practised. All households in Mas village barter, 54% in Koy and 77% in Tangaich. Bartering may be more common in Mas village owing to the fact that the village is more isolated. The main products bartered are rice, traditional baskets and chickens. For example, in Mas village 40 cans of rice are exchanged for 1 kg of tobacco, and 60 baskets of rice are exchanged for 1 buffalo. Household expenditure patterns and bartering practices clearly illustrate the limited interaction Highlanders still have with the cash economy and commercial markets, and hence their dependence on their farms and forest land, that is, the natural resource base.

4.5 Valuation of NTFP in Tapean Forest

NTFP encompass the variety of physical goods other than timber that are derived from forests and that are either used for subsistence purposes or traded or sold (IIED, 1994). Traditionally forest value was based on the commercial worth of its timber.

⁴³ Mas - 88% visit the forest every 1-10 days, 12% visit the forest once a month. Koy - 13% of villagers visit the forest every day, 74% every 5-15 days, and 13% once a month. Tangaich - 18% of villagers visit the forest every day, 73% every 3-7 days and 9% once a month.

Recent economic studies, however, have shown the real (or potential) value of NTFP to be substantial (see Section 9.3 for a review of NTFP studies). A further consideration is that higher economic values may be derived if forest management incorporates the production of both timber and NTFP (Panayotou and Ashton, 1992). The omission of NTFP in conventional economic analysis means that the forest resource is undervalued. This can result in unsustainable timber extraction or the conversion of forest land to alternative land uses, since these options appear more attractive. This is of particular concern for forest land in areas such as Ratanakiri where indigenous people are wholly dependent on the forest for their existence.

4.5.1 Fuelwood

Fuelwood is used by all families in the study villages for cooking and heating. No other form of fuel is used. While fuelwood is readily available, 61.5% of interviewees stated that it was becoming more difficult to collect because of the increased number of farms and of people collecting. Fuelwood is not bought or sold by villagers.

In Kancheung fuelwood is collected from around the village. It takes on average 30 minutes to collect one basket. In one month one family will use, on average, 25 baskets of fuelwood (10 baskets for domestic use and 15 baskets for use on the farm). Using the market price of fuelwood of 1,000 riel per basket (Banlung market⁴⁴), fuelwood may be valued at: $25 \text{ (number of baskets used per family per month)} * 1,000 \text{ riel (market price of fuelwood per basket)} * 48 \text{ (number of families in village)} = 1,200,000 \text{ riel (\$444) per month, or } 14,400,000 \text{ riel (\$5,333) per year.}$ A similar approach is used to calculate the value of fuelwood for the other three villages surveyed. A summary of results is presented in Table 4.5. These values represent gross estimates since harvesting and transport costs have not been accounted for.

⁴⁴ Banlung is the provincial capital.

Table 4.5. Gross Values of Fuelwood

Village (No. of hh)	Average number of baskets collected / year	Value to household / year riel / \$	Value to village / year riel / \$
Kancheung (48)	300	300, 000 riel \$ 111	14, 400, 000 riel \$5,333
Mas (28)	252	252,000 riel \$93	7,056,000 riel \$2,613
Koy (46)	256.8	256, 800 riel \$95	11,812,800 riel \$4,375
Tangaich (27)	231	231, 000 riel \$85	7, 161, 000 riel \$2,652

Notes: The average weight of a basket of fuelwood is 12.6 kg.

4.5.2 Malva Nuts

Malva nuts (Kreung name, *Hajong*. Khmer name, *Samrong*) are a popular forest fruit used in soup or as a dessert. They are also believed to be good for energy. They have an irregular and seasonal fruiting cycle with a bumper crop every seven years between May and June. In other years there are only a few malva nuts and collection is not considered worthwhile. They are an important source of income for villagers.

All four villages collect malva nuts from Tapean forest (Tapean mountain located within Tapean forest is possibly the richest location in the province for the collection of the nuts). The distance to Tapean mountain for the four villages is 7-15 km. The nuts are collected mainly for sale to Khmer traders from Banlung. They are typically

sold to Vietnam and then on to Hong Kong and China⁴⁵. Prices vary through the season from 500 riel to 2,400 riel per kg, increasing with the increase in traders. The most commonly quoted price is 2,000 riel per kg (\$0.74). According to survey findings, when a bumper crop occurs one family collects on average 500 kg of fruit a year. Taking a market price of 2,000 riel/kg, a family can earn on average 1,000,000 riel (\$370). The potential income to Kancheung village as a whole is estimated at \$17,760. It should be noted that such returns are only possible every seven years, and are gross estimates as no account is taken of harvesting costs. Similar calculations were performed for the other study villages. Table 4.6 summarises harvesting practices and malva nut benefits for the four study villages.

⁴⁵ The market price for malva nuts in Vietnam, Hong Kong and China is unknown. It is assumed that prices in these locations would be quite high, given that malva nut is considered to be a delicacy.

Table 4.6. Summary of Malva Nut Harvesting Practices and Gross Value

Village: number of households (% collected from Phnom¹ Tapean)²	Average quantity collected per hh per seven year cycle / kg	Value per hh per seven year cycle³ / riel and \$	Value to village per seven years cycle / \$ (annual value / \$)⁴	Average number of days collect / 7 years
Kancheung 48 (100%)	500	1,000,000 riel \$370	17,760 (2,537)	not known
Mas 28 (10%)	46.5	93,000 riel \$34	964 (138)	10
Koy 46 (31%)	36	72,000 riel \$27	1,227 (175)	4
Tangaich 27 (86%)	120	240,000 riel \$89	2,403 (343)	11

Notes: 1/ Phnom means hill or mountain in Khmer. 2/ Based on the number of days spent collecting from each location per survey information. 3/ Based on market price of 2,000 riel / kg. 4/ Annual returns from malva nuts based on 7 years production cycle (no discount rate used). For example, annual value for Kancheung is $17,760 / 7 = 2,537$.

The forest is an open access resource, so anyone can collect the nuts. Villagers raised concerns over the sustainability of current harvesting practices, these are supported by the forest inventory (see Section 4.3). Sustainable harvesting practices need to be introduced and collection of the fruit by outsiders controlled. One option is for the villages to introduce a tax on the quantity of malva nuts taken out of the forest, or to base the tax on the number of days people spending collecting. This presupposes strong community management.

4.5.3 Rattan and Bamboo

Rattan (Kreung - *Rare*, Khmer - *P'deo*) and bamboo (Khmer - *Russey*) are considered to be the most important products collected from the forest and are harvested by all families. They are used for making baskets and rice stores, and for constructing houses. All households stated that collection was becoming more difficult as a result of the clearing and burning of the forest to establish farms and the increase in the number of people collecting. Tables 4.7 and 4.8 present value estimates for bamboo and rattan for the four study villages. The value of bamboo and rattan is based on the quantity collected per survey information and available market prices for certain species. Value estimates may overestimate true value in that not all rattan and bamboo collected may be of commercial value, and also harvesting costs have not been deducted.

Table 4.7. Estimates of the Gross Value of Bamboo

Village / Number of hh	Average quantity stems collected / hh / year * average market price¹	Value per hh / riel and \$ / year	Average quantity of stems collected per village / year	Value per village / \$ / year
Kancheung 48	90 * 350 riel	31,500 riel \$12	4,320	560
Mas 28	288 * 475 riel	137,156.25 riel \$51	8,085	1,428
Koy 46	237 * 300 riel	71,100 riel \$26	10, 902	1,196
Tangaich 27	34 * 300 riel	31,050 riel \$12	9118	324

Note: 1/ Types of bamboo collected vary in composition across villages. The average price used per stem based on market price for available species (Banlung market): Pork –200 riel (3-6m); Kley 200 riel (3-5m); Bonla 1,000 riel (5-6m); Phor – 500 riel (6-7m); Ping Pong – 1,500 riel (6-7m); Skokcham – 3,000 riel (6-7m).

Table 4.8. Estimates of the Gross Value of Rattan

Village / Number of hh	Average quantity vines collected / hh / year * average market price ¹	Value per hh / riel and \$ / year	Average quantity of vines collected per village / year	Value per village / \$ / year
Kancheung (48)	100 * 750 riel	75,000 riel \$28	4,800	1,333
Mas (28)	132 * 750 riel	99,000 riel \$37	3,696	1,036
Koy (46)	56 * 750 riel	42,000 riel \$16	2,576	736
Tanaigch (27)	54.3 * 750 riel	40,725 riel \$15	1,466	405

Note: 1/ Average price based on available market prices for rattan per vine (Banlung market) Chaing – 500 riel (8-11 metres); Achmonn 500 riel (8-11 metres); Domdorn – 100 riel (5-30 metres); Som – 1,000 riel (5-metres).

4.5.4 Traditional Baskets

Traditional baskets (Khmer name: *kappah*, Kreung name: *Reo*) are made from woven bamboo or a cane species found near rivers. The straps are made from rattan strips. Almost all families make baskets. They take on average four days to make, while the materials needed can be collected in one day. Traditional baskets are the principal means of transporting produce from the forest or garden and for transporting products to the market. In addition, they are an important source of income to the village and are sold for 3,500 riel (small) to 5,000 riel (large). The baskets are mainly bought by tourists in Banlung market. Baskets are sometimes bartered for fish sauce (*prahok*) and salt.

The survey results from Kancheung village show the average number of baskets made and sold per household to be eleven and seven respectively. Taking 4,250 riel as the average price, the average value of traditional baskets per family is estimated at 46,750 riel (\$17.30) per year, and \$830.40 to the village as a whole. Average income per family based on the average number of baskets sold per household is 29,750 riel (\$11.90). Similar calculations were performed for the other villages. A summary of the results is presented in Table 4.9.

Table 4.9. Estimates of the Gross Value of Traditional Baskets

Village / No. hh	Av. No of days to make	Av. no made / hh / year	Value per hh at average market price 4250 riel. riel and \$	Value to village / year / riel and \$	Av. No sold / hh / year	Average selling price / riel	Av. income per hh riel and \$/year
Kancheung 48	3	11	46,750 riel \$17	2,244,000 riel \$830	7	4,250	29, 750 riel \$11.90
Mas 28	6	7.6	32, 300 riel \$12	904,400 riel \$336	3.25	2,916	9,477 riel \$3.80
Koy 46	4	15	63, 750 riel \$42	2,932,500 riel \$1,086	12	3,395	40,740 riel \$16.30
Tangaich 27	3.5	4.4	18,700 riel \$7	504,900 riel \$189	2.6	3,312	8,611 riel \$3.45

4.5.5 Other Manufactured Products

In addition to traditional baskets, a range of products are manufactured by villagers from forest materials. These include: hunting, fishing, cooking and weaving implements; wine jars; musical instruments; rice wine; handwoven cloth; rice stores; mortar and pestle; mats; and fish/vegetable baskets. Manufactured products are a potential source of income for villagers. Sufficient information was available from the survey to value two commonly manufactured products - rice shallows and mats (Table 4.10 and 4.11). Shallows are used for sifting rice and are typically made from

1 bamboo stem and 3 rattan vines, mats are used for drying rice and for sleeping. They are woven from about 40 sloek romcheck (*Pandanus odoratissimus*) leaves. Valuation is based on the average quantity manufactured and the selling price reported by villagers.

Table 4.10. Estimates of the Gross Value of Shallows

Village	Average quantity manufactured / year/ hh	Selling Price riel	Value / hh riel and \$	Value/ village riel and \$
Mas	1.5	3,000	4,500 riel \$1.70	126,000 riel \$47
Koy ¹	2	3,000	6,000 riel \$2.20	276,000 riel \$102
Tangaich	0.5	3,000	1,500 riel \$0.55	42,000 riel \$16

Notes: One family sells 10 shallows a year. Other families manufacture product for home use.

Table 4.11. Estimates of the Gross Value of Mats

Village	Average quantity manufactured / year / hh	Selling price riel	Value / hh riel	Value / village riel and \$
Mas	1.5	2,500	3,750	105,000 riel \$40
Koy ¹	2.8	2,500	7,000	322,000 riel \$119
Tangaich	1.75	2,500	4,375	1,225,000 riel \$44

Note: One family interviewed sells 17 mats per year.

The value of rattan and bamboo, based on the quantities of vines/stems collected, is significantly higher than the value based on goods manufactured from these materials (Table 4.12). One explanation for this is that many goods made from rattan and bamboo are not included in the analysis. Only the value based on manufactured products is used in the analysis to avoid double counting.

Table 4.12. Summary of Rattan and Bamboo Gross Values

Village	Value based on quantity of rattan / bamboo collected / \$ ¹	Value based on manufactured goods / \$ ²
Kancheung	1,893	831
Mas	2,464	423
Koy	1,932	1,307
Tangaich	729	249

Notes: 1/ Based on values reported in Table 4.7 & 4.8; 2/ Based on values reported in Tables 4.9-4.11.

4.5.6 House Construction

The forest is extremely valuable to local people as a source of construction materials. Houses are made from bamboo, rattan, wood, saek and kam ma leaves, all of which are collected from the forest. It takes one to three months to collect the necessary building materials, and 6.5-23.5 days to construct a house. Houses last for approximately 3 years. An average house is made from: 35 trees; 73 bamboo stems; 50 rattan vines; and 282 kanma leaves. According to the commune chief a number of tree species are used in house construction including: la ngeang; chraing; kreang, baing and ring. The value of village houses has been estimated using the direct substitution approach based on the market price of a similar size and style house in Banlung. The cost to build a basic one room village style house can be as high as \$1,300 (including the cost of a metal roof). The lower bound estimate of \$222 is used in the analysis.

Table 4.13. House Construction and Value in Study Villages

Village	Estimated No of houses	Value using market price \$222	Average life of house	Average collection time	Average construction time
Kancheung	32	7,104	4	1 month	12.5 days
Mas	14	3,108	3.5	2 months	23.5 days
Koy	16	3,552	2.5	1.5 months	6.5 days
Tangaich	27	5,994	2.5	2-3 months	12.5 days

Notes: Estimated number of houses based on survey responses. No discount rate information available.

4.5.7 Wildlife

Tapean forest is rich with wildlife including elephants, gaur and monkeys. With the exception of households in Kancheung, nearly all households interviewed claimed to collect wildlife for subsistence purposes only (perhaps to avoid any suggestion of illegal practices). Reported quantities collected are much lower for Kancheung village. Over 20 species are collected, many of which are classified as endangered or threatened by CITES ⁴⁶ (e.g., pangolin, wild buffalo (gaur), gibbon and otter). Valuation of wildlife was limited by the fact that while price data are available in kilograms for a number of species, the average weight in kilograms of some species was not determined. Species for which valuation was possible are pangolin, wild pig, barking deer, wild chicken, wild buffalo, sambar deer and lizard. Table 4.14 details the range of wildlife collected by the study villages based on survey information. Available price information on wildlife, presented in Table 4.15, clearly shows the large difference between the 'farm gate price' obtained by villagers and subsequent profits made by middlemen trading with villagers and sellers in Banlung market.

⁴⁶ Convention on the International Trade in Endangered Species of Wild Fauna and Flora

Table 4.14. Estimated Quantity of Wildlife Collected (village / year)

Species	Kancheung	Mas	Koy	Tangaich
Pangolin	35	42	0	0
Wild pig	25	88	607	121
Barking deer	25	126	129	0
Wild chicken	65	6,328	19,872	2,430
Wild buffalo (Gaur)	2	0	184	0
Apple snail	0	84	0	0
Rat		[700kg]	1,104	9,720
Lizard	50	[30.80kg]	276	0
Sambar / Rusa deer	10	21	0	0
Banteng	25	28	0	0
Large deer	0	0	276	135
Grey squirrel	0	0	2,760	0
Squirrel	0	0	2,208	3,078
Turtle Dove	0	0	331	567
Monkey	0	0	3,312	0
Musk Deer	0	0	0	101
Bird sp.	0	0	0	2,430
Porcupine	55	0	0	0
White Macaque	4	0	0	0
Gibbon	4	0	0	0
Monitor lizard	80	0	0	0
Otter sp.	25	0	0	0

Table 4.15. Wildlife Prices

Species	Price at Location riel / kg ¹	Market Purchase Price riel / per kg or per animal ²	Market Selling Price / riel / per kg or per animal ²	Quantity sold at market / year ³	Average weight (kg) ²
Pangolin ⁴	8,500 20,000	9,000-10,000	11,000-12,000	144	3
Wild pig	2,500	2,500-6,000	3,000-9,000	30	30-50
Barking deer	3,000	6,000-7,000 2,500	4,000-12,000	48	35
Wild buffalo (Gaur)	2,500	5,000-6,000	6,000-8,000		10-30
Wild chicken		5,000-6,000	7,000-8,000		0.6
Large Deer		2,000-2,500	4,000 - 5,000	36	45
Porcupine	3,000				
Indian Elephant		\$200-300/ animal	\$1,000		
Lizard	2,500	5,000-6,000	7,000-8,000		
Monitor Lizard	2,700	7,000-8,000	10,000-12,000		
Rusa / Sambar Deer	3,000				30

Species	Price at Location riel / kg ¹	Market Purchase Price riel / per kg or per animal ²	Market Selling Price / riel / per kg or per animal ²	Quantity sold at market / year ³	Average weight (kg) ²
Python			4,000		
Otter		5,000-6,000	6,000-8,000		
Squirrel				1	
Apple Snail				1	
Black Tortoise			3,500	300	3
Malayan Sun Bear ⁵			\$500 per live animal		

Notes: 1/ Based on survey information from Kancheung village; 2/ Based on market survey; 3/ Based on interview with wildlife meat seller in Banlung market. The number of wildlife sellers unknown; 4/ 8,500 riel is price quoted in Kancheung, 20,000 riel is the price quoted in Mas village; 5/ Gall bladder sold for \$450.

The price of wildlife 'at location' has been used to estimate the value of wildlife to local communities. For example, assuming that on average 35 pangolins are caught each year in Kancheung village (Table 4.14), returns to the village are 35 (number of animals sold per year) * 3kg (average weight) * 8,500 riel (price at location per kg) which equals 892,500 riel (\$331) per year. This represents a gross value (harvesting costs are not known and have not been deducted). The value of wildlife to the four study villages is summarised in Table 4.16.

Table 4.16. Summary of the Value of Wildlife (\$)

	Kancheung	Mas	Koy	Tangaich
Value for village / year	6, 683	39, 163	153, 671	27, 000
Value per hh / year	139	1, 398	3, 201	1, 000

Wildlife is reportedly declining in most areas. High demand coupled with the high prices being offered for wildlife products in neighbouring countries encourages commercial hunting, which is taking place indiscriminately and in an unsustainable fashion. A survey of large mammals in Ratanakiri reported that 42 species of mammals were being traded and projected that at the present rate of hunting, it is unlikely that either gaur or banteng would survive the next 5 to 10 years (Deasi and Vuthy, 1996). The number of gaur, banteng, elephant and sambar deer tracks recorded were very low, despite the availability of large areas of suitable habitat. The only species commonly found was the wild boar.

4.5.8 Fish

Most families fish for subsistence purposes. Table 4.17 summarises harvesting practices and the estimated value of fish using a market price of 4,000 riel/kg (general price used for all species). Information on fishing activities are not available for Kancheung village. The main types of fish caught are tilapia, snakehead, mud carp and catfish. Fish are caught using many different techniques including nets, traps, bamboo barriers to stop fish, water drainage, and the use of poison (using a tree root). A high percentage of households interviewed, 62%, claimed that it is becoming more difficult to catch fish because too many people are fishing, and because of the use of poison.

Table 4.17. Fishing Harvesting Practices and Estimates of Gross Value

Village	Percentage of hh who fish	Average number of days fish / year / hh	Average quantity of fish collected kg / hh / year	Value per hh / year / \$	Value to village / year \$
Mas	100%	83	350	519	14,529
Koy	100%	224	294	436	20,056
Tangaich	50%	no data	96	142	3,834

4.5.9 Medicine

Tapean forest is a popular location for the collection of medicinal plants. There are two traditional medicine healers in Kancheung and Mas village, three in Koy and one in Tangaich. The most common illnesses are headaches, diarrhoea, malaria, colds, catarrh and measles. The main types of modern medicine used are aspirin, penicillin and chloroquine. An estimated 20% of households in Koy village buy modern medicine, 50% in Mas and 100% in Tangaich, spending on average \$2.70 per year. Families who do not buy modern medicine say this is because they cannot afford it. Minimum estimates of the value of medicinal products to households, Table 4.18, have been based on the assumption that households not buying modern medicine use traditional medicine instead, and on the average spent by other households on modern substitutes (i.e., \$2.70). Certain wildlife species are also of high medicinal value. For example, pangolin scales and blood are mixed with wine and drunk for energy. Pangolin scales have a market price of 70,000 riel/kg (\$26). Pangolin stomach is also used to treat pregnant women and is sold for 5,000 riel/kg in Banlung market. Bear gallbladder, said to promote good circulation, has a market price of 172,500 riel/kg (\$64).

Table 4.18. Minimum Estimates of the Gross Value of Medicinal Plants

Village	% of Households using traditional medicine	Estimated value per hh / \$	Estimated value per village, \$/year
Kancheung	50%	1.25	60
Mas	50%	1.25	35
Koy	80%	3.40	92
Tangaich	25%	0.40	19

Note: It is assumed that 50% of households in Kancheung village use traditional medicine. It is probable that households purchasing modern medicine also use traditional medicine so estimates of households using traditional plants can be seen as conservative.

4.5.10 Valuation of NTFP based on Inventory Results

The quantities of forest products determined through the forest inventory were also used to estimate the value of malva nuts, bamboo and rattan. These figures can be seen to represent the potential benefits from sustainable harvest, as opposed to the actual benefits.

Malva Nuts: Based on the forest inventory results, there are estimated to be 4,833,452 malva nut trees in Tapean forest (62,014 of which are mature)⁴⁷. In a good year one tree is estimated to yield 100kg of fruit (communication with villagers). We can therefore estimate the potential annual harvest of the Tapean forest area (on a seven year cycle): 62,014 (total number of mature trees) * 100kg (fruit harvest per tree) * 2,000 (price per kg/riel) = 12,402,819,200 riel (\$4,593,629). An optimal harvest rate for malva nuts is not known. However, using different fruit harvesting intensities (100%, 80%, and 50%), estimates of the potential present value (PV) of

⁴⁷ Ground truthing suggests that these calculations based on inventory results may over estimate actual numbers, due to the fact that malva nut trees are believed to occur in greater density on higher levels.

malva nut harvesting over a 90 year cycle can be estimated (Table 4.19). It should be noted that these represent gross benefits as harvesting costs have not been netted out. Also these estimates represents potential values and are dependent on a market for considerably higher volumes of malva nuts existing. In support of this, malva nuts are typically exported to Vietnam and China so the potential market is very large and the channels for international distribution are available. However, it is unclear whether there are other areas in Southeast Asia producing the fruit at different times. Value estimates for malva nuts are much higher than the estimates derived from the household survey (see Table 4.6). However, it is known that two years ago, when there was a bumper crop, only a fraction of the fruit was harvested. Assuming that a strong international market for malva nuts does exist, returns to villagers from sustainable harvest of this resource could be substantial.

Table 4.19. Potential Returns from the Harvesting of Malva Nuts

(value per hectare in parenthesis)

	PV, 6% discount rate (\$)	PV, 10% discount rate (\$)
100% of fruit harvested	13,903,677 (7,623)	9,262,442 (5,078)
80% of fruit harvested	11,123,101 (6,098)	7,409,953 (4,062)
50% of fruit harvested	6,951,939 (3,811)	4,631,220 (2,540)

Note: Assumes 7 year fruiting cycle

Rattan and Bamboo: Based on the forest inventory, the average stocking density of bamboo and rattan is estimated at 171 stems and 266 vines respectively. Species of bamboo include russey phaoror, russey tngor (chuy), russey tngor (chhav) and russey porkotal. Species of rattan include habek and svain. Taking a harvesting cycle of 10

years (based on an assumed growth cycle of ten years), the present value of rattan and bamboo is estimated over a 90 year period at various discount rates (Table 4.20). Again, these figures represent the potential returns from sustainable harvesting, and assumes that a market exists for higher quantities of these products.

Table 4.20. Sustainable Harvesting Rates and Prices for Bamboo and Rattan (\$)

	Bamboo	Rattan
Stocking density / ha	171 stems ¹	266 vines
Price ²	200 riel [3-7 metres] / stem	500 riel [8-11 metres] / vine
Years to maturity	10 years	10 years
Annual stock vines/year	17.1	26.6
Per hectare value / \$		
Annual value	1.3	5
6% discount rate	23	88
10% discount rate	14	53
Value for Tapean Forest / \$		
Annual value	2,310	8,985
6% discount rate	41,364	160,880
10% discount rate	24,945	97,022

Notes: 1/ The forest inventory records the number of individuals (bamboo clumps) and is therefore seen as a lower bound estimate (the average number of stems per clump is not known). 2/ The average market price for all bamboo and rattan species has been used. 3/ The analysis assumes that all species are of commercial value.

4.5.11 Summary of Results

A summary of the benefits of NTFP is presented in Table 4.21. The most important forest resources for local people are wildlife, fish, fuelwood and materials for house construction. Annual benefits are \$30,088 – \$180,564 per village, and \$625 – \$3,925 per household. The high values for Koy village are largely explained by the higher than average reported quantity of wildlife collected compared to the other study villages.

Table 4.21. Summary of Gross Annual Value (\$) of Forest Products per Village (household values in parenthesis)

Village	Fuelwood¹	Malva nuts²	Baskets³	House Construction ⁴	Manufactured Goods⁵	Wildlife⁶	Fish⁷	Medicine⁸	Total
Kancheung	5,333 [111]	2,537 [53]	830 [17]	1,776 [37]	123 [2.6]	6, 683 [139]	12,806 [267]	60 [1.25]	30,088 [627]
Mas	2,613 [93]	138 [5]	336 [12]	777 [30]	87 [3.10]	39, 163 [1,399]	14,529 [519]	35 [1.25]	57, 678 [2, 060]
Koy	4,375 [95]	175 [3.8]	1,086 [24]	888 [19]	221 [4.80]	153, 671 [3, 123]	20, 056 [436]	92 [3.40]	180,564 [3, 925]
Tangaich	2,652 [98]	343 [12.70]	189 [7]	1,498 [55]	60 [2]	27,000 [1, 000]	3, 834 [142]	19 [0.40]	35,576 [1,318]
Total	14,973	3, 193	2, 441	4, 939	491	226, 517	51,225	206	

Notes: 1/ Based on Table 4.5; 2/ Based on Table 4.6. 3/ Based on Table 4.9; 4/ Based on Table 4.13. Annual house construction benefits based on 4 year life time for houses (no discount rate used); 5/ Based on Tables 4.10 and 4.11. Kancheung - benefits based on the average benefits for other three study villages; 6/ Based on table 4.16; 7/ Based on Table 4.17. Kancheung - benefits based on the average benefits for other three study villages; 8/ based on Table 4.18.

Annual benefits per village are discounted over a 90 year time horizon to illustrate the present value (PV) of forest benefits to local communities (Table 4.22). Two discount rates have been used - 6% and 10%. At a 6% discount rate the present value of NTFP benefits are \$510,167 - 3,005,917 per village, or \$10, 628 - 65, 346 per household. The figures represent gross estimates and therefore over estimate true value. Harvesting costs should be netted out (e.g., the opportunity cost of labour, and the cost of materials used for harvesting forest products - such as bullets and arrows used for harvesting wildlife). The opportunity cost of labour has been taken at zero in this study given the extremely limited opportunities for paid employment in the area. The difference between gross and net costs is therefore considered to be low.

A further issue not addressed in the calculations presented, is that price estimates should be applied to the quantities that could be *sustainably harvested* from the forest area. This question is particularly important for wildlife given that current levels are believed to be unsustainable, and could become important for malva nuts, since collection of this lucrative fruit is currently un-managed, and the cutting of trees is evident. Sustainable harvest rates for wildlife and malva nuts are at present unknown. The results can be expected to contain a further margin of error due to the difficulties of carrying out economic valuation in the remote setting of Ratanakiri. Apart from the fact that market influences are limited in the study area (and were in fact non-existent until fairly recently), determining reliable measurements of the quantity of products collected and distance travelled is a problem. Often forest products are collected in baskets, and villagers have unreliable concepts of weight, for example, in kilograms.

Table 4.22. Present Value of Forest Benefits per Village and per Hectare (\$)

Village	6%	10%
Kancheung		
per village	510,167	311,830
per household	10,628	6,496
per hectare	280	171
Mas		
per village	961,944	580,682
per household	34,355	20,738
per hectare	527	348
Koy		
per village	3,005,917	1,813,445
per household	65,346	39,423
per hectare	1,648	994
Tangaich		
per village	604,739	365,934
per household	22,398	13,555
per hectare	331	201
Average per hectare value	697	428

Notes: 1/ Figures rounded to nearest decimal; 2/ Returns for malva nut based on 7 year harvest; 3/Houses assumed to be built every 4 years; 4/ All other benefits assumed to occur on an annual basis; 5/ All per hectare values based on total area of Tapean forest (1,824ha).

4.6 Valuation of other Forest Values and Services

There are many other services provided by the forest, in addition to NTFP, which are important to take into account when land use decisions are being made (see Table 4.1). A qualitative discussion of other important forest values identified for Tapean forest is presented below. In some cases monetary estimates have been derived.

4.6.1 Direct Use Values

Eco-tourism could be developed in Tapean mountain and forest. The area is considered good for hiking, and visits to minority Kreung villages might also be arranged. Tourism development would need to be carefully managed and small scale so as not to disturb the local people or mar the natural environment.

Well preserved forest areas such as Tapean forest can be important as research and education facilities. Valuation of forest research and education benefits could be based on specific expenditures within the park - although such expenditures do not represent economic values *per se*, they do indicate a minimum WTP to take advantage of the park resources (IIED, 1994).

4.6.2 Indirect Values

Forests provide many watershed benefits (see Tables 3.5 and 9.12 for summary). The destruction of watersheds can be devastating to rural poor communities, such as the Highlanders, that rely on natural resources for their basic requirements.

The area of Ratanakiri province forms part of three major catchments - Tonle Se San, Tonle Srepok and Tonle Se Kong, which can be further divided into 24 sub-watersheds. Phnom Tapean forms the upper part of O Ta Phlay watershed in Tonle Se San catchment (Himel, 1997). Tapean forest is considered to have high watershed value and the conservation of the upland and lowland forest and soils is considered vital for the retention of the area's natural balance. Water resources in Ratanakiri are good as a result of: high rainfall (an average of around 2,300 mm/year compared to the 1,200 - 1,500 mm in lowland Cambodia); the relatively pristine state of its upper watershed areas owing to low population and resource pressures up until recently; and, the good quality soil of the central plateau and hills. There is abundant

groundwater in most areas and even small streams have flows throughout the year unlike the rest of Cambodia (*ibid*). Furthermore, soils in Ratanakiri appear to be more fertile in general than those in other areas of Cambodia, for a range of geographical and cultural reasons such as the fact that even in more intensively farmed areas, pockets of forest remain for cultural reasons enabling genetic resources to survive and regenerate native vegetation during fallow periods (*ibid*).

The biodiversity value of Tapean forest is considered to be high. Cambodia is the home to a number of distinctive fauna and flora species. The Kouprey, Indochinese Tiger, Asian Elephant, Gaur, Banteng, Brow-antlered Deer, Giant Ibis, Greater Adjutant Stork and Green Peafowl, are some of the globally threatened species known to exist in the rich dipterocarp forests, but whose distribution and status remain undocumented. While no systematic survey of wildlife has been carried out in Tapean forest, an area to the north-west of Lomphat Wild Life Sanctuary has been surveyed (Desai and Vuthy, 1996). The survey recorded 44 mammals, 76 birds and 9 reptile species. In addition several endangered bird species were sighted - the Giant Ibis, the Greater Adjutant Storks and several Green Peafowl, making the region an important site for the conservation of large, endangered bird species. The sighting of the Giant Ibis is of great conservation significance as prior to 1992 it had not been sighted for nearly three decades and was feared extinct. The inventory carried out for this study highlights the impressive variety of flora known to exist in Tapean Forest. Habitat loss and degradation (as a result of swidden agriculture, frequent fires, planned commercial concessions and illegal logging) and unsustainable levels of hunting all threaten Ratanakiri's biodiversity.

4.6.3 Option and Existence Values

The option and existence value of Tapean forest is considered to be extremely high, but has not been estimated owing to resource and data constraints. The cultural and ethnic diversity of the area make it unique and form part of Cambodia's heritage and natural wealth, which the co-Prime Ministers (1997) indicated needs to be preserved for future generations (Paterson, 1997)⁴⁸. Preservation of the unique cultural diversity

⁴⁸ In reality, however, these sentiments have not been endorsed (see Section 9.5).

of the many indigenous groups dependent on the forest in Ratanakiri requires maintaining the forest resource intact. Paterson argues (1997): 'It can be said that an indigenous people's culture is a product of the natural environment in which they have learned to survive, adapt and make a living over many generations. We cannot have survival of their culture unless we also have preservation of their natural environment in which their culture has evolved. Cultural survival also requires that these communities retain their rights to make informed choices about how they will develop and adapt their way of life to changing circumstances.'

4.6.4 Distributional Impacts

Few studies of forest land options attempt to quantify how the costs and benefits of each option will be distributed between different groups, despite the fact that such issues often deserve top priority, especially in remote areas where local dependence on forest resources is high. Distributional issues should be at the centre of land use decisions in Ratanakiri. While commercial ventures are likely to bring handsome returns to a few (possibly foreign) businessmen, their negative impacts are likely to affect whole communities whose whole existence and culture is based on the forest.

As a measure of the inequity in current transactions, forest land in Ratanakiri has effectively been 'bought' from local communities at \$36 per hectare. However, according to the results of this study, the value of NTFP alone can be estimated at \$280-1,648 per hectare per year. This represents subsistence values lost as a result of losing access to the forest. That is a minimum estimate of the value (compensation) of the forest to local communities. One explanation as to why local people sell at this low price is that they are uninformed of planned developments in the province and misled by commercial companies. The concomitant loss of unquantified cultural values suggests that the communities are in reality losing much more than just the largely unmarketed subsistence products identified. Moreover, the survey results show that these individuals are among the poorest in the country, as they have little or no access to the formal wage sector. This places them in a vulnerable position; one in which the distributional impacts are of greater concern because they are not, in fact, in a position to bargain effectively with purchasers. This potential loss of livelihood and culture has not, to date, been reflected in the amounts offered to indigenous people.

4.6.5 Indirect Value Estimates for Tapean Forest

Estimates for some of the indirect values of Tapean forest are presented in Table 4.23.

Table 4.23. Estimates of Forest Services, Tapean Forest (\$)

Forest Service	PV estimate / hectare 90 years	Valuation method / assumptions
Watershed benefits (General protection of agriculture from flooding, soil erosion etc.,)	6% - 75.59 10% - 44.44	Change in Productivity Approach Average rice production per hh / year (47 baskets per year) * market price (5,000 riel) * number of hh affected Assumptions: Agricultural output of 93 hh (Mas and Kancheung village) protected by watershed functions. Under-estimates value to the extent that rice is the only crop included in the analysis, and by the fact that watersheds also protect fish productivity and human dwellings.
Biodiversity	6% - 511 10% - 300	Benefits Transfer Based on \$30/hectare potentially 'capturable' biodiversity benefit (Ruitenbeek, 1992). Assumes that cultural diversity and biodiversity values of the area are high.
Carbon storage	6% - 6.86 10% - 0.27	Benefits Transfer Based on one time 'opportunity cost' of \$1,300 / hectare (Pearce and Warford, 1993) ⁴⁹

⁴⁹ See Chapter 9 for a discussion of the social cost of carbon.

4.6.6 Commercial Timber Extraction

Tapean forest contains timber of commercial value. One grade 1 species (Sralao), two grade 2 species (Khvao, Koki) and four grade 3 species (Kray sor, Prous, Smach and Tramoung) are evident from the forest inventory. In order that returns from logging could be compared to the benefits of traditional use of the forest by local communities two different scenarios were analysed representing sustainable and unsustainable logging practices.

For an area of forest to be sustained, each harvest must be limited to the accumulated growth since the last harvest and must leave the stand in a condition to support a resumption of growth at least at the same rate (World Bank, 1996). Mean annual increment (MAI) in Cambodia is estimated to be 0.3 cubic metres/hectare/year. Applied to a cutting cycle of 30 years, this has been used to establish a harvest limit of 10 cubic metres/ha at one cut, or approximately 30% of the total volume viable for harvest (all merchantable trees that satisfy the necessary diameter). This is essentially the Cambodian standard as established under Article 3 of the 'regulation on forest resources exploitation', (*ibid*)⁵⁰.

Using a \$74 per cubic meter stumpage value (considered as a conservative estimate of average economic stumpage value - World Bank, 1996)⁵¹, returns from timber harvesting at a 10 cubic metre and 50 cubic metres per hectare per year for the study area were calculated (Table 4.24). The analysis is based on a 90 year period (taken to represent three cutting cycles). Since the forest is assumed not to regenerate after the first cutting cycle under an intensive cutting regime of 50 cubic metres per hectare per year, benefits end at year 30.

⁵⁰ Cambodia's growth rate is substantially lower than the growth rate commonly expected in Indonesia (1.0 m³/hectare/year) or Malaysia (1.0 - 1.5m³/hectare/year). In these countries all forests are equatorial evergreen forest with higher growth potential than the forests of Cambodia which include both moist evergreen and deciduous forests (World Bank, 1996).

⁵¹ Stumpage value represents the difference between the price of logs paid by a mill or exporter and the cost of harvesting the logs and transporting them to the point of sale.

Table 4.24. Benefits from Timber Harvesting at Different Harvest Intensities (\$)

	Sustainable Timber Extraction (10 cu.m. hectare)	Unsustainable Timber Extraction (50 cu.m. hectare)
Forest extent (ha)	1,813	1, 813
Log cycle	30 years	30 years
Annual cut / ha / year	60.40	60.40
Stumpage value (\$/cu.m)	74	74
Annual harvest / ha / year	10 cu.metres	50 cu.metres
Annual value/ha:		
NPV	24	122
6%	408	1,697
10%	247	1,156
Annual value total area:		
NPV / Total area	44,696	223,480
6%	741,001	3,076,164
10%	447,616	2,095,181

4.6.7 Comparison of Alternative Land Uses

A comparison of the net benefits of commercial timber extraction and local traditional use of Tapean forest is presented in Table 4.25. It is assumed that sustainable collection of NTFP will maintain the current environmental benefits offered by the forest, while unsustainable timber production will result in the complete loss of these benefits. Sustainable timber production is assumed to reduce these benefits by half.

Projections were carried out over a 90 year time period, at 6% and 10% discount rates. At a 6% discount rate, sustainable collection of NTFP can be seen to be more economic than timber production when environmental benefits of the forest are taken into account. At a 10% discount rate the returns from unsustainable timber production are slightly higher than the benefits to households from the collection of NTFP. However, it is clear that the benefits to households are underestimated due to the omission of certain environmental functions of the forest and the significant cultural values of the area. This coupled with equity concerns clearly make unsustainable timber practices untenable. The benefits of sustainable collection of NTFP deserve a higher utility weight due to locals being very poor. This would increase their value relative to timber production. Furthermore, the actual returns from timber harvesting have been severely questioned. Without accounting for lost environmental benefits, it has been asserted that even at sustainable timber harvest levels, and with subsidised royalties, the current concessionaires are unlikely to be able to operate as planned because of low conversion rates, poor marketing strategies and high capital costs (World Bank, 1996). This suggests that the returns to timber may well be overvalued.

The benefits of traditional collection of NTFP may also be over estimated to the extent that wildlife values may not be based on sustainable harvest levels and estimates are gross not net values (although this effect is expected to be minimal). However, the value of traditional medicine is considered to be significantly undervalued, some of the indirect benefits of the forest are excluded, and, importantly cultural heritage has not been given a monetary value, all of which biases estimates downwards. Estimates for the sustainable collection of NTFP based on the forest inventory are significantly higher than for any other scenario. While these figures represent potential returns, there is reason to believe that considerably higher returns from malva nut harvesting, based on community management and marketing of the resource, could be gained by villagers.

Table 4.25. Comparison of Alternative Land Uses Benefits (NPV / ha / \$)

	Sustainable collection of NTFP¹	Sustainable collection of NTFP (malva nuts, rattan and bamboo) per inventory²	Sustainable timber³	Unsustainable timber production
	ACTUAL BENEFITS	POTENTIAL BENEFITS		
Annual value	41 (NTFP) + 35 (env.ben) = 76	186 (NTFP) + 35 (env.ben) = 221	24 (timber) -17 (env.ben) = 7	122 (timber) -35 (env.ben) =87
6%	697 (NTFP)+ 587 (env.ben) = 1,284	3,922 (NTFP) + 587 (env.ben) = 4,509	408 (timber) - 294 (env.ben) = 114	1, 697 (timber) - 587 (env.ben) = 1,110
10%	428 (NTFP) + 344 (env. ben) = 772	2,606 (NTFP) + 344 (env.ben) = 2, 950	247 (timber) - 172 (env.ben) = 75	1,156 (timber) - 344 (env.ben) = 812

Notes: 1/ Per hectare values for Tapean forest are difficult to calculate given that villages collect forest products from a number of locations other than Tapean forest. About five villages collect products from Tapean forest, but the forest is most closely associated with Kancheung and Mas villages. The average per hectare value for the four study villages has been used (Table 4.22). That is, the benefits of Tapean forest are conservatively based on the use values to only one village; 2/ Benefits from Malva nuts based on 50% harvesting intensity (Table 4.19); 3/ Timber values based on Table 4.24; 4/ Environmental benefits include watershed and biodiversity values only (Table 4.23).

Table 4.25 shows that Cambodia could get \$221/ha a year from managed sustainable extraction of NTFP. The actual value (\$76/ha/year) reflects the local community's share without ownership which is currently threatened by development pressures. With ownership of the resource local communities could potentially sell the excess over their domestic consumption and hence potentially capture the full benefits from sustainable management.

4.7 Conclusions

The main conclusion of this study is that NTFP are worth a lot, much more than hitherto thought, and are very important to the poorest sectors of society. Land use planning processes that ignore these values can lead to a loss of economic value and even to increased security problems and conflicts in the area. Furthermore, it is clear that local communities have the motivation, capability and knowledge to sustainably manage their customary forest. Conversely, large-scale commercial interests in the area currently threaten the environmental stability and rich cultural heritage of Tapean forest and other areas of Ratanakiri.

Results show that, in Ratanakiri, forest products have a value that may be as high as \$3,922 per hectare of forest. If this forest were to be harvested for timber, it would have a value of less than this; no more than \$ 1,697 per hectare. When one considers the other environmental functions that would be lost from timber harvesting - such as the loss of significant watershed functions, carbon storage and biodiversity values - then the net benefits from harvesting timber are diminished further. In short, NTFP values are an important part of the economy. Furthermore, the rich cultural heritage of the many ethnic minorities of Ratanakiri is intricately based on the forest. The forest must remain intact if these unique values are not to be lost. Detailed surveys in the region demonstrated that the value of NTFP is a critically important source of subsistence. All households rely on such products as a source of fuelwood, foods and materials for house construction. Moreover, only 30% of households in the region have a family member engaged in the wage economy. Forest products therefore provide an important natural mechanism for alleviating poverty without explicit government investments. Loss of the forest may result in a loss of this 'natural

subsidy'. In addition, one forest product in particular - the malva nut, has extremely high potential commercial value.

The results show that land use allocation decisions are currently being made to the detriment of indigenous people. Although forest products are worth a large amount, recent cash compensation levels are less than 1% of the value of NTFP; compensation has typically been of the order of \$36 per hectare, while the value of the NTFP approaches \$4,000 per hectare. This inequity arises primarily because of the weak bargaining position of indigenous people, which is exacerbated by their economic vulnerability. Elsewhere in the world, such continued exploitation has often resulted in security problems, particularly when coupled with a *de facto* loss of forests.

In view of the high demonstrated economic value of NTFP in Tapean forest coupled with the forest's extremely high social, cultural and environmental values, it would seem wise to exclude the area from current and future commercial concessions. The area could be legally recognised as a customary forest. This would provide the incentive for local communities to sustainably manage the forest and set a precedent for granting legal status to customary forest land throughout the province.

5 The Estimation and Capture of Forest Biodiversity Values in Turkey

This Chapter focuses on the identification and valuation of local and global biodiversity benefits associated with Turkey's forests. A complementary objective is an assessment of the current institutional arrangements influencing forest management⁵².

5.1 Turkey's Forest Biodiversity

Turkey is a very biodiversity rich country. Forests covering around 20.7 million hectares (Ministry of Forestry (MOF), 1998), over a quarter of the country, contain a significant part of Turkey's biodiversity. Forest areas include: the mixed temperate rain forests and alpine ecosystems of the Black Sea coast; the Mediterranean forest ecosystems in the western and southern regions; the transition forests between the coastal zones and inner parts; and, the semi-arid/arid zone forest ecosystems dominated by oak species covering large areas in the Eastern and South-eastern Anatolia regions.

There are over 40 economically important forest tree species having natural distribution in forest ecosystems. Many endemic tree species are found in the Taurus mountains, the Nur mountains and in north-eastern Anatolia and the eastern part of the Black Sea region. The Taurus Mountains of southern Turkey support the largest forest of *Cedrus libani* and *Abies cilicica* on earth, with important stands of *Liquidambar orientalis* and *Platanus orientalis* in the river gullies and flood plains flowing south from their slopes. At the opposite extreme there are the extensive sub-tropical and montane humid forests such as *Fagus orientalis*, *Castanea sativa*, *Acer cappadocium*, *Abies nordmandiana*, *Picea orientalis* occupying the cooler and wetter Euxine forest of the Black Sea mountains. In addition to this diversity, other forest types of environmental importance include the *Pinus nigra* spp. *pallasiana* forest on

⁵² This Chapter is based on Bann, 1998c which contains more detail on the status of individual forest components, data and methodology.

the margin of Anatolia, the enclaves of humid forest with *Diospyros kaki* and *Pterocarya fraxinifolia* on the south coast, the *Populus euphratica* / *Tamarix* riverine forest on the eastern river flood plains, and the extensive coppice *Quercus* forest of Thrace (Byfield *et al*, 1997). In addition to tree species, forest habitats contain a rich array of flora and fauna species. Table 5.1 summarises the status of known species in Turkey.

Table 5.1. Numbers of Described, Endemic, Rare and Extinct Plant and Animal Species in Turkey

Plant and Animal Groups	Described Species	Endemic Species	Rare and Endangered	Extinct Species
Plants				
<i>Non-vascular plants</i>				
Algae	4,500			
Mosses	234			
Lichens	8,950	3,072	3,011	12
<i>Vascular plants</i>				
Ferns	78	1		
Seed plants	8,869			
Gymnospermae	22	3		
Angiospermae	8,850	3,068		
Monocotyledons	692			
Dicotyledons	8,155			
Animals				
<i>Invertebrates</i>	160,000			

Plant and Animal Groups	Described Species	Endemic Species	Rare and Endangered	Extinct Species
Unicellular	65			
Nematodes	1			
Molluscae	190			
Crustaceae	556			
Vertebrates				
Fish	508	2	17	
Amphibians	22	2		
Reptiles	105,451	4	5	
Aves	132		39	1
Mammalian	28	1	25	7

Source: Biodiversity Assessment, Strategy, and Action Plan - Turkey, 1997

Turkey's flora is by far the richest, both in terms of overall plant diversity and level of endemism, of any country in Europe, North Africa, the Middle East or Middle (Central) Asia. There are estimated to be 8,950 species of vascular plants in Turkey, 3,072 of which are endemic. Around 75% of plant species found in Europe occur in Turkey. The rich fauna of the country includes 28 species of mammals, 132 bird species, 508 fish species, and 49 lizards and 36 snake species. Most of Turkey's large mammals live in forest ecosystems. Various deer (*cervus elaphus*) including the forefather of the European fallow deer (*Cervus dama*), roe deer, the bezoar, chamoix, bear, wild bear, and squirrels are important elements of forest fauna. Turkish forests are home to many birds including pheasant, the Caspian and common snow cock, black vulture, various species of owl as well as many species of song birds. Turkey is also one of the three major flyways for millions of migratory birds, which move from the Western Palearctic and Africa every year.

Turkey is one of the world's most important centres of plant genetic resources⁵³. Several of Turkey's endemic plant species are wild relatives of important grain and pulse crop species (e.g., wheat, barley, lentils, chickpeas), fruits (e.g., cherries, apricots and figs), and ornamental flowers (e.g., tulip). Since domestication of plants took place in the region, there is also a wide variety of landraces of domestic species⁵⁴. The genetic resources of wild relatives and landraces are of high potential economic value as sources of information in the research and development efforts (R&D) of the pharmaceutical industry in the search of new drugs, and the agricultural industry in the search of new strains resistant to disease and capable of improved yields.

Turkey's forests are state owned except for 200,000 ha of productive private plantations of poplar and other fast growing species. A high percentage of forest, 84%, is managed for wood production. Other management categories are: protection forest delineated for the conservation of land and water resources (13%); and, conservation forest such as national parks and nature parks (2.6%). There are also 1.5 million ha of productive grazing land within the forest regime.

5.2 The Economic Value of Turkey's Forests

According to the State Statistics Institute (SSI), forest products and services contributed 0.8 % of GNP in 1992. However, most forest products and services are not incorporated into these estimates. These include the full range of NTFP, tourism and recreation values, biodiversity values, and the watershed protection and carbon storage benefits of Turkey's forests. In order to address this shortcoming estimates were derived for key forest components (see sections 5.3-5.10). When these values

⁵³ Genetic resources are defined as the different combinations of genetic information of crop and tree species and their relatives.

⁵⁴ Landraces are found in areas where crop species first arose through domestication and are often produced under 'traditional' farming systems. They are often highly heterogeneous in their environmental characteristics. Landraces are highly variable since they may be comprised of different species and sub-species of domesticated crops as well as numerous local varieties with unique characteristics.

are taken into consideration the value of NTFP and services alone is around 2% of GNP⁵⁵. Valuation of the full range of forest goods and services is clearly fundamental to an accurate assessment of the forests economic worth.

Because diversity valuation requires some idea of WTP for the range of species and habitats, it is hard to use the term 'biodiversity' as the object of valuation. Economic studies normally measure the economic value of 'biological resources' rather than biodiversity itself. *Biological resources* are a more anthropocentric term for biota such as forest and are simply those components of biodiversity that maintain current or potential human uses (Pearce and Moran, 1994).

There are other reasons why it is difficult to put a monetary estimate on biodiversity. There is a lack of consensus on the total number of living species (i.e., baseline measurements for biodiversity), the rate of biodiversity loss, and biodiversity indicators fundamental to the valuation process (Box 5.1). There is also a lack of knowledge of the true value and extent of current and potential future uses of biodiversity.

⁵⁵ Turkey's GNP was around \$184 billion in 1996.

Box 5.1. Biodiversity Indicators and Policy Assessment

Measurement of biodiversity is very complex. There are fundamental definitional problems relating to species and ecosystems. For example, discrete cut-off points for determining boundaries between species (Gaston and Spicer 1998) or ecosystems is still subject to research and discussion, and science has a limited idea of the genetic dissimilarity between species. Beyond this, the inventory task is clearly monumental.

Notions of species richness, evenness and distance are the most used expressions of diversity⁵⁶. Clarification of these measures has important implications for conservation policy. As Solow *et al* 1993 show, if the objective is to conserve diversity, an understanding of species distance is very important. Solow presents an example using the pairwise distance between cranes and their extinction probabilities. The conservation of the most endangered species does not in fact maximise diversity. The reason for this is that the genetic distance between the endangered species and at least one of the 'safe' species is small. Minimising the probability of the number of species lost is not the same as minimising the value of lost biodiversity.

In practice conservation resources are largely allocated to scarce 'exotic' species such as giant pandas and tigers. Explanations for this may be that the difference between biological diversity and biological resources is not recognised, or that conservation policy is responding to the high values attached to scarce species. However, if the aim is to conserve diversity, those policies may not be soundly based (OECD, 2002).

Despite these drawbacks there is considerable scope for at least securing minimum values for biological diversity through the use of approaches focused on the market values of the sustainable uses of biodiversity (e.g., eco-tourism, and the collection of medicinal plants and other NTFP). Measuring these direct use values of biodiversity conservation is extremely important as biodiversity will be more prone to loss when these direct use values are not appreciated and captured, and in addition estimates of direct use values provide an important benchmark for other, less easily quantified,

⁵⁶ Species richness relates to the number of species contained within an area and is still the most common diversity measure; species evenness relates to the distribution of populations of various species within ecosystems - a habitat would be preferred over another if there is less chance that two randomly chosen instances will be of the same species (Purvis and Hector, 2000); distance is a measure of the dissimilarity of the resources in question.

uses. While most of these other uses are still associated with some particular current or future use (such as bioprospecting or amenity), the uncertainty associated with valuing these goods and services is often orders of magnitude greater than the uncertainty associated with the simple direct (but often untraded) uses. The availability of such baseline information is necessary, for example, to estimate 'option values' for future uses. Also, the baseline information allows setting of management and research priorities (Huber *et al*, 1997). In this chapter, therefore, forest biodiversity values for Turkey are partially valued through current estimates of NTFP, fodder, wildlife, tourism and recreation values.

5.3 Non -Timber Forest Products

NTFP such as medicinal and ornamental plants, fruits and nuts, and resins, occur in forest lands throughout Turkey. Medicinal products are of particular importance - Turkey is the third largest exporter of medicinal plants of wild origin after China and India.

Gross revenues from NTFP exports in 1996 were over \$102 million (SSI) - larger than the revenue from timber exports. Furthermore, imprecise monitoring means that the exact quantities of materials harvested for export is unknown and is likely to be underestimated. A domestic trade in a wide range of medicinal plants is also evident from observations and records such as salesmen's catalogues. However, there are no estimates of the scale of this trade. It is clear that NTFP make a substantial contribution to local livelihoods in rural areas (cash income, subsistence foods and fodder), although traditional (subsistence) use of NTFP is also unrecorded (See Box 5.2). Gross values of chestnuts and bayleaves were estimated to be \$750/ha and \$900/ha respectively at high value sites (see Boxes 5.5 and 5.6). While it is of course impossible to extrapolate from a small case study area to a regional or national scale, it is evident that the use value and potential of NTFP is very high in certain regions of the country. In some cases NTFP provide the bulk of cash income and are especially important for poorer sections of the community.

Box 5.2. The Economic Value of NTFP: A Case Study of Ovacik Research Forest.

Ovacik research forest, located in Izmir (Aegean region), covers an area of 2,000 ha. Around 10 villages make extensive use of the area for the collection of NTFP. Surveys of 24 households in 3 villages were undertaken. The most important NTFP collected are chestnuts and walnuts (bayleaves, mushrooms, cornel, thyme and hypercium are also collected, mainly for domestic use). On average 35% of household income is derived from NTFP, but dependence is as high as 100% for some families (the average income of households in the area is \$4,206). NTFP make a significant contribution to villagers both in terms of cash income and subsistence use. If income from other sources is low in any given year more time is spent collecting NTFP. In this sense NTFP act as a kind of security to villagers.

There are reasons to believe that NTFP are even more significant in other parts of the country because (i) the distribution of NTFP is generally lower in the Aegean region compared to other areas of Turkey such as the Black Sea region, (ii) and red pine forests such as Ovacik typically have fewer species.

The economic value of NTFP based on available official information on export revenues, tariff revenues and benefits to local communities, is conservatively estimated at \$110 million per year (Table 5.2)⁵⁷. For the reasons given above the gross value of NTFP based largely on export revenues can be taken as a minimum estimate of the value Turkey's NTFP⁵⁸.

⁵⁷ Fuelwood is not included in this analysis.

⁵⁸ Since information on distribution of NTFP, sustainable harvesting techniques, and harvesting cost are unavailable, it is not possible to accurately estimate the optimal value of the resource.

Table 5.2. Summary of the Annual Value of NTFP

	\$	Comments
Export Value	102,175,221	Underestimate due to fact that not all exported products are recorded Overestimate because gross value.
Income from tariffs	693,511	Revenue to General Directorate of Forestry (GDF)
Revenue to villagers	7,590,338	May be overestimate because gross value.
Subsistence value	Unknown	Significant for some areas.
Total	110,459.070	\$5.30/ha

Source: State Statistics Institute (SSI), 1997.

5.4 Fodder

Forest fodder represents a valuable free resource for forest communities, with around 2.3 million tons of fodder obtained annually from forest pastures (Table 5.3). The market price of 1 kg fodder cut from meadows is around 35,000TL (\$0.23) (Ministry of Forestry - MOF)⁵⁹. Assuming that the value of forest pasture is lower than this, i.e., 20,000TL, forest fodder can be valued at around \$306 million annually which is equivalent to \$56 per hectare of forest rangeland (De Haan, 1998).

⁵⁹ Exchange rates used in this chapter: \$1=260,000TL (1998); 150,000TL (1997); 89,500 TL (1996).

Table 5.3. Estimated Dry Matter (DM) Production of Forestry-Owned Rangelands

Type of rangeland	Estimated Area (ha)	Utilisable DM/ha (kg)	Total DM production (million ton)
Central and Eastern Anatolia	2, 610,000	300	0.8
Black Sea	331,000	400	0.1
Aegean	930,000	300	0.3
Mediterranean	444,000	200	0.1
Alpine Meadow	1,500,000	700	1.0
Total	5,800,000		2.3

Source: De Haan, 1998

5.5 Wildlife

Estimates of the economic value of Turkey's wildlife can be derived from revenues from hunting, the sale of animal products, and the value of freshwater fish productivity, fish breeding and sport fishing (Table 5.4).

Game hunting is a traditional activity in Turkey. Species taken include game birds and hare associated with steppe, arable and forest ecosystems; migratory waterfowl associated with wetlands; and several large game species occurring primarily in forest lands (e.g., bear, wolf, wild pig and ibex). An estimated 2 million hunters are currently registered at Hunting Associations. Revenues from hunting licences in 1997 were 2,345 trillion TL (\$15,600,000) when around 350,000 hunters renewed their

licences, or obtained a new licence, for 7 million TL (\$46.60)⁶⁰. In 1998 Hunting licences cost 27 million TL (\$130) and revenues from hunting licences were estimated to be 5,525 trillion TL, \$21,250,000 (GDNPGW⁶¹). In addition a permit is required to hunt in forest areas. Hunting permits have been issued by the MOF for hunting bear, ibex, wild goat and wild boar (participation fees range from \$10-40, while fees for hunted and wounded species range from \$10-1,800). Income from hunting was around \$200,000 in 1996/7, mostly derived from foreign hunters (92%).

Freshwater fishing is enjoyed in 69 lakes and ponds located in forest areas. Freshwater fish production in 1996 was around 37,500 tons, and based on the market prices of captured species may be valued at around \$79 million⁶². This could be significantly increased by the proper development and management of freshwater habitats and fishery activities. There are 20 government managed fish production and breeding stations within forest areas, with a capacity ranging from 50,000 to 2 million fish per station. Net revenues from selected trout breeding stations in 1997 were \$85,521 (GDNPGW). By the end of 1997, 255 permits had been issued by the GDF authorising the development and operation of private hatcheries. Around 233 farms are currently in operation.

Sports fishing, while currently underdeveloped, is likely to attract an increasing number of enthusiasts in the near future. In 1977, there were 700 sports fishers in Yedigöller National Park, who generated 210 million TL in revenues (\$1,400). Data at the national level is unavailable. In 1998 fishing fees were 400,000 TL (\$1.70) per day, and 4 million TL (around \$15) for a seasonal fishing permit. Fishers will be permitted to catch a maximum of 3 fish a day. According to a recent regulation on Amateur Fishing Tourism, organised fishing tourism will cost \$20/person/day plus \$5 for each fish caught. There are no estimates of current or potential number of fishers.

⁶⁰ Hunting licences are valid for 5 years.

⁶¹ General Directorate of National Parks, Game and Wildlife.

⁶² Freshwater fish production and average market prices per species derived from State Planning Organization 'Water Products Production Prices' 1996.

Table 5.4. Summary of Wildlife Values (\$)

Category	Value
Hunting Licences	15,633,333
Hunting Permits	200,000
Fur and leather ¹	1,333,333
Fish	79,000,000
Trout breeding	85, 521
Sport fishing	1,400
Total	96,253,587 (4.60/ha)

Note: 1/ According to the GDNPGW around 20,000 pieces of animal fur or leather are sold per year at an average market price of 10 million TL. Total gross revenue is therefore estimated at \$1,333,333.

5.6 Tourism and Recreation

Tourism is the fastest growing sector in Turkey. Eco-tourism is likely to contribute significantly to the future growth of the sector on account of the country's exceptional number and variety of natural and historical resources within national parks and other protected areas. The number of visitors to national parks and preservation areas reached nearly 5.5 million in 1997.

Gross revenues from tourism in protected areas (national parks, nature parks and nature reserves) are estimated at \$7million. This is a minimum estimate based on official visitor numbers and entrance fees, plus tour operator revenues in Antalya province only. The majority of national parks (56%) and nature parks (63%) do not have entrance gates, and are accessible to the public for free, while others are poorly monitored and managed. Estimates of value based on visitor numbers and receipts

will therefore underestimate the full value of this forest service⁶³. In addition, 428 forest recreation sites covering 15,946 ha play an important part in meeting the growing demand for recreation facilities in Turkey. Based on visitor numbers and entrance fees, recreation benefits are estimated at \$2 million annually (1997) (GDNPGW).

5.7 Watershed Maintenance

The watershed protection benefit of many forest areas throughout Turkey has been lost or is severely damaged due to the extensive deforestation of uplands areas and subsequent loss of vegetative cover. Watershed degradation has led to excessive runoff resulting in soil erosion and flooding. These effects continue to have an impact on important economic activities such as agriculture, livestock grazing and dam productivity. The human costs are also enormous with nearly 5,000 human lives lost as a result of natural disasters related to watershed degradation since 1910. Of the many and varied costs associated with watershed degradation in Turkey, only an estimate of the cost of reduced dam productivity as a result of reservoir sedimentation was possible.

There are 175 reservoirs in operation in Turkey. According to the State Hydraulic Works, total water reservoir volume of the existing (operating) dam reservoirs is 155 billion m³. Measurements of the sedimentation accumulated within reservoir catchments per year are available for 16 critical catchments areas (Table 5.5). The electrical energy potential of Turkey's reservoirs is estimated to total 10,108 MW, representing a maximum operating capacity of 88,546 GWh. In 1997, the system was operating at 42% capacity, generating 36,866 GWh of energy. The price of 1 KWh is \$0.05. Assuming that the original economic life of the dams was 100 years (based on a typical engineering standard), the value of foregone production for 16 catchments is estimated at \$64,266,435 annually (PV, 10%).

⁶³ More sophisticated valuation techniques such as travel cost methods (TCM) by which consumer surplus can be estimated, were not possible given resource limitations.

Table 5.5. Sedimentation Rates of Key Dam Reservoirs in Turkey

Name of dam	Year built	Catchment Location	Reservoir Volume m ³	Annual sediment accumulated m ³ /year	Existing life of dam years	No years production lost ¹
Altinapa	1965	Central Anatolia	15,689,000	377,417	19	48
Bayindar	1964	Central Anatolia	6,970,000	102,500	28	38
Buldan	1966	Aegean	46,000,000	984,000	72	-
Caygoren	1970	Aegean	137,622,000	915,231	77	-
CIP	1965	E. Anatolia	7,000,000	105,800	40	27
Cubuk-1	1935	Central Anatolia	12,500,000	166,333	75	-
Demirkopru	1957	Aegean	123,160,000	8,563,800	41	18
Hirfanh	1957	Central Anatolia	5,980,000,000	98,400,000	33	26
Karamanh	1972	Aegean	24,000,000	379,000	13	61
Kartalkaya	1970	Mediterranean	195,000,000	2,684,263	19	53
Kemer	1957	Aegean	538,810,000	4,612,955	22	37
Kesikkopru	1964	Central Anatolia	97,454,000	624,200	66	-
Selevir	1963	Central Anatolia	74,681,000	995,857	27	38
Seyhan	1955	Mediterranean	1,200,000,000	11,450,000	70	-
Surgu	1967	E. Anatolia	72,196,000	931,625	35	34
Yalvac	1971	Mediterranean	8,900,000	225,700	27	46

Source: State Hydraulic Works, 1996 and Middle East Technical University.

Note: 1/ Assumes that the original economic life of the dam was 100 years (based on a typical engineering standard).

5.8 Carbon Storage

Estimates of the carbon storage functions of forests are typically based on 'carbon credits', i.e., credits that should be ascribed to an intact forest (Pearce and Moran, 1994). In order to derive a 'carbon credit', we need to know: (i) the net carbon released into the atmosphere when forests are converted; and, (ii) the economic value of one tonne of carbon released.

Carbon is released at different rates according to forest type, method of forest clearance and the subsequent use of the land. To estimate the amount of carbon released, data on forest carbon dynamics is required, for example: estimates of biomass and soil carbon densities in mature, logged and secondary forest; the products derived from forests; the magnitude of the forest detritus pools, including dead wood, and how this changes over time as result of forest management; and rates of biomass carbon accumulation in recovering forests. Sequestration benefits in the literature suggest that the location of the forest with respect to urban or rural environments is also important. Sequestration in an urban environment tends to have greater benefits because of the higher CO₂ emission levels of the surroundings.

A number of benefit transfer approaches are available. Primarily the information arises out of the 'LCGAS' project (Least Cost Greenhouse Gas Abatement Strategy), a multilateral effort to undertake an inventory and assessment of sources and sinks. The factors provided below are based on a methodology recommended by the Intergovernmental Panel on Climate Change (IPCC), the Environmental Directorate of the OECD, and the International Energy Agency (IEA).

Using an approximation of 50 - 100 t dm/ha (and assuming 45% of dry matter as carbon) implies stored carbon of 23-45 tC/ha. This would have a CO₂ equivalent of 83-163t CO₂/ha released, assuming all stored C is released. A valuation range of \$10-20 per ton of carbon is consistent with international valuation estimates⁶⁴. This implies that the 'average temperate forest' converted would have a maximum

⁶⁴ See Chapter 9.

negative externality of: $1,000,000 \text{ ha} * (75 \text{ t} * 0.45) \text{ tC/ha} * \$10 = \$0.3375 \text{ billion}$, or about \$337 per hectare of forest⁶⁵.

Based on the area of productive forests alone, the current carbon sequestration value of Turkey's forest can be estimated at over \$3 billion (Table 5.6). This may be overestimated to the extent that a lower sequestration factor should be used for coppice forest. However, this may be counterbalanced by the current unknown sequestration rate of degraded forest areas which, if we use productive forest estimate as the carbon storage benefit of the total forest area, is taken as zero. The potential carbon storage value for Turkey's forests is over \$6 billion, and the negative external cost associated with current forest degradation is somewhere below \$3 billion and probably in the billion dollar range.

Table 5.6. Carbon Values for Turkey's Forest (\$)

Category	Area (ha)	Value	PV (10%)
Total forest area	20,743,000	7,000,762,500	6,364,329,545
Degraded area	10,164,070	3,430,373,625	3,118,521,477
Productive area	10,578,930	3,570,388,875	3,245,808,068

It should be noted that the carbon storage value of Turkey's forests is a social value in that it is the benefit of avoiding global warming impacts in the global sense. It is not therefore the benefit captured by Turkey for carbon sequestration, or the financial or opportunity cost of forest conversion from the perspective of the forest owner. However, it could be a value to Turkey if others are WTP part, or all, of this amount.

⁶⁵ The 75t dm/ha is used as the average of the range, 50-100 t dm/ha, cited in the previous paragraph.

5.9 Genetic Resources

5.9.1 Pharmaceutical Values

Economic valuation of medicinal plants is possible at two levels. Firstly, relating to the current use value for commercial and traditional medicine, and secondly, relating to option value, i.e., the extent to which conservation is required to protect future use values of medicinal plants⁶⁶. Option value is reinforced by the extremely limited knowledge that exists about the medicinal properties of plants, and will partly depend on the nature of future research in the medicinal drugs sector with respect to the base materials that are likely to be used.

Box 5.3. Temperate vs. Tropical Forest Biodiversity

The pharmaceutical industry is estimated to generate about \$43 million in annual revenues from these rainforest related drugs. Available studies on the medicinal value of genetic resources all relate to tropical forests. This raises the question of whether the tropical valuation literature can be used as a valid starting point for estimating temperate values under a benefits transfer approach. One reason for caution here is a (common) presumption that temperate forests are 'worth less' than tropical forests. The intuition for this seems to be that temperate systems are less complex, and therefore harbour less information. Because genetic value comes from information, temperate forest must therefore have less value. There are however good reasons for questioning this assumption: (i) current studies of temperate forest suggest a high diversity e.g., Russia's temperate and Boreal forests (Lutz and Caldecott, 1996). Also, moist (old growth and mature) temperate forests such as those found in North America's and Chile's Pacific Coast areas have biodiversity potential that seems to match many tropical systems. Turkey's high number of endemic species further highlights the high diversity of temperate systems; (ii) The institutional systems for capturing values are likely to be more progressed in temperate zones than many tropical zones (e.g., better initial access for bioprospecting, more secure tenure in event of discovery, longer traditions of property rights). This suggests that 'capturable' biodiversity values are likely to be higher in such areas; (iii) The consumer surplus values cited in some valuation studies focus on international markets for medicinal plants and are therefore independent of where the plant might come from. In this case, all one needs is a 'species count' to estimate value.

⁶⁶ Estimates of current use values for Turkey are included within NTFP estimates.

The Value of Pharmaceuticals

The value of pharmaceuticals derived from genetic material in Turkey's forests can be estimated in a model which takes account of: the number of forest species; the probability of a species yielding a medicinal product; the royalty rate on the sales of such a product which would be payable to Turkey; a coefficient of rent capture; the likely value of an internationally traded pharmaceutical product; and the forest area (Pearce and Puroshothaman, 1992, Adger *et al*, 1995).

$$V_p(L) = \{N * p * r * a * V/n\} / H \text{ yr}^{-1}$$

Where, $V_p(L)$ = the pharmaceutical value of 1 ha of forest (\$ ha⁻¹); N = the number of plant species in the forest; p = the probability of a 'hit'; r = the royalty rate; a = the appropriation rate, or rent capture; V/n = the average value of drugs developed (\$ yr⁻¹); and H = the area of forest (ha).

Based on best guess factors for Turkey, the range of potential values estimated are given in Table 5.7. Based on the total forest area (i.e., 20.7 million ha), the potential use value of pharmaceutical drugs can be seen to range from \$0.04 - \$75 per hectare⁶⁷.

⁶⁷ See Section 9.3 for a critique of this approach.

Table 5.7. Option Value of Pharmaceuticals from Turkey's Forest Resources

Scenario	Value \$/yr	Assumptions
Low:	877,500 \$0.04/ha	appropriation rate =0.1; drug value = \$0.39m
Medium:	112,500,000 \$5.40 / ha	appropriation rate =0.5; drug value = \$1m
High:	1,575,000,000 \$ 75/ ha	appropriation rate =1; drug value = \$7m
Assumptions: N = 9000; Probability of a hit = 0.0005 ¹ ; Royalty rate = 0.05; H = 20,743,000		

Note: 1/ A hit rate of 0.0005 has been estimated for tropical forest ecosystems, and is applied here on the assumption that Turkey's biodiversity is comparable in richness.

5.9.2 The Value of Plant Genetic Resources for Agriculture

Genetic diversity is of great benefit to agriculture in offering the possibility for plant improvements and increases in yield, and as a form of 'natural insurance' against the unpredictability of homogenised systems (OECD, 2002). Given Turkey's high endemism and large number of wild crop relatives and landraces, the potential contribution of Turkey's genetic resources to agriculture constitute a leading rationale for biodiversity conservation, making estimation of this potential value important. However, little is known of the value of genetic resources for agriculture and economic estimation is difficult. For example, common landraces based on wild species are typically the result of generations of innovations by international research centres so it is very hard to identifying the contribution of an original landrace to the success of a particular modern variety. An accurate picture of the contribution of genetic resources requires assessment of the net incremental yield value at every stage of recombination. Furthermore, given that the production process includes labour and

technology, the contribution of these complementary inputs also needs to be determined.

One empirical study attempting to estimate the relative contribution of genetic resources in the R&D process in plant breeding (Evenson, 1995) specifies the R&D process as follows: $\text{New varieties} = f(L, K, G)$. Where: L is the level of input from human capita (scientists); K is the level of input from physical capita (technology, machinery); and, G is the level of input from genetic capita (biodiversity). This study was based upon the records of plant breeding at the International Rice Research Institute since 1960 and estimates that approximately 35% of the production of modern new varieties (i.e., the gain to yield enhancements) is attributable to the genetic resource input into the R&D function. The imputed present value of a single landrace accession according to this study is \$86-272 million, while the imputed present value of one thousand accessions with no known history of use is \$100-350 million. Evenson also estimates the extent to which diverse germplasm was used in order to maintain the resistance and prevent the deterioration of existing systems. On average (across all plant species) 6.5% of all new varieties are estimated to emanate from the incorporation of traits from diverse germplasm (i.e., from germplasm not already a modern variety). This indicates that external (non-modern) sources of germplasm must be accessed at a rate of 6.5% per year in order to prevent the system from depreciating.

Plant breeders from all over the world use strains of the wild progenitors, primitive forms, and landraces of major crops from Turkey to develop plants that are more productive and resistant to cold, drought, salinity, pests and disease. For wheat and barley disease resistance programs, *in situ* materials from Turkey have been frequently used (Hoyt 1992). For example, a wild relative of wheat from Turkey provides disease-resistant genes to commercial wheat varieties worth \$50 million annually to the United States alone. If we broadly assume that 35% of this value is attributable to the genetic resource input, then around \$1,590,909 per annum should accrue to Turkey (NPV, 10% 4,545,454).

The global benefits from gene conservation are therefore enormous. However, the benefits to Turkey are dependent on the institutional mechanisms governing what proportion of this global value it can capture. Currently, Turkey captures a very small

amount of the global value of its genetic resources, around \$45,000 per annum from the export of seeds. It is also unclear how much, if any, of this potential value resides in forest areas.

5.10 Existence Value

Existence value can, to some degree, be based on WTP by international organisations to conserve biodiversity (Table 5.8).⁶⁸ On this basis, values are around \$0.70 per ha (based on total forest area of 20.7 million ha).

Table 5.8. Summary of Foreign Assistance for Protected Areas Management

Project Title	Funding Agencies	Budget / \$	Objective
Management of National Parks and Protected Areas, Protection of Biological Diversity and Rural Development	UNDP/FAO	293,500	Strengthening of institutional capacity of GDNPGW
Ecological Risk Analysis and Management Plan for the Manyas Lake	LIFE-Third country program	278,562	
In-Situ Conservation of Genetic Diversity	GEF 1	5,100,00	Identification and establishment of <i>in-situ</i> conservation areas
Protected Areas and Sustainable Resource Management	GEF 2	8,200,000	Development of model management plans for Artvin-Camili, Sultansazligi, Koprulu Kanyon and Longoz forests
TOTAL		13,872,062	

⁶⁸ Lower bound estimates of existence value have been based on donations to environmental charities / conservation societies, GEF funding, and debt for nature swaps (Pearce, 1996, and Chapter 9).

5.11 Summary of Valuation Results

A summary of the valuation results for individual forest components is provided in Table 5.9. Aggregation of component values indicates a total value of around \$4 billion annually (\$190 per hectare). This represents around 2% of GDP. While these estimates could be refined by more in-depth research, the results clearly indicate of the high value of Turkey's forests.

Table 5.9. Summary of Valuation Estimates (\$/year)

Component	Value	Per ha
1. NTFP	110,459,070	5.30
2. Fodder	306,666,667	14.81
3. Wildlife	96,264,615	4.60
4. Tourism	6,914,049	0.33
5. Recreation	2,000,000	0.10
6. Watershed Protection	64,266,435	3
7. Carbon storage ²	3,245,808,068	156
8. Genetic resources ¹	112,500,000	5.4
Total	3,944,878,904	190
Biodiversity ³	634,804,401	30
Global Values ⁴	3,358,308,068	162

Notes: 1/ Median estimate used; 2/ Annuited at 10% discount rate; 3/ Biodiversity estimate comprised of components (1, 2, 3, 4, 5, 6, and 8); 4/ Global values comprised of components 7 and 8.

Most of the component estimates are gross values, i.e., costs have not been deducted, and therefore appear to over-estimate actual value. However, it can perhaps be more

forcibly argued that these estimates in fact under-estimate forest values due to the following factors: (i) only a partial analysis of many value components was possible (e.g., NTFP, wildlife, watershed protection functions, genetic resources); (ii) all estimates exclude consumer surplus; (iii) many forest values are not included in the analysis such as: research and education benefits; use of the forest for human habitat; micro-climate, air pollution reduction, nutrient cycling functions of the forest; and existence value; and, (iv) the potential value of many forest components, dependent on improved management, policies and institutional mechanisms, is significantly higher than estimates provided (e.g., NTFP benefits, tourism and genetic resources).

By means of comparisons, timber sales were worth \$500 million (1996). Based on a actual cut 14m^3 and an allowable cut of 18m^3 , and a stumpage value of \$30, timber can be valued at between \$420 - 540 million per year, \$20-26 per hectare (Carbonier, 1998). The reasons why deforestation occurs given that the value of NTFP and services are far in excess of timber values are detailed in Section 5.15. Importantly, around 85% of the total value of Turkey's forests represents global values (carbon storage functions, potential genetic resource values). This highlights the important role of international arrangements in providing the incentives to host countries to manage their resources for the global good.

5.12 Institutional Context

A summary of the institutions involved in forest management is provided in Table 5.10.

Table 5.10. Institutions Involved in Forest Management

Product/Service	Responsible Government Agency	Others
Timber	Ministry of Forestry (MOF)	
Fuelwood	General Directorate of Forestry (GDF)	
NTFP	General Directorate of Forestry (GDF)	Private export companies ; NGOs
Wildlife	General Directorate of National Parks, Game and Wildlife (GDNPGW)	Hunting Association; NGOs; Owners of private hunting grounds; Private hunting tourism operators
Protected Areas	GDNPGW; GDF; Ministry of Tourism (MOT); Ministry of Culture (MOC); Ministry of Environment (MOE); Ministry of Agriculture and Rural Affairs (MARA)	Private Sector ; NGOs; IOs
Genetic Resources	Forest Trees and Seeds Research Directorate (FTSRD)	Forest Research Institutes; Universities; Ios
Tourism and recreation	GDNPGW; MOT; MOC	Private sector (tour operators, service contractors)
Watershed Management (reforestation and soil erosion control activities)	General Directorate of Reforestation and Erosion Control (GDREC); State Water Works (DSI); General Directorate of Rural Services (GDRS)	NGOs

Note: The Ministry of Forestry is the main body responsible for the protection, planning and management of state forests. It is made up of four centrally located general directorates (the General Directorate of Forestry (GDF) - responsible for forest production and management, the General Directorate of Reforestation and Erosion Control (GDREC), the General Directorate of National Parks Game and Wildlife (GDNPGW), and the General Directorate of Forest Village Relations (GDNPGW)), 9 Ministerial Regional Directorates, 27 Forestry Regional Directorate and their sub units, 11 Forestry Research Directorates and 9 Forest Soil Laboratories.

The legal status of forests is reflected in legal documents such as the Constitution, laws, international conventions, protocols and related regulations (Table 5.11).

Table 5.11. Legislation Related to Forests

Category	Law	Comments
General	Forest Law; Law no.2862, on the Protection of Cultural and Natural Values; Environment Law no. 2872; Government Decree on Specially Protected Areas; National Reforestation Mobilisation Law; Forest Villages Development Support Law	Participatory forest management planning and implementation omitted from current laws and regulations No specific reference to sustainability in natural resource management and protection
NTFP	Forest Law (Article 37&40); Regulation on Collection, Production and Export of Natural Flower Bulbs (1989); Official Gazette no.20059	Insufficient regulation and monitoring of collection practices and trade Inadequate pricing system
Wildlife	Government Decree on export of animal species; Regulation on Hunting and Fishery activities; Hunting Tourism Regulation; Hunting Law no. 3167; Law no.797 (approves International Agreement on the Protection of Birds)	1/ New Hunting law under submission to parliament. Community hunting grounds are not promoted under new law. 2/ Although wildlife reserves are also protected areas, they are not counted among the protected area categories under the National Parks Law. This reduces the opportunities for management and for co-ordination between concerned institutions
Fish and water resources	Water Products Law no 1380	
Protected areas	National Parks Law 1983; National Parks Fund Regulation; Tourism Encouragement Law; Environment Law; Law on Protection of Cultural and Natural Values	No management plans for majority of sites although legally required

Category	Law	Comments
Recreation/Tourism	Tourism Encouragement Law no. 2634	Changes in Tourism Encouragement Law required to reduced pressures on protected areas
Watershed management	Article 23-24 of Forest Law, on the establishment of conservation forests; Article 58 of Forest Law defines responsibilities of GDREC; National Forestation and Erosion Control Mobilisation Law, 1995	
Grazing	Article 19 and 21 of Forest Law	
Laws affecting land management and conversion	Construction Law no.3194; Coastal Areas Law no.3086; Forest Law (Article 63) - 50 year tax exemption for establishment of forest plantation; Forest Law – Article 2B ⁶⁹	Laws prepared on land tenure, rangelands and the regulation of grazing are yet to be approved. Lack of such legislation particularly effects <i>in situ</i> conservation of large areas of biodiversity outside of protected areas. Article 2B of the Forest Law is criticised for encouraging forest encroachment, and has led to disputes between forest villages and the forestry organisation. However, there are likely to be cases where application of this law is reasonable.

⁶⁹ Under Article 2B forest lands that scientifically and technically have lost their forest character prior to 31 December 1981, and are determined suitable for agricultural, grazing or human habitat may be taken out of forest regime and: (a) used as settlement for forest villagers who have to be taken out of their present areas (i.e., due to serious threats such as landslides or extreme natural resource degradation) (b) allocated to village communities as common grazing lands (c) sold to the inhabitants presently using them, and the revenues from such sales transferred to the Forest Villagers Development Fund.

International pressure to include environmental concerns in legislation has resulted in the rapid introduction of complex legal concepts without supporting legal implementation mechanisms. There is no clear definition of the roles of responsible agencies or institutional mandates. In addition there are frequent overlaps, and national legislation often contradicts itself and international laws making enforcement difficult. A review and revision of present legislation is needed to eliminate existing conflicts and shortcomings.

In general the management and protection of forest biodiversity is restricted by a lack of funds. Current financial arrangements for the management of NTFP and forest services are provided in Table 5.12.

Table 5.12. Financial Arrangements

Product / Service	Budget Sources and Allowance (\$ 1997)	Comments
Wildlife	General Budget ¹ Revolving Capital Budget ² \$425,000 (\$2.22ha) for management of wildlife reserves	Revenues from hunting licences are not made available to support sustainable management of game species and hunting activities (this is addressed under new hunting law)
Protected areas	General Budget (\$8,839,633) National Parks Budget (\$2,254,000) ³ Revolving Capital Budget National parks, nature parks, national monuments and nature monuments (\$4.07/ha)	A significant portion of the income from protected areas (66-75%) is transferred to the Central State Fund ⁴ . This leaves only a small percentage for reinvestment under the National Park Fund Budget, which is not sufficient to cover management costs. Measures for increasing revenues from this fund and/or other sources requires attention. It is estimated that around 2-3 times current budget allocations are required.
Genetic resource	Allocation from the Forest Tree and Seed Improvement Research Directorate's budget provided under the General Budget.	
Recreation areas	Revolving Capital Budget \$2,928,733 (\$236/ha)	Insufficient budget allocations is one of the main constraints to management. In 1998, 1,146 billion TL was requested for in-forest recreation areas, but only 350 billion TL budgeted.

Product / Service	Budget Sources and Allowance (\$ 1997)	Comments
Watershed management	General Budget / Reforestation Budget GDREC budget based on surcharges on the sale of industrial wood, fuelwood and finished products, tourism revenues and allocations from Environmental Pollution Prevention Fund. \$35 million	Current funds are insufficient

Notes: 1/ The General Budget is managed by the Ministry of Finance who annually sets the limits for budget proposals to be submitted by State agencies; 2/ The Revolving Capital Budget is made up of income from forest recreational areas, game and wildlife, and fisheries; 3/ The National Parks Budget within the MOF is theoretically to cover the establishment and management of protected areas. It is prepared along the same principles of the General Budget, i.e., the yearly budget is based on expected funds according to income estimates for the coming year; 4/ Central State Fund is a common pool of revenues from state organisations.

5.13 Trends in Forest Utilisation

According to official figures, over half (10.4 million hectares) of forest land in Turkey is currently degraded, and forest loss and degradation are still occurring as a result of unsustainable forest practices and development pressures. Furthermore, around 80% of Turkey's land area (63 hectares) is suffering from various levels of erosion. The severity of Turkey's soil erosion problem is in part explained by the country's fragile geological structure, harsh topography and climatic conditions. However, human activities including overgrazing (especially in fragile mountainous regions), illicit fuelwood cutting, settlement expansion, and fires are largely responsible for the loss of vegetative cover on forest and pasture areas. These effects are exacerbated by an almost sixfold increase in population over the last sixty years, from 12 million to around 62 million. A summary of the trends in the use of forest resources follows.

5.13.1 Over-utilisation

Turkey has 17,900 'forest villages' accommodating over 9 million people. The income level of forest villagers is below the national average and they are largely economically dependent on forest resources, in particular fuelwood for heating and cooking, and forest rangeland and fodder resources for livestock.

Around 10 million m³ of fuelwood is consumed legally each year. In forest areas with adjacent settlements there are estimated to be 16,000 cases of illicit fuelwood cutting annually, and illegal collection is considered to match the quantity legally supplied (NEAP, 1997). The production area for forage crops in Turkey is small, covering only 2.5 % of the total agricultural area and total feed production is insufficient. This increases the pressure on forest areas which are commonly utilised for livestock grazing. There are an estimated 6,000 cases of illicit grazing annually (NEAP, 1997).

While limited data means that it is difficult to determine the exact status and potential of forest flora and fauna, the evidence suggest that the many species are being harvested unsustainably. Some important export products such as *Laurus nobilis* (bayleaves used for medicinal purposes, soap manufacture and as an oil extract) and ornamental bulbs are known to be over harvested, and many of Turkey's important endemic plant species are endangered (e.g., *Gentiana lutea*, which is collected illegally (Ozhatay *et al*, 1997)). Species whose genetic resources have been adversely affected by excessive utilisation include: walnut; Taurus cedar; sweet gum and elm. In terms of wildlife, the Anatolian lion, tiger, beaver, and darter are now extinct, while endangered species include leopard, lynx, hyena, and the Monk seal. In addition, populations of 45 species are estimated to have greatly declined including - deer (*cervus elaphus maral*); roe deer (*capreolus capreolus*); fallow deer (*dama dama*); wild sheep (*Ovis amon anatolica*); and, gazelle (*Gazella subgutturosa*).

Tourism pressures, such as overcrowding and/or excessive hotel and tourist facility expansion, is evident at many protected areas (e.g., Dileck peninsular national park, Bey Mountains Coastal national park and Seven lakes national Park). In European countries, 2% of forest areas are reserved for recreational purposes while in Turkey the figure is around 0.01%. Current areas are insufficient to meet demand. As a

result, existing areas are being used excessively leading to problems with drainage, compacting of the ground and damage to flora and fauna.

5.13.2 Forest Conversion and Encroachment

Urban and agricultural expansion, tourism development and land speculation have all been responsible for the conversion of forest land, and for exerting increasing pressure on the forest resource. By 2020 the urban population is forecast to increase from 61% to 71%. While this is likely to reduce the pressures on rural forest ecosystems, urban expansion into forest areas near large urban centres is set to increase. In Istanbul alone, 12,000 hectares of land were removed from the forest regime between 1973-1993, under Article 2B. Up to 81% of the settlement area of the city's suburbs is founded on land previously classified as forest land (Erdonmez, 1995).

The conversion of forested areas for marginal agriculture (often on steep slopes) constitutes a major threat to Turkey's forest resources. These areas are often not suitable for cultivation and should be maintained as forest areas. There are estimated to be 7,000 cases of forest clearing for new farm land and 2,200 case of illicit settlement per year. As a result of these activities, around 809,000 ha of forest land have been converted to farm land, and 109,000 ha of forest land have been settled between 1937-1995 (NEAP, 1997).

Other threats to the forest include pollution, the introduction of exotic species that have displaced native species, and forest fires.

5.14 Explaining Forest Degradation

The current unsustainable use of Turkey's forests can be explained to a large extent by market, institutional and policy failures at the local, national and international level. Market failures include: externalities; the existence of unpriced and under-priced environmental assets; the public goods nature of the resource and problems of open access; and the lack of, or inappropriate, property rights. Policy failures include the lack of government interventions necessary to correct market failures (e.g., the

lack of forest management), and Government interventions that distort market prices. How these failures are affecting Turkey's forest resource is described below.

5.14.1 Externalities and Missing Markets

Externalities exist when the effects (costs) of an action by one party are borne by other parties. As an example, tourism and urban expansion into forest areas in Turkey often take place without considering the full social costs. In many cases, while such developments result in high profits for developers, society as a whole is worse off as a result of loss of forest resources (e.g., fuelwood and NTFP) and the important regulatory functions offered by forests. Economic incentives motivating individuals to protect land and water resources, or disincentives targeted at destructive practices are yet to be introduced in Turkey (Box 5.4).

Box 5.4. The External Costs of Forest Grazing

Grazing is permitted within the 1.5 million ha of forest rangeland. However, nearly all forest areas are subject to free grazing. It is difficult to estimate the exact extent of illegal forest grazing, but it can be conservatively set at the area of degraded coppice, i.e., 4,300,000 ha. Based on an estimated DM for these areas of 1.3 millions tons (De Haan, 1998), free grazing in these areas is estimated to be resulting in a negative externality of around \$173 million annually, or \$40/ha. The cost to society of excessive grazing is in fact much higher than this once the reduced productivity of the area and lost biodiversity are taken into account. The problem of overgrazing is also closely linked to watershed degradation and associated costs. These social costs need to be reduced by fines on offenders comparable to the damage cost caused.

There is evidence that in some areas local people would be willing to pay a small amount for rangeland improvements. In some areas villagers charge nomads for grazing rights (50,000 - 100,000 TL per sheep). This assumes a property right, and illustrates recognition of the value of rangelands and a willingness to pay for it. A market in grazing rights could be considered as a mechanism for improving incentives for sustainable management.

Most forest components are not marketed and thus appear as free goods (e.g., some NTFP, biodiversity, carbon storage and watershed maintenance functions of forest), and all NTFP are underpriced, and over harvested. Villagers generally sell products

as raw material resulting in a significant leakage of production benefits away from local sources. This is due to limited experience in, and facilities for, processing and marketing. For example, an important medicinal plant - Jew's Myrtle (*Ruscus aculeatus*), is purchased from villagers at a value of \$0.12 / kg (damp material), processed in Izmir and sold for \$0.20 / kg, and after drying and packaging exported for \$1.45 / kg. In Germany the firm Heumann Pharma use this plant's active compound 'Ruscogenin' in order to prepare the haemorrhoid pomade - Ruscorectal. The value of the final product is not known, but is likely to be many times the value captured by local resource users. Current arrangements therefore mean that middlemen and foreigners gain most of the money from the production of NTFP. Low producer prices encourage overharvesting. Higher producer prices would likely encourage more sustainable management by local communities (as higher prices would ensure constant or higher revenues from lower harvesting levels). Where resources are undervalued then some type of price related market or policy correction would have an immediate beneficial effect.

5.14.2 Property rights

Unsustainable harvesting practices in Turkey are in many cases related to inappropriate tenure arrangements. Under the current system there is little incentive for hunters or rural communities living in the vicinity of hunting areas to monitor and manage game populations sustainably, since these resources are State owned, and the benefits derived from their use are not appropriately valued or allocated to user groups⁷⁰. While villagers may have NTFP harvesting rights, or grazing rights, they have no legal ownership to land. In some instances even when it is clear that returns from sustainable harvesting are more profitable than current activities, distrust of forestry officials and lack of secure tenure means that damaging practices continue. Over-grazing in forest areas in Turkey is related to open access nature of the resource. Even when access is theoretically managed by local communities, a lack of social

⁷⁰ In 1996 approximately \$53,000 of total revenues (25%) were paid to village communities. In 1997, around \$140,000 was allocated to the GDNPGW revolving fund, and \$40,000 to village community budgets (20%).

cohesiveness means that often the detrimental actions of a few individuals cannot be controlled imposing losses on the group as a whole. Examples of the effects of tenure insecurity on management decisions are provided in Boxes 5.5 and 5.6.

Box 5.5. Bayleaf (*Laurel nobilis*) Production in Yayalalan-Manavgat Forest, Antalya.

Manavgat Forest District has a total forest area of 26,000 ha, and includes a degraded bayleaf coppice area of 133.5ha. Current bayleaf production is 225 kg/ha (around 300 tons for total area). However, based on an experimental plot, rehabilitation of the area could provide yields of 3,375kg/ha - nearly 4,500 tons for the total area. At a current market price of 120,000TL (\$0.80), gross value could increase from \$180/ha to \$2,700ha following rehabilitation, an increase of \$60 - \$900 ha per year based on a three year production cycle.

There are 5 villages in the area - Sraur, Sevinic, Sirkoy, Tilkiler and Yayalalan, with a total population of 2,439. Income levels are low and based on animal husbandry (goats and sheep), rainfed farming, employment in forest harvesting activities, and bayleaves. Bayleaf production is threatened by irregular grazing. There are 18 families (6% of the village) dependent on goats who do not accept closure of the area, reportedly based on a distrust of the forestry organisation. Formal allocation of land to individuals might encourage sustainable bayleaves management rather than a continuation of current destructive grazing practices. Rehabilitation of the area would cost \$1,153/ha (over a 3 year period). However, 92% of this amount represents protection costs (fencing and guards). If local communities were committed to the protection of the area themselves, rehabilitation costs would be only \$88 /ha over three years. Improvements in the ability of local populations to capture the value of bay leaf production would further encourage sustainable management by villagers. Currently, bayleaves are sold to middlemen visiting the village. By developing processing facilities within the village (drying, soap production), and marketing, the revenue of villagers from a given production quantity could be significantly increased.

Box 5.6. Chestnuts of Simav District and Land Tenure Issues

Simav district produces 20% of Turkey's chestnuts. Chestnuts are found as pure stands, or mixed with pine and beech, and cover a total area of 1,735 hectares. The number of trees is 91,219 and the standing volume is 17,768 m³. Around 800 ha is designated as conservation forest (due to steep slopes and shallow soils). Traditional ownership of this forest area pre-dates the nationalisation of forest land in 1947. Between 1956-1966, local people started grafting trees with materials from Bursa province in order to produce selected domestic varieties for sale. Local villagers have no legal right to these trees, but are recognised as the 'owners' of the trees they have grafted. Revenues from chestnuts harvesting, shared between 10 villages, is estimated at 200 billion TL (around \$1,333,000), or \$768/ha, and is the main source of income for some families. Recently, there have been conflicts between the local community and government officials. According to the Forest Law (6831), the cutting of chestnuts trees for grafting, or other forest trees (i.e., pine) to provide sufficient light for chestnuts, and the clearing of ground vegetation (for easy collection of the fruit) is illegal. Due to these illegal activities, 60 people have been taken to court in the last year.

Concerns over the sustainability of the resource do need to be addressed. The removal of non-chestnut trees and vegetation on steep slopes may cause soil erosion and disturb the ecological balance of the area. Also excessive grafting may leave the resource susceptible to disease (e.g., ink disease which wiped out the chestnut population in Bursa). Furthermore, goat grazing in the area is not adequately managed. There is also a need to conserve the 100-150 natural adults occurring in their original association with pine in the area. This would ensure an island of high level breeding trees. The formal allocation of land rights to local communities is a possible solution for promoting sustainable resource use and for counteracting conflicts between local communities and officials.

5.14.3 Lack of Management

Management plans for production forests consider only timber and fuelwood values within each planning unit. Failure to assess the importance of other forest values, such as NTFP, tourism and watershed protection, and to understand the current and potential dependence of local populations on the area is resulting in economically inefficient utilisation and inequitable distribution of benefits in some cases.

Management of protected areas is weak, and constrained by limited institutional capacity of the GDNPGW and budget limitations. Despite the legal requirement, the majority of protected areas lack management plans. No plans have been prepared or are under preparation for 17 national parks, 30 nature reserves, 9 nature parks, or any

of the 119 wildlife reserves. Even where plans are available, they are rarely implemented. As a result, many protected areas are subject to resource use pressures. An estimated 56% of national parks and 63% of nature parks do not have entrance gates making the control of visitor numbers and activities within the parks impossible. Furthermore, in the establishment and subsequent management of protected areas, there has been little or no consultation or collaboration with local communities. Management arrangements thus currently provide limited incentives for local communities to support protection efforts.

Management of hunting activities is also inadequate. Arrangements for monitoring and management of both game populations and harvest levels, are set nationally rather than for eco-regions or specific hunting areas, and in practice, the number of most species taken is limited by hunting effort not scarcity. With the exception of some areas in Eastern Turkey under the World Bank Eastern Anatolia Watershed Rehabilitation Study, integrated watershed management is not practised. This project integrates activities on range, forest and agricultural land, and aims to improve productivity by focusing on activities that conserve soil and moisture and reduce erosion, and ensure the long-term sustainability of farming in the watershed. Such an integrated approach is necessary for the successful long-term rehabilitation of degraded watersheds.

5.14.4 Government Interventions

Inappropriate Government interventions include: subsidies or taxes that create incentives for unsustainable forest use (e.g., subsidies for forest conversion to agriculture, and incentives for expansion of tourism); and, inappropriate land reforms that create tenure insecurity. Broad incentives given to the tourism industry in the 1980s facilitated large scale construction of tourist facilities on stretches of the Aegean and Mediterranean coast, putting pressure on coastal habitats, dunes, lagoons, forest and agricultural land. Fodder production is not supported within Turkey's agricultural strategy while State subsidies of fertilisers and seeds are high. A rationalisation of current agricultural subsidies would decrease current pressures on forest rangelands.

5.14.5 Global Market and Policy Failure

Turkey's biological resources, and forest carbon storage functions are 'global public goods'. Without additional incentives, global resources are typically managed with the national interest in mind, which is likely to differ from the globally optimal level (and may in fact threaten the resource). Global market failure is the failure of the world economic system to enable those who generate global benefits, from the conservation of their national assets, to capture some part of the global benefit through the international market. In such cases, optimal resource use requires mechanisms that deal with the existing missing global market for these assets (Pearce, 1996). At present Turkey captures a very small part of the global value of its forest resource. Market and policy failures at the global level are further reasons why Turkey's forests are degraded.

A summary of the threats to forest resources and services and their underlying causes is presented in Table 5.13.

Table 5.13. Summary of Main Threats and Underlying Causes of Forest Degradation

Main Threat	Underlying Causes
Over-Utilisation (e.g., over harvesting of fuelwood , NTFP, and genetic resources, over grazing, tourism pressures)	Inappropriate tenure arrangements Open access Unpriced / underpriced assets Externalities Lack of information Weak management Weak institutional and legal arrangements Population pressures
Forest Conversion and Encroachment (agriculture, urban development, tourism pressures)	Unpriced assets Inappropriate / unclear tenure rights Open access Inappropriate government subsidies for habitat conversion Weak management Weak institutional and legal arrangements Ineffective cross-sector arrangements
Miscellaneous: Pollution; introduction of exotic species; forest fires.	Unpriced / underpriced assets Externalities Lack of management Inadequate co-operation between sectors Weak institutional and legal arrangements

5.15 Management of Turkey's Forests - Options for Reform

5.15.1 Forest Management Options

Turkey's forests can be broadly classified under three management categories - production forest, plantation forest, and protection forest. The economic returns to the sector will vary depending on the management strategies and policies implemented by each of these categories, and the extent to which forest areas are allocated between them.

5.15.2 Timber production

Sustainable management of production forests requires more than the maintenance of timber volumes and site productivity. It requires the retention of viable populations of particularly tree species as well as important structural characteristics of the forest such as steep slopes and critical watersheds. The role of the forest as a habitat for NTFP and the support to local livelihoods provided by these products is also an important consideration. Management of production forests in Turkey is mainly focused on timber production. There is a need to develop a multi-functional management planning process that identifies and incorporates the full range of forest values. While there is some interest in multi-functional planning in Turkey, these principles have yet to gain widespread support, and there are no real examples of its application.

5.15.3 Plantation Forestry

There is some interest in Turkey in increasing the area of forest under plantation forestry in order to increase timber production and reduce the existing gap between demand and supply. However, plantation forestry is the most intensive form of forest management and has the greatest effect on biodiversity. The simple physical structure of plantations, even age and size of trees, absence of other plants species or types, and the fact that trees in plantations are often exotic greatly reduces the variety of habitats available to indigenous biodiversity (Kellenberg, 1997). The viability of plantations should be assessed based on a full understanding of the environmental costs.

5.15.4 Protected Areas

Turkey's protected areas system plays a central role in the conservation of forest biodiversity and over 2.5 million hectares of protected areas have been established by the MOF (national parks, nature parks, nature reserves, game and wildlife reserves). In addition to developing and implementing sustainable management strategies for existing protected areas, a systematic review of the forest resource is needed in order to identify additional forest areas warranting protection. Currently 45 national parks, 13 nature parks, 7 nature monuments and 18 nature reserves are under proposal, and based on expert opinion a number of additional areas warrant protection. The identification of environmentally sensitive and valuable forest areas falling within production forest areas may require these areas being taken out of production.

5.15.5 Conversion of Forest Land

Converting natural forest to non-forest land (e.g., urban areas and agriculture) obviously has the most drastic impact on the forest. Conversion of forest areas should only be permitted after a full social cost benefit analysis has shown these alternative uses of forest land to be economically viable. Such practices are yet to be introduced into the decision making process in Turkey.

5.15.6 Incentives for Community Participation

The support and participation of local resource users is very important for sustainable forest management (Box 5.7). It is therefore critical that mechanisms are introduced which ensure the appropriation of the national and global benefits of sustainable forest management (including biodiversity conservation) at the local level. Possible initiatives include: granting of land tenure; introduction of higher producer prices; the provision of grant financing for environmentally friendly micro-enterprises and community conservation initiatives; the provision of local community infrastructure in exchange for adoption of non-destructive forest practices and conservation activities; and assistance to local communities to develop and benefit from jointly managed eco-tourism and hunting ventures.

Box 5.7. Animal Grazing and Forest Degradation & Community Participation

The main reasons for the slow progress in forest rehabilitation are (i) limited budget resources coupled with the application of expensive erosion control and rehabilitation measures; and (ii) widespread opposition by forest communities to rehabilitation efforts requiring closure of grazing areas. In recent years around \$130 million has been allocated for erosion control and reforestation activities. Based on this budget allocation, 30,000 ha of erosion control and 70,000 ha of reforestation activity are planned for rehabilitation in 1998. In reality it is not possible to carry out activities on a wider area due to the lack of personnel and labour force in rural areas (villagers to do the work), and opposition from villagers.

Livestock is a major resource in Turkey, accounting for 32% of agricultural GDP. Animals feed on range and pasture grasses in the summer, and crop residues, conserved forages and purchased concentrates in the winter. The winter diet is often deficient, and animals are frequently put out to graze on communally owned rangeland too early in the spring for vegetation to be well established. Rotational grazing is rarely practised. A number of people are dependent on free grazing, and rehabilitation is still opposed by the local population for 50-90% of the eroded areas. This attitude appears to be related to short term feed shortages and long term perceptions regarding land tenure and *usufruct* rights. Villagers who are poor and without legal rights to the land resist the closure of their grazing areas as they think that the Government will take their land. However, in areas where erosion is very severe, local communities tend to support erosion control measures as the direct benefits to them are high.

Watershed maintenance rehabilitation plans need to be developed with local communities. Such plans would define the feed and fuelwood needs of local communities and the opportunities for other NTFP and include: (i) a grazing management plan involving reseeding and deferred grazing in degraded areas for 1-3 seasons depending on conditions, and the establishment of rotational grazing practices. (ii) A fodder production plan that would include the establishment of improved fodder species. (iii) A forest management plan which would include rehabilitation of degraded productive forests, and the establishment of fast growing woody species for fuelwood, or multi-purpose (wood and fodder), such as *Robinia pseudoacacia* (iv) An erosion control plan - including areas to be permanently closed for grazing (De Haan, 1998). Greater participation of all stake holders in the decision and participation process (i.e., in the preparation of management plans and continuous dialogue in the implementation of the grazing schemes) is a core component of any successful rehabilitation program. Social assessments are needed to determine the cohesiveness of village institutions and their ability to impose the internal discipline for range management to be successful.

5.15.7 Non-forest Sector Policies

Non-forest sector policies, institutions and programs also impact the forest resource (e.g., agriculture, tourism, energy, industry, urban development). Environmental policies were first introduced into sector strategies under the Sixth Five Year Development Plan and the subject of the environment is frequently mentioned in the industry and energy sectors, however there is no specific mention of the conservation and sustainable use of biodiversity. Greater understanding of how non-forest sector policies, institutional arrangements and laws impinge on the forest resources is required, followed by a general co-ordination of sector policies and activities towards the common objective of optimal forest use.

5.15.8 Options for Reform

While there is a lack of information on Turkey's flora and fauna (species number and distribution) which hinders the development of precise management plans, the overall trends in management and use clearly point to broad market and policy revisions which would improve the situation immediately, pending more detailed scientific studies. Policy and institutional reforms considered most necessary and appropriate for improving management of Turkey's forests are summarised by forest component in Table 5.14. Generally speaking four main areas of reform can be identified: (i) improved tenure arrangements; (ii) the introduction of social cost pricing; (iii) improvements in management (including institutional and legal reforms); and, (iv) International agreements in order to capture global values. Site-specific knowledge and accurate resource inventory data are prerequisites to the success of these interventions.

Table 5.14. Summary of Reform Scenarios

Component	Current management	Reform Options/Requirements
Timber	Forest management plans (FMP) focused on timber production, do not adequately incorporate social and environmental values Allocation of roundwood to State and private industries and forest villages at subsidised prices	Multi-functional Management Plans which account for NTFP production, tourism/recreation potential, protection of endemic/endangered species, genetic resources and other environmental and conservation values Social cost pricing. Harvesting levels based on optimal management of each stand
Fuelwood	Incorporated in FMP Subsidies to forest villagers	Promotion of fast growing species of poplars and other species Improvements in existing production levels Development of incentives for sustainable collection and alternative energy sources Introduction of energy saving programs
NTFP	Production plans for some NTFP Weak controls (production and export) Inadequate pricing system Poor tenure arrangements	Improved tenure arrangements Pricing reforms Production plans based on sustainable harvest rates Comprehensive inventory process

Component	Current management	Reform Options/Requirements
Wildlife and hunting	No management of wildlife reserves Poor monitoring and control of game species Inadequate pricing system	Development of management plans for wildlife reserves Definition of hunting rights and hunting areas Improvement of fee collection and use Comprehensive inventory
Tourism and recreation	Some areas managed by State and/ or private sector Management non-existent or weak for most sites	Development of eco-tourism plans based on carrying capacity Incentives for local community participation
Protected areas	Weak management Lack of management plans for the majority of areas Inadequate emphasis on biodiversity conservation	Development of management plans Involvement of local communities Proper resource pricing Improved financial arrangements Identification of additional sites warranting protection
Genetic resources	No specific recognition of genetic resource within current management plans for protected areas Model management plans for Gene Management Zones (GMZ) under preparation	Incorporation of <i>in-situ</i> gene conservation principles within protected areas Identification of additional areas to be brought under <i>in-situ</i> conservation (either as GMZ or other protected categories) Appropriate property rights (local and global level) Comprehensive inventory

Component	Current management	Reform Options/Requirements
Watershed	Lack of integrated management (i.e., at eco-basin level incorporating forestry, agriculture and grazing concerns)	Adoption of integrated watershed management country-wide Appropriate tenure arrangements and other incentives for community participation in watershed rehabilitation

Whether Turkey fully incorporates the global benefits of its forests into planning and management decisions will depend upon the benefits it can capture from doing so (currently it captures only a very small proportion of this global value). For these incentives to be effective, they should be targeted at individuals making land use decision, in particular local resource users (possible mechanism are discussed in Chapter 9).

5.16 Conclusion and Recommendations

A significant part of Turkey's biodiversity is found in its forests. Valuation of important forest components in Turkey puts the current value of Turkey's forest at around \$4 billion per year. The potential value of Turkey's forest is higher than this estimate, but is dependent on a number of substantive policy and institutional reforms to address current trends in resource degradation. The reliable information that is available however shows that Turkey's forests are being used unsustainably. The main threats are the over-harvesting of forest flora and fauna, over-grazing, tourism expansion and urban development. These threats can be broadly explained in terms of poor resource pricing (unvalued and under-valued forest assets), inappropriate tenure arrangements, and the general exclusion of local communities from conservation benefits. A revision of current policies and institutional arrangements is needed, at the local, national and global level, to provide incentives for sustainable forest utilisation (coupled with disincentives for destructive practices), before the current and potential values of the forest resource can be fully captured. Specific recommendations relating to key individual forest components are presented in Table 5.15.

Table 5.15. Key Recommendations

Category	Key Recommendations
Protected Areas	(i) Development of a range of mechanisms to involve local communities in protected areas management to ensure that they capture a reasonable proportion of the benefits of protection. (ii) Development and implementation of protected area management plans which identify biodiversity protection as the prime management objective. (iii) Identification of new sources of funding and/or mechanisms for raising additional revenue for the management of existing areas and for the identification and management of new areas requiring protection. This includes possible international mechanisms for capturing the high global values emanating from protected areas. (iv) Development of the institutional capabilities of the GDNPGW.
Non timber forest products	(i) Review of current property rights, and transfer of land rights to local resource users where it is clear that secure tenure would foster sustainable management of NTFP. (ii) An increase in producer prices as a practical way of capturing more of the value of NTFP within the local community, and encouraging sustainable resource management by reducing the need to over-harvest resources. (iii) Support to local co-operative organisations in the production and marketing of NTFP (e.g., the provision of technical and managerial assistance, creation of credit options, and improvements in harvesting techniques and local processing facilities), is another practical way of helping local resource users to capture a greater portion of NTFP value. (iv) Country-wide development of NTFP production plans detailing production and protection areas and sustainable harvesting techniques as part of wood production management plans.

Category	Key Recommendations
Wildlife	(i) Allocation of hunting rights for specific areas and species, and/or the development of benefit sharing mechanisms for key stakeholders, such as local communities and hunting associations. (ii) Improved public awareness of the potential benefits and losses of a move to improved and sustainable wildlife management systems. (iii) Allocation of resources and training to enable the Department of Game and Wildlife to improve monitoring and management through collaboration with game resource users.
Tourism and Recreation	(i) Development and implementation of a well defined zoning plan that elaborates high use areas, light use areas, and excluded areas. (ii) Incorporation of local communities in planning and management process. (iii) Introduction of tiered entrance fee system in order to bolster returns from tourism and capture a small part of the global benefits offered by Turkey's protected areas.
Watershed Management	(i) Introduction of integrated watershed management on a country-wide basis. Such programs must be developed in a participatory manner including all stakeholders and local communities. (ii) The introduction of charges for illegal grazing and possible subsidies and incentives for sustainable practices (such as more sustainable forms of credit and enhanced <i>usufruct</i> rights of areas to be rehabilitated).
Genetic Resources	(i) Development of management plans for GMZ. (ii) Extension of <i>in-situ</i> and <i>ex-situ</i> conservation programs throughout the country. (iii) Recognition in timber production, and protected area management plans (iv) Development of international agreements to ensure management of Turkey's genetic resources at the globally optimal level.

6 Economic Analysis of Alternative Mangrove Management Strategies in Koh Kong Province, Cambodia

6.1 Introduction⁷¹

There are estimated to be 85,100 hectares of mangroves in Cambodia occurring in fringe coastal areas along the Gulf of Thailand (Mekong River Commission, UNDP, FAO, 1994). The vast majority (63,700 hectares) of Cambodia's mangroves are located in Koh Kong Province. While the total area of mangrove forest in Cambodia is small compared to surrounding countries, unlike other forests in the region they were relatively undisturbed until recently. However, Cambodia's mangroves are now under intense pressure from competing resource uses. Two important threats to the mangrove resource are the clearance of mangrove areas for intensive shrimp farming and charcoal production⁷². Neighbouring countries such as Thailand and Vietnam have seen widespread destruction of their natural coastal resources as a result of unmanaged exploitation. Sound management strategies for Cambodia's mangrove areas are needed to avoid a similar outcome.

Koh Kong's mangrove products are economically valuable (e.g., fuelwood, food, and construction materials). Their ecological services are also of economic importance (e.g., they act as nurseries and shelters for commercially important finfish and crustaceans, and help to safeguard property and economic activities from storms). Furthermore, local communities in Koh Kong are heavily dependent on the mangrove resource for their livelihood. Community based alternatives to current unsustainable practices are thus central to the success of any management strategy in Koh Kong.

In certain circumstances, using the mangrove resource for productive purposes, such as charcoal production or shrimp farming, may be justified. Typically, however, such decisions are based narrowly on the potential financial returns. The alternative uses

⁷¹ A longer version of Chapter had appeared as an EEPSEA working paper, See Bann,1997b

⁷² Other threats to mangroves in Cambodia include: Klim chan production; clearance for salt farms; and uncontrolled exploitation for firewood.

of the mangrove resource, and the many important environmental values of mangroves that are subsequently lost, often irreversibly, as a result of these productive activities are ignored. This is a serious oversight in cases where the economic value of a mangrove's resources and natural services exceeds the gains from productive uses. In order to make a rational choice between conservation and development options, or to decide whether to halt, modify or continue with an activity that is inflicting damage on a mangrove, alternative management options must be properly evaluated. This entails incorporating the full range of benefits and costs associated with the different uses of the mangrove ecosystem. With this in mind, this Chapter delineates the economic benefits and operational practices of key activities in the area including shrimp farming, charcoal production and traditional use of the mangrove, within a social CBA framework. This information is also important for the identification of an economically optimal integrated management strategy for the mangrove resource in Koh Kong Province.

6.2 Background

Koh Kong province covers an area of 11,160 km² and borders Thailand to the west, Pursat province to the north, Kompong Speu province to the northeast, Kampot and Kompong Speu provinces to the east and southeast, and the South China Sea and Thailand to the south and southwest. Koh Kong has an estimated population of 80,000. Approximately 54% of the population are adults (16 years of age and older) and 51% women. In-migration is an important issue in Koh Kong on account of the perceived economic opportunities. The main types of employment in the province are: fishing, farming, government staff, collection of NTFP, trading, woodcutting and charcoal production.

Koh Kong has some of the last remaining areas of pristine mangroves in Southeast Asia. The mangrove areas in Koh Kong province have been described as ecologically and economically significant to Cambodia and all other countries situated around the Gulf of Thailand. Most of the mangrove areas are designated within the protected areas system under the Royal Decree 'Creation and Designation of Protected Areas,' which was signed in 1993 by King Sihanouk. These protected areas are under the responsibility of the Ministry of Environment (MOE), but management plans for

these sites do not yet exist. In recent years mangrove forest areas have been degraded (Table 6.1). A field study in 1995 found 42 species of trees and shrubs belonging to 20 families in the mangrove forest of Koh Kong. The most dominant species are of the families *Rhizophaceae* (species *Mucronata* and *Apiculata*), *Combretaceae*, and *Avicenniaceae* (DNCP/MOE, 1995). Mangrove forests in Koh Kong are believed to be similar in plant community structure to those in Chhattaburi province Thailand.

Table 6.1. Mangrove Forest Degradation, 1995

Province/City	Total Areas (ha)	Area of degradation (ha)
Koh Kong	63, 700	1, 500
Kompong Som	13, 500	800
Kampot	7, 900	400

Source: ADB, 1996

6.3 Study Site

Koh Kapik, a proposed Ramsar site, was selected as the main study area. Koh Kapik is close to the Thai border, south east of Koh Kong town. The area (12,000 ha) includes all of Koh Kapik with associated islets together with part of the mainland between Prek Thngo and Prek Khlang Yai. A much wider area which includes this site is a designated Wildlife Sanctuary - Peam Krasaop (31,022 ha). Koh Kapik mangroves are considered to be representative of the mangrove communities found on the coasts of Cambodia and Thailand but which have been largely destroyed elsewhere. Although some areas are under threat, there are large areas of undisturbed old growth mangroves such as *Rhizophora apiculata* and *Lumnitzera littoreas*. The three villages in the area - Koh Kapik, Koh Sra Lao, and Lamdan, are dependant on the mangrove resource for their livelihood. Research on this area may be used as the basis for suggesting an optimal management strategy for the total mangrove area of Koh Kong.

6.4 Main Productive Uses and Ecological Functions

The possible value components of a mangrove area (i.e., its TEV) are summarised in Table 6.2.

Table 6.2. Total Economic Value of Mangrove Resource

Use Values			Non-Use Values
(1) Direct Value	(2) Indirect Value	(3) Option Value	
Timber	Storm protection	Future use as per (1) and (2)	Cultural and aesthetic
Fuelwood	Shoreline / riverbank stabilisation		Spiritual and religious
Woodchips	Prevention of saline water intrusion		
Charcoal			
Fisheries	Storage and recycling of human waste and pollutants		
Forest resources: food, medicine, construction materials, wildlife	Nutrient retention		
Agricultural resources	Maintenance of biodiversity		
Water supply	Provision of migration habitat for birds		
Water transport			
Genetic resources	Provision of nursery and breeding grounds for fish and crustaceans		
Tourism / recreation			
Human habitat			
Educational, historic and scientific information	Coral reef maintenance and protection		
	Micro climate stabilisation		

Source: Bann, 1998b.

Valuing a mangrove resource essentially means valuing the components of a system. The relative importance of the individual components of TEV for a given mangrove area is site specific. The key productive use values and ecological values for Koh Kong, based on available information, are identified in Table 6.3 and discussed in more detail in Section 6.6⁷³.

⁷³ For a more detailed account of methodology, results and analysis see Bann, 1997b.

Table 6.3. Key Productive Use Values and Ecological Values

Key Value	Importance		
	High	Medium	Low
Charcoal	X		
Fuelwood	X		
Construction materials	X		
Medicine			X
Wildlife		X	
Marine fisheries	X		
Recreation and tourism		X	
Education and scientific value	X		
Water transport		X	
Biodiversity	X		
Flood and Flow control		Not known	
Shoreline stabilisation and erosion control	X		
Sediment retention	X		
Nutrient retention		X	
Water quality and maintenance		X	
Storm protection	X		
Micro climate stabilisation	X		

Ideally, one would like to evaluate and compare the TEV of the mangrove resource under each management option. However, valuing *all* the characteristics of the

mangrove resource would be time consuming and costly, and in certain cases impossible given data limitations. Valuation of a few key mangrove benefits is typically sufficient to indicate that the loss to society (foregone benefits) of competing options. In such cases, it is important to focus research efforts on components of high value.

6.5 Household Survey

There are three villages (Koh Sra Lao, Koh Kapik and Lamdam), and approximately 581 households in Koh Kapik⁷⁴. A survey of 90 households (Koh Kapik village - 36; Koh Sra Lao - 36; and Lamdam - 18) representing 15% of the total was undertaken in December 1996. The survey provided the information needed to quantify the value of the mangrove area for traditional uses.

The population has grown rapidly in the three study villages over the last fifteen years largely as a result of in-migration. Migrants were attracted by fishing and charcoal production in what was prior to the late 1980s, an area of low population and resource exploitation. Overall, only 6% of households originate from Koh Kong Province. The remaining population originates from 13 of the 18 provinces in Cambodia⁷⁵. An estimated 87% of households are dependent on fishing for their livelihood (for 65% of households fishing is their only form of income). At the time of the survey 6% of households were involved in charcoal production (all in Koh Sra Lao) and 8% were involved in other activities such as trading fish or general products. As of January 1997 no charcoal kilns were in operation in Koh Sra Lao and it is assumed that ex-charcoal producers will now turn to fishing as their only alternative means of income. This increases the number of households dependent on fishing to 93%. As many as 90% of households (excluding charcoal producers) claimed that it was harder to fish now compared to five years ago. The main reasons for this being more fishermen, water pollution caused by shrimp farms, illegal fishing and the use of modern fishing equipment, and the loss of mangroves owing to charcoal production. The majority

⁷⁴ Koh Kapik – 225hh; Koh Sra Lao – 226 hh; Lamdam – 130 hh.

⁷⁵ Cambodia has 18 provinces, and one commercial city Sihanoukville (also known as Kompong Som)

feel that there are no alternatives to fishing in the area (66%). Annual income estimates derived from survey information are presented in Table 6.4.

Table 6.4. Net Income per Household (\$/year)

\$1=25Baht, 1996¹

Village	Average income	Average income from fishing ²	Trader (fish or general products)
Koh Sra Lao	2,023	1,296	6,120
Koh Kapik	2,703	1,832	7,987
Lamdam	2,811	2,795	3,520

Notes: 1/ This exchange rate is used throughout this chapter; 2/ Other employment includes: soldier; nurse; lottery ticket seller; video seller; repair man; policeman; seller of general products; and, carrying wood from sawmill and trading.

Only 15% of households claim not to face any economic problems. The main economic problems faced by other families include: poverty / low standard of living (34%); loss or lack of fishing equipment (28%); fall in fish productivity (18%); health problems (10%); food security (9%); illegal government checkpoints (8%); and 'others' - including too many children and shortage of water in the dry season (5%). The main environmental problems cited by households include: storms and unstable climate patterns (66%); deforestation (36%); water pollution created by shrimp farms (19%); the use of illegal fishing techniques (14%); loss of fish (8%); and the catching of wild water birds (1%).

Nearly all households interviewed (94%) consider themselves to be totally dependent on the mangrove forest or see it as very important to them. Only 2% do not consider mangroves important to their livelihood. The vast majority of households, 93%, do not support the shrimp farms in the area. The main reasons for this are: water pollution caused by the farms leading to the loss of fish (60%); loss of mangroves (9%); restricted access to fishing areas (4%); and the shortage of fresh water (1%).

6.6 Valuation of Mangrove Goods and Services

The research focused on the economic valuation of NTFP collected from the mangrove area by households. This information highlights the traditional uses of the mangrove by local communities and the high monetary value of these products. Information on charcoal production is also included.

6.6.1 Direct Use Values

Fuelwood

Fuelwood is collected from the mangrove by 55% to 66% of households. It is readily available and is used for cooking (sometimes small amounts are burned to repel mosquitos and other insects). Charcoal and gas (LPG) are also used for fuel (Table 6.5). Since the market price of fuelwood is unknown, its value has been based on the average expenditure on charcoal per household by village as the closest available substitute (the market price of charcoal is 2 baht per kilogram). Using this approach fuelwood is estimated at \$42,302 per year (Table 6.6).

Table 6.5. Types of Fuel Used by Households

	% hh collecting fuelwood (average quantity kg/hh/year) ¹	% hh purchasing fuelwood	% hh purchasing charcoal (average quantity kg/hh/year)	% hh buying LPG (average number of tanks)
Koh Sra Lao	58% (21,019)	0%	47% (3,051)	0%
Koh Kapik	55% (3,488)	0%	39% (594)	19% (16)
Lamdam	66% (9,668)	6%	22% (640)	6% (8)

Note: 1/ Quantity collected is considerably higher in Koh Sra Lao. It is assumed that this is because at the time of survey, fuelwood was being collected for charcoal kiln production as well as domestic use; 2/ Some households buy charcoal and collect fuelwood; 3/ Gas is purchased predominately by traders.

Table 6.6. Fuelwood Value - Based on Charcoal Value (\$/year)

Village	Average net value to hh	Average net value to village [number of hh collecting fuelwood * average net value / hh]
Koh Sra Lao	244	131*244 = 31,964
Koh Kapik	48	124*48 = 5,952
Lamdam	51	86*51 = 4,386
Total	343	42,302

Note: 1/ Based on average quantity of charcoal used multiplied by the market price, e.g., for Koh Sra Lao 3,051 kg * 2 baht = 6,102 baht (\$244).

If charcoal is no longer available, it is assumed that households previously using charcoal will collect fuelwood instead. The market price of LPG is 200 baht (\$8) per tank, and households use on average 12 tanks per year. Using \$96 as the average expenditure per household per year on gas (the closest substitute to fuelwood if charcoal is no longer available), fuelwood can be valued at \$50,880 per year (Table 6.7).

Table 6.7. Use and Value of Fuelwood – Based on LPG (\$/year)

Village	% of hh collecting fuelwood	Value per village @\$96 per household
Koh Sra Lao	100%	226*96 = 21,6 96
Koh Kapik	81%	182* 96 = 17,472
Lamdam	94%	122* 96 = 11,712
Total		50,880

Charcoal

Mangrove species are well suited for charcoal production being dense and hard, with a high calorific value and producing little smoke on burning. Mangrove species such

as *Rhizophora apiculata* and *Rhizophora mucronata* are especially valued. In 1992 there were estimated to be more than 300 charcoal kilns producing over 24,000 tons of charcoal, 94% of which was exported to Thailand.⁷⁶ An estimated 100,000 tons of mangrove wood is needed to produce this amount of charcoal (Chea Peng Chheang, 1994)⁷⁷. Despite the fact that the export of charcoal has been illegal since mid-1994, the number of kilns has continued to increase. The total number of kilns located in Koh Kapik is unknown. Charcoal production in Koh Kong has destroyed large areas of mangrove forest resulting in loss of species diversity, sedimentation and erosion. It is recognised that local people need to produce charcoal because they cannot afford to buy fuel.⁷⁸ However, what level of charcoal production would be sustainable for the area is as yet unclear, and needs to be considered in any future management plan. Many households in Koh Kong turned to charcoal production when fish catches became insufficient (the fact that charcoal production increases in the rainy season when it is difficult for people to fish would appear to support this linkage effect).

An economic analysis of charcoal production was undertaken in order to determine the returns from charcoal production. Ten charcoal producers were surveyed (December 1996). On average, kilns were found to produce 28 habs (1,680 kg) of charcoal per month. The duration of burning depends on the size of the kiln and where the kiln is located. The production cycle (i.e., wood collection, loading of the kiln, burning and cooling) ranges between 21-40 days (assuming that wood is collected during the burning/cooling period). A production cycle of one month is used in the analysis. A low price of 120 baht / hab is used in calculations as the average farm-gate price quoted by charcoal producers.

⁷⁶ According to local provincial officials, the number of charcoal kilns totalled 224 in 1993.

⁷⁷ In 1992 Taiwan reportedly contracted with the Cambodian Government for 10,000 tons to be exported (Chea Peng Chheang, former Deputy Director of the Department of Fisheries, 1994).

⁷⁸ Charcoal production is reportedly practised under licence for subsistence purposes in the upland areas along route 4. This model might be adopted in Koh Kong.

Table 6.8 shows the net income per kiln to be \$868 per year if the costs of kiln construction are taken into account and \$927 if construction costs are excluded. However according to survey results, 60% of households borrow money to set up their kiln operations. A typical arrangement is for half of the returns from the sale of charcoal to go to the creditor. In such cases average gross returns to family per kiln are \$464 / year. Approximately 60% of households claim to sell all charcoal produced (left over charcoal ash is sometimes use domestically). Other households use on average 52 kg of charcoal per month or 624 kg per year for domestic purposes. This reduces their net income by 1,256 baht (\$50.24). Net returns per kiln are therefore \$414 - 868 per year with the maximum representing returns to a family which is not in debt and which sells all charcoal produced, and the minimum representing returns to a which is family in debt and which uses charcoal domestically⁷⁹.

Table 6.8. Net Benefits per Kiln Per Year (\$/year)

	A Prod kg¹	B Returns @ 0.08/kg	C Cons cost²	D Hired Labour costs³	E Net Ben (B-C-D)	F Net Ben (B-D)	G Debt
Average	20,160	1,612	104	640	868	927	266

Notes: 1/ 1 hab = 60 kg; 2/ Construction cost per kiln is \$159 to \$600. The average life of a kiln is 3 years; 3/ 0-2 workers are hired per kiln (with an average of one worker per kiln). The average salary is 1,100 baht per month, the range being 500-2,000 baht/month. Family labour is considerable averaging 11.5 man-months per kiln per year. At an average monthly salary of 1,100 baht, the opportunity cost of family labour could be estimated at \$506 per year. This has not been included in the calculations on the basis that employment opportunities in the area are limited and therefore the opportunity cost of labour is low.

⁷⁹ Analysis assumes one kiln per households, which is typical.

Around 30% of households sell charcoal to creditors, 30% to Thai traders, and 40% to local traders. Charcoal is exported to other Cambodian provinces and to Thailand. Demand is high locally, nationally and regionally due to its competitive price. Assuming a trader or creditor buys all the charcoal produced by a single kiln in a year (20,160 kg/year) at \$0.08/kg (selling price reported by charcoal producers) and sells to the market for \$0.128 (market price), he will be making a profit of \$959 per year, per kiln. This analysis suggests that the only people really earning money from charcoal production are the larger producers who have not borrowed money to produce, and the traders and creditors. Smaller producers who borrow money to set themselves up, and are therefore tied to their creditors who control the production and sale of the product, often remain trapped in debt.

Forest Inventory

A forest inventory was undertaken in December 1996, in order to provide an estimate of the number of trees in a hectare of mangrove forest, and to derive the area of mangrove forest required per kiln per year. The results are presented in Table 6.9.

Table 6.9. Estimated Number of Trees in One Hectare of Mangrove Forest

	No. of trees diameter 0.15m- 0.20m ¹	No of trees diameter 0.1m – 0.15	Total number of trees	Hectares required per kiln/ year ²	Comment
Long time disturbed area, close to Koh Sra Lao	304	368	672	0.59	Selective cutting. Some old trees
Regeneration area (in front of checkpoint)	n.a	n.a	1,088	0.37	Clear-cut area. Natural regeneration
Undisturbed mangrove forest (Koh Kapik)	368	192	560	0.71	Less trees because big old trees dominate

Notes: 1/ A 25m*25m area was covered for each category. Only trees bigger than 0.1meter diameter were included in the count. 2/ The number of trees collected per year per kiln based on survey responses ranges from 266-538. The number of hectares required per kiln is equal the average number of trees collected per kiln (i.e., around 400) / total number of trees.

Assuming that 400 kilns were operating in Koh Kong up to December 1996 then between 148 and 284 hectares of mangroves would have been affected (the lower bound estimated being for kilns located in the regeneration area and the upper bound estimate for kilns located in undisturbed mangroves areas)⁸⁰. With 30 kilns operating in Koh Sra Lao, charcoal production is estimated to have affected between 11 - 21 hectares of mangrove. Assuming a 30 year cutting cycle, and that only already disturbed areas would be allocated for charcoal production, potential returns for

⁸⁰ Charcoal producers were questioned on their wood collection practices and on the quantity of wood required for one kiln.

sustainably managed charcoal production can be estimated at \$ 146 –232 ha per year⁸¹.

House Construction

Mangrove wood is used for building houses, boats and fences. All households within the study villages use mangrove wood in combination with upland wood for house construction. Upland wood is either collected or bought from the sawmills while mangrove wood is all collected. The proportion of upland to mangrove wood used per house is unknown. Information on the cost of building and repairing houses is presented in Table 6.10. These figures are based on expenditures on house construction as expressed by households. It is not clear, what proportion of this cost is attributable to labour and what proportion is attributable to the purchase of materials. It is also unclear why house construction costs are higher in Koh Kapik relative to the other study villages. Houses typically last 3 years and are repaired once a year.

Table 6.10. The Cost of House Construction and Repair (\$)

Village	Average construction time / days	Average construction cost / hh / 3 year period ¹	Construction cost per village / year	Average repair cost / hh / year	Repair cost per village / year
Koh Sra Lao	27	557	125,882	47.50	10,735
Koh Kapik	25	955	214,834	71.25	16,031
Lamdam	113	511	66,430	37.20	4,836

⁸¹ Based on gross value of charcoal per kiln using market price of \$0.128/kg charcoal and production quantity of 20,160 kg / kiln / year. (i.e., \$2,580), the number of hectares required per kiln in areas where mangroves have been regenerated (0.37ha) and long time disturbed areas (0.59ha), and a cutting cycle of 30 years. The potential returns per hectare have simply been allocated over a 30 year period.

Local Fishing

Fishing is the main source of income for the majority of coastal families. Local fishing tends to occur near the shore since boats are typically 5HP and local people cannot afford the equipment needed to fish offshore⁸². Species caught and fishing techniques in the three study villages vary according to the season, location and equipment available. Proximity to fishing grounds appears to be a key factor (there are no boundaries regarding where people can fish). In Koh Kapik 80% of households collect shrimp as the village is close to the Big Gulf. Only 8% of households collect crab. In Koh Sra Lao op(which is close to the mangrove) 70% of households catch crab, and only 3% catch shrimp. Proximity to the mangrove resource is also one explanation why charcoal is produced in Koh Sra Lao and not in Koh Kapik. In Lamdam people mainly catch crab. Fish caught is often used for domestic consumption. It is also used as bait.

Shrimp fishing is more expensive, requiring a boat with an engine and fishing net in order to fish in the Big Gulf. However, income from shrimp is higher than that from crab, hence living conditions are generally better in Koh Kapik than in Koh Sra Lao. The fact that no one produces charcoal in Koh Kapik may reflect the linkages between low income levels and charcoal exploitation, but location would be another factor. Big shrimp are caught in the rainy season and small shrimp in the dry season. Typically fewer days are fished during the rainy season, but the price of big shrimp is much higher⁸³. When not fishing, time is spent repairing fishing equipment. Push nets, while illegal, are commonly used. Officials at the Fisheries Department are aware of illegal fishing activities but do not have the resources to monitor and control such activities. Information on the market price of key species and the average

⁸²Commercial fishing only exists as Thai-Khmer joint ventures due to the high cost of the big boats and good equipment necessary for such fishing. Most of the commercial production is exported to Thailand (Smith, 1996).

⁸³ It is often not possible to fish in June and July due to storms, also when there is a lot of rain the water is shallow and yields are low.

quantity of each species collected per household in each village was collated. Data for Koh Sra Lao village is provided as an example (Table 6.11).

Table 6.11. Koh Sra Lao: Summary of Benefits from Fishing per Species

	Average Quantity Collected kg / hh / yr	Selling Price baht / kg	Gross income \$	Average Petrol Costs hh / year @ 12 baht / litre	Estimate of annual cost of fishing equipment	Average net income per hh /yr	% of hh who catch product	Net value to village per year
Stonecrab	360	56	806	163	367	276	50%	113*276 = 31,118
Horsecrab	398	70	1,114	240	367	507	70%	158*507 = 80,106
Shrimp	360	120	1,728	113	367	1,248	3%	7*1,248 = 8,736
Snails	96	20	77	51	n.a	25	36%	81* 25 = 2,025
Fish	72.5	9	26	n.a.			11% for home use	

Notes: 1/ Stone crab: selling price ranges from 10-140baht/kg depending on size and quality. Typically prices are: small 10-30baht/kg; Med: 40-80baht/kg; Large: 85-140baht/kg. Given that information on the quantity of the different sized crabs caught was not available, a price of 56 baht/kg has been used in the calculations, which represents the average price derived from the survey information; 2/ The cost of equipment is based on the cost of using a net for one season; 3/ The cost of fishing boats has not been included in the analysis.

Data on fishing practices were collected in each of the study villages for horsecrab, stonecrab, shrimp and fish. A summary of horsecrab collection practices is provided as an example (Table 6.12).

Table 6.12. Horsecrab: Collection Practices

	Av. No. months / year	Av. No. days / month	Av. No. days / year	Av. Quantity kg/day	Av. Travel time hrs/day	Av. Collection time hrs/day	Av cost of petrol \$/ Trip
Koh Sra Lao	6	21	126	2.7	2.4	9.8	50
Koh Kapik	6	22	132	5	1.25	5	54
Lamdam	5	21	105	4.5	1.6	5	48

Estimates of the returns to households net of the cost of fishing equipment and petrol are derived for each species (the cost of fishing boats is not included). These estimates overstate the net benefits to households, as the opportunity cost of time spent fishing is not accounted for on the assumption that this is close to zero in the study area, given the limited employment alternatives. No data were available on the quantity of fish used for domestic consumption. Net benefits from fishing per village and per household are summarised in Table 6.14. Debt is not included in the calculation. Based on survey information, 27-55% of households have borrowed \$174-\$540. Creditors typically do not charge interest on monies lent but buy fish from their debtors at low prices, while debtors are required to buy all fishing equipment, and sometimes household goods, from them at inflated prices. Creditors are reportedly reluctant to provide credit now because of low fishing yields and as a consequence the long payback periods.

Table 6.13. Net Benefits from Fishing (\$/Year)

	Koh Kapik	Koh Sra Lao	Lamdam
Net benefits / village	309,239	121,985	56, 695
Average net benefits / hh¹	1, 373	540	436

Notes: 1/ The net average benefits per household are considerably lower than the income estimates presented in Table 6.4. This is partly explained by the fact that the total village figures in Table 6.13 are averaged across all households.

Other direct use values

There are many additional direct use values attributable to the mangroves of Koh Kong which have not be estimated because of data limitations. These include:

(i) **Medicine.** Coastal people have traditionally used various resources extracted from mangroves for medicinal and other purposes.

(ii) **Wildlife resources.** Wildlife resources that are hunted (e.g., for meat, skins or fur), or gathered (e.g., honey from bees, tortoise and birds eggs) will have either a commercial or a subsistence value.

(iii) **Recreation and ecotourism.** The mangroves of Koh Kong have ecotourism potential, but this is unlikely to be developed on a significant scale in the near future.

(iv) **Provision of nursery and breeding grounds for fish.** Mangrove ecosystems are an important support to inshore and offshore fisheries. They provide nurseries and shelters for important marine stock, while decomposed litterfall supplies a considerable amount of nutrients that can be used directly by fish and other aquatic species. Detritus matter is known to be exported to nearby seagrass beds, coral reefs and other coastal communities. The value of mangrove forest as a food source as well as shelters and nurseries for both culture and capture fisheries along coastal areas of Koh Kong is not well understood but is considered to be high. This mangrove function is especially important to local communities given that around 90% of the

population of Koh Kong are fishermen (see Section 7.5 for a more detailed exposition of this indirect function).

(v) **Education and scientific research.** There has been no scientific research undertaken at the site, although the education and scientific research value of the study site is considered to be high.

(vi) **Water transport.** Villages in Koh Kong are situated near channels, along rivers, or on islands near and inside the mangrove forest areas. The lack of an alternative transport system to boats suggests that the value of mangrove transport is high.

6.6.2 Indirect Use Values

A qualitative discussion of some of the indirect use values of mangroves in Koh Kong is presented below. Owing to data constraints it was not possible to place a monetary estimate on these functions. However, many are believed to be of significant value and will be lost if the mangroves are not conserved.

Koh Kapik is considered to have a high biodiversity value. The site is an excellent representative of a mangrove system backed by *Melaleuca* forest, which is rapidly being lost elsewhere. It is also considered to be an internationally important site for migratory birds. The buffer zone offered by shoreline mangroves in Koh Kapik is recognised as helping to protect against the damaging effects of severe storms and tidal surges. It may be one of the main reasons why Koh Kong has not been devastated by any natural disasters, although the survey results show that storms and unstable weather patterns are the biggest concerns of villagers in the area. Koh Kapik mangroves may therefore have indirect value through the natural protection they afford coastal property and economic activity (Box 6.1). Using the estimates on the cost of house construction (Table 6.10), if villages within Koh Kapik were to suffer storm destruction, the loss to property alone can be estimated at \$407,146. This estimate may be taken as an upper bound figure for the damage protection function of mangroves since it is unlikely that all houses would be completely destroyed by storms. However, given that most houses are located by the waters edge on stilts, it is assumed that the damage would be significant. Further, this figure does not account for the probability of such an event occurring given the deterioration or loss of the

mangrove (again, on the information available it may be assumed that this probability would be high).

Box 6.1. The Coastal Erosion Control Function of Mangroves

Mangroves typically occur on sheltered accreting coasts so it can seem contradictory to say that mangroves afford coastal protection. However mangroves in storm prone areas protect coastlines in the sense that if they are removed or degraded, storm damage is likely to be more severe. Even in sheltered coasts there are likely to be areas of erosion due to natural processes e.g., strong wave action particularly during the monsoon. Human activities can further contribute or cause coastal erosion such as: bunding of mangroves to protect agriculture; changes in land use (logging, aquaculture); sandmining offshore and inshore; the building of coastal infrastructure (jetties, embankments and breakwaters); and wash from boats and powerful engines. Mangroves can prevent or reduce coastline erosion through: the trapping of sediments brought down by rivers (which may enable coastline accretion); the binding and stabilising of soil by plant roots and deposited vegetative matter; and, the dissipation of erosion forces such as wave and wind energy.

The sediment retention function of mangroves may have two important effects. Firstly, it may lead to accretion of arable land within mangrove areas, and secondly it may protect downstream economic activities and property from sedimentation. The sediment retention value of mangroves in Koh Kong is believed to be high. Organic nutrients, including those from human and animal waste, are often also trapped along with sediment by mangroves. The nutrient retention value of mangroves in Koh Kong is believed to be medium to high. Nutrient and sediment retention is linked to other water quality maintenance functions, such as nutrient transformation (i.e., actual uptake of mangroves vegetation), retention of toxins and particle suspension. The overall hydrological, nutrient and material cycles and energy flows of mangroves may stabilise local climatic conditions, particularly humidity and temperatures. This in turn has an influence on any agricultural or resource-based activities, as well as on the stability of natural ecosystems and the mangrove itself. The micro-climate stabilisation function of mangroves in Koh Kong is considered to be high.

6.6.3 Summary of Results

A summary of the estimated values of the mangrove forest components is presented in Table 6.14. Value estimates per hectare have been derived for the sustainable traditional use of the mangrove by local communities, and for sustainable charcoal production⁸⁴. If sustainable charcoal production was introduced these two estimates could be added giving an annual per hectare value of \$224. At present, however, charcoal production is illegal and unsustainably practiced. Table 6.15 summaries the annual benefits per household in each of the study villages.

Table 6.14. Summary of Net Benefits (\$/year)

Resource / Service	Total value per survey results¹	Sustainable Traditional Use – Value / ha²	Sustainable Charcoal production -Value / ha
Fuelwood³	42,302	3.5	
Charcoal⁴			146
Local Fishing⁵	487,919	41	
Storm protection⁶	407,146	34	
Total	937,367	78.5	146

Notes: 1/ Estimates for all three villages; 2/Based on the area of Koh Kapik, i.e., 12, 000 hectares; 3/ Based on Table 6.6; 4/ Lower bound estimate of sustainable charcoal production; 5/ Based on Table 6.13; 6/ Based on Table 6.10.

⁸⁴ Chapter 9 compares these results with other studies.

Table 6.15. Average Net Benefits to Households / Year (\$)

Forest product	Koh Kapik	Koh Sra Lao	Lamdam
Fuelwood ¹	48	49	51
Charcoal ²	-	-	-
Fishing ³	1,373	540	436
Total	1,421	589	487

Notes: 1/ Fuelwood benefits for Koh Sra Lao based on the average benefit of the other two villages so as to remove distortion due to collection for charcoal production in this village. 2/ Due to lack of reliable information it is not possible to derive average estimates of benefits of (illegal) charcoal production to households. However, the available information collected suggests that households earn between U\$414-868 a year. 3/ Based on Table 6.14.

6.7 Analysis of Shrimp Farms

Koh Kong province has the highest concentration of shrimp farms in Cambodia, all of which are located in areas supporting mangrove forest. Shrimp farming began in Koh Kong in 1988 and by 1991 intensive shrimp farms involving high stocking densities, formulated feeds, aeration and regular water exchange were in operation. Thai influence in the shrimp farming industry in Koh Kong is intense. Thai investors enter into joint ventures with Cambodians in order to gain concession licences to operate the shrimp farms. Investment and labour and almost all the inputs required such as feed, seed, chemicals and equipment are supplied from Thailand. Almost all production is exported back to Thailand. Cambodians supply cheap labour and the benefit to Cambodia is minimal.

A review by the ADB (1995) showed licensed shrimp farms in Koh Kong province to cover 1,000 ha (1.56% of the total mangrove area), with 280 ha stocking and growing out and 150 ha under construction. Statistics for 1996 show the total area of shrimp farms to be around 905 ha. A feature of the 1996 figures is the considerable area of abandoned 'unprofitable' shrimp farms (71% of total area devoted to shrimp farming). This illustrates the fact that the industry in Koh Kong is increasingly plagued by the

self-induced negative side-effects of its operations. Economic losses are common, resulting from shrimp disease, and sea pollution of culture areas caused by indiscriminate discharge of pond effluents (ADB, 1996). Resource conflicts, particularly with farms located in or near mangrove areas are also increasing. Table 6.16 shows shrimp productivity in Koh Kong since 1991. The year 1996 can be seen as the first year in which total production in Koh Kong fell.

Table 6.16. Shrimp Production, Koh Kong

Year	Production (tons)
1991	5
1992	50
1993	470
1994	510
1995	730
1996 ¹	604

Source: Dept of Fisheries, Koh Kong, 1996.

Note: 1/ 1996 total may overestimate production in the range of 20-40 tons representing fish and oyster production which may not have been netted out.

Pond yields are reported to be up to 7-8 ton/ha/crop which is relatively high. High potential profits continue to attract investors. In reality, however, shrimp farming requires substantial initial investment and operating costs, and has proved to be a risky business. Productivity has been very unpredictable and depends on disease, water quality, technique and climate. An estimated 87% of farms have experienced a fall in productivity since they started producing and poor yields have meant that many shrimp owners have made losses and can no longer afford to run their farms. Typically, farms are abandoned after five years. These problems have led the local Government and concerned Ministries (MAFF and MOE) to place a moratorium on the further licensing of shrimp farms.

In Thailand and most other countries where it has been attempted, widespread semi-intensive and/or intensive culturing of shrimp has resulted in a catastrophic collapse of the industry, primarily through disease (Phillips *et al* 1993; Wigglesworth 1994). The precise reasons for failure are unknown (Kikuchiu 1993). Poor water quality is commonly cited as the reason, there being a generally accepted, but little understood relationship, between poor water quality and disease proliferation. Collapse can be more gradual as pond productivity generally declines at a rate of 3-8% per production cycle (Briggs and Funge-Smith 1994, Primavera 1993). The exact reason has not been identified, although deterioration of pond sediment quality, the loss of essential minerals from pond soil, and poor pond management (which leads to low oxygen and high ammonia concentrations) are common explanations.

The shrimp farming industry in Cambodia appears to be mirroring the industry in Thailand where the explosion of intensively operated shrimp farms from the mid-1980s has had a negative impact on the coastal zone, while failing to establish a sustainable industry. Abandonment of shrimp ponds owing to either drastic collapses caused by disease or more gradual year to year reductions in the productivity of the pond is common. The difference between Thailand and Cambodia is that Thailand has at least benefited socially and economically. In 1992 shrimp export was valued at \$124 million, close to 1% of Thailand's GDP (FAO, NACA, 1995).

6.7.1 Financial Analysis of Shrimp Farming

Eight shrimp farms were surveyed in Koh Kong in December 1996, in order to provide information on farm management practices, investment costs and productivity. All farms practice intensive shrimp farming. The average farm size is 5 hectares, with a total of 5 ponds of just over 1 hectare each. All farms cleared an area of mangrove forest equal to the size of the farm. All farms have sediment ponds for waste. However, untreated waste water is being discharged directly into the sea.

Information on investment costs, operating costs and productivity was provided by the shrimp farm owners and used to calculate the financial returns to shrimp farming. Investment at the construction stage includes the cost of a licence, and expenditure on farm construction and equipment (e.g., dike construction, gates, and fan for aerating water). The average expenditure at construction stage derived from the survey

information is \$28,662 per hectare. Only 25% of farms surveyed were operating under licence. Licences valid for the lifetime of the farm cost \$800-1,200. Technically, the fisheries department needs to be informed each year of the farm's intention to continue its operations. Costs per harvest include expenditure on labour and inputs such as larvae and food, which have to be imported from Thailand. A tax of 2,000baht/ha year is said to exist, payable to the Department of Fisheries, but is rarely collected. Average expenditure per year, per hectare on inputs and labour is estimated at \$38,777 (ranging from \$12,604 - 87, 520).

Productivity per harvest ranges from 3 to 16 tons per hectare, with an average of 5.1 tons per hectare. The 16 tons per hectare figure is very high and represents the first harvest of a newly constructed farm. Excluding this figure, productivity per harvest is 3.1 to 4.4 tons per hectare, with an average of 3.6 tons per hectare. The price of shrimp ranges from 35-185 baht/kg depending on size and quality. The shrimp are sold to Thailand. Prices are dependent on the international market and have fallen over recent years from a high of 210 baht. Table 6.17 shows gross returns at different price levels and indicates a relationship between farm age and productivity.

Table 6.17. Relationship between Farm Productivity and Age

Age of farm / years	Average Yield/ha/ Harvest / tons	Gross value \$ per hectare / harvest @120baht kg	Gross value \$ per hectare / harvest @ 35baht / kg	Gross value \$ per hectare / harvest @ 185 baht / kg
1	16	76,800	22,400	118,400
2	3.78	18,144	13,230	27,972
3	3.26	15,648	4,564	24,124
4	3.12	14,976	4,368	23,088

Using a price of 120 baht/kg (weighted average) and an average productivity of 5.1 tons/hectare/harvest, the average gross income from shrimp production per harvest can be estimated at \$24,480 per hectare. Assuming a productive life of five years, and two successful harvests per year at 5.1 tons/hectare/harvest, net income per farm is

estimated at \$4,451 per hectare⁸⁵. If however, one harvest fails because of disease or technical problems (which is very common), the farm will face a loss of \$20,029 per hectare. A year in which both harvests fail means losses of \$44,509. At 120 baht / kg productivity has to be at least 4.7 tons/hectare/harvest to break even. At a productivity rate of 3.6 tons per harvest, a loss of \$9,949 per hectare is incurred. Given the risks facing shrimp farming it is becoming increasingly rare for farms to have two successful crops a year. Half of the farms surveyed incurred losses ranging from 1-6 million baht (\$40,000 - 240,000). Calculations for each of the eight farms surveyed revealed 50% of farms to be making profits and 50% to be making losses. Excluding the farm with the unrealistically high productivity rate of 16tons/harvest, profits range from \$17,508 - 74,658 per farm (\$- 1,782 - 11,109 per hectare). Overall the farms are making a loss of \$8,826, or \$1,103 per hectare.

The survey results show that intensive shrimp farming in Koh Kong as currently managed is unsustainable. On a narrow financial analysis alone (without accounting for the wider environmental costs imposed by the industry), shrimp farming is seen to be unprofitable. The additional social costs imposed by the environmental damage make shrimp farming even less economically viable. The results suggest that shrimp farmers are acting irrationally (i.e., shrimp farming is not financially viable, yet investment continues in this area). A possible explanation for this is that, in the past, farmers have been attracted by the high potential returns from a successful production cycle, without appreciating the risks associated with poor management and over exploitation. Moreover, owing to the lack of any industrial standards and management requirements, investors have no reason to behave responsibly. The fact that they do not have to account for their impacts on the environment and society has promoted a 'hit-and-run mentality' whereby investors simply abandon unprofitable ponds. Unless sound management of the shrimp industry is enforced, such a trend will logically result in collapse of the natural resource base, a common occurrence elsewhere in the region.

⁸⁵ Average gross income of \$48,960 per year per hectare minus average investment cost of \$28,662 per hectare over five years (i.e., \$5,732 / year) and average annual operating costs of \$38,777 / year.

6.7.2 Environmental Impacts

The environmental impacts associated with shrimp farming are significant and should be incorporated into any evaluation in order to present an accurate statement on the economic viability of the industry. At present, shrimp farming in Koh Kong is practised in a way that is detrimental to the environment. Large areas of mangrove forest have been cleared for shrimp farms, untreated liquid waste is discharged directly into nearby waters, and some farms are operating without sediment ponds. It was not possible given data limitation to quantify these impacts. However, a qualitative description of the possible ecological costs associated with shrimp farming is presented below:

(i) Intact mangroves provide a range of goods and services, which are foregone if mangroves are converted. Shrimp farming in Koh Kong has resulted in the widespread destruction of mangrove forests through their conversion to ponds, with the resultant loss of associated biodiversity and other resources and ecological functions of the ecosystem. This is detrimental both to the stability of the system and to the livelihoods of the local people. These foregone benefits (costs) need to be included in the evaluation process.

(ii) Groundwater is sometimes pumped to the culture ponds to dilute salt water in the belief that brackish water is best for rearing shrimp. Groundwater depletion has resulted from excessive pumping⁸⁶. The emptied aquifers are then subject to salt water intrusion. Furthermore, the fall in water level and attendant compaction of aquifers can lead to land subsidence and vulnerability to floods.

(iii) The soil composition of both prawn pond and adjacent areas may change irreversibly. Pond salination and the use of chemicals may affect the soil so as to preclude conversion to agriculture or even other aquatic crops.

(iv) Eutrophication as a result of the use of antibiotics and chemicals is common.

⁸⁶ In the absence of official statistics, estimates show that roughly 66,000 cubic meters of freshwater are needed to dilute full seawater in a one hectare pond at one metre depth over a cropping period of 4 months.

(v) The discharge of harmful effluents from shrimp ponds (e.g., excess lime, organic wastes, pesticides, chemicals, and disease micro-organisms) can directly or indirectly affect estuarine and marine organisms and neighbouring communities⁸⁷.

(vi) The sediment that accumulates within the rearing cycle is typically removed or allowed to oxidize after each production cycle as a maintenance measure to safeguard against deteriorating water quality during the next cycle. Sediment disposal in Thailand has led to water pollution (when disposal is done illegally), salinisation of soils and water, and a solid waste disposal problem.

(vii) The average lifetime of an intensive shrimp pond in Koh Kong is estimated to be 5 years before disease outbreaks make the enterprise unprofitable. Abandonment of ponds is therefore a common phenomenon. In Thailand this has resulted in a pattern that has been dubbed 'shifting aquaculture', as investors move on to new, unspoiled locations.

6.7.3 Equity Concerns

When mangrove areas are converted to shrimp farms, the potential for multiple use of the resource is lost to a single use that, if not carefully managed, provides only short term gains for a small number of investors. In Cambodia these gains are not even realised nationally. A communal resource is thus transformed into a privately owned single purpose resource because local populations typically lack formal property rights to the mangrove areas. Local communities therefore become marginalised from the traditional benefits provided by mangroves such as materials for fuel and construction and aquatic products.

Over 90% of local people in Koh Kong oppose shrimp farming in the area. Mangrove conversion and water pollution by shrimp farms are seen by local people to be one of the key factors explaining the decline in fish productivity over recent years. The depletion of coastal fisheries has further marginalised subsistence fishermen

⁸⁷ Methods do exist for improving the quality of waste water discharged from brackish water aquaculture activities. These include the culture of seaweed in ponds, the introduction of oysters and mussels, or the introduction of settlement tanks.

dependent on mangroves. In some cases, shrimp farms have also restricted access to local fishing areas and created a shortage of fresh water for local communities. The distributional reality must be a factor in any assessment of a shrimp farm's economic viability. Any development must show, over and above financial profitability, a responsiveness to society's needs (in addition to the requirement that environmental resources are not threatened).

6.8 Selection and Specification of Management Options

Management plans for the mangroves of Koh Kong have yet to be developed. A broad discussion of possible management options follows. Mangroves should be managed in a way that ensures sustainable use of mangroves for traditional purposes by local communities, and that controls commercial productive uses of the mangrove resource (charcoal production and shrimp farming) so that other values of the mangrove resource are not damaged. Commercial fishing activities also need to be regulated in order that conflicts between local and commercial fishermen are minimised. An *integrated management plan* for the mangroves in Koh Kong is therefore proposed. The main productive uses of the mangroves to be incorporated within the integrated management plan are: (i) Traditional uses; (ii) Charcoal production; (iii) Shrimp farms; (iv) Commercial fisheries.

6.8.1 Management Zoning System

A zoning system has been proposed for the mangrove areas of Koh Kong (AWB/SSE, 1994). The mangrove area may be divided into 2 main zones - a conservation zone (or core zone) and a multiple use zone. Koh Kapik is a possible conservation zone, since the mangrove resource in this area is relatively unspoilt and of high biodiversity value. The conservation zone will be carefully protected from any impacts that might threaten the mangroves in their natural state. Traditional sustainable uses of the mangrove area by local communities may be permitted. No shrimp farms will be allowed in the core conservation zone. The multiple use zone may be utilised for traditional and other purposes under strict management guidelines and based on sustainable yields (possibly including limited selective cutting of mangrove forest for

domestic charcoal production). Some shrimp farms will be allowed, provided they are managed sustainably.

To be successful any management plan must account for the needs of local communities given their intricate relationship with mangrove areas. Research into viable alternative income sources for communities within mangrove areas would be valuable in this respect. Alternative income sources which might be developed include: frog culture; crab culture; seaweed culture; and oyster and mussel farms. However, it is not known what alternatives would be suitable for conditions in Koh Kong and would be supported by local communities. Pilot projects might be an effective way of determining this. A range of management options is presented in Table 6.18.

Table 6.18. Broad Management Options for Mangrove Resource in Koh Kong

Management Option	Comments
Protection	Prohibition of productive uses Costs: Foregone benefits of sustainable traditional/commercial uses Cost of enforcement of protected area Cost of regeneration of mangrove areas (if necessary)
Sustainable traditional community use of forest resources	Communities are allowed to collect forest products and produce charcoal on a sustainable basis Optimal selective cutting cycling to be determined for charcoal production Prohibition of shrimp farms Management Considerations Promotion of alternative livelihoods for local communities dependent on mangrove resource Management of fisheries to reduce conflicts between resource users
Commercial charcoal production	Use of mangrove forest for sustainable commercial charcoal production under a range of cutting cycles
Conversion to shrimp farms	Introduction of sustainable management practices, e.g., buffer zones / green areas, enforcement of environmental standards on water and waste discharges and other environmental impacts associated with shrimp farms

Note: Not all these management options are mutually exclusive. For example, traditional subsistence use of the mangrove could be combined with shrimp farming and/or commercial charcoal production for selected areas.

6.9 The Issue of Relocation

One possible option for improving the livelihoods of households located within the mangrove areas, and reducing the pressures on the mangrove resource (especially in sensitive areas) is relocation. Land is said to be available in nearby upland areas where households could cultivate crops as well as fish. According to the First Deputy Governor of Koh Kong province more than 100 households have already voluntarily moved to a new village in the uplands called Wonk Ka Thak. While the provincial office is promoting relocation, it is unable to offer any financial support. Households moving to the uplands initially need assistance for building houses and for food up to the period of the first harvest. The provincial office has only been able to provide small amounts of sugar and rice to some households.

If it were decided that the total protection of the core area (Koh Kapik) was the best option, then it would be necessary to relocate communities currently living there. Alternatively, the best option may be to relocate some households in the mangrove area to reduce current pressures on the resource. Compensation for local people could be assessed in many different ways. Cash compensation (in addition to providing land and housing in viable new settlement areas) could be based on a transitional allowance (perhaps one year) equal to the average per capita income. Cambodia's GNP per capita in 1996 was \$217. Relocation costs can therefore be estimated at \$51,767, equivalent to \$891 per household.⁸⁸ This figure assumes that there is only one main wage earner per family, and may need to be adjusted upwards for large families.

In-migration to the new area is happening in an uncontrolled fashion, with people from around the country attracted by the opportunity to own land. Careful and early management of the area is therefore required to avoid unsustainable exploitation practices taking over the upland areas (indiscriminate cutting of trees is evident). If the area is to be earmarked for relocating people out of the sensitive mangrove areas, priority should be given to this purpose. More information on the suitability of the

⁸⁸ Based on (\$674 (average cost of constructing a house - Table 6.10) * 581 number of households in Koh Kapik) + (581 number of households * \$217 (GNP)).

area as a relocation site is also needed (e.g., soil suitability studies, water availability).

6.10 Conclusions and Recommendations

The mangroves of Koh Kong support a number of coastal households, are of high ecological importance and represent a base for sustainable economic exploitation if carefully managed. In the past a number of activities in the area (in particular shrimp farming and charcoal production) have been carried out in a way detrimental to the mangrove resource. Isolated policy initiatives introduced to address these issues have not been successful (e.g., charcoal kiln destruction, shrimp farm bans) as they have had knock on effects everywhere else. Given the complexity of the system and the linkages existing between different components of the system, it would appear that only an integrated management plan for the area could be successful in sustaining the mangrove resource.

Nearly 90% of households were dependent on fishing for their livelihood at the time of survey, the figure may now be as high as 93% assuming that ex-charcoal producers now turn to fishing as their only means of income. However, fish productivity has reportedly declined dramatically in recent years owing to the increased number of fishers, the loss of mangrove areas due to the construction of shrimp farms and water pollution from these farms. Households claim to have turned to charcoal production and logging in upland areas because of low fishing yields which mean that returns from fishing are no longer sufficient for subsistence purposes. If this is correct, a linkage can be made between, for example, shrimp farming, declines in fish yield and the adoption of new activities by local people resulting in new and additional stresses on the resource base.

Following the closure of the charcoal kilns in the area, the Government intends to fully regenerate the mangrove forest and then to regulate and legalise the charcoal industry. However, what level of charcoal production would be sustainable for the area is as yet unclear, and would require careful consideration in any future management plan. The area of mangrove forest required per charcoal kiln per year is estimated by this study to be between 0.37-0.71 hectares. Assuming a 30 year cutting cycle, and that only already disturbed mangrove areas would be allocated for charcoal

production, potential returns from sustainably managed charcoal production are conservatively estimated at \$146 ha per year.

One important result of this study is that on a narrow financial analysis alone shrimp farming in Koh Kong is unprofitable and unsustainable. Farms are typically abandoned after five years of operation. While 50% of farms made a profit in 1995, overall shrimp farms in the area suffered an average loss of \$1,103 per hectare. Largely owing to problems with disease, associated with poor water quality management, it is rare for farms to have two successful harvests a year, and in some cases both harvests have failed. The real costs of shrimp farming are in fact much higher than this. The analysis does not account for the environmental costs associated with shrimp farming and there is also a social linkage in that it is causing resentment among local people. Over 90% of local people oppose the shrimp farms. This could result in social unrest and security problems in the future if not adequately addressed.

The survey results show that 94% of the population have migrated to the area, attracted by the potential returns from fishing and charcoal production at a time when population and hence resource exploitation were low. The issue of the 'carrying capacity' of the mangrove resource base in Koh Kapik is linked to the possibility of relocation. The mangrove resource in Koh Kapik cannot adequately support the current population living within the area. Returns from fishing are low and no viable alternative livelihoods have been identified to date. Faced with low living standards, people can be seen to be making short term myopic production decisions which are not in the interest of long term management. This is despite the fact that villagers recognise that activities which destroy the mangrove areas will affect their livelihood. Furthermore, there seem to be some barriers to mobility that are trapping people following the fall in living standards thereby further exacerbating matters. These barriers include - the lack of money to move (the majority of people have no money at all, being in debt), insecurity in making the move and lack of a place to go. The relocating of families out of sensitive mangrove areas is supported by provincial authorities. Some households in Koh Kapik have expressed an interest in relocation, if land were to be allocated to them. While an in-depth assessment of the suitability of the assigned location for resettlement is lacking, the possibility of voluntary

relocation is not ruled out as a way of protecting an ecologically valuable area and potentially improving the living standards of the local people.

Recommendations

A comprehensive integrated land use management plan for the mangrove areas needs to be developed which: safeguards the important ecological functions of the mangroves; allows sustainable traditional productive uses of the mangroves by local communities; and, supports a sustainably managed commercial shrimp farming industry in designated areas. A land zoning system is proposed consisting of a core area representing areas of high ecological value such as Koh Kapik. This area could be afforded total protection, or permitted to be utilised for sustainable local use. The remaining area - the multiple use area, could be used for sustainable traditional uses, and shrimp farming and charcoal production in appropriately identified zones. The management plan should be developed in close consultation with the local people. This has been very limited in the past. Local capacity building should be emphasised and included throughout the development of the management plan.

The issue of relocation should be carefully and thoroughly assessed. Voluntary relocation of people living within Koh Kapik to nearby upland areas within the province may be viable following an adequate period of consultation with local people and a proper assessment of the suitability of new lands for relocation (e.g., soil suitability studies).

Efforts should be directed at working with the local people to manage their areas better, whether this is within the mangrove area or at new relocation sites. Giving local people a greater stake in the mangrove resource would provide additional incentives for sustainable management. One possibility is to pay local people a wage to act as guardians of the mangroves. Such a system is currently practised in Southern Vietnam (To Thi *et al*, 1999). This would also be an effective way of providing much needed local employment.

Studies to determine the sustainable level of charcoal production for the area need to be initiated. Before charcoal production is legally permitted in the area, a system needs to be put in place to regularise charcoal production. For example, the

introduction of a licensing system to prevent the proliferation of charcoal kilns. A programme to improve kiln efficiency might also be started.

Future management of the shrimp farming industry requires a tough focus on sustainable practices, not short-term profit, and greater involvement of the local community. Improvements in shrimp farm management will require not only strict environmental management and technical improvements, but institutional support.

7 Valuing the Mangroves of Johor State, Malaysia

7.1 Introduction

This Chapter shows the economic value associated with the sustainable use of mangroves in Malaysia. Estimates of the direct and indirect use values associated with Johor State's seventeen mangrove sites are presented, along with a detailed distributional analysis. These estimates are combined with estimates of the non-use value of a site of high conservation value known as Benut (detailed in chapter 8) to provide a more complete valuation of this particular site. This information is necessary for the development of an economically optimal integrated management plan for the mangroves of Johor. Such values are also needed in any rational model of land use choice. However, due to resource constraints it was not possible to evaluate the economic value of the competing development options threatening the mangrove areas⁸⁹.

Malaysia has an estimated 641,000 hectares of mangroves, 17% of which are found in Peninsular Malaysia. Johor State has roughly one quarter (27,000 ha) of the mangroves of Peninsular Malaysia. Between 1980 and 1990, 12% of Malaysia's mangrove area was lost (Chan *et al*, 1993). Mangroves in Malaysia are classified either as Forest Reserves (FR), managed by Johor State Forestry Department (JSFD), or Stateland mangrove forest under the jurisdiction of State Governments. FR are managed as sustainable timber production areas, but may be converted into more 'economically' beneficial uses. Stateland forests can be converted into any use and are therefore particularly vulnerable to development pressures. In terms of conservation, mangrove areas are under-represented as national parks, wildlife reserves and sanctuaries. In Peninsular Malaysia only 0.3% of mangrove is protected. This is despite their value ecologically and economically, both locally and internationally.

⁸⁹ This Chapter is based on Bann 1999a.

As in Koh Kong, local coastal communities in Johor are dependent on the mangrove resource for their livelihood (i.e., in terms of fishing, logging and charcoal production), and in terms of the protection the mangroves provide to their property and land. The mangroves of Johor State are however under intense pressure from industrial, urban and tourism development proposals.

7.1.1 Background on Johor State

Johor State is located at the southern tip of Peninsula Malaysia and covers an area of 18,986 km². It is divided into six districts – Muar, Batu Pahat, Pontian, Johor Bahru, Mersing and Kota Tinggi, and is linked to Singapore by a causeway. It is the second most populous state in Malaysia, with an estimated population of 2.75 million (2000). Malays are the largest ethnic group and dominate most rural and coastal areas (with the exception of a relatively large number of ethnic Chinese fishermen along the west coast of Pontian District).

Johor is one of the most developed States in Malaysia and is a major producer of rubber, oil palm and pineapple. Nearly one quarter of the population depends on primary resources (agriculture, animal husbandry, forestry, or fishing) for their livelihoods. Average annual income for the State is RM20,496 while the incidence of poverty is 6% (lower than the overall average for Peninsular Malaysia of 10.5%)⁹⁰. Currently over half (53%) of Johor's land area is used for agricultural purposes. The main agricultural land uses are oil palm rubber and coconut. Since 1965, 11,500 hectares of mangrove has been converted to agricultural use (40% of the total mangrove area converted) despite the fact mangrove soils are considered to be unsuitable for agriculture (DWNP, 1987).

⁹⁰ The incidence of poverty is defined as: the percentage of households below the poverty line compared to the total number of households. The poverty line in Peninsular Malaysia is set at RM425 per month per household.

7.1.2 The Mangroves of Johor

Johor's mangroves occur all along its 2,000 km coastline and may be divided into three sections:

(i) The east coast mangroves facing the South China Sea. This is a relatively exposed area with sandy shores. The mangroves in this section are only found in river mouths (e.g., Sungai (Sg.) Sedili Kechil and Sg. Sedili Besar⁹¹).

(ii) The southern coast mangroves facing the narrow Straits of Johor. This area has a number of estuaries (e.g., Sg. Pulai and Sg. Johor) and narrow fringes along part of the remaining coastline.

(iii) The sheltered western coast mangroves facing the narrow Malacca Strait. This section contains fringing mangroves, such as the mangroves of Benut, which have been reduced to a narrow strip by bunding and reclamation for agriculture.

There are estimated to be 27,000 hectares of mangroves remaining in Johor, 13,238 ha on Stateland. Nearly all, 97%, of the remaining FRs are on the southern coast. The largest reserve is Sg. Pulai, which covers 7,336 ha. Johor's mangroves are dominated by *Rhizophora apiculata*, which is the main commercial species utilised for charcoal and poles. Most belong to the tidal-dominated allochthonous type, which occurs where there is a high tidal range with strong bi-directional currents. They are considered to be similar to the mangroves of Matang (Perek) and Klang (Selangor) in Malaysia which have been extensively studied. A second type of mangrove occurs along accreting shores, such as the mangroves at Benut.

Management of Johor's FR is based on a 1972-76 Working Plan (Clarke, 1972), which places sustainable wood production as the primary management objective for mangrove forests. Harvesting is by clear felling under a 20 year cutting cycle. Trees greater than 10 cm dbh (diameter at breast height) are harvested for poles, whereas trees less than 10 cm dbh are used for charcoal. To date, management plans have not explicitly considered the multiple uses and functions of the mangroves or assessed

⁹¹ Sungai means river.

social dependence on the mangrove site. Management plans are not prepared for Stateland mangrove forests. The only responsibility of the JSFD with regards to Stateland forests is in the processing of applications for harvesting forest resources.

It has been proposed that mangroves in Johor be managed under three main categories based on their key values (Table 7.1). Table 7.2 lists the nineteen mangrove sites of Johor (both Stateland and FRs), ordered in an east to west direction along Johor's coastline. The recommended management status of the sites relates to the categories provided in Table 7.1.

Table 7.1. Proposed Management Classification for Mangroves

Category	Main Objective	Comments	Possible Status
A	Biodiversity Conservation and Nature Tourism	Larger areas that also can be used for nature tourism.	Virgin Jungle Reserve / Forest Sanctuary for wildlife
B	Sustainable Use Forestry (Biodiversity Conservation)	Sustainable production of poles and charcoal. 'Pockets' of Biodiversity reservoirs to remain unlogged.	Forest Reserve
C	Protection Forest (biodiversity conservation, fisheries, shoreline protection, recreation, nature education, urban green space)	Non-logged areas valuable for a wide range of purposes.	Forest Reserve

Source: Christensen and Olsen, 1999.

Table 7.2. A Summary of Johor Mangrove Sites

	Location	Area (ha)	Key Values	Threats	Current Status	Recommended
1	Sg. Kesang – Sg. Muar	350	Biodiversity, coastal protection, local community use	Reclamation for agriculture	Stateland	C
2	Sg. Muar – Tanjung Tohor	1,380	Biodiversity (Muar to Benut is a priority area for the conservation of bird diversity), coastal protection, local community use, recreational potential	Bunding for agriculture, tourism development	Stateland	C
3	Sg. Batu Pahat	354	Biodiversity, education and amenity, recreation potential	Reclamation for urban development, agriculture, erosion	Stateland	C
4	Sg. Suloh Kecil	494	Biodiversity, local community use (fisheries), shoreline protection (Accreting)	Reclamation for agriculture (coconut, oil palm and banana)	Stateland	C
5	Benut	1,690	Biodiversity, coastal protection, local community use, tourism potential, education, shoreline protection (accreting)	Reclamation for agriculture, timber exploitation, hunting, illegal trawling	Stateland	A

	Location	Area (ha)	Key Values	Threats	Current Status	Recommended
6	Pulau Kukup	563	Biodiversity (proposed Ramsar site), tourism, fish cage culture	Tourism expansion, oil pollution from shipping	State Park	A
7	Tanjung Piai	162	Biodiversity (migratory birds), coastal protection, tourism (this is Asia's southern most tip)	Bunding for agriculture, erosion, aquaculture, oil spills, tourism development	National Park	A
8	Sg. Pulai	7,336	Poles, charcoal, tourism potential	Large scale development projects, bunding for agriculture, aquaculture, shipping pollution	Forest Reserve	B
9	Sg. Pendas	607	Amenity forest, local community use, tourism potential	Urban development	Stateland	C
10	Sg. Kemudi – Sg Bahan	156	Amenity forest, nature education, local community use, biodiversity	Urban development	Forest Reserve	C
11	Sg. Melayu – Sg Skudai	802	Recreation, biodiversity (birds)	Residential development	Stateland	C
12	Sg. Tebrau	356	Education, biodiversity (birds)	Urban and industrial development, aquaculture	Stateland	C

	Location	Area (ha)	Key Values	Threats	Current Status	Recommended
13	Sg, Johor	2,341	Tourism, production (poles, charcoal)	Reclamation for agriculture, urban development	Forest Reserve and Stateland	B
14	Sg. Lebam	1,397	Production forest, fisheries	Development projects	Forest Reserve	B
15	Sg.. Belungkor	602	Production forest, fisheries	Development projects	Forest Reserve	B
16	Sg. Santi	1,611	Biodiversity (unique mangrove habitat), forestry production, fisheries, tourism	Reclamation for mining	Forest Reserve	C
17	Sg. Sedili Kecil	229	Shellfish collection, fishing, forestry, hunting, aquaculture	Tourism	Stateland	A
18	Sg. Sedili Besar	47	Harvesting of nipa and fishing	Reclamation for agriculture and oil palm, residential development	Forest reserve	A
19	Sg.. Endau	209	Forestry and fisheries (substantial crab fishery)	Pond culture, landfill, reclamation for agriculture, urban development	Stateland	C

Between 1995-1997 an estimated 39,000 ha of mangroves were lost, equivalent to an annual deforestation rate of 0.7%. It is speculated that mangrove cover in Johor was originally around 50,000 ha (JSFD, 1999). While historically agriculture and aquaculture development were the main causes of mangrove loss, today the main threats are industrial, urban, and tourism developments. The pressure to convert mangrove land for such 'development' purposes is intense, fuelled by high land prices and incentives, such as 10 year tax exemptions offered to promote development of industrial estates. Mangroves are often looked upon as marginal or unproductive land that can be converted, at low cost, into industrial and urban areas. Included in the total extent are 2,055 ha of mangroves for which conversion has been approved, but has not yet occurred. This includes 145 ha in Sg. Pulai, and all of Sg. Kim Kim (Sg. Johor FR) and Sg. Pendas FR. There are many additional proposals to develop or convert mangrove land, some of which are summarised in Table 7.3.

Table 7.3. Examples of Development Proposals Affecting Mangrove Areas

Forest Reserve	Area (ha)	Purpose
Sg. Johor	202	Tanjung Langsat Technopark. To be developed by Johor Corporation.
Sg. Johor	318	Aquaculture project approved by the State Government
Sg. Pulai	45	Police Marine Base and Training Centre.
Sg. Pulai	89	Johor second port.
Sg. Lebam	81	Aquaculture
Sg. Kemudi & Bahan	156	Part of new township to be developed as part of second link to Singapore
Sg. Pendas	53	Part of approved area for second port
Sg. Pendas	2	Right of way for second link to Singapore
TOTAL	945	

Mangrove areas are further threatened by off-site impacts. These include: coastal siltation and pollution due to logging of catchment areas; agro-based pollution from surrounding palm oil mills, rubber factories and pineapple processing factories; and general pollution in the straits of Johor, which is undergoing heavy industrialisation and urbanisation. In all cases, the private companies involved are not accountable for the social costs of their actions on fisheries, aquaculture and coastal tourism ventures within the mangrove areas and the health of the mangrove resource in general.

7.2 Assessing Direct Use Values

Four study sites were selected on the bases that they would be representative of the main 'categories' of mangrove areas in Johor, that is, a FR utilised for wood production (Sg. Pulai FR), a Stateland mangrove forest of significant biodiversity value (Benut), a FR used for wood production with significant biodiversity value (Sg. Santi FR), and a FR site suffering from nearby development impacts (Sg. Kim Kim)⁹². For all these sites forestry and fishing are the key occupations of the local populations and are likely to remain so in the future. Also, the mangroves have been significantly reduced in size as a result of conversion to aquaculture, agriculture, and industrial and urban developments. Proposals on the table for the further development of these mangrove areas means that these sites, like most other sites in Johor, are threatened.

Direct use values are based on information derived from a household survey using market and imputed prices⁹³. The main survey was carried out over a one-week period in July 1998. A total of 218 households, in 13 villages, were interviewed, representing 16% of the total population of the selected study villages (Table 7.4). The survey covered fishermen, loggers and FR licence owners, charcoal kiln workers

⁹² The survey sites were selected based on information gained through sites visits, discussions with village headmen and forestry officials, and a review of available documentation. This information was also used to clarify important direct use values and hence in the design of the questionnaire.

⁹³ The survey instrument used in Johor is presented in Appendix 1, and represents an example of a direct use valuation questionnaire, similar to those used in Ratanakiri and Koh Kong, Cambodia.

and owners, middlemen involved in fishery and logging activities, and small-scale tourism operators.

Table 7.4. Summary of Survey Mangrove Areas and Villages

Mangrove Area	Village	No. of hh	No. of hh Surveyed	% of hh Surveyed
Pulai FR	Kg. Perkajang Lurus	69	17	25
	Kg. Simpang Arang	60	19	32
	Kg. Gelang Patah	348	26	7
	Kg. Sg. Boh	57	15	26
Total		534	77	14
Benut	Kg. Asli Pontian Besar	200	17	8.5
	Kg. Lapis Sayang	60	16	27
	Kg. Tampok Laut	60	15	25
Total		320	48	15
Santi FR	Kg. Pasir Gogok	100	12	12
	Kg. Lepau	60	23	38
Total		160	35	22
Sg. Kim Kim	Kg. Perigi Acheh	90	14	16
	Kg. Kong Kong	43	11	26
	Kg. Sg. Lato	40	9	23
	Kg. Tg. Langsat	140	24	17
Total		313	58	18
TOTAL		1,327	218	16

There are estimated to be 68 villages located near the four study sites, which are assumed to have a high dependence on the mangrove resource (Table 7.5). The number of villages located near other estuary and fringing mangrove areas is not known, but is assumed to be high.

Table 7.5. Number of Villages Located near Mangrove Study Sites

Area	Number of Villages
Sg. Pulai FR	38
Benut	13
Santi FR	3
Sg. Kim Kim	14
Total	68

7.3 Socio-Economic Conditions

Respondents are mainly Malay (79%)⁹⁴. Chinese, Indian and ‘others’ (which include Indonesian immigrants) represent 4.5%, 12% and 4.5% of the overall sample respectively (Table 7.6). This is considered to be representative of the ethnic composition of the coastal / rural population.

⁹⁴ This includes indigenous Orang Asli (12%).

Table 7.6. Ethnic Composition of Respondents (%)

Village	Malay	Chinese	Indian	Others
Kg. Perkajang Lurus	100	-	-	-
Kg. Simpang Arang	10.5	10	79	-
Kg. Gelang Patah	88.5	11.5	-	-
Kg. Sg. Boh	93	7	-	-
Kg. Asli Pontian Besar	53	6	35	6
Kg. Lapis Sayang	75	-	25	-
Kg. Tampok Laut	73	-	-	27
Kg. Pasir Gogok	92	8	-	-
Kg. Lepau	96	-	4	-
Kg. Perigi Acheh	82	-	6	12
Kg. Kong Kong	100	-	-	-
Kg. Sg. Lato	67	11	-	22
Kg. Tg. Langsung	90	5	-	5
Overall	78	4.5	12	4.5

Most respondents are married (96%), male heads of households. The average age of respondents is 45 years (ranging from 17-86 years), with a high proportion of the sample (46%) between 31-50 years of age. The level of education of respondents ranges from 1-12 years of schooling, with an average of 6 years. Household size

ranges from 1-21 members, with an average of 6 (the average for Johor is 5)⁹⁵. Age, educational level of respondents and average household size are fairly homogenous across villages.

With the exception of Kg. Gelang Patah, fishing is the main source of income in the survey villages. The average household income from fishing ranges from RM662 a month in Kg. Sg. Latoh (Sg. Kim Kim), to RM3,467 a month in Kg. Asli Pontian Besar (Benut). Factors determining income from fishing include: the area fished (open sea or river); type of fishing gear; whether fisherman is a crewmember or 'tekong' (chief)⁹⁶; type of fish caught (fish, shrimp or crab); and water quality. Kiln ownership and sports-fishing activities (Kg. Asli Pontian Besar) appear to be the most lucrative of mangrove related occupations (Table 7.7).

⁹⁵ Household size reflects the number of members living in a home. It includes immediate and extended family members.

⁹⁶ This system is known as '*panggu*'. Fishermen either own the boat, work as a chief owning the boat, or work as a crew member.

Table 7.7. Average Monthly Household Income by Economic Activity

Job Category	No. of Respondents	Average Household Income (RM/month)
Estuary fisherman	26	1,250
Coastal fisherman	95	1,521
Logger (worker)	12	625
Logger (licence owner)	1	1,267
Kiln worker	10	552
Kiln owner	5	1,977
Sport-fishing	2	1,850
Factory worker	4	1,478
Farmer	6	1,258

Some mangrove dependant households' income is below the State average (i.e., RM1,216 per month for rural areas, RM2,166 month for urban areas), indicating that they are amongst the poorest in the State. While reported average income levels for mangrove dependent households are above the poverty line of RM425 per month, 16% of fishermen have reported income levels below RM300 per month. Many fishermen report they have been forced to seek alternative employment because of the falls in fish catch related to the pollution of fishing grounds (from nearby developments and oil palm factories). However, there is also a trend away from fishing, particularly among the young. To what extent this 'trend' can be explained by the falling returns from fishing is unclear. Non-mangrove-related job opportunities for villagers are: farming; working in factories and on golf resorts; and running small business. Other sources of income for households include: odd jobs; security guards, sawmill workers; small businesses; and, remittances from relatives.

7.3.1 Attitudes to Johor Mangroves

A high percentage of respondents, 81%, consider the mangroves important to some degree. Nearly one quarter of respondents claim to be totally dependent on the mangrove resource (Table 7.8).

Table 7.8. Attitudes to the Mangroves

Degree of Importance	Number of Respondents	% of Respondents
Unimportant	21	9
Low Importance	10	5
Important	81	37
Very Important	45	21
Totally Dependent	51	23
No response	10	5

Table 7.9 summarises respondents' attitudes to the mangroves based on occupation. A high percentage of loggers (60%) and charcoal workers (80%) consider themselves to be totally dependent on the mangroves.

Table 7.9. Attitudes to the Mangroves According to Occupation (%)

Degree of Importance	Fishermen	Loggers	Charcoal workers	Others
Unimportant	10			27
Low Importance	4		7	13
Important	43	30	7	33
Very Important	24	10	7	20
Totally Dependent	19	60	80	7

Table 7.10 documents the main reasons why respondents consider the mangroves to be of importance to them. Over 60% of respondents value the mangroves for their protection functions and/or as a source of income.

Table 7.10. Reasons why Mangroves are Important

Reason	Number	%
Source of income	65	55
Timber / Charcoal Production	41	35
Protection (erosion / wind)	43	36
Habitat provision / protection	68	58
Other	18	15
Don't know / No Response	20	17

Note: Percentage column does not total, as respondents could give more than one answer.

7.4 Pole and Charcoal Production

Two important wood products are obtained from Johor FR - poles, mainly used in the construction industry and billets used for charcoal production. Producers operate under licences issued by the JSFD which is also responsible for supervising pole and charcoal production. Mangrove wood is harvested by clear cutting using chainsaws and axes, and transported by boat to designated sites. The main species harvested are: *Bruguiera cylindrica*; *Bruguiera gymnorhiza*; *Bruguiera parviflora*; *Ceriops tagal*; *Rhizophora apiculata*; and *Rhizophora mucronata*.

The number of licences, and pole production for FR and Stateland mangroves is shown in Table 7.11. Sg. Pulai FR is the most important wood production area. There have been significant reductions in areas allocated for felling within FR in recent years (1996/7) pending the development of a management plan by the JSFD (increases were however evident in 1998). Production has also been affected by the

on-going loss of mangrove. In Benut, for example, the production area for one licensee was reduced from 10,000 to 1,000 acres due to the conversion of mangrove land to agriculture. These production restrictions have resulted in shorter working periods, with many loggers unemployed for up to 8 months a year. Restrictions on production have also caused mangrove wood shortages. According to one licence owner, only 10% of Johor's requirements are produced locally. The remaining 90% is imported from Indonesia's Riau Island⁹⁷.

Table 7.12 shows the number of licences and the number of charcoal kilns in operation per reserve, 1994-1998. In total 19 kilns were in operation in 1998, located at Sg. Pulai (15 kilns), and Sg. Johor (4 kilns).

⁹⁷ Batu Pahat is the premier port for imported wood from Indonesia, Malacca and Muar also import wood from here.

Table 7.11. Number of Licences and Pole Production by FR and Stateland 1994-1998

Year	FR / Stateland	No. Licences	Extent /ha	Pole Production
1994	Sg. Pulai	15	208	122,316
	Sg. Johor	3	213	20,997
	Sg. Santi	1	37	
	Sg. Lebam	2	23	1,150
	Sg. Belungkor	2	17	5,561
Sub total		23	497	150,024
	<i>Stateland</i>	3	37	5,985
1995	Sg. Pulai	24	276	130,332
	Sg. Johor	5	38	6,494
	Sg. Santi	1	38	820
	Sg. Lebam			
	Sg. Belungkor	3	27	9,385
Sub total		33	379	147,031
	<i>Stateland</i>	3	37	5,985
1996	Sg. Pulai	6	74	18,044
	Sg. Johor	5	120	14,388
	Sg. Santi			
	Sg. Lebam	2	36	580
	Sg. Belungkor	1	10	1,745
	Sg. Pendas	1	16	100

Year	FR / Stateland	No. Licences	Extent /ha	Pole Production
Sub total		15	256	34,857
	<i>Stateland</i>	3	30	1,652
1997	Sg. Pulai	1	16	188
	Sg. Johor	2	28	1,851
	Sg. Santi			
	Sg. Lebam	2	36	680
Sub total		5	80	2,719
	<i>Stateland</i>	2	12	122
1998	Sg. Pulai	18	211	69,231
	Sg. Johor	2	34	650
Sub total		20	244	69,881
	<i>Stateland</i>	1	9	0

Source: JSFD, 1999.

Table 7.12. Charcoal Kilns by Forest Reserve

Year	Forest Reserve	No. Licences	No. of kilns
1994	Sg. Pulai	5	13
	Sg. Johor	2	2
	Sg. Lebam	1	4
Sub total		8	19
1995	Sg. Pulai	7	21
	Sg. Johor	1	1
	Sg. Belungkor	2	3
Sub total		10	25
1996	Sg. Pulai	2	6
	Sg. Johor	1	1
	Sg. Lebam	1	1
	Sg. Belungkor	1	2
	Sg. Pandas	1	1
Sub values		6	11
1997	Sg. Lebam	1	1
Sub total		1	1
1998	Sg. Pulai	6	15
	Sg. Johor	1	4
Sub total		7	19

Source: JSFD, 1999.

Available charcoal prices are presented in Table 7.13. In Johor charcoal has been widely substituted with LPG and charcoal prices have fallen over the past 5 years due to a reduced demand. Charcoal is now mainly exported to Japan.

Table 7.13. Charcoal Price (RM/kg)

Market	Class 1	Class 2	Class 3
Sold to Middlemen	0.50	0.40	0.30
Market Price	0.80- 1.10	0.70	n.a

Note: Class 1 charcoal: unbroken; Class 2 charcoal: broken.

The estimated value of wood products from FRs over the period 1994-1998 shown in Table 7.14 can be seen to range from RM1,561 – 8,974 per hectare harvested. These figures over-estimate the value, as no account is taken of production costs. The number of poles per hectare harvested ranges from 147 – 865.

Table 7.14. FRs - Annual Yield and Value (RM) of Poles, Charcoal and Fuelwood 1994-1995

Year	Area ¹ (ha)	Total no. of Poles (per ha values)	Value of Poles ² (RM)	Charcoal (tons)	Value of Charcoal ³	Fuelwood (tons) ⁴	Total Value	Value/ha ⁵
1994	517 (406)	150,024 (369)	1,050,168	453	317,100	660	1,367,268	3,368
1995	379 (170)	147,031 (865)	1,029,217	709	496,300	1,006	1,525,517	8,974
1996	256 (241)	34,857 (145)	243,999	189	132,300	308	376,299	1,561
1997	80 (15)	2,719 (181)	19,033	9	6,300	10	25,333	1,689
1998	244 (215)	69,881 (325)	489,167	239	167,300	191	656,467	3,053

Source: JSFD, 1999.

Notes: 1/ Figures in brackets refer to actual area logged according to compartment records; 2/ Based on a market price of RM7 per pole; 3/ Based on a market price of RM0.70/kg; 4/ Market price per ton not known; 5/ Based on area harvested.

Over the same period only 1-3 logging licences a year were issued for Stateland mangroves (only 1 licence was in operation in 1998). Production of poles ranged from 0 - 5,985, charcoal from 0 –40 tons, and fuelwood 67-79 tons (Table 7.15).

**Table 7.15. Stateland Mangroves - Annual Yield and Value (RM) of Poles,
Charcoal and Fuelwood 1994-1995**

Year	Area (ha)	Total no. of Poles	Value of Poles	Charcoal (tons)	Value of Charcoal	Fuelwood (tons)	Total Value	Value/ha
1994	37	5,985	41,895	40	28,000	79	69,895	1,889
1995	37	5,985	41,895	40	28,000	79	69,895	1,889
1996	30	1,652	11,564	40	28,000	79	39,564	1,319
1997	12	122	854	6	4,200	69	5,054	421
1998	9	0	0	0	0	67	0	0

Source: JSFD, 1999.

Survey Results - Logging

An estimated 20 households are involved in logging in Kg. Gelang Patah, and 4 in Kg. Sg. Latoh (the two villagers where loggers were surveyed). Stated earnings average RM625 month (ranging from RM300-900), and over 60% say that their household is self-sufficient. On average, loggers work for 10 months of the year. Of those logging for less than 12 months a year (i.e., 45%), many undertake temporary employment such as fishing, factory work, security guards, carpentry and farming to supplement their income. However, for some logging is their only source of income.

Loggers typically receive RM1.00-RM1.50 per pole (Table 7.16). A few workers are paid at a daily rate of RM35 per day. Based on piecemeal prices and a production of 35 poles per day, a logger's daily income is estimated to range from RM35-RM54⁹⁸.

⁹⁸ 35 is the average number of poles collected based on survey responses (ranging from 10-50). This may be low. During pre-survey field visits loggers reported averaging 60-70 poles per day. A worker in Matang Mangrove FR, Perak, harvests on average 20 trees per day (from second thinning, where the

This is equivalent to around RM730 - RM1,130 per month, based on an average work schedule of 10 months a year, 25 days a month. This is higher than the monthly estimate of RM625 communicated by respondents, but does not take into account costs for loggers (e.g., travel costs, possible chainsaw purchase, maintenance and petrol costs), which are estimated to be in the region of RM200 per month⁹⁹.

Table 7.16. Pole Prices

Price	5 inches	4 inches	3 inches
Paid to worker	1.55	1.20	1.00
Sold to Market by licence owner	7.5	6.5	5.5
Sold to middleman by licence owner	7	6	5

Based on data presented in Table 7.11 average pole production per hectare licensed was 286 in 1998. The average number of poles per compartment in this year was therefore 3,494. Using an average profit of RM4.75 per pole (Table 7.16), gross income to license owners is estimated at RM16,596 per year. Costs that need to be deducted from this include royalty, premium, registration fee, production costs other than labour, and replanting costs. Estimates of these costs are not available.

Survey Results – Charcoal

The survey covered 10 charcoal kiln workers in Kg. Gelang Patah, and 5 kiln owners (4 in Kg. Gelang Patah and one in Kg. Lato). Kiln workers are employed for around 8.5 months a year, and are typically without work the remaining time. On average workers are estimated to earn RM775 per month (this is higher than survey

age of the crop is 20 years) which can produce about 40 poles (2 poles per tree). This is slightly higher than cutting rates in Johor.

⁹⁹ Boats and chainsaws are often provided by the employer. Chainsaws are sometimes hired at a cost of RM20 per day. Axes cost RM55. Travel costs are estimated to be in the region of RM120 per year and petrol costs for chainsaws RM1,560.

respondents' estimates of RM552)¹⁰⁰. A high percentage (77%) of respondents claim to be self sufficient despite this low wage.

The average charcoal production cycle is around 56 days: stacking of wood - 4 days; burning - 34 days; cooling down - 15 days; unloading - 3 days. Based on these figures, 6 'burns' are possible per year. However, based on JSFD data, the average number of burns per year, per kiln is 3. The amount of wood required for each burn is estimated to be 70 tons/kiln based on survey responses. Survey findings also suggest that the total quantity of charcoal produced per kiln, per burn is around 14 tons, 65% of this is estimated to be Class 1, 30% Class 2, and 15% Class 3¹⁰¹. JSFD records indicate charcoal production levels lower than this, ranging from 8.50-11.50 tons per cycle.

A producer owns on average 3 kilns, and the potential income per producer per year from charcoal production is around RM176,400¹⁰². Production costs include – kiln licence (RM120/year); registration of the kiln (RM100/year); royalty (RM5.00 per ton); kiln construction costs (kilns costs around RM20,000 and have a lifetime of 10-15 years); salaries (at RM30 per day); and wood purchases. Costs for producers are estimated at RM83,080 per year (this excludes the cost of wood purchase), leaving a net benefit to producers of RM93,320 per year, or RM31,107 per kiln. However, based on an output of 10.5 tons of charcoal per kiln and 3 burns per year, benefits to charcoal producers are estimated at RM66,150 per year. This is below production costs estimated at RM79,000.

¹⁰⁰ One worker is paid RM30 per day, another RM28 / ton.

¹⁰¹ One operator estimated that as much as 15% of the final product consisted of half burned wood and another 15% of fines. These figures seem pessimistic, in particular compared to the figures from Matang, which gives an average of only 3% broken pieces (by weight).

¹⁰² Assumes production of 14 tons of charcoal per kiln, market price of RM0.70 kg and 6 burns per year.

Employment

The number of people employed in the production of poles and charcoal based on official figures is presented in Table 7.17. There are a number of discrepancies between this data and the survey results. Based on survey findings, with a total of 19 kilns operating, and an average of 4 workers employed per kiln, the number of charcoal workers is estimated at 76. Also, according to the survey results one logger harvests on average 8,750 poles per year. Production figures for 1998 (i.e., 69,881 poles), however, suggest that only around eight loggers are currently engaged. The reasons for these discrepancies are not entirely clear, but the total number of loggers and charcoal workers by both assessments are reasonable close, suggesting that perhaps the JSFD's figures for loggers include those 'logging' for the kilns.

Table 7.17. Employment in Logging and Charcoal Production, 1994-1998.

Occupation	1994	1995	1996	1997	1998
Log Licensees	17	33	15	5	20
Loggers	83	133	57	21	80
Charcoal Licensees	8	10	6	0	7
Charcoal Kiln Workers	27	28	15	2	13
Total	135	204	93	28	120

Source: JSFD

Government Royalties

The JSFD collects royalties on the basis of the number of poles extracted and the tons of charcoal produced, as well as licence fees and annual fees for kiln productions (Table 7.18)

Table 7.18. Government Revenue from Mangrove Wood Products

Year	Revenue				Kilns			Total
	Poles	Charcoal	Fuelwood	Sub-total	Licence	Annual fee	Sub-total	
FR								
1994	105,215	7,016	1,056	113,287	800	380	1,180	113,767
1995	89,494	10,989	1,931	102,414	1,000	500	1,500	103,914
1996	21,328	2,930	591	24,849	600	220	820	25,669
1997	1,843	140	19	2,002	100	20	120	2,122
1998	46,520	3,705	367	50,592	700	380	1,080	51,672
Av/ha	179	17	7	203	0.40	0.20	0.64	204
SMF								
1994	4,197	618	126	4,941				4,941
1995	4,197	618	126	4,941				4,941
1996	1,158	618	126	1,902				1,902
1997	85	98	111	294				294
1998	0	0	108	108				108
Av/ha	77	15	5	97				9t

Source: JSFD, 1999.

The distribution of benefits from poles production is presented in Table 7.19. Government rent capture in terms is at least 10%. The benefits to license owners are over estimated since productions costs are not been included. Nevertheless, the figures suggest that licence owners enjoy significant economic rent encouraging production and thereby inimical for conservation.

Table 7.19. Distribution of Benefits: Pole Production, 1998

Category	Workers	Licence owner	Government	Total Value
Benefit (RM)	83,857	358,790	46,520	489,167
%	17	73	10	100

Notes: Based on pole production of 69,881. Piecemeal rate paid to workers of RM1.20

Ideally, the value of mangrove wood products should be based on sustainable production quantities. Sustainable production levels for Johor mangroves, based on an annual production area of 400 hectares, are presented in Table 7.20.

Table 7.20. Sustainable Production Quantities and Value (RM) for Wood Products

Product	Quantities	Value	Value / ha ¹
Poles (pieces)	428,000	2,996,000	111
Charcoal (tons)	990	700,000	26
Fuelwood (tons)	2,400		
Total		3,696,000	137

Source: JSFD, 1999

Notes: 1/ Value calculations are based on a mangrove area of 27,000 hectares

7.5 Fisheries

Inshore fisheries in Malaysia are over-fished but offshore fisheries may still have some development potential. The Fisheries Comprehensive Licensing Policy was introduced in the early 1980s aimed at reducing fishing effort through a Licence Limitation Scheme. In response to declining fish stocks and damage to fish habitat

(mangroves), the Government is also promoting the construction of 'replacement' refuge sites in the form of artificial reefs along the east and west coasts of Malaysia. According to the Fisheries Department, about RM10 million and RM7 million were earmarked for artificial reef building under the Sixth and Seventh Malaysia Plan (1996-2000) respectively¹⁰³.

The fisheries sector in Johor accounts for 3% of GDP, and employs around 1.5% of the labour force. This is slightly above the national average of 1.6% and 1.3% respectively. Johor's fisheries are dualistic in nature: a small scale or artisanal sector operates besides a large-scale commercial sector. In terms of employment, Johor's fisheries are predominately artisanal, with drift and gill nets commonly used. An estimated 4,925 boats operate in the State, of which 97% are powered (Fisheries Department Johor, 1997).

Fish landings for Johor declined at an average rate of 3.5% per annum between 1991-7 (Table 7.21). This decline is considered to be linked to on-going fish stock depletion. The fisheries of Johor have been over fished, and remain under pressure from the large number of boats competing around Johor's coastline. This is compounded by the loss of mangroves, pollution and the use of destructive fishing methods. Currently, 10,000 tons of fish are imported into Johor to meet the high demand for fish products.

¹⁰³ Actual expenditure is not known.

Table 7.21. Fish Landings, Johor 1991-1997

Year	Landings (metric tonnes)	Annual change (%)
1991	89,523	
1992	84,252	-5.9
1993	88,975	5.6
1994	89,368	0.4
1995	80,937	-9.4
1996	81,497	0.7
1997	71,267	-12.6
Average (1991-1997)	83,688	-3.5

Source: Fisheries Department Johor, 1997

There are estimated to be 125 fishing villages and 8,800 fishermen in Johor. Overall, nearly 70% of fishermen in Johor State are Malay, and 24% Chinese (Fisheries Department Johor, 1997). The fishing industry also supports a number of ancillary activities such as boat repairs, fish and prawn processing, fish marketing and distribution, ice factories and refrigeration. According to official statistics, the total number of people dependent on fishing in the State is estimated at 39,000. This is around 1.5% of the state's population. However, this masks higher dependence at the district level, reaching 13% in Mersing. It is not clear how 'dependence' is defined in these statistics, but it is assumed to involve the fishing industry in the broad sense (i.e., including ancillary services noted above).

The Link between Mangrove and Fish Productivity

The support that mangrove ecosystems provide to inshore and offshore fisheries production is widely accepted. Mangroves serve as an important habitat for part of

the life cycle of commercially valuable fish species. Box 7.1 summarises species dependent on mangrove areas in Malaysia.

Box 7.1. Prawn and Fish Species Dependent on Mangrove Area.

Shrimp: Many species of commercially important shrimp spawn offshore, but use mangroves as nurseries. The most significant are *Penaeus merguensis* and *P. monodom* whose catch is correlated with the occurrence of mangroves. Many other prawn species, e.g., species of *Metapenaeus*, live in mangrove areas as juveniles, but are also found on mud flats or in seagrass beds and are therefore less dependent on mangroves. Most species of *Parapencopsis* live as juveniles on mudflats and sandy-muddy bottoms.

Fish: Some fish live in mangroves, but most fish species just use mangrove as feeding grounds during high tide. Mangroves are important feeding grounds for juveniles of a number of species, but most do not seem to depend on mangroves as a habitat where they must spend part of their life cycle. Commercial species common in mangrove areas include: *Lates calarifer*; *Lutjanus argentimaculatus*; *L.johni*; *Liza subviridis* and *Plotosus canius*. Juveniles of one species of *Epinephlus* can also be found.

Crabs: Mud crabs (*scylla serrata*) spawn in marine waters. The larvae spends about a month in marine waters before they settle in mangrove.

Molluscs: The blood cockle, *Anadara granosa*, is characteristic of inter-tidal mudflats

Source: Christensen, 1998

A proportion of the value of coastal and inland fisheries outside of the mangrove area may therefore be attributed to this vital mangrove support. Ideally, one would like to know the net loss in productivity of these fisheries if the mangrove area could no longer support them. The value of this change in productivity would thus approximate the contribution of this support service. In practice, however, it is extremely difficult to estimate the 'value added' provided by the mangrove to external fisheries or any other economic activity that it may be supporting due to the uncertainties surrounding the quantification of the ecological linkages. While studies of mangrove fish fauna exist, very few studies on the life cycle of common fish have been carried out making it difficult to specify the importance of mangroves to

fisheries (Alias and Hayases, 1996)¹⁰⁴. Table 7.22 summarises estimates of the value of mangrove dependent fisheries in Johor.

Table 7.22. Estimates of Fish Values

Area	Estimate	Comments	Source
Johor State	The value of mangrove dependent fisheries are estimated at 54 million RM (i.e., 20% of the value of total landings). 11% of the total fish catch, and 34% of the shrimp catch is estimated to be dependent on mangroves.	Catch in each category used in the annual fisheries statistics (fish landings 1995) multiplied with a factor representing the degree of dependence of the category on mangrove.	Christensen 1998
Pulai Forest Reserve	RM3-4 million		
Sg. Johor	RM 12.6 million annually		Chong, 1998

Survey Findings

A total of 172 fishermen in 12 study villages were interviewed regarding their fishing practices, income and views on fisheries management. For the purposes of analysis fishermen are broadly classified into two main fishing zones: offshore, and estuary, based on survey responses¹⁰⁵. Estuary fishing is assumed to be more related to the health and area of the mangroves. It is practised by 31.5% of respondents (20% only fish in estuary areas, while 11.5% fish in estuary areas and offshore) and is most common in Sg. Pulai. Offshore fishing is more common on the west coast, and

¹⁰⁴ See Ruitenbeek, 1992, for a discussion and methodology for incorporating uncertainties over the ecological-economic linkages into the economic appraisal process.

¹⁰⁵ This is considered to be a more reliable indicator of fishing practices than fishing licences which are categorised as: coastal, deep-sea, cage and aquaculture.

exclusively practised in Kg. Asli Pontian Besar, Kg. Tampok Laut and Kg. Pasir Gogok (Table 7.23).

Table 7.23. Division between Offshore and Estuary Fishermen for Study Areas

Mangrove area / Village	Offshore (%)	Estuary (%)	Estuary and Offshore (%)
Pulai Forest Reserve¹			
Kg. Perkajang Lurus	29	57	14
Kg. Simpang Arang	18	47	35
Kg. Boh	43	4	53
Sub-Total	20	36	34
Benut			
Kg. Asli Pontian Besar	100		
Kg. Lapis Sayang	56	19	25
Kg. Tampok Laut	100		
Sub-Total	85.5	6	8.5
Sg. Santi Forest Reserve			
Kg. Pasir Gogok	100		
Kg. Lepau	82	14	4
Sub-Total	91	7	2
Sg. Kim Kim			
Kg. Perigi Aceh	82	18	
Kg. Kong Kong Laut	54	46	
Kg. Sg. Latoh	57	43	
Kg. Tg. Langsat	77	17	6
Sub-Total	67.5	31	1.5
Overall %	68.5	20	11.5

Note: 1/ Gelang Patah is not included as only loggers were interviewed at this site

Overall 42% of households in the study villages are estimated to be dependent on fishing. Dependence is particularly high in Benut (Table 7.24).

Table 7.24. Dependence on Fishing

Mangrove Area / Village	Estimated no. of hh engaged in fishing	% of hh per village
Sg. Pulau Forest Reserve		
Kg. Perkajang Lurus	27	39
Kg. Simpang Arang	35	58
Kg. Sg.Boh	24	42
Benut		
Kg. Asli Pontian Besar	189	94
Kg. Lapis Sayang	52	87
Kg. Tampok Laut	60	100
Sg. Santi Forest Reserve		
Kg. Pasir Gogok	22	22
Kg. Lepau	23	38
Sg. Kim Kim		
Kg. Perigi Acheh	47	52
Kg Kong Kong	27	63
Kg. Sg. Latoh	13	32
Kg. Tg. Langsat	61	43
OVERALL	580	42%

Overall, a high percentage of fishermen earn over RM1,500 per month (Tables 7.25 and 7.26). However, 19% of estuary fishermen and 15% of offshore fishermen estimate their household income to be below RM300 per month and are therefore below the poverty line of RM470 per month. In addition around 15% of households estimate their household income to be in the region of RM300-600. High incomes are evident in Kg. Asli Pontian Besar where deep-sea fishing with trawlers is prevalent, while low incomes are common for estuary fishing activities around Sg. Kim Kim, whose waters have been seriously polluted by development activities (see Box 7.2).

Table 7.25. Distribution of Income from Offshore Fishing

Mangrove Area / Village	% of hh per Income Group (RM/HH/Month)					
	<300	301-600	601-900	901-1,200	1,201-1,500	>1,501
Pulai Forest Reserve						
Kg. Sg.Boh (6)		33%	17%	33%		17%
Benut						
Kg. Asli Pontian Besar (10)						100%
Kg. Lapis Sayang (8)	12.5%		12.5%	12.5%	25%	37%
Kg. Tampok Laut (14)	7%			7%	7%	79%
Santi Forest Reserve						
Kg. Pasir Gogok (10)	10%	40%			20%	30%
Kg. Lepau (16)	6.3%	6.3%	25%	12.5%	25%	
Sg. Kim Kim						
Kg. Perigi Acheh (14)	36%	7%	7%	21%	27%	
Kg Kong Kong (6)		17%	11%		33%	50%
Kg. Sg. Latoh (3)	67%	33%				
Kg. Tg. Langsat (14)	29%	29%		7%		36%
TOTAL (101)	15%	14%	7%	10%	11%	42%

Table 7.26. Distribution of Income from Estuary Fishing

Mangrove Area / Village	% of hh per Income Group (RM/HH/Month)					
	<300	301-600	601-900	901-1,200	1,201-1,500	>1,501
Pulai Forest Reserve						
Kg. Perkajang Lurus (3)				33%		67%
Kg. Simpang Arang (2)					50%	50%
Kg. Sg.Boh (4)			50%	25%		25%
Benut						
Kg. Lapis Sayang (2)				50%	50%	
Santi Forest Reserve						
Kg. Lepau (3)	100%					
Sg. Kim Kim						
Kg. Perigi Acheh (2)		50%		50%		
Kg Kong Kong (5)	20%	20%				60%
Kg. Sg. Latoh (3)		33%			33%	33%
Kg. Tg. Langsat (2)	50%	50%				
TOTAL (26)	19%	15%	8%	15%	11%	31%

Note: Tables 7.25 and 7.26 are based on respondents' own assessment of their household income.

Table 7.27 summarises fishing practices including the average travel time, time spent fishing and number of trips per month, for both offshore and estuary fishing activities. Time and costs are higher, as expected, for offshore fishing. In the case of offshore fishing, villages tend to visit specific sites. For estuary fishing, however, there are a great number of common fishing grounds, the most popular being Sg. Pulai, Sg. Benut, and Sg. Boh, which are large and accessible enclosures.

Table 7.27. Summary of Fishing Practices

Practice	Open Sea Fishing	River Fishing
Average travel time per trip	39 mins	35 mins
Average duration of fishing per trip (hours)	6 hrs	5 hrs 30 mins
Average no. of fishing trips per month	19	26
Average no of fishermen per trip	2	2
Average petrol cost per month (RM)	503	224

Over 30 species are caught by fishermen. They are categorised according to price by the Fishery Authority Development Board (LKIM)¹⁰⁶. Many of these species are considered to be mangrove dependent for part of their life cycle (Table 7.28).

¹⁰⁶ Category - A: High - average price RM16.50; B: Medium - average price RM4.70; C: Low - average price RM2.55 (October 1988)

Table 7.28. Mangrove Dependent Species

No	Local Name	Scientific Name	English Name	Category
1	Kerapu	<i>Epinephalus sexfasciatus</i>	Coral cod	A
2	Kurau	<i>Eleutheronema spp</i>	Threadfin	A
3	Senangin	<i>Eleutheronema tetradactylum</i>	Threadfin	A
4	Siakap	<i>Lates calcarifer</i>	Giant Sea Perch	A
5	Unga (Jenahak)	<i>Lutianus johni</i>	Mangrove Snapper	A
6	Belanak	<i>Valamugil seheli</i>	Bluetial Mullet	B
7	Merah	<i>Lutianus argentimaculatus</i>	Red Snapper	B
8	Sembilang	<i>Plotosus canius</i>	Catfish Eel	B
9	Bilis	<i>Stolephorus heterolobus</i>	Shorthead anchory	C
10	Duri	<i>Yachysurus</i>	Catfish	C
11	Gelama	<i>Johnius spp</i>	Jewfish	C
12	Selangat	<i>Anodontostoma chacunda</i>	Gizzard-shad	C

Only seven species of fish are caught by estuary fishermen - Bawal, Duri, Gelama, Kurau, Sembilang, Siakap and Jenahak. All of these species are mangrove dependent (Christensen, 1998). Fish catches are highest for fishermen in Kg. Asli Pontian Besar, and Kg. Tampok Laut in Benut where deep-sea fishing is practised. Average monthly catch per household is lower for estuary fishermen (Table 7.29).

Table 7.29. Average Household Catch (kg/month)

	Fish	Shrimp	Crab¹
Estuary	72	39	31
Open Sea	491	47	21
Estuary/Open Sea	89	44	22
Overall	377	45	25

Note: 1/ Based on an estimated 74% of households catching crabs

Fishing Costs

Fishing costs include: equipment (boat, engine and fishing gear); and operating costs (petrol, bait, staff salaries, maintenance costs and licences). Boats have an average economic life of 9 years, and cost on average RM2,092 (offshore fishing), and RM1,729 (estuary fishing). Trawlers are commonly used in Kg. Asli Pontian Besar (RM35,000). Engine costs average RM2,265, and have an average economic life of 8 years (ranging from 2-30). The types of nets employed by fishermen depend on: fishing area; boat type; and category of licence. For offshore fishing drift nets, jaring undang and pukat tunda, are the most effective for catching fish. Fishtraps are an effective way of trapping crab. For estuary fishing, fish traps and 'jaring udang' or shrimp nets support the highest catches. The cost of nets ranges from RM97-3,142 / year. The average cost of fishing gear for each village is presented in Table 7.30.

Table 7.30. Average Cost of Fishing Gear (RM/hh/year)

Mangrove/Village	Offshore sea	Estuary
<i>Sg. Pulau</i>		
Kg. Perkajang Lurus	2,399	956
Kg. Simpang Arang	162	240
Kg. Boh	300	82
<i>Benut</i>		
Kg. Asli Pontian Besar	1,555	n.a
Kg. Lapis Sayang	304	204
Kg. Tampok Laut	3,239	n.a
<i>Sg. Santi</i>		
Kg. Pasir Gogok	727	n.a
Kg. Lepau	269	382
<i>Sg. Kim Kim</i>		
Kg. Perigi Acheh	341	187
Kg. Kong Kong	200	148
Kg. Sg. Lato	131	450
Kg. Tg. Langsung	365	90
<i>All villages</i>	<i>924</i>	<i>320</i>

Petrol expenditure is the most significant operational cost averaging RM503 per month for offshore fishing and RM244 for estuary fishing (Table 31). Bait is reportedly purchased by only 50% of respondents, and only 15% of respondents claim

to pay salaries. Salary costs range from RM50 – 800 per month, and therefore are significant outgoings for some fishermen.

Table 7.31. Average Operating Costs (RM/hh/month)

	Petrol	Bait	Salary	Maintenance
Estuary	244	39	45	45
Offshore	503	44	30	66

Note: Fishermen in Kg. Perkajang Lurus incur higher petrol cost perhaps due to their use of high-powered boats, and greater distance travelled.

Overall, 19% of fishermen borrow between RM200-7,500. Sources of credit for fishermen include: fish middlemen; boat owners; banks; and family and friends. Offshore fishermen tend to take out larger loans. Repayment is typically made through deductions from fish catch. Sometimes the loan is considered as an ‘advance’, whereby capital and equipment is provided by the boat owner. This system is known as ‘taukeh’. The amount paid is based on a mutual agreement between the fishermen and the boat owner and involves no legal documentation.

Net Benefits from Fishing

Net benefits for estuary and offshore fishermen are presented in Tables 7.32-4. The estimates are based on average quantities collected (Table 7.31) and an average price of RM4.70/kg for category B fish species. This obviously imposes some smoothness on the value of catch per household. The estimates do not take into account loans, licences and boat fees and therefore underestimate costs. For a fisherman who might have to pay up to 50% of income in loan repayments, income may fall below the poverty line. Licences for trawlers and purse seine-fish range from RM20-10,000 per year depending on Gross Restoration Tonnage (GRT). Boat fees range from RM3-395 per year depending on engine size. An additional consideration is that a percentage of catch is allocated to domestic consumption, further reducing income.

The vast majority of fishermen, 86%, believe that fish numbers and catch have declined over the past 5 years. Reasons for this include: pollution from mills; an increase in the number of fishermen; an increase in the number and size of trawlers; coastal development (e.g., port expansion); and loss of mangrove areas. Increases in fish prices over the period, due to a strong demand from Singapore, have helped to maintain incomes. However, most fishermen claim that the higher prices have not fully compensated for the declines in production.

Table 7.32. Average Net Benefits for Selected Villages: River Fishing (RM/hh)

Mangrove / Village	Net benefits / month	Annual net benefits
<i>Sg. Pulai FR</i>		
Kg. Perkajang Lurus	2,155	25,860
Kg. Simpang Arang	1,929	23,148
Kg. Boh	1,370	16,440
<i>Benut</i>		
Kg. Lapis Sayang	818	9,816
<i>Sg. Kim Kim</i>		
Kg. Perigi Acheh	715	8,580
Kg. Kong Kong Laut	755	9,060
Kg. Sg. Lato	619	7,428
<i>All villages</i>	<i>1,022</i>	

Table 7.33. Average Net Benefits By Village: Open Sea Fishing (RM/hh)

Mangrove / Village	Net benefits / month	Annual net benefits
<i>Sg. Pulai FR</i>		
Kg. Simpang Arang	2,410	28,920
Kg. Boh	885	10,620
<i>Benut</i>		
Kg. Pontian Besar	12,012	144,144
Kg. Lapis Sayang	3,207	38,484
Kg. Tampok Laut	5,042	60,504
<i>Sg. Santi</i>		
Kg. Pasir Gogok	1,171	14,052
Kg. Lepau	1,278	15,336
<i>Sg. Kim Kim</i>		
Kg. Perigi Acheh	1,008	12,096
Kg. Kong Kong	2,227	26,724
Kg. Tg. Langsat	880	10,560
<i>All villages</i>	<i>3,084</i>	

Table 7.34. Average Net Benefits (RM/hh/Month)

	Fish (kg)	Income @ RM 4.70/kg	Prawn (kg)	Income @ RM 28 / kg	Crab (kg)	Income @ RM 8 / kg	Total Income	Costs¹	Net Income
Open Sea	491	2,308	47	1,316	21	168	3,792	706	3,086
River	72	338	39	1,092	31	248	1,678	656	1,022

Notes: 1/ Costs based on operating costs, plus monthly boat and engine estimates of RM19 and RM24 respectively for open sea fishing, and RM16 and RM24 for river fishing; 2/ A study by Fishery Authority Development Board (LKIM), 1995 reports an average monthly income of RM759.

While these figures can only be seen as ballpark estimates, they do provide an indication of the differences in fishing returns by location and fishing area. Particularly low incomes are consistently reported in the Sg. Kim Kim area (Box 7.2).

Box 7.2. Impact of Development on Fishing Activities: The Case of Kg. Perigi Acheh

Sg. Kim Kim and its surrounding mangroves are in the centre of a project by the Johor Corporation (a State Government agency) to develop Malaysia's premier heavy industrial estate at Tanjung Langsat. The RM1.2 billion project approved by the State Government in 1991, involves the construction of a second port, factories, infrastructure and recreational facilities. Construction of the port involves the clearance of 200ha of mangroves. The Johor Corporation has reportedly paid RM1.78 million in compensation to the State (RM8,900 / ha) for the loss of these mangrove areas. A remaining 557 hectares of mangrove will be maintained.

As a result of the construction works, the Sg. Kim Kim is silted with mud and fish productivity has fallen by around 50%. There are around 47 fishermen living at Kg. Perigi Acheh. Average income from fishing is around RM700 per month. Developers offered RM1,200 to 112 fishermen in compensation for 14 months of lost income. This represents less than two months of net income. Alternative employment opportunities are limited, especially for the old.

The area is said to be one of the few spots in the world that contains four *Avicennia* types: Api-api Merah (*Avicennia marina*); Api-api Ludat (*A. officinalis*); Api-api Hitam (*A. alba*) and Api-api Berbulu (*A. Rumphiana*) – native to Sarawak, but rare in Peninsular Malaysia.

Box 7.3. Other Mangrove Products

It is estimated that 57 households engage in the collection of mangrove products such as snails, cockles and crab in the study villages. The exact number is difficult to gauge as often fishermen will collect on a seasonal, part-time basis. These products are typically collected for home consumption, representing an important food supplement for coastal households. Crab numbers are said to have fallen over the past 5 years due to pollution of the mangrove areas.

7.6 Aquaculture

Coastal aquaculture, in particular offshore cage culture, has been encouraged by the Government in recent years as a means of offsetting the declines in marine capture fisheries, and meeting the increasing demand for fish. Subsidies are offered to small

and medium sized farmers by 'Khidmat Perkembangan Tenak Ait' (Expand Aquaculture Services)¹⁰⁷.

Johor's aquaculture industry features pond and cage culture of shrimp and finfish, and raft culture of shellfish. In 1998, around 3,000 aquaculture ponds, cages and rafts were operating in mangrove areas in Johor (Fisheries Department). There are also 18 hatcheries based in Johor which support the shrimp farming industry.

Pond Culture

In 1998, 695 brackish water ponds were in operation in Johor, mainly situated in Johor Bahru and Kota Tinggi (Table 7.35). Most are used to raise tiger prawns (*Penaeus monodon*) and white prawns (*P. merguiensis* and *P. indicus*) and sea bass (*siakap*).

¹⁰⁷ Small farmers (defined as those who own 3 or less ponds, or operate on 3 acres or less) qualify for equipment subsidies. Medium sized farmers (i.e., farmers with a capital investment below RM 500,000) are entitled to technical advice and assistance.

Table 7.35. Brackish Water Ponds, Johor 1998

District	No. Ponds	Area (ha)	Estimated average productivity (tons/ha)	No. of workers
Bahtu Pahat	90	27.7		13
Johor Bahru	230	114.9	1.9	71
Kota Tinggi	294	491.4		37
Mersing	22	5.8	1.9	Family run
Muar	16	12.7		5
Pontian	43	16.2		21
TOTAL	695	668.7		147

Source: derived from Aquaculture Listing Report, Johor 1998.

Compared to other Southeast Asian countries, shrimp culture is not a major economic activity in Malaysia. Johor has the largest production area, with 837 tons produced in 1995, representing an average yield of 1.4 tons/ha (by comparison, in Thailand production is more intense and the average yield is 3.6 tons/ha). Like elsewhere in Southeast Asia, many aquaculture operations in Johor have failed due to poor pond design, viral and bacterial diseases, deteriorating water quality and management problems. Many farms have also been affected by water pollution caused by upstream logging and the siting of incompatible development projects adjacent to the farms. The total area of brackish water ponds in Johor has not increased since 1989 (and a number of intensive farms were closed down in 1992). In total, 49% (1,656ha) of prawn farms have been abandoned (Table 7.36). No attempt has been made to rehabilitate / replant mangroves in areas abandoned, most of which are located in Kota Tinggi.

Table 7.36. Mangrove Areas Cleared for Shrimp Ponds and Area Abandoned

District	Mangrove cleared (ha)	Abandoned (ha)	Abandoned (%)
Mersing	37	27	73
Johor Bahru	588	26	4
Kota Tinggi	2,419	1258	52
Muar	14	7	50
Pontian	347	338	97
Total	3,405	1,656	49

Source: Christensen, 1998.

Small aquaculture farms are typically managed by local people, while larger farms tend to be jointly owned with Thai, Singaporean or Taiwanese partners and employ Indonesian workers. The average worker earns RM500/month. The profit per hectare is estimated to be RM50,000-60,000 (depending on market price of shrimp), but with a high risk of loss from shrimp disease.

Cage culture

Cage culture refers to the rearing of fish in cages suspended from floating racks anchored in sheltered locations. It requires sheltered waters, good water quality, available feed and market access. In comparison to pond culture, cage culture has expanded rapidly in Johor the last 10 years. Table 7.37 summarises production in 1998. If well managed cage culture can be compatible with the sustainable utilisation of the mangrove ecosystem (Sasekumar and Lim, 1994). The most important species are mangrove snapper, sea bass and grouper. In view of the constraints on capture fisheries, the Department of Fisheries in 1998 made plans to experiment with large scale, offshore cage culture.

An individual household may operate between 6-32 cages. Fish are harvested on a 3-6 month cycle, and output ranges from 30 to 60 kg per cage per harvest. Fish are

typically sold to a middleman at a price of RM14-18 per kg. Average gross income per cage is estimated to be RM 2,160 per year. The main market for aquaculture fish is Singapore.

Table 7.37. Cage Culture, Johor 1998

District	No	Area (m ²)	Estimated average productivity (kg/year/m ²)	No. of workers
Johor Bahru	870	19,239	6	52
Kota Tinggi	691	12,873	0	63
Mersing	308	7,336	9	5
Muar	38	418	n.a	n.a
Pontian	71	n.a	n.a	207
TOTAL	1978	39,866		327

Source: Drived from Aquaculture Listing Report, Johor 1998.

Mussel rack culture is also compatible with sustainable use of mangrove areas if properly managed. Green mussel (*Perna viridis*) or *kupang* culture is now popular in Johor, particularly in Johor Bahru and Masai area (Chong, 1998). The mussels are cultured in sea water by being suspended from wooden racks. Available information on mussel rack culture is presented in Table 7.38.

Table 7.38. Mussel Rack Culture, Johor 1998

District	No. of mussel racks	Area (ha)	Estimated average productivity (kg / year / m ²)	No. of workers
Muar	3	50.49	n.a	5

Source: Derived from Aquaculture Listing Report, Johor 1998.

In 1995, some 467 tons of cockles were produced in Johor (less than 0.5% of Malaysia's total production). Some information on cockles rafts is presented in Table 7.39.

Table 7.39. Cockle Rafts, Johor 1998

District	No. of cockle rafts	Area (m ²)	Estimated average productivity (kg/year/m ²)	No. of workers
Johor Bahru	319	60,159	n.a	69
Kota Tinggi	4	920	n.a	2
Muar	4	369	n.a	n.a
TOTAL	327	61,448		71

Source: derived from Aquaculture Listing Report, Johor 1998.

Small scale oyster culture (*Ostrea folium*) started up in Johor around five years ago. In 1995, total production was around one ton (Christensen, 1998). Crab culture depends entirely on the provision of young crabs from the mangroves. In Johor, both

net cages and (bamboo fenced) ponds are used. In 1995, the mud crab production was 14 tons.

Economic Value

The total retail value of brackish water aquaculture in Johor was RM35.3 million in 1995, with cage culture fish (RM14 million) and pond culture of prawns (RM20 million), representing most of this value (Table 7.40).

Table 7.40. Aquaculture in Johor, 1995

Type	No. of Culturalists	Tons	RM million (retail)
Freshwater ponds	480	529.7	3.749
Freshwater cages	27	8.7	0.051
Freshwater cement tanks	68	41.9	0.203
Brackish water ponds	112	837.4	20.397
Brackish water cages	184	1,048.4	14.095
Cockles	2	467.2	0.327
Mussels	106	661.4	0.496
Oysters	10	1.1	0.016
Ornamental fish			30.759

Source: Cristensen, 1998.

Employment

Aquaculture presents employment opportunities for coastal communities, and an additional food source. In terms of employment, cage culture is the most important form of brackish water aquaculture, but many people are also engaged in pond culture and mussel culture. The total employment in brackish water aquaculture in 1995 was

414 or about 5% of the total employment of capture fisheries. Based on available information the number of workers currently employed in aquaculture activities is conservatively estimated at 500. The number of pond and cage owners, and middlemen involved in the sale of aquaculture products is not known.

7.7 Tourism

Johor Bahru is Malaysia's third largest tourist destination after Kuala Lumpur and Peneng. In 1992 nearly 10 million visitors crossed the causeway to Johor, a large number of which constitute shopping-excursionists from Singapore and tourists using Johor as an entry point to the Peninsular (Traeholt and Gan, 1999). With proper development and marketing a niche for mangrove ecotourism could be developed. Activities already available include boat trips through the rich estuarine mangroves and bird watching (Kg. Tampuk Laut, Benut); recreational raft fishing (Kg. Tg. Langsat, Sg. Kim Kim), and sport-fishing (Box 7.4). Such tourism activities would need to be fully assessed for their impact on the environment, and local communities would need to be involved in the planning and management of such initiatives.

Box 7.4. Sport-fishing in Kg. Asli Pontian Besar, Benut

Sport-fishing excursions to nearby sites have been organised by the residents of Kg. Asli Pontian Besar for the past 10 years. On average 8 trips are undertaken each month. Anglers pay RM150 per person (for a 5 person boat), or RM400 per group of 10 people, for a 6-10 hour trip. Boat maintenance costs range from RM150 to RM300 per year, and fuel costs are around RM200 per month. Excluding capital costs, benefits to the sport-fishing operators are estimated at RM1,200 per month. This is a conservative estimate based on a RM150 boat hire cost (i.e., one person per boat) and 8 trips a month. The net benefit after deducting fuel and maintenance cost is RM975 per month. This is an attractive income for the 20-30 families involved. Fish caught include Kerapu (*Epinephalus spp.*), Jenahak (*Lutjanus johni*), Merah (*Lutjanus argenthimaculatus*) and Pari (*Gymnura spp./Dasyatis spp.*). Demand for angling as a leisure activity is increasing among Malaysians and Singaporeans.

Twelve chalets accommodate tourists interested in experiencing a traditional Orang Asli fishing village and mangrove environment. The chalets cost RM40 per night and accommodate around 20 guests per month. Operating costs are estimated at RM300 per month. Excluding the capital cost (of RM 1 million), net benefits to chalet operators is around RM500 per month.

7.8 The Shoreline Protection Function of Benut Mangroves

The Western Johor Agricultural Development Project, implemented in 1984 and supported by the World Bank, covers 148,517 hectares of agricultural land in south-west Johor and involves 500,000 people including 80,000 farming families. The project aimed to increase the economic potential of the area by preventing flooding and saline intrusion in the coastal area of the valley plains. A 66km earth bund was constructed along the coast and estuaries to protect agricultural land at a cost of RM50 per meter (i.e., a total cost of RM3.3 million). Along parts of the coast mangroves had disappeared exposing the existing bunds to direct wave action. Additional bund protection work was thus needed along 13.7km of coastline, at an estimated cost of RM14.42 million - present value at a discount rate of 8%, over 25 years - Department of Drainage and Irrigation (DID) 1987. These costs could have been avoided if the mangrove had been maintained. The direct benefits from bund construction are (DID, 1987):

- (i) A nearly twofold increased in land value from RM12,500/ha to RM20,000/ha.
- (ii) An increase in incomes for farmers working on coconut land intercropped with cocoa. For 7,260 ha (the land area previously abandoned due to tidal flooding), the net increase is estimated at RM5,424,144 / year.
- (iii) An estimated RM39 million of property protection benefits. Without the project, continuing erosion was expected to lead to the loss of agricultural and village land, damage to commercial buildings, private and public houses and other amenities such as fish farms.

There are many other indirect benefits that are difficult to quantify. For example, in the event of a bund breach due to erosion, about 1,050 ha of farmland would be inundated by seawater during high tides affecting crop yields. The bunding also formed a major component of the drainage improvements in the study area. Therefore, in evaluating the economic benefits of the coastal protection works, a proportion of the project across the study area would be justified. Based on the direct benefits only, DID estimates the present value of the benefits of protecting 13.7 km coastline at RM17.75 million (over 25 years, 8% discount rate).

7.9 Biodiversity

A contingent valuation study was undertaken to estimate the WTP for biodiversity protection at Benut mangroves. A detailed account of this study is presented in Chapter 8. Some monetary estimates of Malaysian wildlife is presented in Table 7.41.

Table 7.41. Estimates of Wildlife Values

Species	Value (RM)	Comments
Birds		
Milky Stork	246,000	Cost of reintroduction
Lesser Adjutant Stork	246,000	Based on cost of reintroducing Milky Stork
Spotted Dove	10 per bird	
Waders (various species)	0.25 - 2.25	
Mammals		
Long tailed Macaque	1,650	
Wild Boar	200 - 300	

Source: Ministry of Science, Technology and Environment, 1997

A description of mangrove biodiversity in Malaysia is provided in Box 7.5.

Box 7.5. Mangrove Biodiversity

Mangrove forests are not botanically rich compared to other tropical forests, but they support a special fauna and flora adapted to brackish water. Malaysia's high species richness is reflected by the country's mangrove diversity, with approximately two-thirds of the world's mangrove trees and shrubs represented in Malaysia. Similarly high numbers of species are found in fauna groups, with certain species of Peninsular Malaysia only occurring in mangrove areas.

Mangroves provide important *habitats* for the life cycle of plants and animal species. For some species, especially plants, a particular mangrove may provide every element required to complete their life cycle. Other species may depend on the mangrove area for part of a more complex life cycle, including many aquatic animals (see Box 7.1). Seagrass beds in the mangrove estuary support a diverse fauna, and are vital for dugongs. Many species serve important economic functions. The cave fruit bat (*Eonycteris spelaea*) and the long tongued fruit bat (*Macroglossus minimus*), contribute to the healthy functioning of the mangrove forest ecosystem by pollinating various flowering plants. These species have also been linked to *durian* (*Durio zibethius*) production further inland. Likewise, the potential economic importance of honeybees (*Apis dorsata*) is high. They utilise nectar and pollen from flowering mangrove trees

There are several species of birds (some rare and endangered) in the mangrove and associated mudflats. Several areas are important foraging sites for various species of resident birds as well as stop over sites for migratory species. About 120 bird species (20% of the Malaysian total) have been reported within Malaysian mangrove habitat. All but 2 species have been noted in Johor. Mangroves are also particularly important as roosting, nesting and feeding sites for herons, egrets and storks. In Johor, herons and storks are found mainly in the Benut, including the rare lesser adjutant storks (*Leptoptilos javanicus*), numbering only 250-300 individuals in the whole of Peninsular Malaysia, and the even rarer milky storks (*Myctera cinerea*), numbering about 115 in the Peninsular. Johor mangroves are vital for migratory and native birds such as: common redshank (*Tringa totanus*); tereck sandpiper (*Xenus cinereus*); Mongolia plover (*Charadrius mongolus*); marsh sandpiper (*T.stagnatilis*); greenshank (*T.nebularia*); Asian golden plover (*pluvialis fulva*); white-winged black tern (*Childonias leucopterus*); little tern (*Sterna albifrons*); common tern (*S.hirundo*); and common sandpiper (*Actitis hypoleucos*). This rich birdlife, of value as a recreational and scientific resource, is threatened by loss of mangrove areas, hunting and human disturbance of habitat. The Lesser Adjutant Storks, for example, nest in tall trees.

7.10 Summary of Valuation Results

A summary of mangrove values for Johor is provided in Table 7.42. This Table is based on direct values only, and derives average per hectare value for all the mangrove sites of Johor. The value of mangrove wood products, aquaculture and offshore fisheries are seen to total RM3,426 per hectare per year (\$900)¹⁰⁸. While this figures does not account for all costs and so overestimates value, on balance it can be taken as conservative estimate of mangrove value since a number of mangrove value components are not included in the analysis. For example, no overall estimates are available for the direct use values – water transport, genetic resources, tourism and recreation and educational and scientific information, the indirect use values of shoreline stabilisation, biodiversity and nutrient retention, and non-use values.

¹⁰⁸ Using an exchange rate of \$1 = RM3.8 (1999)

Table 7.42. Summary of Mangrove Goods and Services Valuation Results

Category	Value / RM	Per / ha	\$ / ha
Direct Use Values			
Charcoal	700,000	26	7
Poles	2,996,000	111	29
Aquaculture:			
Cage culture fish	14,000,000	519	136
Pond culture (prawns)	20,000,000	741	195
Cockles	300,000	11	3
Mussels	500,000	19	5
Oysters	20,000	0.7	0.2
Capture Fisheries	54,000,000	2,000	526
Indirect Use Values	?		
Non-Use Values	?		
TOTAL		3,428	902

Notes: 1/ Charcoal and poles: value based sustainable production levels, a 20 year rotation cycle and mangrove area of 27,000 hectares; 2/ Aquaculture and fisheries: per hectare values based on mangrove area of 27,000 hectares.

A more complete analysis was possible for Benut mangroves where a contingent valuation study of mangrove biodiversity was undertaken (Table 7.43). Direct and indirect use values for the site are estimated at RM5,330 ha annually (\$1,403). If Benut were to be managed as a protected area, pole production may no longer be permitted reducing use value benefits to around \$1,370. The non-use value of Benut's mangroves, which is assumed to largely reflect the existence value placed on

the protection of Benut's rare and endangered biodiversity is estimated at \$7,396/ha/yr¹⁰⁹. This value however, will remain unrealised by Malaysia unless mechanisms can be put in place to 'capture' this value. Based on the CV survey results, local communities value the mangrove resource at Benut at around RM151,800 a year (\$40,000), or \$24 per hectare per year (see Chapter 8).

Table 7.43. Benut: Summary of Mangrove Values

Category	Value Estimate	RM/ha	\$/ha
Poles ¹		111	29
Capture Fisheries ²		2,000	526
Tourism ³	RM 17,700	10	3
Shoreline protection ⁴	RM 5,424,144	3,209	845
Sub-total		5,330	1,403
Non-use values ⁵	\$12,500,000		7,396
TOTAL			8,799

Notes: 1/ As per Table 7.44; 2/ as per Table 7.45; 3/Tourism values relate to sport-fishing benefits. This estimates is based on one family involved in sport-fishing and one chalet owner only, and are therefore a conservative estimate of tourism benefits (see Box 7.4); 4/ Shoreline protection benefits are based on benefits to agricultural productivity only (see section 7.8); 5/ Results of CV study, see Chapter 8; 6/ Tourism, shoreline protection and non-use values based on area of Benut mangroves (1,690ha).

The Johor coporation paid RM8,900 / ha (\$2,342 / ha) to the State for the loss of the mangroves at Tanjung Langsat (Box 7.2). This is well below the value of the mangrove resource when non-use values are included. Between 1996-8 land prices

¹⁰⁹ This is the result of the CV survey detailed in Chapter 8.

near mangrove areas ranged from \$15,000 – 210,000ha¹¹⁰. These areas include sites that have recently been developed for industrial use. Mangrove conservation values cannot compete with this conversion ‘value’ even when non-use estimates are included. However the market price of land is distorted by incentives and does not account for the social costs of development activities. Emphasis in management decisions needs therefore to be placed on equity considerations and the fact that mangrove areas are likely to become more economically valuable as they become increasingly rare.

7.11 Equity Concerns

In addition to the significant monetary values lost once mangroves are converted to other uses, the distributional effects of different mangrove land use decisions need be considered. Coastal communities depend on mangroves for income, food, and coastal protection. The total number of people estimated to be employed in mangrove related occupations is nearly 40,000, the majority of which, 39,000 representing 1.5% of the population of the State, are dependent on fisheries (Table 7.44). There are 125 fishing villages, and 8,800 fishermen. Assuming that 31% of fishermen are estuary fishermen, this means that the livelihood of around 2,730 fishermen is very closely linked to the integrity of the mangroves. However, it is important to note that many fishermen fishing outside of estuaries also depend on mangrove dependent species to some degree.

¹¹⁰ Based on verbal communications with Valuation Department, Ministry of Finance, Johor.

Table 7.44. Direct Dependence on Mangrove Areas

Occupation	Number Employed
Loggers	80
Log Licensees	20
Charcoal kiln workers	7
Charcoal licensees	13
Fisheries	39,000
Aquaculture	500
Tourism (Pulau Kukup, Benut)	84
TOTAL	39,704

7.12 Conclusions and Recommendations

A lower bound estimate of the value of Johor's mangroves is \$900 per hectare per year. This value does not include many important indirect and non-use values of the mangrove. The mangroves of Benut, which are of important global biodiversity value, have an estimated value of nearly \$9,000 per hectare per year. Around 80% of this value relates to non-use value placed on the resource by the global community. However, local use benefits from protecting the site in terms of capture fisheries, tourism and shoreline protection are seen to be in the region of \$1,370 per hectare. These results demonstrate that even without accounting for the high existence value placed on Benut's rare and endangered biodiversity, Malaysia's mangroves are of significant value. These mangrove values will be lost if mangrove areas are converted to other uses.

Around 1.5% of the population of Johor is dependent on the mangroves for their livelihood. Mangrove-dependent fishing households also represent a high percentage of households below the poverty line in Johor. Decisions to convert mangrove areas

must therefore, in addition to being based on a comprehensive economic analysis, address equity issues. Who gains and who loses from mangrove land use decisions is an important management issue. Local communities, such as fishermen in Sg. Kim Kim, have incurred significant losses in livelihood due to the negative impacts of development projects.

Sustainable management of Johor's mangroves can also improve the states self-sufficiency by reducing its dependence on imported wood products and fish. Mangrove protection also means that costly replacements of the mangrove's natural support functions might be avoided, e.g., bund construction behind mangrove areas needed to protect coastal property and agricultural land, and the construction of artificial reefs in order to boost declining fish stocks.

With the rapid and continuing loss of mangrove areas in Malaysia, opportunities to conserve and protect pristine mangrove areas are disappearing quickly. Given the under-representation of mangrove areas within protected areas in Malaysia, and the high biodiversity value of Benut mangroves, it is recommended that this area, and other areas of high biodiversity value in the State, be afforded adequate protection. In order for Johor to fully realise these demonstrated mangrove values, management plans, policies and strategies must be restructured accordingly. As a first step, in order to realise local mangrove benefits, land use decisions for mangrove areas need to be properly evaluated, and full social cost pricing introduced (e.g., pollution taxes imposed to encourage the sustainable use of the resource). Further to this, options for capturing the significant global biodiversity values of Johor's mangrove areas need to be explored (see Chapter 9).

8 A Contingent Valuation of Benut Mangroves, Malaysia

8.1 Introduction

The objective of this Chapter is to estimate the WTP for the protection of the mangroves of Benut using a stated preference methodology. As chapter 7 showed, mangroves in Johor are under considerable resource pressure and are likely to suffer further decline. Information on the economic value of priority conservation areas, such as Benut, is extremely important and useful to decision makers and planners involved in the design of mangrove management programs. A secondary objective of this chapter is to identify gaps in public knowledge of the roles and functions of mangrove resources revealed by the survey process, at both the local and international level¹¹¹.

A contingent valuation (CV) study was undertaken to value Benut's mangroves in the belief that existence and option value components, which can only be measured through stated preference approaches, are dominant. Few CV studies of biodiversity valuation have been attempted, particularly in developing countries, due to the difficulties perceived in conveying complex concepts such as 'biodiversity' to local communities in rural areas with low levels of education. This CV study of Benut is one of the few studies in this area.

For this study the non-marketed good in question is mangrove habitat, on which important global biodiversity is dependent. The CV study sought to estimate the value of mangrove habitat to the public, based on which the value placed on mangrove biodiversity could be inferred. Households in Benut were directly asked their maximum WTP for the implementation of a new management plan which would protect the mangroves and ensure the provision of a wide range of mangrove goods and services currently under threat. This WTP is a measure of the economic value of the service. Given the global significance of Benut's mangroves, an indication of the strength of the international demand for protection of the site was also sought. A

¹¹¹ The non-parametric analysis presented in this Chapter is based on Bann, 1999b.

sample of visitors to Malaysia were surveyed and used as a proxy for the international WTP for the protection of the mangroves.

Although still somewhat controversial, CV is widely accepted amongst academics and policy makers. A special panel appointed by the US National Oceanic and Atmospheric Administration (NOAA) in 1993 concluded that correctly structured and implemented CV studies can produce estimates reliable enough to be used in judicial proceedings assessing natural resource damage (Arrow *et al* 1993).

8.2 Survey Design and Implementation

8.2.1 Survey Design

The questionnaire was divided into 4 main sections as summarised below¹¹².

Section A: General Attitudes

The survey opened with three ‘general’ questions on the environment (i.e., not specifically related to mangroves) in order to:

- (i) help respondents explore their personal thoughts and attitudes towards the environment, and mangrove related issues in preparation for responding to the valuation question;
- (ii) reveal important underlying factors determining respondents support, or otherwise, for a mangrove protection scheme, which could be usefully included in the interpretation of the valuation responses;
- (iii) identify respondents’ level of environmental commitment.

Other ‘attitudinal’ questions were also included in Sections B and C (see below).

¹¹² Version A of the survey instrument used, plus show cards, is provided in Appendix 2.

Section B: Use of Mangroves and Background Information

This section collected information on respondents' current use of, and benefits from, the mangrove. It also sought to uncover respondents' awareness of the importance of the mangrove, and the threats it was currently under. Much of the information pertinent to the creation of the hypothetical market was also covered in Section B of the survey, as described below.

(i) Respondents were first presented with a *scenario*, which provided a clear description of the mangrove of Benut, that is the 'good' that they were to be asked to value. Information on Benut's mangroves was present through maps, text and graphics. Respondents were initially shown a map indicating the nineteen mangrove areas found around Johor's coastline and the study area. The purpose of this map was to clearly show the study area in relation to Johor State, and to impress upon respondents that the mangroves of Benut are just one of many mangrove sites found within the State. A second map defined the Benut study area, indicating local towns and villages, in order to familiarise respondents with the geographical area over which the scenario would be applied. A number of showcards were read to respondents. Showcard A described mangrove biodiversity and was complimented with illustrations of mangrove bird and mammal species. Showcard B defined mangroves and their many uses and functions, explained the current threats to the mangrove area, and emphasised the importance of the mangroves of Benut as a bird site of global significance. The information on this show card was interspersed with relevant photographs.

All references to Benut were replaced with 'mangroves between Pontian and Rengit' so that there could be no confusion as to the extent of mangrove within the study area. In the pre-test it was found that respondents only associated the 'mangroves of Benut', with the mangrove areas found closest to Benut town. 'Benut' mangroves are defined as stretching from Pontian to Rengit (Christensen, 1998). The same information was provided to all respondents. Standard answers to questions likely to be asked by respondents were also prepared based on pre-test experience.

(ii) Respondents were then presented with a summary of the current management scenario, followed by the proposed new management scenario. The proposed new

management plan entailed a reclassification of Benut mangroves from Stateland to a Protected Forest Reserve and would change (improve) the ‘quality’ of the mangrove resource by ensuring its diverse range of values were properly protected and managed. This is the hypothetical change that respondents were to be asked to value. Showcard C presented the two management scenarios: (A) present state of affairs with no protection; and, (B) proposed new management plan which would protect the Benut mangroves and reclassify them as a Protected Forest Reserve. This card was accompanied by illustrations of mangroves in good and bad condition.

The final question of Section B asked respondents to assess the likely damage to the mangroves of Benut if the current management scenario continued. This question was intended to serve as a bridge between the qualitative description of the good provided in this Section and the posing of the WTP question in Section C.

(iii) The payment vehicle, the final component of the contingent market, used in this study was an annual payment to a Biodiversity Fund to be managed by the Government. This was introduced in Section C.

Section C: Willingness to Pay

Respondents were asked their WTP to protect the mangroves of Benut (through a move from scenario A to scenario B) in terms of a *monthly fee* to a biodiversity fund which would be managed by the government. Despite the concerns over the payment vehicle used in the pre-test (largely by non-Malay households who have a lack of trust in the Government), this was not changed due to the lack of credible alternatives. Showcard D was available for respondents who required more information on the proposed management plan and the sorts of activities that would be carried out under this plan. Only 10 respondents were shown this card. Having created a contingent market, it was then possible to elicit individuals’ maximum WTP.

Elicitation Method

Two different elicitation techniques were adopted on an equally split sample: the payment ladder approach (which had worked well in other CV surveys conducted in

Malaysia)¹¹³; and a referendum question, followed by a double bounded dichotomous choice (DBDC) type question. Given that previous studies in Malaysia had used the payment ladder approach, an alternative elicitation method was used in order to detect if this made any significant difference to WTP responses. The surveys were identical in all other respects.

Payment ladder

A payment ladder is a type of 'payment card' which sequentially lists a range of values from low to high. Respondents are asked to first tick the amounts they are sure they would pay and then to cross amounts that they are sure they would not pay. The values represent possible monthly payments to the Biodiversity Fund. For example, in Figure 8.1, the respondent is almost certain that he would be WTP as much as RM1 per month and equally certain that he would not be WTP as much as RM10 per month. Between these two values, the respondent was unable to mark either a tick or cross, indicating that WTP was uncertain over this range, revealing in effect the degree of confidence that respondents have in stating their WTP.

¹¹³ See, for example, Mourato and Day, 1998, and Dubourg, 1988.

Figure 8.1. Payment Ladder: Benut

<i>RM</i>	✓/ ✕
0	
0.5	✓
1	✓
2	
3	
4	
5	
6	
7	
8	
9	
10	✕
15	✕
20	✕
25	✕
30	✕
35	✕
40	✕

Referendum Followed by Double Bounded Dichotomous Choice

A referendum question was posed at the beginning of the second elicitation process, which simply asked respondents if they would be WTP anything for the proposed policy ('YES' or 'NO'). Respondents answering 'NO' to the referendum question were then asked to give their reasons for not being WTP for the protection of Benut's mangroves. Respondents answering 'YES', were presented with the Dichotomous Choice (DC) WTP questions.

The DC format presents respondents with a take-it-or-leave-it price (known as the *bid level*) for the good being valued. It is the format most commonly used in CV studies and is recommended by NOAA. Its favour is based on the intuition that responses to DC type questions are more 'reliable' because they more closely resemble the choice confronting people in 'real' markets. A drawback of DC questions is that large samples are required to obtain statistically significant results. This requirement can be partly overcome by adopting a double-bounded dichotomous choice (DBDC) approach.

The DBDC approach supplements the initial DC question with a follow-up question. For example, the respondent is first asked if he is WTP RM1.5. A second WTP question is then asked dependent on the response to the first. If the answer is 'YES' to the first question, the respondent is asked if he is WTP a higher amount (e.g., RM3), but if the answer is 'NO', the respondent is asked if he is WTP a lower amount (e.g., RM0.5). The DBDC format thus gives more information on the underlying WTP than the DC question (Hanemann *et al*, 1991). The 'bids' (prices) used in the main survey, were defined with reference to the pre-test results. In the pre-test, the highest bid was RM10, so RM15 was taken as the highest bid in the DBDC process. The DBDC questions used are presented in Table 8.1.

Table 8.1. DBDC Questions

Number of Respondents		First DC Question (Initial bid level): Would you be WTP x ?	Second DC Question: Would you be WTP x?
Planned	Actual	If 'yes', go to (2a)- Upper bid level If 'no', go to (2b) – lower bid level	
Version 1			
60	49	(1) RM 1.5	(2a) RM 3 (2b) M 0.5
Version 2			
40	33	(1) RM 2	(2a) RM 4 (2b) RM 1
Version 3			
30	27	(1) RM 5	(2a) RM 8 (2b) RM 2.5
Version 4			
20	21	(1) RM10	(2a) RM 15 (2b) RM 6

Some empirical evidence suggests that the DC elicitation method can result in a bias called 'yea-saying' in which respondents accept to pay amounts that they are not really WTP. This leads to higher values than those elicited in open-ended formats, thereby running counter to the recommendation of a conservative survey design. Advantages and disadvantages of the payment ladder approach are summarised in Table 8.2.

Table 8.2. Potential Advantages and Disadvantages of the Payment Ladder Approach

Advantages	Disadvantages
(i) Information. Compared to other elicitation procedures it uncovers relatively detailed information on WTP. For example, it reveals the range of uncertainty that exists in the respondents' minds regarding the amounts they are prepared to pay. (ii) The payment ladder process allows respondents the time to carefully consider the amounts they are and are not WTP. (iii) Requires less statistical assumptions.	(i) It is suggested that 'payment card' type elicitation procedures suffer from payment card bias. That is, WTP responses are influenced by the particular amounts presented to them on the payment ladder.

At the end of Section C, following the valuation questions, respondents were asked a final set of 'attitudinal' question seeking to ascertain:

- (i) why they were willing, or not willing, to pay to protect the mangroves.
- (ii) Respondents' attitudes to the questionnaire.

Section D: Socio-economic Characteristics.

The final section of the survey collected relevant socio-economic data, such as: sex; age; educational attainment; employment status; and income level. This socio-economic information is important:

- (i) to determine whether the survey sample is representative of the population;
- (ii) to examine the similarity of the two groups who received different versions of the questionnaire;
- (iii) to study how WTP for protection of the mangroves of Benut varies according to respondents' socio-economic characteristics.

8.2.2 Implementation

The surveys were conducted, under the supervision of the author, by PE Research¹¹⁴. All interviewers attended training sessions, run by the author and PE Research, for both the Benut and the international survey. The fieldwork consisted of three main phases: development, pre-test, and main survey.

In the development phase, the draft questionnaire was developed, refined, and informally tested. Background information on the study area was collected both through sites visits and a review of existing literature. Recent specialised surveys of the area on biodiversity and birds (Christensen, 1998 and Noramaly, 1998) meant that the questionnaire could be based on up-to-date scientific information. Considerable attention was paid to the wording of all economic and ecological concepts occurring in the questionnaire, in an effort to ensure that these could be easily followed and understood by local respondents. Visual aids were selected to illustrate the key points of the text and the questionnaires were translated into Bahasa Malay and Mandarin.

For the pre-test two versions of the questionnaire were tested, each on 25 respondents (February 1999). One version of the questionnaire asked respondents their WTP for the protection of the mangroves of Benut, while the second asked respondents their WTP to protect mangrove wildlife. Face to face interviews with individual households were conducted in Rengit town - a representative urban area, and two villages (Kg. Sungai Jambi, and Kg. Sungai Merlong Laut) – representative of coastal areas. The payment ladder elicitation process was used for the whole sample, and the payment vehicle was an annual fee to a Biodiversity Fund to be managed by the government.

Through the pilot-study process it was possible to put to rest a number of concerns over the feasibility of the CV approach at the chosen site. A fundamental concern had been whether respondents could meaningfully value a public good such as a mangrove area, and whether the concept of biodiversity could be successfully

¹¹⁴ PR Resaerch are a firm experienced in consumer research and contingent valuation studies in Malaysia.

communicated. The pilot-survey also highlighted remaining problems in the wording of the questionnaire, the format used, and the choice of payment vehicle. Visual aids were found to be an effective means of communicating information and were consequently heavily relied upon in the final survey.

Key points coming out of the pre-test survey, that facilitated the design of an effective final survey instrument included:

- (i) The WTP for wildlife was found to be difficult to understand by respondents, and so was dropped in the final survey.
- (ii) The study site was henceforth referred to as ‘the area of mangroves between Pontian and Rengit’, and not as Benut.
- (iii) The pre-test WTP responses were used to define a double bounded dichotomous choice WTP elicitation format to be used in the main survey

The main survey was carried out in March 1999. A total of 307 households were visited. However, there were 34 rejections (households not wanting to answer the questionnaire), 19 households without a qualified respondent (i.e., people at home were either incapable of understanding the questionnaire, or insisted that the household head was the only appropriate respondent), and 11 non-responses (i.e., no one at home)¹¹⁵. The number of interviews completed was therefore 243. Higher rejection rates were noticed at areas near main roads, and amongst Chinese, compared to Malay, respondents. Respondents were equally assigned to one of the two versions of the questionnaire (i.e., version A – payment ladder elicitation approach, and version B – DBDC elicitation approach).

8.2.3 Sampling Strategy

The study area stretches from Pontian to Rengit, and falls within the districts of Pontian and Batu Pahat, and 5 *munkims* - Sungai Kluang, Benut, Sungai Pinggan, Ayer Baloi and Api Api. The boundaries of the 5 *munkims* were used to set the extent

¹¹⁵ Selected households were visited three times before being classified as a non-response household.

of the study area which covers approximately 53,000 ha. The first main road running parallel to the coastline was used to define the coastal / inland divide. There are 48 villages in these 5 *munkims*. The concerned population of the study area is 12,650 (1991 population census).

It was planned to survey 300 households in 18 survey villages, constituting 7% of the population of the survey villages (4,208 households). Random sampling techniques were used to select the villages from each *munkim*. The ratio of interviews per number of households was then computed and a random sample assigned to each village. Table 8.3 shows the distribution of the total population and sample, and the ratio and random number for each village in the survey. Table 8.4 shows the number of planned and completed surveys.

During the course of the main survey there appeared to be less houses in the selected villages than suggested in the 1991 census. This could be due to: (i) the demolition of houses since the 1991 census; (ii) fieldworkers missing houses situated in remote areas; (iii) discrepancies in village boundaries as defined by the local authorities and the head of the village.

Table 8.3. Sampling Plan for Benut

Munkim	No. hh	% of hh	Sample needed	Selected Kampung	No. of hh	Selected hh /munkim	Ratio - survey:hh	Category
Sg. Kluang	3,510	28%	83	Belahan Tampok	191	1,205	1:14	I
				Seri Merlong	545			I
				Sungai Jambi	233			I
				Sungai Klunag Darat	236			I
Benut	2,878	23%	68	Pekan Benut	478	960	1: 14	C
				Kg. Permatamg Sepam	148			I
				Kg. Permatang Duku	153			I
				Kg. Lubuk Sipat	181			I
Sg. Pinggan	1,242	10%	30	Kg. Pt. Ramunia	130	484	1:16	I
				Kg. Pt. Syang	96			C
				Kg. Pt Marunit	258			I

Munkim	No. hh	% of hh	Sample needed	Selected Kampung	No. of hh	Selected hh /munkim	Ratio - survey:hh	Category
Ayer Baloi	2,195	17%	52	Pekan Snaglang	242	770	1:15	C
				Kg. Pt Kabar	166			I
				Kg Pt. Maklami	233			I
				Kg. Pt Terus	129			I
Api Api	2,825	22%	67	Kg. Pulau Sebatang	325	793	1:11	C
				Kg. Pt. Sikom	248			I
				Kg. Jawa Ulu	220			I
TOTAL	12,650	100%	300		4,212	4,212		

Source: *Penghulu* (local authorities) of each munkim updated 1996

Notes: Pekan Benut's households number is estimation from population; C = coastal; I = inland.

Table 8.4. Planned and Completed Surveys, Benut

Selected Kampung	Planned Sample ¹							Completed Surveys							Rejection	Non- qualified	Non- response	Final	Lack / extra respondents
	A	B	Q1	Q2	Q3	Q4	Total	A	B	Q1	Q2	Q3	Q4	Total					
Sg. Klung							83							58				81	-2
Belahan Tampok	7	7	3	2	1	1	14	6	6	3	2		1	12		2		14	
Seri Merlong	19	18	7	5	3	3	37	11	13	5	4	2	2	24	2	4	1	31	-6
Sungai Jambi	8	8	3	2	2	1	16	7	5	1	3		1	12	6		1	19	3
Sungai Klunag Darat	8	8	3	2	2	1	16	5	5	2	1	2		10	3	2	2	17	1
Benut							68							60				80	+12
Pekan Benut	17	17	7	5	4	1	34	12	18	7	5	3	3	30	12	3	4	49	15
Kg. Permatamg Sepam	5	5	2	1	1	1	10	5	5	2	1	1	1	10				10	-3

Selected Kampung	Planned Sample ¹							Completed Surveys							Rejection	Non- qualified	Non- response	Final	Lack / extra respondents
Kg. Permatang Duku	5	6	3	1	1	1	11	5	6	3	1	1	1	11				11	
Kg. Lubuk Sipat	7	6	2	2	1	1	13	5	4	2	1		1	9	1			10	
Sg. Pinggan							30							37				39	+9
Kg. Pt. Ramunia	4	4	1	1	1	1	8	10	7	2	1	3	1	17				17	9
Kg. Pt. Syang	3	3	1	1	1	0	6	2	2	2				4	1	1		6	
Kg. Pt Marunit	8	8	4	2	1	1	16	8	8	4	2	1	1	16				16	
Ayer Baloi							52							42				49	-3
Pekan Snaglang	8	8	4	2	1	1	16	6	7	3	2	1	1	13	1		1	15	-1
Kg. Pt Kabar	5	6	2	2	1	1	11	4	5	2	1	1	1	9	1	1		11	
Kg Pt. Maklami	8	8	3	2	2	1	16	7	4	2	2			11	2		1	14	-2
Kg. Pt Terus	5	4	1	1	1	1	9	5	4	1	1	1	1	9				9	

Selected Kampung	Planned Sample ¹							Completed Surveys							Rejection	Non- qualified	Non- response	Final	Lack / extra respondents
Api Api							67							46				58	-9
Kg. Pulai Sebatang	13	14	6	3	3	2	27	14	12	4	3	3	2	26	2	2		30	3
Kg. Pt. Sikom	11	10	4	3	2	1	21	7	6	2	2	1	1	13	2	1	1	17	-4
Kg. Jawa Ulu	9	10	4	3	2	1	19	4	3	2	1			7	1	3		11	-8
TOTAL	150	150	60	40	30	20	300	123	120	49	33	27	21	243	34	19	11	307	7

Note: 1/ There are four WTP questions in version B.

Table 8.5 summarises the distribution of the population and proposed and actual sample between coastal and inland areas.

Table 8.5. Distribution of Population and Sample

	Population	%	Proposed sample	%	Actual Sample	%
Coastal	1,141	27%	83	28%	73	30%
Inland / Town	3,071	73%	217	72%	170	70%
TOTAL	4,212		300		243	

8.3 Results

8.3.1 Attitudes Towards, and Use of, Benut Mangroves

Respondents were asked to specify from a list of five social and environmental problems which they considered to be the most, and second most, important in Johor State and in which the Malaysian Government should invest money. Over one third of respondents consider increasing agricultural productivity to be the most important issue for the area. This is not surprising since agriculture is the main land use in the area. While not a top concern, nearly one-quarter of respondents cited the protection of natural habitat as being of primary or secondary concern to them (Table 8.6).

Table 8.6. Ranking of Social and Environmental Problems in Johor

Problem	Most important (rank)	Second most important (rank)	First or second most important (rank)
Increasing agricultural productivity	35% (1)	42% (1)	77% (1)
Inflation	24% (2)	17% (3)	41% (3)
Reducing water pollution	9% (5)	16% (4)	25% (4)
Protecting natural habitats & wildlife	13% (4)	10% (5)	23% (5)
Improving quality of education	19% (3)	28% (2)	47% (2)
Other ¹	4% (6)	4% (6)	8% (6)

Notes: 1/ Others include: provision of housing for locals; fair price for agricultural products; electricity; water shortages; poor telecommunications facilities; job creation; and better communications between government and public; 2/ There were no significant differences between the two versions of questionnaire

Air and water pollution are the top environmental concerns. Wildlife preservation (taken here as a proxy for biodiversity preservation) is considered to be the fourth most important environmental problem in the State. Overall, however, only 15% of the population cite wildlife preservation as a personal concern (Table 8.7).

Table 8.7. Ranking of Environmental Problems in Johor

Problem	Most important (rank)	Second most important (rank)	First or second most important (rank)
Air pollution	35% (1)	28% (2)	63% (1)
Water pollution	31%(2)	32% (1)	63% (1)
Logging	2% (5)	8% (5)	10% (5)
Landslides / Floods	24% (3)	17% (3)	41% (3)
Wildlife preservation	5% (4)	10% (4)	15% (4)
Other / Do not know	3	6	9%

Note: For wildlife preservation, 6% of version A and 4% of version B felt this to be the most important concern, and 11% and 10% respectively the second most important concern.

Respondents were then presented with a series of attitudinal statements about habitat and wildlife protection and asked whether they agreed or disagreed with each statement. The responses reveal a high positive value placed on natural resources (Table 8.8).

Table 8.8. Attitudinal Statements on Mangrove and Wildlife Management and the Percentage of Respondents Who Agree and Disagree with Each Statement

Statement	Strongly agree	Agree	No opinion	Disagree	Strongly Disagree
(i) We have a duty to protect the environment from development regardless of the cost (<i>intrinsic value/overall duty to protect</i>)	19	56	10	13	2
(ii) We should reduce our use of the environment now, so that our grandchildren may benefit from it. (<i>Bequest value</i>)	17	71	4	7	1
(iii) Malaysia needs to develop her forests, seas, and land to increase jobs and incomes, regardless of the environmental damage (<i>role of environmental assets in development</i>)	2	17	5	62	14
(iv) Because rare birds depend on the mangroves, they should be protected regardless of the costs (<i>existence value</i>)	17	70	6	6	1
(v) I should pay for the protection of parks and nature reserves even if I do not visit them (<i>selfish use value motive</i>)	4	31	14	44	7
(vi) Even if I don't use the mangroves now, I am prepared to pay to protect them in case I want to use them in the future (<i>option value</i>)	2	45	10	40	3
(vii) It is worth spending money to protect the mangroves because they help to protect agricultural productivity in the area (<i>indirect use motivations</i>)	8	66	12	13	1

Statement	Strongly agree	Agree	No opinion	Disagree	Strongly Disagree
(viii) We have more important things to think about than the loss of the mangroves (<i>putting issue in context</i>)	7	47	29	14	3

The first question sought to reveal whether respondents felt that natural resources were of ‘intrinsic value’ and if we therefore have a duty to protect them. Three-quarters of the respondents agreed that we do have such a moral duty, with nearly 20% of the overall sample strongly agreed with this statement. A very high percentage of respondents, 88%, believe that natural resources are of value because of the benefits they can provide to future generations (statement (ii)). A pertinent question in a country such as Malaysia, which has experienced very high rates of growth over the past decade, is the extent to which natural assets may be sacrificed to this development process. This was explored in statement (iii). Over three-quarters of respondents disagreed with this statement (77%), only 2% strongly agreed with this.

This study was particularly interested in uncovering the value respondents placed on rare birds found in the study area. It is assumed that part of the value of rare species is pure existence value. Affinity with the existence value concept was sought through the statement (iv). A high number, 87%, of the respondents agreed with this statement. Statement (v and vi) further probed the importance of non-use values to the respondent. Only 35% of respondents disagreed with statement (v) suggesting that the majority value such areas for their use benefits only. Close to 50% of respondents agreed with statement (vi), affirming the mangrove’s option value.

Within the study area, an important function of the mangroves is the protection they provide to agricultural land situated behind the mangroves, by acting as a buffer to shoreline erosion and possible saltwater intrusion. Nearly three-quarters of respondents agreed with statement (vii) suggesting a high appreciation of the indirect value of the mangrove. Finally, in order to put the issue of mangrove loss and degradation into context, respondents were presented with the statement (viii). Over

50% agreed with this statement. This result is consistent with the finding that mangrove and wildlife protection are of relatively low priority within the study area.

Table 8.8 is summarised in Table 8.9 and clearly shows a strong appreciation of the non-use values of natural resources.

Table 8.9. Respondents who Recognise Indirect & Non-use Environmental Values

Type of Value	% Respondents who implicitly 'recognise' values
Indirect use Value (vii)	74
Option Value (vi)	47
Bequest Value (ii)	88
Existence Value (iv & i)	87 / 75
Non-use values (v)	35

Uses

Section B of the questionnaire elicited information on current use and knowledge of the mangroves of Benut. This information provides a better understanding of a respondent's profile, and can also be used to explain WTP responses. Variables, such as whether the respondent has visited the mangroves, and/or derives direct benefits from it, are expected to affect household WTP for the protection of the mangroves of Benut. Overall, 75% of respondents have heard of the mangroves of Benut, while 53% of respondents have visited them. 70% of the respondents stated that they were likely to visit the area in the next 5 years (Table 8.10).

Table 8.10. Knowledge and Use of Benut Mangroves (% of Respondents)

	Version A	Version B	Overall
Heard of Benut mangroves	78	71	75
Visited Benut mangroves	55	55	53
Likely to visit in next 5 years	69	71	70

We would expect the WTP of households who currently benefit from the mangroves to be higher than those who do not. For those respondents who claim to receive no benefit from the mangroves (41%), WTP can be taken to represent non-use value (Table 8.11). The most important direct use values of the mangroves are forestry products and seafood.

Table 8.11. Benefits Derived from Mangroves Reported by Respondents

Type of benefit	No. of respondents	%
No Benefits	100	41
Do not Know	15	6
Direct use		
Seafood	51	21
Source of Income	7	3
Recreation	25	10
Forestry products (poles/charcoal)	75	31
Education	3	1
Habitat for wildlife and bird species	8	3
Amenity (fresh air / shade)	10	4
[Land conversion] ¹	2	1
Indirect benefits		
Flood prevention / soil erosion / environmental protection	25	10
Non-use value		
Benefit for next generation	1	0.5

Notes: 1/ Land conversion was cited as a benefit by a small number of respondents.

For 85% of respondents (equal across versions), all or part of the information presented on mangrove biodiversity and threats facing the mangroves of Benut was new. The CV survey instrument can therefore, in addition to being a valuation tool,

be seen as an effective educational mechanism. The remaining 15% of respondents claimed to be familiar with all the information offered (Table 8.12).

Table 8.12. Familiarity with Information Presented (% of respondents)

Familiarity with Information Presented	Version A	Versions B	Overall
All new	30	36	33
Some of it new	56	48	52
Know all already	14	16	15

A high percentage, 83% (equal across versions) believed that the damage to the mangroves would be severe if the current management practices continued (Table 8.13).

Table 8.13. Perceived Damage to Mangroves Under Current Management (%)

Damage to Mangroves if Current Management Continues	Version A	Version B	Overall
Very Severe	37	31	34
Severe	46	53	49
Not so severe	17	15	16
Not at all severe		1	0.5

8.3.2 Socio-economic Characteristics of Respondents

The respondents were predominately male (64%)¹¹⁶ and Malay (90%) (Table 8.14). Household size ranged from 1-25 people and averaged 5.

Table 8.14. Ethnic Background of Respondents (%)

	Version A	Version B	Overall
Malay	90	90	90
Chinese	10	9	9.5
Orang Asli	0	1	0.5
Indian	0	0	0.0

The age of respondents ranged from under 21 (but over 18) to over 70, and was broadly similar across versions (Table 8.15).

¹¹⁶ For version A, 70% of respondents were male, while for version B, 58% were male.

Table 8.15. Age Group of Respondents (%)

Age group	Version A	Version B	Overall
<21	1	3	2
21-30	23	18	20
31-40	15	22	18
41-50	23	22	22
51-60	22	23	23
61-70	7	8	8
>70	9	4	7

Educational attainment was similar across versions. Half of the survey sample had received an education to primary school level (Table 8.16).

Table 8.16. Educational Attainment of Respondents

	Version A	Version B	Overall
No formal education	8	8	8
Primary School Education	50	50	50
SRP/PMR	13	13	13
SPM/SPVM	22	22	22
STPM	4	2	3
Diploma/ professional certificate	2	4	3
Degree	1	1	1

A high percentage of respondents are farmers (34%), while 30% of respondents are unwaged (housewives, unemployed, retired, and students). Some differences are apparent between the occupational distribution of the sample and official occupation categorisation of the population. However, the population figures only account of those in employment and so over-estimate overall percentages. Also, definitions for job categories are not clearly defined, so errors may have been made in the assignment of respondents to the main job categories (Table 8.17).

Table 8.17. Occupations of Respondents

Job category	Version A	Version B	Overall (number)	Overall (%)	Population¹ (%)
Professional	1	1	2	1%	7%
Administrative and managerial (includes businessmen, government staff and teachers)	14	18	32	13%	0%
Clerical and related workers	5	0	5	2%	3%
Sales worker	1	2	3	1%	7%
Service workers					4%
Agricultural (includes 2 fishermen, otherwise all farmers)	47	36	83	34%	46%
Production workers (includes: factory workers; lorry drivers)	26	18	44	18%	33%
Others (includes housewives; unemployed; part-time workers; retired and students).	28	45	73	30%	
Total	122	120	242		

Notes: 1/ Population data based on official statistics for the area.

The average household income in 1992 in Johor was RM1,708. Nearly 90% of respondents report incomes below this (Table 8.18). Overall, 36% earn less than RM500 per month and may be below the poverty line (RM425 per month).

Table 8.18. Income Level of Respondents (RM/Month)

Level of Income	Version A (%)	Version B (%)	Overall (%)
No income	1	1	1
RM500 and below	32	43	36
RM501 – RM1000	44	34	38
RM1001 – RM1500	15	14	14
RM1501 – RM2000	5	1	3
RM2001 – RM3000	3	3	3
RM3001 – RM4000		2	1
RM4001 – RM5000		1	0.5
RM5001 – RM6000		0	0
RM6001 – RM7500		1	0.5
Above RM7500			0
No response			3

8.3.3 Evaluation of Questionnaire

At the end of the interview, respondents were asked to evaluate the questionnaire. A very high percentage of the respondents found the survey to be interesting (91%) and educational (92%). The educational benefits are assumed to relate to the information presented on mangrove biodiversity and its relevance to the study site. Around a third of respondents found the survey too long. This is not an unreasonable result however given that CV questionnaires are typically longer than other types of surveys such as opinion polls, due to the time taken communicating complex hypothetical scenarios and to undertake WTP elicitation processes. Around one third of respondents found the survey difficult to understand (compared to 50% for the pre-test survey). Given the complexities of the survey, this can be taken as a fairly good result. Only 8% of respondents found the hypothetical scenario ‘unrealistic’ (Table 8.19).

Table 8.19. Respondents' Views on Survey (%)

Views on Survey	Version A	Version B	Overall
Interesting	89	95	91
Too long	29	39	34
Difficult to understand	30	31	30
Educational	93	93	93
Unrealistic/not credible	12	5	8

The interviewers also evaluated each questionnaire in terms of the respondent's interest in the survey, comprehension of it and sincerity of responses. Over 50% of respondents were assessed to have shown more than moderate interest in the survey (Table 8.20). Only 1% of respondents were not at all interested in the survey process. For 50% of the surveys, other people were present.

Table 8.20. Interest of Respondents

Degree of Interest	% of Respondents
Extremely interested	20
Very interested	37
Somewhat interested	31
Slightly interested	10
Not interested at all	1

The mean and mode of respondents' comprehension of the four Sections of the survey are presented in Table 8.21. Sections A and B were the most difficult to understand, but were still ranked at the lower end of the scale (where 1 equals 'not at all difficult to understand').

Table 8.21. Assessment of the Comprehension of the Survey

	1 Not at all difficult	2	3	4	5	6	7	8	9	10 Extreme difficulty
SECTION A		*	X							
SECTION B		*	X							
SECTION C		X / *								
SECTION D	*	X								

X = mean; * = mode and median.

The interviewers were very confident in 81% of the survey responses (Table 8.22). The three respondents who were 'not at all confident', were all classified as protest 'no' votes. They therefore do not affect the WTP analysis, having been removed from the reduced sample (see below).

Table 8.22. Assessment of the Sincerity of Respondent's Answers

Level of Confidence	% of surveys	Number
Very confident	81	197
Not so confident	18	43
Not at all confident	1	3

Overall, therefore, from the point of view of respondents and interviewers the questionnaire worked well in the field.

8.3.4 Willingness to Pay

Overall, 56% of respondents reported a positive WTP for the protection of the mangroves of Benut (66% ticked a value greater than zero on the payment ladder, and

47% answered ‘YES’ to the referendum question posed at the beginning of the dichotomous choice valuation procedure). Only one respondent refused to answer the WTP question, and was therefore excluded from the WTP analysis (Table 8.23).

Table 8.23. Summary of Positive and Negative Responses to WTP Question

WTP response	Payment ladder		Dichotomous choice		Overall	
Yes	81	66%	56	47%	137	56%
No	41	33%	64	53%	105	44%
Don’t know	1				1	
TOTAL	123		120		243	

A summary of the motivations for being WTP for the mangroves is presented in Table 8.24. The most common motivation appears to be concern over the loss of mangroves and related biodiversity.

Table 8.24. Reasons Why WTP to Protect the Mangroves of Benut

REASONS TO PAY	Payment Ladder	Dichotomous Choice	Overall (%)
I think the management plan is a good one	14%	18%	16%
I feel this is a reasonable amount to pay	25%	23%	24%
I am concerned about the loss of mangroves /biodiversity	35%	29%	32%
It is what I can afford to pay	4%	7%	5%
I am not sure I could pay what I said but I wish I could	22%	23%	23%

Respondents stating a zero WTP were asked to express their reason for *not* wanting to contribute to the protection of Benut's mangroves. Reasons for not wanting to pay can be divided into two categories: (i) genuine economic reasons; and (ii) reasons related to a rejection of the contingent market (Table 8.25). Individuals might reject the contingent market if they find any part of it implausible or unacceptable. These respondents are known as protest voters, i.e., respondents who do not report genuine economic reasons for not wanting to pay anything for protecting the mangroves, but reject the contingent market nonetheless. Protest voters are removed from the WTP analysis, since it cannot be assumed that their WTP is truly zero.

Table 8.25. Reasons for Zero WTP Statement (Number / % of Respondents)

Reason	Payment ladder		Dichotomous choice		Overall	
Valid Reasons for Not Participating in the Contingent Market						
I have no spare income but would otherwise contribute	12	29%	21	33%	33	31%
I feel that environmental protection of Benut is unimportant	1	2%	1	2%	2	2%
I'd rather have the current situation than pay more	3	7%	0	0%	3	3%
The user should pay	6	14%	7	11%	13	12%
I believe that this improvement will take place without my contribution	0	0%	3	5%	3	3%
Sub-total	22	52%	32	50%	54	51%
Rejection of Contingent Market						
I don't believe the system would bring the changes you describe	2	5%	3	5%	5	5%
It is the government's responsibility	14	33%	26	41%	40	38%
I fail to understand the question	2	5%	1	2%	3	3%
We cannot place a monetary value on biodiversity	1	2%	2	3%	3	3%
No-response	1	2%	0	0%	1%	1%
Sub-total	20	48%	32	50%	52	49%
TOTAL	42		64		106	

Overall, 49% of zero WTP responses may be classed as protest votes. This means that 52 surveys (21% of the sample) needed to be excluded from the WTP analysis, reducing the overall sample to 191 (i.e., payment ladder - 103 surveys; DBDC - 88 surveys).

Table 8.26. Summary of Valid Sample

WTP response	Payment ladder	Dichotomous choice	Overall
Yes	81	56	137
Valid No	22	32	54
[Protest No]	[20]	[32]	[52]
Valid Sample	103	88	191

Voluntary Help in Lieu of Monetary Contribution

Respondents stating that they were not WTP to protect the mangroves of Benut, were asked if they would instead be willing to volunteer some of their spare time to protect the mangroves. This presented those unable to pay with a non-monetary means of expressing their value of the area. Just over a quarter of the 'no' respondents were willing to contribute their time (Table 8.27). This suggests that 26% (23 respondents) of zero WTP respondents actually 'value' the mangroves, but are unable or unwilling to make a monetary contribution towards their protection. On average these respondents were willing to volunteer 14 hours per month to activities which would help to protect the mangroves. The main reasons for being willing to volunteer time were a desire to protect the mangroves and its wildlife and to increase mangrove benefits.

Table 8.27. Willingness to Volunteer Time to Protect the Mangroves

	Version A		Version B		Overall	
	No.	%	No.	%	No.	%
Yes	12	29%	16	25%	28	26%
No	30	71%	48	75%	78	74%
Total	42		64		106	

8.3.5 Test for Scale

Respondents were asked if they would be WTP more if other mangrove areas, in addition to Benut, were protected. The intention of this question was to determine how scale and the existence of ‘substitute’ mangrove areas influence WTP. One would expect a higher WTP figure for a policy which would protect additional mangrove sites from further deterioration and loss. Overall, only 16% of respondents were WTP to protect additional sites. This result was consistent across versions. The average maximum WTP to protect additional mangrove sites was RM10 per month (Table 8.28).

Table 8.28. WTP for the Protection of Other Mangrove Areas (RM)

Maximum	Minimum	Mean	Median	Mode	No. respondents
100	1	10	4	10	39

Reasons for the not being WTP an additional amount to protect the mangroves are summarised in Table 8.29.

Table 8.29. Reasons not WTP to Increase Payment in Order to Protect Other Mangrove Areas

Reason	Number (96)	%
Place no value on the protection of other mangrove areas	2	2%
Not enough money	40	41%
Project may fail	5	5%
Previous stated amount considered reasonable	2	2%
Responsibility of people of the areas / not my responsibility	38	39%
There are other methods to protect mangroves	1	1%
Do not know	13	13%

Note: Respondents could give more than one answer.

8.3.6 Estimating Existence Value

Respondents answering 'YES' to the WTP question were also asked to imagine that they had migrated from the area and were never to 'use' the mangrove again, but otherwise followed an unchanged lifestyle. Given such a scenario, respondents were asked if they would still be WTP to protect the mangroves. Nearly 70% of respondents answering 'YES' to the WTP question (i.e., 94 respondents, representing 40% of the total sample) said that they would still be WTP to protect the mangroves in such an eventuality (Table 8.30). Such WTP is one measure of the existence value of the mangrove resource.

Table 8.30. WTP after Migrating from the Area

	A		B		Overall	
Yes	24	30%	18	32%	42	31%
No	56	70%	38	68%	94	69%
Overall	80		56		136	

The majority, 88% (83 respondents), stated that they would pay the same amount as before. The remaining 12% (11 respondents) claimed that they would pay a different amount ranging from RM0.20 - RM5.00. Most were WTP 20-60% of their original bids to protect the mangroves of Benut after they had left the area¹¹⁷. The reasons respondents were not WTP after leaving the area are summarised in Table 8.31.

Table 8.31. Main Reason Why Not WTP if Left the Area

Reason	Number	%
Only people staying in the area should pay	20	48
No benefit	9	21
Not capable	7	17
Do not know	4	9
Not related to me	2	5

¹¹⁷ A small number of respondents (3) stated that they were WTP more. The reasons for this are not clear.

8.3.7 Payment Vehicle

There was some concern that a fund managed by the Government would be rejected by respondents with low confidence in the Government's ability to implement a mangrove management project. Respondents were therefore asked if they considered payments to a biodiversity fund managed by the Government to be the best payment and management mechanism. Over 90% of the survey believed that it was. Respondents who did not feel comfortable with the payment vehicle would prefer to see: (i) a fund managed by a non-profit organisation or local community committee; (ii) a fund managed by a private organisation; or (iii) a co-operation between the Government and the private sector.

Direct Benefits

Respondents were also asked if they believed that the project would bring them any direct benefits, and if these benefits were as stated in Section B of the questionnaire, or additional to these benefits. Over three-quarter of respondents believed that the project would bring them direct benefits (Table 8.32).

Table 8.32. Summary of Direct Benefits from The Project

	Version A		Version B		Overall	
Yes	97	80%	87	74%	184	77%
No	25	20%	31	26%	56	23%
Total	122		118		240	

Over 70% of respondents answering this question felt that the project would bring them additional benefits. This represents 54% of the overall sample (Table 8.33).

Table 8.33. Additional Benefits

	Version A		Version B		Overall	
Benefits same as described in B3	27	28%	24	28%	51	28%
Other benefits	70	72%	61	72%	131	72%
Total	97		85		182	

Overall, the questionnaire affected the preferences of 62% of the respondents. This again illustrates the educational benefits of the CV process, and suggests that initiatives to improve awareness of mangrove goods and services may allow a more 'reliable' expression of the demand for such assets (Table 8.34).

Table 8.34. Impact of Questionnaire on Respondents' Preferences (%)

Impact	A	B	Overall
Changed your preferences about whether extra resources should be spent on mangrove protection	10	10	10
Merely given you more information than you had before	29	33	31
Both informed you and changed your preferences	51	53	52
Had no effect	10	4	7

8.4 Non-parametric Analysis

Non-parametric measures have the advantage of avoiding the assumptions necessary to define a parametric distribution of WTP, to which statistics such as the mean are particularly sensitive. Such estimates of mean and median WTP can be taken as lower bound measures for these statistics and provide a guide to the central tendency of the sample data (Bateman *et al*, 2002).

Both the payment ladder and DBDC elicitation approaches return interval data, i.e., respondents state that their WTP lies within a range defined by a lower value and an upper value. The methodology used to derive non-parametric estimates from interval data depends on whether the data is ‘overlapping’ or not. The payment ladder returns non-overlapping interval data. That is, it defines a set of mutually exclusive ranges of WTP values and each respondent declares that their WTP lies in one of these ranges. Non-parametric estimation from non-overlapping data is similar to procedures used for continuous data. One typically takes the lower bound of the range and uses the Kaplan-Meier product limit estimator to estimate the survivor function at each of the lower bound values. For overlapping intervals, such as those returned by the DBDC elicitation procedure, non-parametric estimation requires the use of a technique known as *Turnbull’s self-consistency algorithm* (TSCA).

Payment Ladder

The results of the valid (reduced) sample are summarised in Tables 8.35 and 8.36. For Table 8.35 the frequency column relates to the number of individuals who ticked this amount as the highest amount that they are WTP, or crossed it as the lowest amount they are certain they would not pay. The ‘cumulative’ ticks column, indicates the number of respondents who are certain they would pay at least this amount for protection of the mangroves. The cumulative crosses column, shows the number of respondents who at this value had not yet stated that they would not pay. When presented as a function the cumulative figures define a *survivor function*. This function describes: for ticks - the portion of the sample at each value whose highest ticks are at least that value; and for crosses - the portion of the sample at each value whose lowest cross is higher than this value.

Table 8.35. Payment Ladder Responses

WTP (RM)	Ticks			Crosses		
	Frequency	Cumulative	Survivor	Frequency	Cumulative	Survivor
0	23	103	1	23	103	1
0.5	33	80	0.78	0	80	0.78
1	28	47	0.46	13	80	0.78
2	6	19	0.18	19	67	0.65
3	2	13	0.13	6	48	0.47
4	0	11	0.11	2	42	0.40
5	8	11	0.11	9	40	0.38
6	0	3	0.03	13	31	0.30
7	0	3	0.03	1	18	0.17
8	0	3	0.03	1	17	0.16
9	0	3	0.03	0	16	0.15
10	3	3	0.03	5	16	0.15
15	0	0	0	9	11	0.11
20	0	0	0	2	2	0.02
25	0	0	0	0	0	0.00

The mean of the values ticked, RM1.38, can be taken as the lower bound WTP (i.e., the average value which respondents were certain they would pay each month). The mean value of the crosses – RM5.43, may be considered as the upper bound WTP (i.e., the average amount respondents are certain that they will not pay). The

difference between the ticks and crosses defines the range over which respondents' valuations are uncertain.

The mean provides an estimate of what the 'average' household might be WTP. However, since the distribution of WTP is skewed, this would be in excess of the maximum WTP of the majority of the population. For this reason, it is probably more appropriate to take a median figure as a reference point. The median value of the ticks is RM1.00, while the median value of the crosses is RM3.00.

Table 8.36. Payment Ladder - Summary Statistics for WTP Question
(RM/hh/month)

	Tick	Cross
Min	0.5	1.00
Max	10.00	20.00
Mean	1.38	5.43
95% Confidence interval	0.97 – 1.79	4.33 – 6.5
Mode	0.5	2.0
Median	1.00	3.00
N	103	80

Double Bound Dichotomous Choice

As described above, four versions of the DBDC questionnaire were specified, each version differing in the bid levels presented to the respondent (Table 8.1). A respondent answering "NO", "NO" to version 2 of the questionnaire would have a WTP lying in the interval 0 to 1.0. This interval overlaps with those respondents answering "NO", "NO" to version 1 of the questionnaire (whose WTP's lie in the intervals 0 to 0.5). The fourteen intervals defined for the DBDC survey, with the numbers of respondents falling into each interval, are listed in Table 8.37.

Table 8.37. DBDC - WTP Intervals

Interval Code	Interval	Number of Respondents in Interval
0	0	32
1	0 – 0.5	0
2	0.5 - 1.5	4
3	1.5 - 3.0	15
4	3 - ∞	8
5	0 -1.0	0
6	1 - 2	6
7	2 - 4	8
8	4 - ∞	2
9	0 – 2.5	1
10	2.5 - 5	2
11	5 - 8	4
12	8 - ∞	0
13	0 - 6	2
14	6 - 10	2
15	10 - 15	0
16	15 - ∞	2

There are then 14 distinct boundary values for the various intervals: 0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 4.0, 5.0, 6.0, 8.0, 10.0, 15.0, ∞ . TSCA seeks to evaluate the survivor function at each of the boundary values. As before, the survivor function at each of

the boundary values is taken to be the number of households with a WTP greater than the boundary value, divided by the number of households in the sample. The complication is calculating the number of households with a WTP greater than a boundary value since the WTP interval reported by each household may span a number of basic intervals such that we cannot say for certain that a household's WTP is contained within any particular basic interval. To overcome this, a fraction can be allotted to each of the basic intervals spanned by the household's WTP interval. The fractions represent the conditional probabilities that a household's WTP lies in a basic interval given that their WTP interval spans that basic interval. If we then add up all the fractions each basic interval receives, we will get a new data set which contains non-overlapping interval observations. There is however no simple one-step technique to calculating the fractions. The TSCA adopts an iterative procedure. The survivor function is estimated, these estimates are used to calculate the fractions to be allotted to each basic interval and the survivor function is then re-estimated. The process is repeated until the point estimates of the survivor function at each of the boundary values converge. The results of the TSCA performed in GAUSS is presented in Table 8.38.

Table 8.38: DBDC - Summary Statistics for WTP Question (RM/year)

Mean	CI (95%)	Mode	Min	Max	N
2.49	1.75-3.22	0	0	15	88

Plotting the non-parametric survivor function is of great assistance in determining the model specification. Several specifications of the model were studied. The survivor functions for three of these are plotted alongside the non-parametric survivor functions derived for ticks and crosses for the payment ladder, and lower bids for the DBDC (Figures 8.2 and 8.3 respectively). For the Payment ladder and DBDC the log normal specification is considered to be the best fit. While the Weibull distribution fits the data well at higher bid levels, it underestimates WTP at lower bid levels where the mass of observations occur.

Figure 8.2. Survivor Functions for Ticks and Crosses and Different Model Specifications - Payment ladder

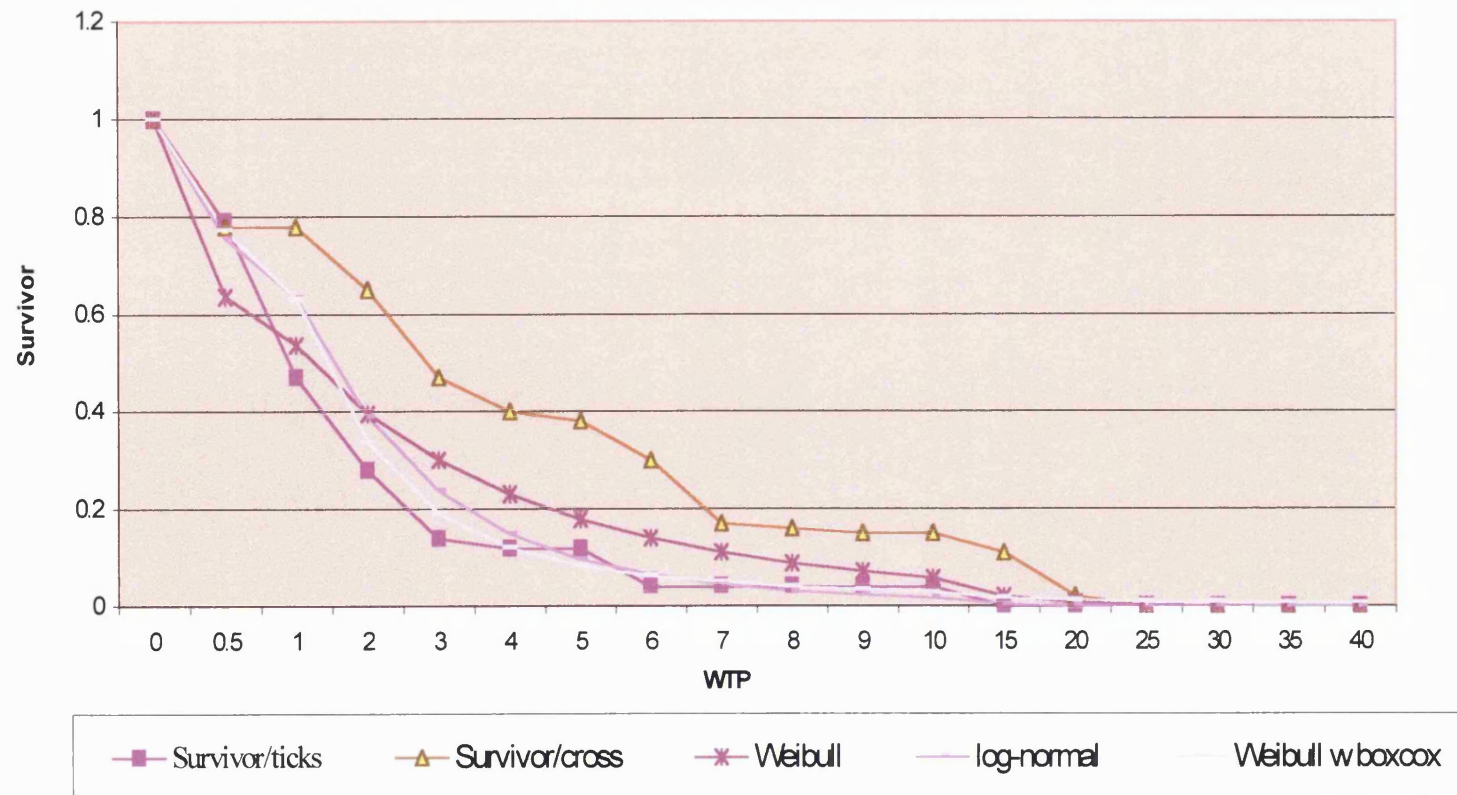
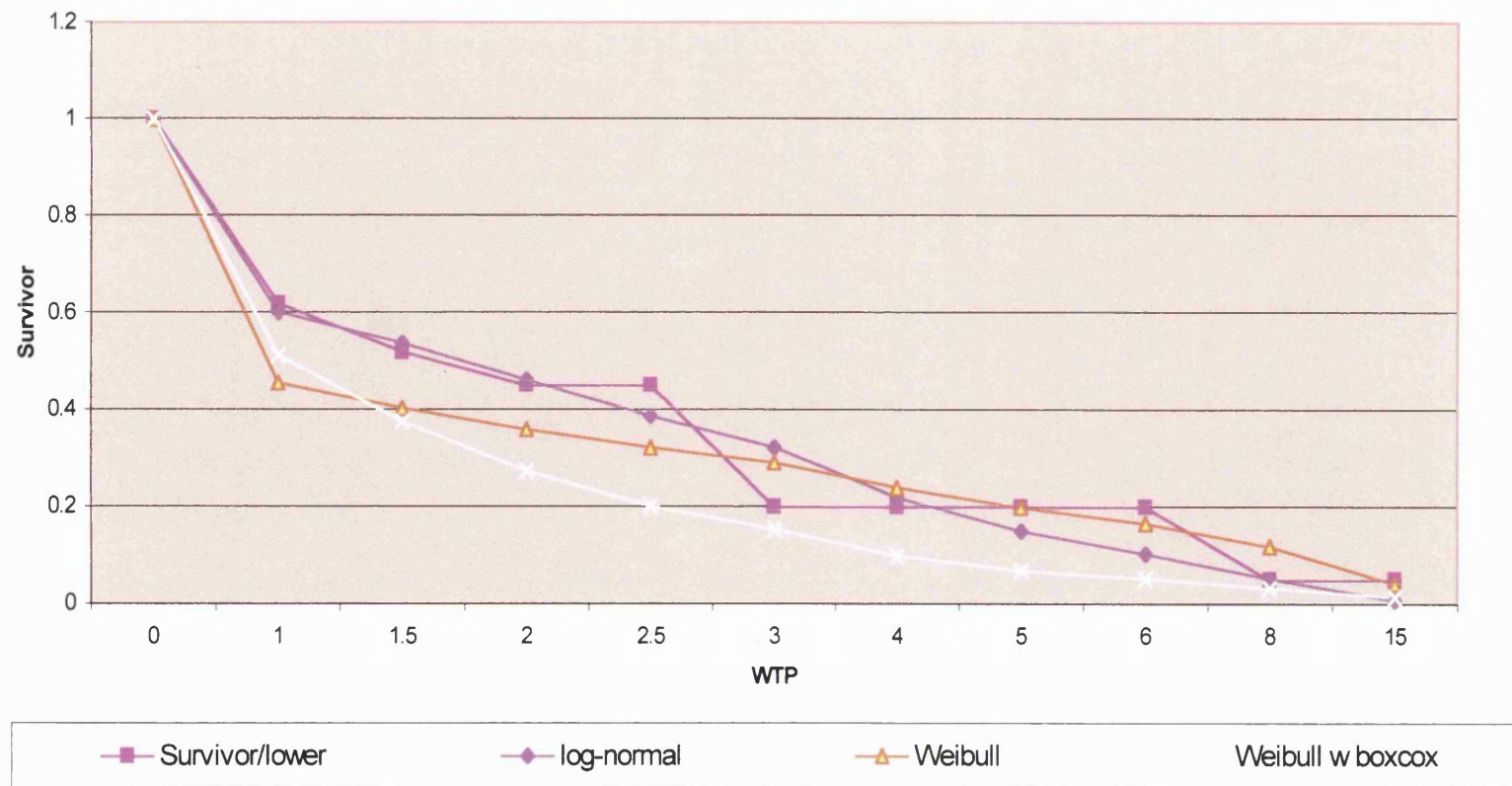


Figure 8.3. Survivor Function for Lower Bid and Different Specifications of the Model – DBDC



8.5 Econometric Modelling - The Spike Model

The econometric models presented in Sections 8.5-8.7 have been adopted in a number of studies, and are similar to Mourato and Day 1998, Day and Mourato, 1998, and Jakobsson and Dragun, 1996.

Both the payment ladder and the DBDC model incorporate a spike model. Responses to the referendum question posed in the DBDC WTP section inform us as to whether a particular household has a zero WTP or a positive WTP. For the payment ladder valid zero responses were incorporated into the spike. The spike distribution corresponds to the point mass at zero WTP, that is it defines the proportion of the population that are not prepared to pay anything towards the proposed policy. It was considered important to model this data given the relatively high percentage of the population with zero WTP.

To model this data we first assume that there exists some underlying latent variable - w_i (subscript 'i' denotes household i). We can think of this latent variable as a utility index that is determined by certain variables including the characteristics of the household. If w_i exceeds some threshold level w_i^* , the household will declare a positive WTP. Since, it does not matter what absolute value w_i^* takes, the threshold level can be normalised to 0.

Hence for household i

$$\begin{aligned} \text{WTP} &= 0 && \text{if} && w_i < 0 \\ \text{WTP} &> 0 && \text{if} && w_i \geq 0 \end{aligned} \quad (1)$$

Since we do not know the value of w_i for a household, we can only make a prediction (v_i), based on variables considered to be influential to its value (X_s , where the s subscript refers to the fact that these are variables used in modelling the spike distribution).

$$w_i = v_i (X_{si} \beta_s) + \varepsilon_i \quad (2)$$

where:

β represents a vector of parameters that measure the influence of the X_{si} variables on the value of v_i ,

ε_i represents the element of the latent variable that the researcher is unable to predict¹¹⁸.

In more formal terms, we can replace Equation (2) in Equation (1) giving,

$$\begin{aligned} \text{WTP} &= 0 && \text{if } v_i + \varepsilon_i < 0 \\ \text{WTP} &> 0 && \text{if } v_i + \varepsilon_i \geq 0 \end{aligned} \quad (3)$$

We can rearrange equation (3) to give,

$$\begin{aligned} \Pr(\text{WTP} = 0) &= \Pr(\varepsilon_i < -v_i) \\ \Pr(\text{WTP} > 0) &= \Pr(\varepsilon_i \geq -v_i) \end{aligned} \quad (4)$$

If v_i is negative then it lies below the threshold at which a household will declare a positive WTP. Only values of ε_i that are more positive than v_i is negative would result in a value for the true utility index (w_i) that was above the threshold. Thus the probability of having a positive WTP is the probability that the random element ε_i will take on a value that is more positive than the estimated utility index v_i is negative.

For a number of reasons, it is usually assumed that the random element follows a standard normal distribution¹¹⁹. Since the normal distribution is symmetric, the probability of ε_i taking a value greater than a certain number is identical to the probability that it will take a value less than the negative of that number. Hence, we can derive the following expression:

¹¹⁸ ε_i is typically considered to represent: (i) the influence of the myriad of variables that influence WTP but that the researcher does not include in the model; (ii) the individual's personal uncertainty concerning his WTP at the time when he is asked. It is assumed that ε_i is not correlated with X .

¹¹⁹ This assumption results in an econometric model known generally as the probit model. The spike model can be seen as a specific application of the probit model to describe the spike distribution in the WTP responses.

$$\begin{aligned}
\Pr (WTP = 0) &= \Pr (\varepsilon_i > v_i) \\
&= 1 - \Phi (v_i) = 1 - p \\
\Pr (WTP > 0) &= \Pr (\varepsilon_i \leq v_i) \\
&= \Phi (v_i) = p
\end{aligned} \tag{5}$$

where

Φ is the cumulative standard normal distribution

p is the probability that WTP is greater than zero.

Using the model described in Equation (5), we can calculate the total probability that the household in the sample would have a zero WTP (payment ladder model), or answer the referendum question as they did (DBDC model), according to

$$L = \prod (p_i^{d_i} (1-p_i)^{1-d_i}) \tag{6}$$

where

d_i is a dummy variable which equals 1 if the respondent has a positive WTP, or answered yes to the referendum question and 0 if the respondent has a zero WTP or answered no, and

L is known as the likelihood function and measures the total probability that respondents will have answered the referendum question, or the payment ladder in the way they did.

For convenience it is more usual to work with the log of this expression

$$\log L = \sum (d_i \log p_i + (1-d_i) \log (1-p_i)) \tag{7}$$

We can further construct an equation that describes how various variables (such as a households income or their proximity to the mangrove area) might influence the value of the latent variable. One simple parameterisation is:

$$V_i = \beta_{s0} + \beta_{s1} X_{s1i} + \beta_{s2} X_{s2i} + \dots + \beta_{sn} X_{sni} \tag{8}$$

8.6 Econometric Modelling - Payment Ladder

The ticks and crosses on the payment ladder provide information on the lower (B_L) and upper bounds (B_U) of households WTP. The amount households would actually pay is unobserved, but we know it lies somewhere between these bounds. We can therefore build a simple behavioural model describing WTP:

$$y_i > B_L$$

$$\text{and } y_i < B_U \quad (9)$$

where, y_i represents unobserved WTP

In order to estimate the value of y_i , an econometric model is built which will predict y_i based on variables considered to be influential to its value. This prediction is denoted as z_i . Thus,

$$y_i = z_i (X_{wi} \beta_w) + \varepsilon_i \quad (10)$$

where:

$z_i(.)$ is a function that gives a prediction of the unobserved WTP (y_i)

X_{wi} represents a vector of variables. The w subscript refers to the fact that these are variables used in modelling the WTP distribution

β represents a vector of parameters that measures the influence of the X_i variables on the value of z_i .

ε_i represents the part of the true WTP that the researcher is unable to predict

Thus, the true value of y_i could lie above or below the researcher's prediction (z_i). Replacing Equation (9) in Equation (10) and rearranging, gives

$$\varepsilon_i > B_L - z_i$$

$$\text{and } \varepsilon_i < B_U - z_i \quad (11)$$

That is, given the prediction of WTP for household i (z_i). The amount ticked (B_L) and the amount crossed (B_U), the bound of the value taken by ε_i can be defined.

It is possible to define the model in terms of a general probability model (Equation 12).

$$\Pr (\varepsilon_i > B_L - z_i)$$

$$\text{and } \Pr (\varepsilon_i < B_U - z_i) \quad (12)$$

In order for this model to be estimated the cumulative density function of ε is specified by the function of $F(\varepsilon)$. That is, $F(x)$ defines the probability that ε will take a value less than x . For the model, the probability that ε_i is less than $B_U - z_i$, whilst not being less than $B_L - z_i$ has to be defined. In formal terms, the probability of a household with characteristics X_i responding to the CV question by ticking a value B_L and crossing a value B_U is given by the statement:

$$P_i = F(B_{Ui} - z_i(X_i, \beta)) - F(B_{Li} - z_i(X_i, \beta)) \quad (13)$$

where P_i is the probability of the household deciding to tick and cross the values that were chosen.

Given the model described in Equation (13), the total probability that the households in the sample would have answered the WTP questions as they did can be calculated according to:

$$L = \prod_i P_i(x_i, \beta) = \prod_i P_i(\beta|X) \quad (14)$$

Again, it is more usual to work with the log of this expression

$$\text{Log } L = \sum \log P_i \quad (15)$$

For the model to be estimated a number of elements in the basic expression for WTP (Equation 2) need to be specified:

(i) The exact form for z_i , the predicted value of WTP. In order to facilitate estimation it is often assumed that the z_i takes a simple linear form. This assumption is adopted here, such that:

$$z_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \dots + \beta_n X_{ni} \quad (16)$$

which in vector notation can be written as

$$z_i = \mathbf{X}\beta \quad (17)$$

(ii) How the value taken by z_i relates to the unobserved WTP, y_i . Up until now z_i has been described as a prediction of WTP, however, it is probably more appropriate to describe z_i as a predicted WTP index. This distinction is made because it may be necessary to transform y_i in order to improve the fit of the model to the data. One common transformation is to take the log of y_i , giving:

$$\log(y_i) = \mathbf{X}\beta + \varepsilon_i \quad (18)$$

In this case $\mathbf{X}\beta$ is a prediction of the log of y_i . By imposing this transformation, an *a priori* assumption is being made concerning the relationship between the predicted WTP index (z_i) and the true WTP (y_i).

(iii) The distribution of ε_i . The log normal distribution was found to best fit the data and was adopted in this study. The cumulative density function of the log normal distribution is given by¹²⁰:

$$F(\varepsilon) = \Phi (\log z - a) / \sigma \quad (19)$$

where:

F is the cumulative log normal distribution

σ is a scale parameter that determines the variance of the distribution

a is a location parameter which fixes the value of the central point of the distribution

The final log likelihood function can be written as:

$$\begin{aligned} \log L = & \sum [d_i (1 - \log F (v_i (X_{si}, \beta_s))) \\ & + \log [F ((\log b_{Ui} - z_i (X_{wi}, \beta_w)) / \sigma)] - F ((\log b_{Li} - z_i (X_{wi}, \beta_w)) / \sigma))] \end{aligned}$$

¹²⁰ The cumulative density function (CDF) of the probability distribution gives the probability that a household's WTP will take a value of z given the parameters of the distribution.

$$+ (1 - d_i) \log F(v_i(X_{si}, \beta_s))] \quad (20)$$

The model is estimated by selecting the set of parameters, β , that maximise this log-likelihood expression. These values for β give the best estimates of how the X variables influence household WTP. The log-likelihood function was maximised using Intercooled STATA 6.0, an econometric package for Statistical Data Analysis published by Stata Corporation.

Willingness to Pay

In order to estimate the total WTP of the population the average WTP of the population is multiplied by the number of households in the population. Average WTP is equal to the average probability of having a positive WTP (derived from the spike model) multiplied by average positive WTP.

Bootstrapping was employed to determine mean and median WTP values along with standard errors and confidence intervals (Table 8.39). The mean based on the Weibull distribution is slightly higher than that of the log normal, explained by the fact that the Weibull distribution overestimates higher values, while underestimating lower values.

Table 8.39. Payment Ladder - Mean and Median WTP

Variable	Value	Std. Err.	95% Confidence Interval
Log Normal			
Spike	0.2	.04	0.1-0.3
Mean	2.2	.30	1.5-2.7
Median	1.6	.17	1.2-1.9
Weibull			
Spike	0.2	.04	0.1-0.3
Mean	2.7	.32	2.0-3.3
Median	1.6	.22	1.2-2.0

The mean and median estimates compare well with the non-parametric estimates (Table 8.40). The non-parametric estimates for the mean are RM1.38-5.43, while the median estimates are RM1.00- 3.00.

Model results

A large variety of variables were modelled. For the final model ‘key variables’ were included regardless of whether they were significant or not in order that their effect on WTP might be determined. Key variables included in both the payment ladder and DBDC model (spike and WTP) are: proximity, income, benefits, education, and age. In addition, all significant variables are included. Table 8.40 explains all the variables used in the final models (local surveys and the international survey carried out at Kuala Lumpur International Airport - KLIA¹²¹).

¹²¹ See Section 8.7

Table 8.40. Variables Used in Econometric Analysis

Variable	Version	Description	Expected results
Proximity	PL / DBDC	1 – if respondent lives in inland area 0 – if respondent lives in coastal area	We expect coastal hh to have a positive WTP WTP: negative / Spike: positive
Income	PL / DBDC / KLIA	Income	We expect income to be positively correlated with WTP. Therefore negatively correlated with the spike.
Direct benefits	PL / DBDC / KLIA	1 - if respondent believed there to be direct benefits from the project 0 – if otherwise	Expect direct benefits to be positively correlated with WTP Negatively correlated with the spike
Education	PL / DBDC / KLIA	1 – Higher than primary school education 0 – no formal education / educated up to primary school	Expect education to be positively correlated with WTP. Spike – negative / WTP – positive
Age	PL / DBDC / KLIA	Age	No a priori expectations on how age will influence WTP
Information	PL (S) / DBDC (S)	1 – information presented changed and / or informed preferences on mangrove protection 0 - information had no effect	Information positively related to WTP Negative value in spike
Trade off	PL (S) / DBDC (S)	1 - if agree with statement ‘we have more important things to think about than the loss of the mangroves’ 0 – if disagree with this statement.	Expect people who agree with this to have a lower WTP. WTP negative / Spike positive

Variable	Version	Description	Expected results
Knowledge	PL (S) / DBDC (W)	1 – if respondent had heard of mangroves 0 – if respondent had no knowledge of the mangrove	Expect people who know of the mangroves to have a positive WTP WTP Positive / Spike negative
Bequest	PL (W) / DBDC (S) KLIA (S&W)	1 – if agree with statement ‘we should reduce our use of the environment now, so that our grandchildren may benefit from it’. 0 – if disagree with this statement	Expect respondent agreeing with this statement to have higher WTP. WTP positive / Spike negative
Problem	PL (W) KLIA (S)	1 – if protecting wildlife and natural habitats considered to be most or second most important problem in Johor 0 – if otherwise	Expect respondents answering yes, to have higher WTP WTP positive / Spike negative
Development	DBDC (S)	1 - if agree with statement ‘we have a duty to protect the environment from development regardless of the cost’ 0 - if no opinion or disagree with this statement.	Expect people who agree with this statement to have a higher WTP WTP positive / Spike negative
Existence	DBDC (S) KLIA (S &W)	1 – if agree with statement ‘because rare birds depend on the mangroves, they should be protected regardless of the cost’ 0 – if disagree with this statement	Expect people agreeing with this statement to have higher WTP. WTP positive / Spike negative

Variable	Version	Description	Expected results
Non-Use	DBDC (W)	1 – Agree with the statement ‘I should pay for the protection of parks and nature reserves even if I do not visit them’ 0 – Disagree with the statement	Expect people agreeing with this statement to have higher WTP
Option	PL (W) KLIA (S&W)	1 – agree with statement ‘Even if I don’t use the mangroves now, I am prepared to pay now to protect them in case I want to use them in the future’ 0 - Disagree with this statement / no opinion	Expect agreement with this statement to have a positive WTP
Indirect Use	KLIA (W)	1 - if agree with statement ‘it is worth spending money to protect the mangroves because they help to protect agricultural productivity’ 0 - if otherwise	Expect people agreeing with this statement to have a higher WTP

Notes: PL (Payment Ladder); (S) Spike model; (W) WTP. Variable used in both spike and WTP model unless indicated.

The results are presented in Table 8.41 (where * indicates that the variable is significant)¹²². For the ‘key variables’ income and direct benefits perform as expected (for benefits the parameter for the spike is significant). Contrary to expectations however, people in inland areas have a higher WTP and are less likely to be in the spike - this may be explained by higher incomes in inland areas. Education is negatively related to the spike model as expected, but negatively related to WTP against our expectations. Age proves to be a significant determining factor in

¹²² Only the log normal specification results are presented as this was considered to best fit the data.

reducing WTP for the new project (i.e., contributing to the spike). This is consistent with general findings, for example age is typically negatively correlated with buying environmentally friendly products, reading about environmental issues and belonging to environmental organisations. However, age is also negatively related to WTP – although not significant. For the spike model, trade off, knowledge and information are significant and have the expected sign. For the WTP model, bequest and option are significant variables with the expected sign. The variable problem, however, has a negative sign – not as expected.

Table 8.41. Results - Payment Ladder Local / Log Normal

	Coefficient	Standard error	P Value
Spike Model			
Constant	-1.014	0.83	0.226
Proximity	-0.648	0.52	0.219
Income	-0.000	0.00	0.205
Direct benefits	-0.978	0.45	0.030*
Education	-0.462	0.50	0.355
Age	-0.059	0.02	0.001*
Trade off	0.92	0.43	0.032*
Knowledge	-1.14	0.47	0.016*
Information	-0.646	0.35	0.068*
WTP Model			
Constant	0.247	0.52	0.638
Proximity	0.32	0.36	0.221
Income	0.00	0.00	0.183
Direct Benefits	0.202	0.29	0.488
Education	-0.25	0.29	0.381
Age	-0.02	0.008	0.856
Problem	-0.44	0.26	0.047*
Bequest	0.50	0.30	0.092*
Option	0.57	.20	0.005*
Ancillary parameters	0.69		
Log likelihood at maximum	-119.92		
Number of observations	98		

8.7 Econometric Modelling - Double Bound Dichotomous Choice

The DBDC question returns data in a binary format. The econometric model used to analyse this data is similar to the one used for the spike model. However, an important difference is that we are no longer dealing with an unobservable utility index but with a WTP function whose value will be used to gauge the likelihood that a household will accept a particular bid level.

We begin by stating that each household has a true WTP for the policy being offered in the valuation question (y_i). As with w_i , the researcher does not directly observe y_i . In the DBDC question the respondent is presented with a threshold value in the form of a bid level. This is represented as b_K for the initial bid level, b_L for the lower bid level, and b_U for the upper bid level.

Thus in response to each question the respondent will answer:

$$\begin{aligned} \text{YES} & \quad \text{if} & y_i \geq b \\ \text{NO} & \quad \text{if} & y_i < b \end{aligned} \tag{21}$$

As for the payment ladder an econometric model is used in order to predict its ‘true’ value.

$$y_i = z_i (X_{wi} \beta_w) + \varepsilon_i \tag{22}$$

As for the spike model, we treat ε_i as a random element, modelled as coming from a normal distribution with a mean of zero and a variance of σ , a parameter that needs to be estimated.

Replacing equation (21) in Equation (22) results in the respondent answering

$$\begin{aligned} \text{YES} & \quad \text{if} & z_i + \varepsilon_i \geq b \\ \text{NO} & \quad \text{if} & z_i + \varepsilon_i < b \end{aligned} \tag{23}$$

And since we know the probability distribution of ε_i , we can rearrange equation (23) to give,

$$\Pr(\text{YES}) = \Pr(\varepsilon_i \geq b - z_i)$$

$$\Pr (\text{NO}) = \Pr (\varepsilon_i < b - z_i) \quad (24)$$

To return to a standard normal distribution, we can account for the variance in the random element ε_i by dividing both sides of the inequality in equation (24) by σ . Hence the probability of a household being WTP a given bid level can be modelled by:

$$\begin{aligned} \Pr (\text{YES}) &= 1 - \Phi ((b - z_i) / \sigma) \\ \Pr (\text{NO}) &= \Phi ((b - z_i) / \sigma) \end{aligned} \quad (25)$$

Of course in the DBDC question format, households are faced by not just one bid level, but two, such that those answering:

- YES, YES have a WTP that is higher than the upper bid level b_U
- YES, NO have a WTP higher than the initial bid level b_K and lower than b_U
- NO, YES have a WTP lower than b_K but higher than the lower bid level b_L
- NO, NO have a WTP below b_L

Expanding Equation (25) to take account of this added information gives:

$$\begin{aligned} \Pr (\text{YES, YES}) &= 1 - \Phi ((b_U - z_i) / \sigma) \\ \Pr (\text{YES, NO}) &= \Phi ((b_U - z_i) / \sigma) - \Phi ((b_K - z_i) / \sigma) \\ \Pr (\text{NO, YES}) &= \Phi ((b_K - z_i) / \sigma) - \Phi ((b_L - z_i) / \sigma) \\ \Pr (\text{NO, NO}) &= \Phi ((b_L - z_i) / \sigma) \end{aligned}$$

Again it is possible to parameterise z_i

$$z_i = \beta_{w0} + \beta_{w1} X_{w1i} + \beta_{w2} X_{w2i} + \beta_{w3} X_{w3i} + \dots + \beta_{wn} X_{wni} \quad (26)$$

The model described in Equation (26) rests on the assumption that the underlying population distribution of WTP follows a normal distribution. However a log normal distribution was again considered to best fit the data and was used in the analysis.

$$F(y_i) = z_i (X_{wi} \beta_w) + \varepsilon_i \quad (27)$$

Once again, the WTP model is estimated using maximum likelihood techniques.

$$\text{Log } L = \Sigma$$

Figure 8.4. Survivor Functions for Ticks and Crosses and Different Model Specifications – KLIA

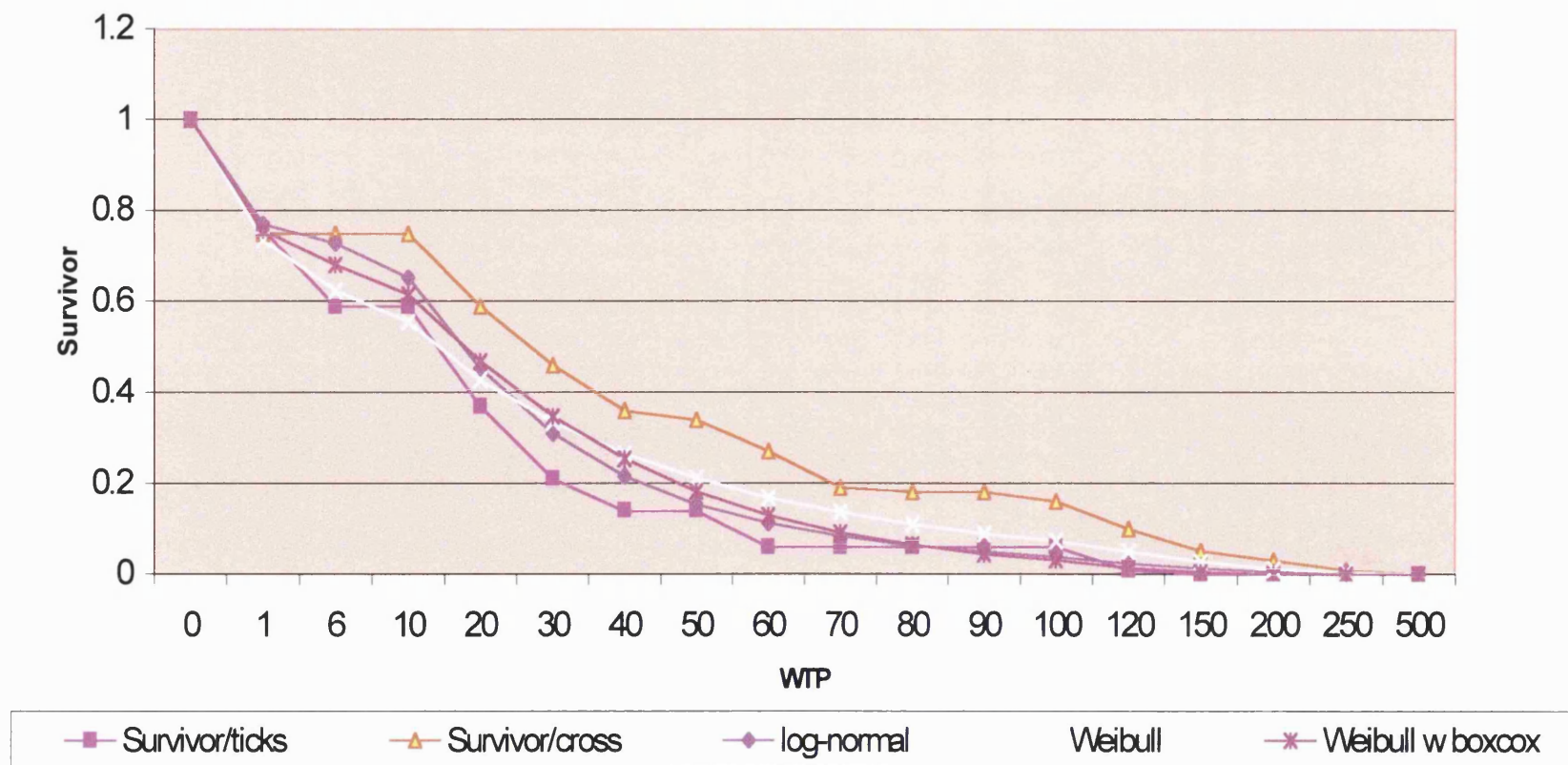


Table 8.60. Payment Ladder Responses

WTP (\$US)	Ticks			Crosses		
	Frequency	Cumulative	Survivor	Frequency	Cumulative	Survivor
0	22	92	1	22	91	1
1	15	70	0.76	0	69	0.75
6	0	55	0.59	0	69	0.75
10	21	55	0.59	6	69	0.75
20	15	34	0.37	21	63	0.69
30	6	19	0.21	9	42	0.46
40	0	13	0.14	2	33	0.36
50	7	13	0.14	6	31	0.34
60	0	6	0.06	7	25	0.27
70	0	6	0.06	1	18	0.19
80	0	6	0.06	0	17	0.18
90	0	6	0.06	2	17	0.18
100	5	6	0.06	5	15	0.16
120	1	1	0.01	5	10	0.10
150	0	0	0	2	5	0.05
200	0	0	0	2	3	0.03
250	0	0	0	1	1	0.01
500	0	0	0	0	0	0.00

Table 8.61. Summary Statistics for WTP Question (\$ / year)

	Tick	Cross
Min	1	10
Max	120	250
Mean	18	42
95% Confidence interval	13 – 22	32 – 52
Mode	0	0
Median	10	20

The econometric model presented in section 8.6 was used for the KLIA data. Table 8.62 presents the bootstrap results for the mean and median and spike distribution. Again, the mean for the Weibull distribution is slightly higher than for the log normal. An estimated 20% of the population have a zero WTP. The mean and median for the log normal are higher than the non parametric estimates.

The number of people visiting Malaysia for eco-tourism is expected to reach 1.25 million by the year 2000. Even conservatively defining the ‘global’ population as the number of eco-tourism visitors to Malaysia, and taking the median WTP of \$10 a year (median for ticks from the non-parametric analysis), the non-use values of Benut may be estimated at \$12.5 million.

Table 8.62. Bootstrap Results - KLIA

Variable	Value	Std. Err.	95% Confidence Interval
Log Normal			
Spike	0.2	0.04	0.1 - 0.3
Mean	27	3.7	19 - 34
Median	18	2.3	14 - 23
Weibull			
Spike	0.2	0.04	0.1 - 0.3
Mean	31	4.3	22 - 39
Median	18	2.4	13 - 23

8.8.6 Regression Results

Explanatory variables used in the final model are summarised in Table 8.63 (see Table 8.40 for explanation of variables). The model does not have strong explanatory power. This is likely to be because of the small sample size compounded by the fact that the sample was very heterogeneous. Key variables were included (income, benefits, education, age) along with variables expected to support the non-use value of the mangroves (i.e., existence, bequest, and option). None of these were significant and typically displayed the same sign for spike and WTP model. Only two significant variables are evident. For the spike model the variable ‘problem’ has a positive sign suggesting that people who believe that protecting wildlife and natural habitats is the most important problem in their own country are more likely to have a zero WTP for the mangroves of Benut. This can be explained by the fact such people are more likely to direct monies to environmental protection at home rather than overseas. Indirect use of the mangroves has a positive sign in the WTP model as expected, suggesting that those who agree with the statement that it is worth spending money to

protect the mangroves because they help to protect agricultural productivity in the area have a positive WTP.

Table 8.63. Results - KLIA, Log Normal

	Coefficient	Standard error	P- Value
Spike Model			
Constant	-2.10	.931	0.02
Income	.00	8.34	0.11
Benefits	-.30	.37	0.40
Education	-.04	.50	0.93
Age	.00	0.1	0.51
Existence	.28	.50	0.60
Bequest	.71	.66	0.28
Option	-.35	.40	0.37
Problem	.80	.40	0.05*
WTP Model			
Constant	2.79	.53	.00
Income	2.3	5.90	.83
Benefits	-.09	.23	.69
Education	-.44	.30	.14
Age	-.00	.00	.23
Existence	.18	.28	.53
Bequest	.04	.34	.90
Option	.065	.27	.80
Indirect use	.80	.32	.01*
Ancillary parameters	.76	.08	.00
Log likelihood at maximum	-116.49		
Number of observations	77		

8.9 Conclusion

The CV study of Malaysians was successfully conducted and on the whole the results are consistent and credible. This supports the view that CV studies of complex goods such as biodiversity can be applied in developing countries where the population of interest have a low educational attainment and where the ability to pay is low. Taking a lower bound WTP of RM1 per household per month, and given a population of 12,650, annual WTP by locals to protect the mangroves of Benut amounts to RM151,800 (\$40,000). On a per hectare basis this represents \$24 a year. The WTP of local communities is however low considering that the average monthly income in the State is RM1,216 and the high dependence of local communities on the mangrove resource. This might be explained by income constraints faced by (poor) households creating a divergence between the use of and the WTP for the resource, and the possibility that households consider themselves to have a right to the resource and are therefore unwilling to pay for it. The local survey revealed a high appreciation of the non-use benefits of the mangrove resource (Table 8.9), however, WTP is considered to be closely correlated with the direct benefits derived from the mangrove resource.

While the KLLA model does not have strong explanatory power, the survey of non-Malaysians reveals a high WTP for the protection of the Benut mangroves and its global biodiversity. This value has been conservatively estimated at U\$12.5 million per year (\$7,400 per hectare). This represents non-use (existence) value. This however, is only relevant to Malaysia if mechanisms can be put in place to 'capture' part of this value. Possible mechanisms include international funding (e.g., via the GEF), higher levies on international tourists, and conservation concessions. The results of this CV study are combined with other mangrove component values in Table 7.47.

PART III: Key Findings and Conclusions

9 Lessons from Case Studies

9.1 Land Use, Land Value and Development Status

How people use and value a forest will depend to a large extent on the availability of the goods and services derived from the area relative to human needs and / or the availability of substitutes. This will differ from site to site and will be influenced over time by the level of development.

In traditional hunter-gathering societies, such as in Ratanakiri, forest land has long been valued for the harvesting of wild game and plants, vines and timber for subsistence purposes. This may be considered the 'original' use of forest. As populations grow and economies develop forest values change. Initially, forests are typically valued for their timber and the agricultural potential of the land. As economies mature, forest management becomes more specialised, with some areas under intensive timber production and others allocated for recreational uses or preserved for their landscape values (Bishop, 1998). This trend is evident in many countries in southeast Asia, such as Malaysia which experienced high growth rates in the 1980s up to the economic crisis of 1997, and can be seen in Turkey. In these countries there is an increasing demand for recreational areas and for conservation.

Public demand for forest conservation tends to increase as a country's economy strengthens. Rising average incomes are typically associated with an increasing demand for environmental protection and amenities, as well as increased means with which to pay for them. For the richest countries this increased demand reaches to remote areas in foreign countries that people will never see. This reflects the emerging, and potentially increasing, importance of 'non-use' values.

While forests are under threat in all of the three countries studied, the nature of these threats differs between countries and can be partly explained by a country's level of development. In Cambodia forest have until recently been used exclusively for subsistence purposes by local communities. This traditional use is now threatened by uncontrolled commercial logging. Turkish forests by comparison are used in a greater variety of ways, however there is intense pressure on forest land as current and

potential conservation areas compete with demands for urban housing and development (Table 9.1).

Table 9.1. Development Status and Forest Use

Study	Main Uses	Threats
Ratanakiri, Cambodia	Local communities for subsistence purposes / habitat	Illegal logging activities
Turkey	Many including commercial logging, subsistence by local communities, tourism, recreation, conservation	Urban and agricultural expansion, tourism developments, land speculation Over utilisation (e.g., NTFP, grazing land)

Similarly for mangroves, in low income countries such as Cambodia these areas are largely valued for their subsistence benefits to local people. As a country develops, investors seek out mangrove land for the development of shrimp farms. In a third phase, (unprofitable) shrimp farming is often abandoned as a land use, and as in Malaysia mangroves are cleared for shopping malls and industrial estates (Table 9.2).

Table 9.2. Development Status and Mangrove Use

Study	Main Threats	Fishing Pressure
Koh Kong, Cambodia	Undisturbed until recently. Now threatened by shrimp farming and charcoal production.	Fish productivity threatened by water pollution caused by shrimp farms, illegal fishing, and loss of mangroves.
Johor, Malaysia	Historically threaten by agriculture and aquaculture Now threatened by industrial, urban and tourism development proposals	Fish stocks declining due to over fishing, loss of mangroves, pollution and destructive fishing practices.

This suggests that while a wider range of forest values might be recognised as a country develops, the development pressures on the resources also broaden and intensify. Such a pattern suggests significant advantage in securing conservation benefits, through innovative financial instruments, at the early stages of development.

9.2 Demonstrating Economic Values in Practice

While valuation in low income countries presents special challenges, the case studies from Cambodia illustrate that economic valuation is possible in even the most remote and under-developed locations. Cambodia at the time of study was emerging from decades of civil war. The country's institutions and human resource base had been destroyed by the Khmer Rouge regime. The studies presented in Chapters 4 and 6 represent the first environmental valuation studies undertaken in Cambodia. In 1996 there was practically no physical data and the vast majority of rural people had little or no interaction with markets. Given the absence of any baseline data original surveys were necessary. Such 'first round' research is typically slow and circumstances dictated the application of the most straightforward approaches.

The location of the study site also has some bearing on the choice of methodology. Travel time to remote villages can cut into survey time, and thus the detail and coverage of questionnaires. Communication is key and considerable up front effort is needed to tune survey instruments to (uneducated) sample populations in remote and culturally sensitive areas.

The human resource base impacts the ease at which valuation studies can be executed and 'sold' to decision makers. There had been no prior exposure to environmental economics in Cambodia at the time of study, no trained economists to work with and a low appreciation of the range of environmental goods and services at decision making levels. A few trained environmental economists work in Malaysia and Turkey which facilitated research efforts. Local involvement in the research process is important for a number of reasons including ownership and interest in the research and findings, and the acceptance of the survey team by respondents, particularly in remote villages. Acceptance of valuation results was found to be guarded at the decision making level in all countries studied. CV studies are particularly hard to sell.

This is largely because they are not seen to represent tangible benefits and this makes it difficult for (environment) ministers to uphold their findings.

All case studies, except for Turkey, are survey based. The surveys developed represent samples that have been adapted by local researchers to other locations within the countries studied. Market prices have been largely relied on in all studies, other than the CV study of Benut. Gross values are typically used, with attempts to net out some costs and indicate the direction of possible biases. The lack of data is the main obstacle to deriving net values. For example, to derive net values for NTFP, data is required on the amount of time spent collecting and processing products and on opportunity costs estimates. This is often time consuming and complicated to derive in remote settings. For timber, extraction and transportation costs need to be deducted from the sale price, while the 'value of the timber stand' should be based on its 'stumpage value'. It is difficult however, to find reliable estimates of these. TEV has not been estimated. In all cases, key resource values were selected to demonstrate the economic importance of the natural resource under competing land use scenarios.

9.3 Forest Values – Comparative Analysis

This Section compares the case study results to other findings in the literature. Both mangrove and forest values are illustrated.

Timber Values

In a comprehensive survey of sustainable forestry practice, Pearce *et al.* (1999) find that sustainable timber management can be profitable, but it is not as profitable as conventional (unsustainable) logging. The results for Ratanakiri are consistent with this conclusion (Table 9.3). This means that the non-timber benefits associated with sustainable forestry need to be internalised for the market to favour this option.

Table 9.3. Timber Values for Sustainable and Conventional Logging in Asia

Study	Country	Type of forestry	Rate of return or net present value (% = discount rate)	Ratio profits CL to STM	Comment
Chapter 4	Cambodia	STM, CL	CL = \$1,697 ha STM = \$408 ha (6%)	4.1	90 yr x 3 cutting cycle for STM; 30 yr liquidation for CL
Boscolo and Mendelsohn, 1998	Malaysia	RIL vs. CL	\$4400 ha CL \$2660 ha STM	1.66	STM assumes RIL and >60 cm dbh
Kumari, 1996	Malaysia	STM vs. CL	CL = \$860-1380 ha STM = \$322-\$944 ha	1.5 – 1.7	Taking 'best' STM and same damage levels
Shawahid <i>et al</i> , 1997	Malaysia	Protection vs. RIL	Protection = RM 10.4 RIL = RM26.6	n.a	Protection less desirable than RIL

Source: Pearce and Pearce 2001. RIL = reduced impact logging; CL = conventional logging; STM = sustainable timber management.

NTFP

Bann, 1988a summarises the results of 20 NTFP studies and finds that values range from \$5-422 ha/year. Pearce and Pearce (2001) suggest a clustering of NTFP net values of \$2-100 / ha per annum¹²⁷. Table 9.4 summarises a few studies for comparative purposes. Estimates for Cambodia and Turkey are within the range

¹²⁷ Other recent surveys of NTFP include: Godoy *et al.*, (1993), Pearce and Moran (1994), Southgate (1996), Lampietti and Dixon (1995), Batagoda *et al.*, (2000).

provided by other studies. The results for chestnuts and bayleaves in Turkey are high, but relate to a small area and cannot be generalised to other sites.

Table 9.4. Summary of NTFP Values \$/ha/year

Study	Result
Cambodia, Chapter 4	17-366
Turkey, Chapter 5	NTFP – 5.30 Wildlife – 4.60 Fodder – 14.80 Chestnuts and Bayleaves- 750-900
Peru, Peters <i>et al</i> 1989	422 - Fruit and latexes – net value of inventory in one hectare
Malaysia, Kumari, 1994	48. - Rattan and bamboo
Malaysia, Caldecott, 1987	8 -Wildlife in one square metre

An essential feature of NTFP values is that they are site specific. Local values can become quickly depressed if large tracts of land are devoted to a particular product. Aggregation or extrapolation of values based on potential production is not then valid unless account is taken of likely price effects (elasticity of demand).

Early arguments that NTFP (plus sustainable timber extraction) values could exceed those to be obtained by land clearance and conversion to a non-forest use (e.g. Peters *et al.* 1989) have largely been discredited (a) because of poor design of these studies and (b) because of subsequent research. The importance of NTFP is now felt to lie more in the role they play in supporting local communities (Pearce 2001). Table 9.5 highlights the importance of NTFP to local communities and represents their value as a percentage of household income where possible. In Ratanakiri local communities are totally dependent on the natural resource base. Only 30% of households earn a salary of up to \$340 year. The benefits from NTFP are estimated at \$625-3,925 a year. Even taking the lower bound of this range, the contribution of

NTFP in terms of cash and non-market returns is considerable. In Turkey NTFP are important for poorer sectors of society and for many families provide the bulk of cash income. In Koh Kong nearly all households depend on the mangrove for their livelihood, while in Johor, a quarter of the population is mangrove dependent.

Table 9.5. NTFP as a Percentage of Income

Study / Source	Finding
Ratanakiri (Chapter 4)	64-100%
Turkey (Chapter 5)	Ovacik Research Forest – on average 35% of income is derived from NTFP, but dependence is as high as 100% for some families.
Koh Kong (Chapter 6)	97% of households totally dependent on fishing for their livelihoods. For 65% fishing is their only form of income.
Johor (Chapter 7)	25% of population totally dependent on mangrove resource. For 55% mangroves are an important source of income.
West Bengal (Kant et al, 1996)	NTFP generally account for 20-35% of household income
Mantadia National Park, Madagascar Shyamsundar & Kramer (1997)	Collected fuelwood from surrounding forest accounts for 14% of household income
Middle Hills of Nepal. Houghton & Mendelsohn (1996)	Fuelwood constitutes between 39-67% of local household income

Source: Non-cases study examples from Pearce and Pearce, 2001.

Clearly NTFP can constitute a *substantial* fraction of household incomes, so that, even if such values fail to compete with alternative land uses, serious local poverty issues can arise if the benefits of the competing land use do not accrue to those who lose the forest products in question.

Tourism and Recreation Values

Table 9.6. lists estimates of tourism values for tropical forests. Some tourism sites attract enormous numbers of visitors and consequently have very high per hectare values. Values vary with location / accessibility and the nature of the attractions. Johor is at the low end of the range explained by the fact that tourism is under-developed in the area.

Table 9.6. Tourism Values for Tropicallly Forested Areas

Study	Values	Comment
Johor State, Malaysia Chapter 7	\$3 ha	Valuation by locals only
Hodgson and Dixon, 1988 Philippines	\$650/ha	Benefit of no logging vs. continued logging near Bacuit Bay.
Adger <i>et al.</i> 1995 Mexico	\$1/ha	Consumer's surplus estimates
Tobias and Mendelsohn 1991 Costa Rica, Monteverde rainforest	\$160/ha	Consumer's surplus estimated by travel cost method. For Costa Rican visitors only
Garrod and Willis, 1997 (a) Forest recreation areas, Malaysia	\$740/ha	Consumer's surplus by contingent valuation and sample tested with travel cost. Large values due to small areas and proximity to sources of demand.

Source: Pearce and Pearce, 2001.

Indicative values for European (temperate) forests suggest per person WTP of around \$1-3 per visit. An exception is Mattson and Li's study of recreational use of North Swedish forests that suggests very high values of around \$1,000 per person per year. The estimate for Turkey is at the low end of the range partly explained by the fact it is based on entrance fees and tourist numbers (Table 9.7).

Table 9.7. Tourism/Recreation Values for non-Tropical Forested Areas**\$/ha/year**

Study	Values
Turkey – all forest (Chapter 5)	\$0.4 ha gross
Willis <i>et al.</i> 1998 English forests	<i>\$0.5-2.0 per person per visit</i>
Elsasser, 1999 German forests	\$42 pp/pa to visit all forests: day users \$13 pp to visit one forest during stay in region
Mattson and Li, 1993 North Swedish forests	\$275 pp / pa for consumptive uses (berries and mushrooms); \$600 pp / pa for on-site recreational experience, and \$430 pp / pa for off-site visual experience.

Source: Pearce and Pearce, 2001.

Biodiversity

The economic value of biodiversity has yet to be rigorously measured. The diversity embodies billions of years of information and of 'resilience' to environmental change. Hence the economic value of any tract of forest must be equal to its informational value plus its insurance value. Informational values for agriculture and pharmaceuticals are being studied.

Pharmaceutical Values

Plant based genetic material is an important source of pharmaceuticals for commercial drugs and for traditional medicines. Some 119 pure chemical substances taken from 90 species of higher plants are used internationally in medicines, while the World Health Organisation (WHO) lists some 21,000 plant names with reported medicinal uses. Some 80% of developing country inhabitants rely to some extent on traditional medicines (WCMC, 1992). It is generally agreed that traditional medicines are of substantial value to local communities, as is evident in Cambodia and Turkey. The

economic value of genetic material with potential pharmaceutical use is however hotly debated.

Some estimates of pharmaceutical values are summarised in Table 9.8. Economic studies that suggest relatively high values (e.g., Pearce and Puroshothaman, 1995, Rausser and Small, 1998, and Simpson and Craft, 1996) are typically based on values to society. These estimates are however modest when translated into per hectare values. More modest estimates still are typically based on the private WTP of drug companies for plant genetic material (e.g., Simpson *et al.*, 1994, 1996).

Table 9.8. Summary of Pharmaceutical Values

Study	Assumptions / Comments	Results
Ratanakiri Chapter 4	Benefits transfer (Ruitenbeek, 1990)	\$30/ha
Turkey Chapter 5	Based on Pearce and Puroshothaman, 1995 Average value	\$5.4 / ha - all Turkey
Ruitenbeek, 1989	Medicinal plant value in the Korup forest, Cameroon Average value	\$0.2 - \$0.7 / ha
Simpson <i>et al.</i> , 1994, 1996	Private WTP Estimate value of marginal species	\$20/ha in Western Ecuador \$1/ ha elsewhere
Mendelsohn and Balick, 1995	Average value based on likely discoveries and their market value. Based on a value of \$2.8-4.1 billion for undiscovered tropical forest drugs to pharmaceutical companies, and 3.1 billion hectares of tropical forests ¹	\$0.9 to \$1.3 /ha
Pearce and Puroshothaman, 1995	Assumes a tropical forest area of 1 billion hectares Based on established probabilities of finding a successful drug from plant species currently at risk. Lower value is private value, and upper is social value based on VOSL of \$7 million. Average value	\$0.1 - \$21 / ha per year [\$743–1.33 million per untested species, OECD]
Simpson and Craft, 1996	Social WTP Estimated value of marginal species	\$29 - \$2,888 per hectare of hotspot' land. Maximum WTP of marginal species = \$33,000

Study	Assumptions / Comments	Results
Rausser and Small, 1998	Private WTP Estimated value of marginal species	\$0 - \$9,177 per hectare of hotspot' land.

Notes 1: The estimates of 3.1 billion hectares of tropical forest appears to be an exaggeration, whereas the Pearce-Puroshothaman (1995) estimate appears too low. Based on 1.7 billion hectares of total tropical forest, the Pearce-Puroshothaman figures would further be reduced to nearly zero - \$12.3 per hectare, and the Mendelsohn-Balick figures would rise to \$1.6 to \$2.4 /ha (Pearce and Steele, 1999).

Pearce *et al*, 1999, note a number of factors to be considered in interpretation of these results.

- (i) Many studies report total values not the marginal value of genetic material (i.e., the value attached to one extra unit of genetic material)¹²⁸.
- (ii) Early studies ascribe the total value of a drug to the plant material which is only legitimate if there are no natural or synthesised substitutes. Similarly, some studies ascribe all health benefits of the drug to the plant material alone, ignoring the other inputs into the drug.
- (iii) The relevant measure should be the social value of the drug.
- (iv) Early studies relied on US prescription data that is heavily influenced by the success of a few drugs, notably from the *Dioscorea* family. These findings may not represent future success rates (Aylward *et al*, 1993).

¹²⁸ The total value of biodiversity is unbounded: without biodiversity there would be no human life and hence no economic value. The policy context is not one of the entire elimination of the world's stock of biodiversity, but changes in that stock. In the pharmaceutical context, the relevant economic value is the contribution that one more species makes to the development of new pharmaceutical products. Studies that derive average value estimates (e.g., the probability that a species will yield some commercial product multiplied by the commercial or social value of that product) have limited policy relevance since they do not relate to the marginal species or the marginal area containing biodiversity (Pearce *et al*, 1999).

- (v) Taking the competitive structure of the industry into account, as Rausser and Small do, seems to have a significant effect on economic value.
- (vi) The focus of the valuation matters. Early studies focused on the value of the drug. For example, Ruitenbeek, 1989, focuses on the value of the research discovery as revealed by the renewal fee for patenting the resulting compound. However, patent fees impart a downward bias to the estimates, since renewal fees are small relative to the other R&D costs. Other studies focus on a royalty approach (i.e., what a 'prospecting' country would pay to a host country for the right to prospect for plant genetic material).

The most sophisticated studies (Simpson *et al.*, 1994, 1996; Simpson and Craft, 1996; Rausser and Small, 1998) reach different conclusions. The original Simpson *et al.*, studies suggest very low values per hectare of forest¹²⁹. The Rausser and Small studies and the later Simpson *et al.*, studies suggest somewhat higher values. Simpson *et al.*, 1994 express WTP in terms of forest land designated as being subject to major threat, the so-called 'biodiversity hotspot'. Very small values emerge (\$0.2 – 20.6 / ha). The essential reasons for this are A/ that biodiversity is abundant and hence one extra species has low economic value, and B/ there is extensive 'redundancy' in that, once a discovery is made, finding the compound again has no value. Such low estimates are unlikely to affect land conservation decisions, and call into question two popular strategies to encourage biodiversity conservation – namely the expanding of biodiversity 'prospecting' and establishing property rights in biodiversity. Simpson and Craft, 1996 estimates however suggest that the larger 'social' values would be relevant to changing land use in some areas. Unlike Simpson *et al.*, 1994, 1996 they assume that species are 'differentiated' such that one is not a perfect substitute for the other.

Rausser and Small, 1998, rework Simpson *et al.*, 1994/6 estimates. They argue that the Simpson *et al.*, work characterises the pharmaceutical companies as testing

¹²⁹ Barbier and Aylward (1996) which analysed the MERCK-INBIO deal between Merck and Costa Rica reached similar conclusions.

samples in a random way, rather than adopting a structured approach based on various clues or leads that are likely to minimise search costs and maximise the probability of success. In effect, samples cease to be of equal ‘quality’ due to their information value. They derive estimates as high as \$9000/ha for the highest quality sites – large enough to motivate conservation activities if this value could be captured. This study is however criticised on a number of grounds (e.g., it adopts numbers from Simpson *et al*’s model under very different assumptions, assumes testing costs for an area are independent of the number of costs taken, and implies that redundancy is not a serious issue). The range of estimates for Malaysia based on recent studies is presented in Table 9.9.

Table 9.9. Estimates of Pharmaceutical Value for Malaysia ‘Hot Spot’ Land Area (Maximum WTP \$ / ha)

	Simpson et al (1994) WTP of pharmaceutical companies	Simpson & Craft (1996) ‘Social Value’ of genetic material / ha	Rausser & Small (1988) WTP of pharmaceutical companies
Malaysia	1.5	206	539
Range ¹	0.2 - 20.6	29 - 2,888	0 - 9,177

Note: 1/ Lower range figure is for California Floristic Province, upper range figure is for Western Ecuador.

Watershed Values

A selection of economic studies of watershed protection functions are summarised in Table 9.10. The few studies available tend to focus on single attributes of the protective function such as nutrient loss or flood prevention. Comprehensive estimates have still to be researched. Available studies suggest that fisheries protection values could be substantial in locations where there is a significant inshore fisheries industry (Hodgson and Dixon, 1988 and the Johor Study).

Table 9.10. Economic Value of Forest Watershed Protection / Water Supply Functions

Study	Type of watershed protection function	Results
All Turkey Chapter 5	Based on cost of dam sedimentation only	\$3 / ha
Johor, Malaysia Chapter 7	Shoreline protection by mangrove forest Fisheries protection by mangrove forest	\$845/ha \$526/ha
Kumari, 1996. Malaysian forest	Protection of irrigation water, valued at productivity of water in crops. Protection of domestic water supplies. Valued at treatment cost for improved quality ¹ .	\$15/ha \$ 0/ha
Pattanayak and Kramer, 2001 Eastern Indonesia	Drought mitigation from forest protection and re-growth, valued at gain in profits to rice and coffee production	\$3 - 35 <i>per household</i> ²
Hodgson and Dixon, 1988 Philippines	Fisheries protection from avoided logging	\$268/ha

Source: Non-case study examples from Pearce and Pearce, 2001.

Notes: 1/ Valued as the difference between currently unsustainable logging and sustainably managed logging, central case; 2/ The forest area is not stated.

The watershed protection values provided by primary forest were traditionally believed to be unambiguously positive. This is now known not to be the case. The hydrological literature suggests that the relationship between land use, hydrological function and flooding is localised at best, that the effects on dry season flow may be positive or negative depending on site conditions, and that annual water yield, or run off, is inversely related to forest cover. A number of the downstream economic activities are likely to respond positively to increases in annual water yields as a result

of forest loss (e.g., water supply, hydropower, navigation and productive land uses). Given the variance that exists from one watershed to the next in terms of biophysical and socio-economic characteristics it is risky to extrapolate results to other sites.

Calder, 2000 argues that land use and water decision making is often based more on myth than science. This can have serious consequences given that forestation and deforestation activities account for the highest area of land use change occurring on the planet today, and some of the largest hydrological impacts. Current scientific knowledge on the hydrological benefits of forests is summarised in Table 9.11.

Table 9.11. The Hydrological benefits of Forests – Myths and Reality

Statements	Fact	Comments
Forests slow the rate of runoff in a watershed	YES	By slowing the rate of runoff, forest can help to minimise flooding in smaller watersheds – although they may not influence large scale flooding - and may also increase minimum stream flows during the dry season. The exceptions are cloud forest and very old forest.
Forests ‘sterilise’ water supplies - improve quality	YES	Except in high pollution climates.
Forest loss shifts aquatic productivity	YES	Trees shade waterways and moderate water temperatures. Woody debris provides fish with habitat while leaves and decaying wood provides nutrients to a wide array of aquatic organisms.
Forests increase groundwater recharge	Site specific	Forest cover can lower groundwater recharge because more precipitation is intercepted by vegetation and returned to the atmosphere through evapotranspiration. In some areas, however, removal of forest cover can result in a crusting of the soil surface that reduces or prevents water infiltration and groundwater recharge (Falkenmark <i>et al</i> , 1999)]
Forests regulate flows – increase dry season flows	Site specific	Competing processes may result in either increased or reduced dry season flow. Detailed, site-specific models will be required to predict impacts.
Forests reduce erosion	Site / species specific	Forest cover as such does not guarantee low rates of erosion - the forest quality (density of trees, quality of the lower canopy layers, availability of surface litter, etc) is an equally, if not more, important factor. Sedimentation levels in waterways of forested watersheds are generally lower than in nearby agricultural or urbanised watersheds, but the degree depends on soil types, topography and climate (Falkenmark <i>et al</i> 1999).
Forests increase rainfall	NO	The overwhelming hydrological evidence shows that forests are not generators of rainfall

Statements	Fact	Comments
Forests increase the total annual water flow in a watershed	NO	Contrary to popular opinion forests generally reduce the total annual steam flow. This is because trees consume water for transpiration, which is then evaporated into the atmosphere.
Forests reduce floods	NO	Hydrological studies carried out in many parts of the world show little linkage between land use and storm flow, and therefore do not support this view. At smaller spatial scale, there is greater likelihood of land use affecting both peak storm flow and time to peak. Management activities - cultivation, drainage, road construction, soil compacting during logging - are more likely to influence flood response, rather than the presence and absence of forests themselves.

Box 9.1. Carbon Sequestration Benefits and Water Resource

Given that forests reduce annual water flows, the promotion of forestry as a land use in rural watersheds through carbon sequestration credits under the Kyoto protocol may be at the expense of reduced water resources. This could aggravate downstream water resource conflicts (Calder, 2000). In such cases it is prudent to compare the value of carbon sequestration credits with the value of the water that will be forgone. Taking 250 and 400 mm per year as the average loss of water under deciduous hardwood and pines / eucalypts respectively (Bosch and Hewlett, 1982), and conservative average values of water for agriculture or industrial water use as \$100 per 1000m³ (values have been quoted as high as \$4,000 for industrial purposes and nearly \$2,000 for some speciality crops) the loss in value of water under hardwood forestation would be \$250/ha and \$400 under pine/eucalypts. Aylward, 1988b suggests from studies in Latin America, that carbon sequestration credits arising from forestation would amount to around \$200-500/ha, with a price of \$20/ton (amongst the highest of the present carbon valuations). Clearly, if there were higher-value uses for water within a catchment and users were able to afford more than \$100-1,000m³ on strict economic arguments alone, forgetting the possible socio-economic downsides, there would be little merit in pursuing carbon credits.

Carbon Storage and Sequestration

A number of studies suggest potentially very large values for the carbon storage functions of forests¹³⁰. Brown and Pearce (1994) suggest benchmark figures for carbon content and loss rates for tropical forests, as shown in Table 9.12. A closed primary forest has around 280 tC/ha of carbon and if converted to shifting agriculture would release about 200 tons of this, and a little more if converted to pasture or permanent agriculture. In reality estimates will vary by region and whether or not soil carbon is released.

Table 9.12. Changes in Carbon with Land Use Conversion: Tropical Forests

tC/ha

		Shifting agriculture	Permanent agriculture	Pasture
	Original carbon	79 (53 soil, 25 biomass)	63 (mainly soil)	63 (mainly soil)
Closed primary forest	283 (116 soil, 167 biomass)	-204	-220	-220
Closed secondary forest	194 (84 soil, 110 biomass)	-106	-152	-122
Open forest	115	-36	-52	-52

Source: Brown and Pearce, 1994

¹³⁰ Carbon storage relates to the carbon stored in a standing forest that is close to 'carbon balance'. Carbon sequestration relates to the net fixation of carbon by a growing forest. The value of the carbon sequestered is the same, per ton of carbon, as in the carbon storage case, but the value will be aggregated only over the rotation life of the forest if that applies.

The economic value of carbon stocks is typically based on the economic value of global warming damage expressed in terms of the economic value of a marginal ton of carbon. Recent literature reviews by Clarkson (2000) and Tol *et al.*, (2000) suggest a consensus value of \$34-50 tC. Pearce, 2002 reviews estimates of the social costs of global warming. He concludes that marginal (unweighted) damages are \$4-9 tC assuming a constant discount rate. This may understate damage due to the omission of major catastrophes and of 'socially contingent' damages such as the cost that may be incurred through induced mass human migration. However, this range may overstate damage because the integrated assessment models generally exclude amenity benefits from global warming. If equity weighting is incorporated the range increases to \$4.5- 22.50 tC, while if a time-varied discount rate is used the range is \$6-40 tC. In practical terms, perhaps the best guide to the value of carbon is what it is likely to be traded at in a 'carbon market'. Zhang (2000) suggests that, if there are no limitations placed on worldwide carbon trading, carbon credits will exchange at just under \$10 per tC. Based on Table 9.12, Table 9.13 reveals the high values obtained for tropical forests when applying a conservative carbon-trading price of \$10.

Table 9.13. Changes in Carbon with Land Use Conversion: Tropical Countries
tC/ha

		Shifting agriculture	Permanent agriculture	Pasture
	Original carbon value \$/ha	790	630	630
Closed primary forest	2,830	-2,040	-2,200	-2,200
Closed secondary forest	1,940	-1,060	-1,520	-1,220
Open forest	1,150	-360	-520	-520

Source: Brown and Pearce, 1994

Carbon regimes in temperate countries have also been extensively studied. Carbon values per hectare of afforested land in the UK and Ireland are estimated to be in the region of \$88-413 / ha (see Pearce 2001). These figures compare favourably with the estimate derived for Turkey, that is \$156/ha (see Chapter 5).

Option and Existence Values

Kling (1993) suggests that option values are likely to be small relative to the general size of use values. This is because option value can be thought of as a measure of risk aversion, i.e., an aversion to not having the good in question available. Based on past studies of recreational demand, Kling suggests that option values are less than 3-4 per cent of use value. Existence values have been shown to be substantial for 'unique' forests, or forest that contain some form of highly prized biodiversity.

Table 9.14 summarises selected studies on option and existence values. The estimates of international WTP for Benut's mangroves, with a focus on the lesser adjutant stork, can perhaps best be compared with Loomis and Ekstrand's study on the spotted owl. The Johor estimates are seen to be high.

Table 9.14. Option and Existence Values for Forests

Nature of the good	Study	Result
WTP for management plan which would protect biodiversity of Benut's mangroves	Benut, Malaysia Chapter 8	\$7,400 ha (International WTP) \$24 ha (Local WTP)
Implied WTP based on international funding for forest protection	Turkey Chapter 5	\$0.70 / ha
Protection of 5% more of the world's tropical rain forests. Assumes 5% already protected, so scenario is 10% protection. Values reflect existence and bequest.	Kramer and Mercer, 1997. Contingent valuation.	US residents willing to pay 'one-off' payment of \$21-31 per household. Across 91 million households, suggests \$2.6-2.9 billion. At 5% interest rate, suggests a fund producing \$130-140 million p.a. Divided by 5% of the area of tropical rainforest (720 million ha), this implies about \$4 per hectare p.a.
Habitat of the Mexican spotted owl	Loomis and Ekstrand, 1998	\$102 per US household p.a. implies \$4400/ha.
Implied 'world' willingness to pay for limited forest areas covered by debt-for-nature swaps	Pearce, 1996	\$ 5/ha
Implies 'world' willingness to pay via Global Environment Facility	Pearce, 1996	\$ 2/ha
Debt for nature swaps and grant aid to Mexico forest conservation	Adger <i>et al.</i> 1995	\$12/ha

Nature of the good	Study	Result
WTP for changes in forest management practice towards richer biodiversity in UK forests.	Garrod and Willis, 1997. Contingent ranking (choice modelling).	Individuals WTP \$0.2 p.a. to ensure forest converted to basic biodiversity levels, \$0.4 to move to 'desired' biodiversity levels, \$0.15 to convert to native woodland. Suggests \$4-5 million p.a. benefits over 23 million households for a 300,000 ha area, i.e. \$13-17 ha.

Source: derived from Pearce and Pearce 2001.

Summary of Economic Values

Table 9.15 compares the economic values of tropical and temperate forests based on a current literature review with case study results.

Table 9.15. Economic Values (\$ ha/pa unless otherwise stated)

Forest Good or Service	Ratanakiri Chapter 4	Tropical forests¹	Turkey Chapter 5	Temperate Forests¹
Timber				
Conventional logging	122	20 - 440		
Sustainable logging	24	30 - 266		
Fuelwood		40		
NTFP	41-366	0 - 100	25	Small
Genetic information	30	0 - 3,000	5	
Recreation				
General		2 - 470	0.4	80
Forest near towns		750		
Unique forest		1,000		
Watershed benefits	5	15 - 850	3	-10 - +50
Climate benefits		220 - 360 (GPV)	156 ²	90 – 400 (afforestation)
Biodiversity (other than genetics)				?
Amenity				
Non-use values				
Option values		2 - 12		70?
Existence values		4,400 (unique areas)		12 - 45

Notes: 1/ Source – Pearce and Pearce 2001. 2/ Annuitised at 10% discount rate

While it is of course impossible to generalise, given that values are site specific, some general conclusions can be drawn from the current body of evidence (Pearce and Pearce 2001). The dominant values are carbon storage and timber. Other values do not compete with carbon and timber unless the forests have some unique features (either unique in themselves or as a habitat for unique species) or are subject to potentially heavy demand due to proximity to towns. Uniqueness tends to be associated with high non-use value. The non-use values for 'general' forests are very modest.

The findings for Ratanakiri compare well with the average values derived for tropical forests. The value for genetic resources cannot be relied upon given the approach used and current understanding of genetic values. However, carbon values were not incorporated in the analysis. Even using a lower bound estimate of \$220/ha the benefits of conservation would outweigh the benefits of conventional logging in Ratanakiri. The estimates derived for Turkey compare well to the average values derived for temperate forests.

As Pearce and Pearce 2001 point out, empirical studies to date have not investigated the potential for annual forest values to rise through time relative to other values. There are two reasons for supposing that there will be a 'relative price effect' for forests: (a) if the forest stock continues to decline, the value attached to a marginal unit of forest should rise (the supply effect) and (b) incomes will rise thus raising WTP per unit of forest.

9.4 Mangrove Values - Comparative Analysis

Table 9.16 presents the results of other mangrove studies. For Koh Kong, if the estimates for local uses and charcoal are combined (i.e., \$190) the findings compare better with other estimates of local use, but are on the low side. For Benut and Johor in general, fishery estimates are high. Non-use values for locals in Johor (i.e., \$25) are low compared to Naylor and Drew's CV study of local mangrove users. The non-use value for non-Malaysians is high, but lower than Dixon's estimate of the value of an intact mangrove.

Table 9.16. Comparison of Mangrove Valuation Studies, \$/ha/Year

Study	Forestry	Fisheries	Erosion	Biodiversity	Storm protection	Purification	Local Uses	Charcoal	Tourism	Intact Mangrove System	Non-use
Thailand. Christensen, 1982	30	130	165				230				
Dixon, 1989										11,600	
Costanza <i>et al</i> 1989		63								500-2,500 ¹	
Fiji. Lal, 1990	6	100	52			5,820 ²					
Indonesia, Ruitenbeek 1992a	67	117	3	15 ³							
Philippines Jansen & Padilla, 1996	151	60									
Kosrae. Naylor & Drew, 1998 ⁴							426-640				640-806

Study	Forestry	Fisheries	Erosion	Biodiversity	Storm protection	Purification	Local Uses	Charcoal	Tourism	Intact Mangrove System	Non-use
Thailand Sathirathai, 1998 ⁵		2			79		27				
Koh Kong, Chapter 6					33		44	146			
Benut, Chapters 7& 8	29	526			845				3		7,400
Johor, Chapters 7 & 8	29	526						7			

Notes: 1/ Forestry and fisheries benefits; 2/ Based on the cost of constructing a sewage treatment plant; 3/ Based on the commercial value of medicinal plants from mangroves; 4/ The mangroves of Kosrae cover 1, 562 hectares. Local use values comprise: mangrove wood for cooking, crabs and near shore fish. Non-use values reflect the additional amount that local people are WTP to protect the use of the mangrove swamp indefinitely; 5/ Estimates of mangroves system in Surat Thani. Local use values relate to the supply of fish, timber and fuelwood. Fisheries estimate relates to offshore fisheries. Coastal protection (storm protection) based on replacement cost approach. Also, estimates carbon benefits at \$2/ha, but uses a low value for carbon (i.e., \$5.67 tC).

9.5 Capturing Economic Values

9.5.1 Framework for Analysis

For the conservation values estimated in the cases studies to be made explicit in the decision-making process, mechanisms need to be put in place to capture these values. This could be achieved through the introduction of property rights, the creation of new markets, the introduction of economic instruments, and the design of institutions, policies and legislation. This Section discusses the capture mechanisms that could potentially be applied in Cambodia (Ratanakiri and Koh Kong), Malaysia (Johor) and Turkey. It is based on the information derived through the valuation exercises and an understanding of local conditions and is intended to provide guidance to any future efforts to develop capture mechanisms at the study sites, rather than definitive conclusions.

In order to identify which mechanisms could be further developed for each site the following steps were undertaken:

1. A framework for analysis was developed which broadly categorises capture mechanisms under property rights, market creation, fiscal instruments, charge systems and financial instruments (this is consistent with Table 3.1) and summarises the key conditions necessary for each category of capture mechanism to be effective (Table 9.17)¹³¹. For each case study, the potential for each category of capture mechanism to be successfully applied was rated according to: A - could be applied, although minor reforms or actions might be required; B – could potentially be applied but serious issues need to be addressed; and, C - no real potential. Mechanisms with ‘no real potential’ were dropped from the analysis (Table 9.17).
2. Following this initial analysis, potential capture mechanisms were identified per resource component valued for each of the study sites. These mechanisms were further

¹³¹ See Chapter 3 for description and discussion of the individual capture mechanisms

analysed in order to determine which should be given priority in any future action plan for capturing forest component values. This was based on considerations such as the ease with which they could be implemented (e.g., amount of information required, administrative costs, likelihood of opposition, concordance with institutional framework, and suitability to local conditions) and the significance of the component resource value they related to.¹³²

Table 9.17 summarises the key conditions necessary for the categories of capture mechanism to be successful, and ranks each category by case study. The potential (ranking) of individual capture mechanisms is discussed for each study in Section 9.5.2.

¹³² Section 3.11 also discusses the pros and cons of different capture mechanism.

Table 9.17. Key Conditions Necessary for Effective Implementation of Capture Mechanisms and Ranking by Case Study

Category of mechanism	Examples	Key Conditions	Ranking ¹			
			Ratanakiri	Koh Kong	Johor	Turkey
Property rights	Ownership rights (land titles, water rights) User rights (concession bidding) Development rights (prospecting rights)	Effective monitoring Consideration of existing community based management systems Sound and enforceable regulations Good information	B	B	A-B	A-B

Category of mechanism	Examples	Key Conditions	Ranking ¹			
			Ratanakiri	Koh Kong	Johor	Turkey
Market creation ²	Trading schemes (e.g., tradeable emissions/effluent permits) Self organised private deals Public payment schemes Carbon offset / CDM Conservation concessions GEF funding Purchase of nature	Secure property rights Strong institutions Market infrastructure Good international relations Good information (stakeholder analysis) Government support	B-C	B-C	A-B	B
Fiscal Instruments	Pollution / Product taxes Royalties and resource taxes Tax differentiation Land use taxes	Strong institutions Good information so that effective tax can be set General acceptability (lack of resistance)	B	B	A	A

Category of mechanism	Examples	Key Conditions	Ranking ¹			
			Ratanakiri	Koh Kong	Johor	Turkey
Charge systems	Impact / access fees	Strong institutions (in particular good enforcement system) Good information so that effective charge can be set General acceptability (lack of resistance)	B	B	A	A
Financial instruments	Environmental funds	Government support Strong institutions (in particular good regulations)	B	B	A	A
Bonds	Environmental bonds	Government support Strong institutions (in particular good regulations)	C	C	B	B

Notes 1/ A - could be applied, although minor reforms or actions might be required; B – could potentially be applied but serious issues need to be addressed; and, C - no real potential. 2/ A range of rankings is presented for the market creation category. This reflects the fact that some mechanisms, such as tradeable systems, require quite sophisticated institutional arrangements and market systems and therefore have limited potential in Cambodia for example, whereas mechanisms such as the CDM and GEF funding which essentially involve international transfers are considered to be the most viable options for Cambodia (see Section 9.5.2).

As discussed in Chapter 3, defining property rights is a logical first step in improving the sustainable management of resources. However, monitoring of natural resources is often required to ensure that property rights are not being infringed. This is particularly important in remote areas. Property rights should also be based on a good understanding of local community based systems and should be rooted in sound regulations.

In the last decade, proposals to market environmental services provided by forests have become a reality in a wide range of settings¹³³. However, the conditions necessary for markets to function effectively in developing countries are typically lacking or weak (Landell-Mills and Porras, 2002). These include:

- (i) Formal and secure natural resource rights. Without clear and defensible rights to land, forest or the environmental service itself, suppliers cannot make a credible commitment to supply an environmental service.
- (ii) Strong institutions to manage high monitoring and transaction costs often associated with market development, administer tradable systems, and set and maintain good regulatory system.
- (iii) Market infrastructure such as good communications, information and transport systems.
- (iv) Expertise in marketing, negotiation, management, financial accounting, contract formulation and conflict resolution so that countries / individuals have the expertise to participate in markets.
- (v) Start up finance.
- (vi) Good international relations (especially important with respect to mechanisms targeted at the capture of global assets).

¹³³ Landell-Mills and Porras (2002) review over 280 cases of market creation worldwide for four forest environmental services - carbon sequestration, biodiversity protection, watershed protection and landscape beauty.

Many of the above conditions apply to the effective application of other capture mechanisms such as fiscal instruments, charge systems, financial instruments and bonds (see Table 9.17). In addition, fiscal instruments require good information so that they can be set at effective levels. They also need to be generally accepted. An understanding of the incidence of taxes on different stakeholders may be necessary to anticipate potential opposition to it. Public information on the purpose and management of fiscal systems may be necessary to help to build support.

In general government support appears to be critical to the development of capture mechanisms in developing countries. Governments can be instrumental in the provision of secure tenure by the formalisation and registration of rights, maintenance of a central public registry, coordination of government departments involved in allocating rights, and the strengthening of monitoring and enforcement systems that ensure rights can be defined where challenged. They can help lower transaction costs and risks for potential participants by investing in (market) infrastructure, efficient communication systems, research on service delivery and measurement, training and investment in supporting regulations and standards¹³⁴. They can introduce stricter environmental standards in order to ease the implementation of mechanisms. Finally, governments can play a role in awareness raising which can promote public support for capture mechanisms.

Global values are seen to represent a significant proportion of total value for the study sites (Table 9.18), highlighting the importance of attracting international support for conservation efforts.

¹³⁴ Coase (1960) showed that provided transaction costs were very small and property rights well defined and enforceable the producer and consumer of an externality would have a market incentive to negotiate a mutually beneficial trade (i.e., to internalise the externality). However, in developing countries transaction costs are typically considerable, and property rights ill-defined and poorly monitored, suggesting a role for government in supporting the development of markets and/or alternative capture mechanism.

Table 9.18. Proportion of Local to Global Value

Study	Local Values	Global Value
Ratanakiri	42%	58%
Turkey	15%	85%
Koh Kong		Not estimated
Benut, Malaysia	16%	84%

Note: Ratanakiri – Global value based on biodiversity estimate of \$30 / ha/ year only. Underestimated due to the fact that carbon values are excluded. Local values include NTFP and watershed protection of agricultural production.

9.5.2 Identifying Potential Capture Mechanisms

Cambodia - Ratanakiri

Weak institutions and lack of funds severely hampers natural resource management in Cambodia. There are no management plans for most protected areas, corruption and illegal activities are commonplace, and legislation relating to forest and agricultural land is ambiguous and not enforced. Only 0.17% of the budget of the Royal Government of Cambodia (around \$520,000 in 1997) is allocated to the MOE. The MOE is therefore reliant on foreign assistance for capital expenditure and the financing of daily operations in the environment sector (De Lopez, 2001). Given the uncertainties surrounding conservation, most Cambodian policy makers favour the immediate cash benefits of ‘development’ alternatives. Furthermore, powerful groups stand opposed to conservation decisions detrimental to their interests. Without international transfers for conservation, high value areas cannot be maintained.

Table 9.19 summarises possible mechanisms that might be introduced at the local and international level to capture the benefits of sustainable use of Tapean forest, Ratanakiri estimated in Chapter 4. In general the application of all mechanisms is hampered by the lack of Government support for sustainable forest management,

wide-spread corruption, weak institutions, lack of funds, poor information and weak local expertise.

Table 9.19. Ratanakiri, Cambodia – Potential Capture Mechanisms

Resource Value	Capture Mechanism / Ranking	Requirements / Comments
Timber	Forest fees and timber taxes (B)	Recent reforms face a number of obstacles
NTFP	(communal) ownership (B)	Lack of government support for sustainable NTFP management Property rights needed
Malva nuts	Tax on quantity of malva nuts taken / days spent collecting (B)	High priority within NTFP management plan Requires property rights Training of local communities
Watershed benefits	Water rights (B) Water pricing (B) Water protection charges (B)	Low priority Restricted by weak institutions and lack of information
Biodiversity	Charges for scientific tourism (B) Conservation concessions (B) Purchase of nature (B) GEF funding (B)	High priority Grant based approaches have the best chance of winning Government support Addresses funding difficulties Requires strong commitment from Government Could be used to leverage great community control of natural resources
Carbon Storage	GEF funding (B) CDM (B) Carbon offset (B)	High priority - <i>see comments on biodiversity</i> Concerns over equity Requires development of local expertise

Illegal logging throughout the 1990s has destroyed much of Cambodia's forests, its most significant economic resource (Global Witness, 2001). A recent ADB concession review described the Cambodian forestry sector as a 'total system failure', and recommended that concessions be terminated unless they radically reformed (ADB, 2000). They were asked to produce social and environmental impact assessments and long term forest management plans by September 2001. None of the 17 concessionaires achieved this deadline or the required standards. The companies have operated in a 'legal vacuum' and all have practiced unsustainable and/or illegal logging. Furthermore, rent capture by the Ministry of Finance has been minimal¹³⁵. It had been predicted that Cambodia's forests would be commercially logged by 2003. Sustained criticism of Cambodia's forest 'management' coupled with the linking of foreign aid to forest sector reform has pushed Cambodian Prime Minister Hun Sen to suspend all logging operations (January 2002)¹³⁶. The establishment of the Forest Crime Monitoring Unit (FCMU)¹³⁷, the drafting of new forestry legislation, and a dramatic decline in illegal logging indicates that there is some hope for Cambodia's forests.

¹³⁵ Total returns generated by the forestry sector between 1994-2000 was \$92 million.

¹³⁶ The Royal Government of Cambodia's (RGC) policy on forestry will remain a criteria used by the donors in determining future aid disbursements.

¹³⁷ The FCMU was established following the 1999 Consultative Group meeting to develop the RGC's capacity to detect and suppress illegal logging, and to provide the international community with an independent oversight of this process. The FCMU consists of: 1/ The Forest Crime Monitoring Office (FCMO) in the Department of Forestry and Wildlife (DFW) to monitor forest crimes in production forests; 2/ The Department of Inspection (DI) in the MOE to monitor forest crimes in protected areas; and 3/ Global Witness – an independent monitor.

Box 9.2. Policy Distortions and Cambodia's Forests

Hun Sen's 17 point declaration, 25 January 1999, is the bedrock of the logging crackdown. Clause 1 requires concessions to allocate 10-20% of their annual harvest to the domestic market at a reasonable price. Concessionaires have to pay royalties on this quota, and the price of their timber is \$100-200 / m³, which local people cannot afford. Hero for example charges \$130 per m³. Local people have no choice but to either cut the timber themselves or buy from sources other than the concessionaires. As it stands the concession system has made criminals out of the people who were previously permitted to cut timber for local use. In Ratanakiri local businessmen illegally supply timber for between \$70-90 per m³ undercutting official rates. Hero has been unable to sell the 10-20% quota locally and, in theory, utilises 100% of its quota. There is also unregulated exploitation of the forest both inside and outside the Hero concession area. Part of the solution is to speed up the establishment of community forest. Although this might satisfy local demand, more work has to be carried out to find ways of satisfying demand at a national level without encouraging illegal exports (Global Witness, 2000).

In order to better manage timber concessions, forest fees and timber taxes need to be revised in order to fully internalise social costs (rent capture is currently low). Timber values are likely to be best captured through concession bidding. However, concession bidding requires an un-corrupt and competitive bidding process and is therefore not currently viable in Cambodia.

Since 1997, when the study of Ratanakiri was undertaken, commercial logging activities have continued in the province by Hero Taiwan Company against the wishes of indigenous communities. Logging has taken place in 'spirit' forests, resin trees have been cut down, and wildlife has disappeared¹³⁸ (Global Witness, 2000). Efforts are still being made to cancel all concessions on indigenous peoples' land.

If the area were to be managed by local communities for the sustainable collection of NTFP it would need to be excluded from commercial logging practices. At present

¹³⁸ Traditionally, old growth forests were kept as reserves as they are integrally tied with highland people's belief systems. These old growth reserves offered a sanctuary and breeding grounds for wildlife.

there is no political support for this option. It would also require the establishment of enforceable property rights backed by strong forest regulations. As mentioned in Chapter 4 these rights would need to be based on existing customary practices in order to be successful. Given the high potential value of malva nuts priority should be given to managing this resource within a NTFP management strategy. Taxing the collection of malva nuts is discussed in Chapter 4 as a possible mechanism for encouraging the sustainable collection. However, implementation of taxes would require a clarification of property rights and cooperation and management among the communities concerned. More information would be needed on sustainable yields in order to set an effective tax. While there is evidence that local people have the motivation to manage their customary forests, additional training and support would be needed (e.g., to administer and monitor a tax, adopt more sustainable harvesting practices). The possible mechanism for realising NTFP values therefore face serious issues.

Market creation for watershed protection (e.g., trading schemes, self organised private deals, public payment schemes) typically involves a large number of stakeholders and transaction costs are therefore high. Payments need to be channelled through intermediaries, allowing buyers and sellers to contract out the negotiations and conclusions of deals, overseeing implementation and enforcing contracts. High transactions costs limit their applicability in developing countries. The scientific uncertainty over the forest-hydrology link also undermines market development. For the most part, markets have emerged as a result of a growing WTP amongst beneficiaries. This is often the result of improved understanding of the benefits provide by watersheds and the growing threats that they are facing. In more developed countries, new government regulations for improved water quality have been the major force behind investment (Landell-Mills and Porras, 2002).

The capture of watershed benefits through market creation is not considered an option for Ratanakiri given the high transaction costs involved, poorly established institutions and the fact that the scientific relationship between forest and watershed in Ratanakiri is not yet definitively understood. Other mechanisms for capturing watershed benefits include water rights, water pricing, water protection charges, all of

which face the generic problems facing the introduction of capture mechanism in Cambodia highlighted above.

The global value of Tapean forest is estimated at 58%. This underestimates actual global value given that carbon storage values are excluded and are likely to be the dominant forest value. The capture of global values can be considered a priority in Ratanakiri – they represent a high proportion of TEV and therefore would present a strong case for conservation and they could be captured through international transfers which are attractive to Cambodia given the country's inability to self fund the protection of its natural resources.

In terms of biodiversity, conservation concessions and GEF funding appear to be the most promising. Both are grants but require donor confidence in the Government's ability to manage forest areas for conservation. Purchase of nature requires that the legal system must allow purchase of nature by NGOs and is therefore restricted by Cambodia's weak legal structures. There may be a market for scientific tourism given Tapean forest's rich biodiversity which is relatively unstudied, however better management and security in the area would be needed to exploit this.¹³⁹

As a priority Cambodia could focus on the capture of carbon storage functions through the CDM. This addresses Cambodia's lack of funding and there is Government interest in this approach. The Department of Forestry and Wildlife has land available for reforestation and afforestation projects (activities eligible for CDM funding) and have been prospecting with Japanese companies in Ratanakiri for potential CDM sites (*pers com.*, Thanak De Lopez, May 2003). The negotiation and monitoring of CDM projects can be complex and the development of local expertise will be needed if Cambodia is to fully exploit its potential in this respect. There are also equity concerns as discussed in Chapter 3 which need to be addressed for any CDM initiative introduced in Ratanakiri. More generally, the ratification of the Kyoto

¹³⁹ The difficulties associated with setting up prospecting rights are summarised in Table 3.8. The returns are also questionable and this mechanism is therefore not considered for any of the case studies.

Protocol and more favourable conditions for forestry within it would be a great impetus to this market.

Cambodia – Koh Kong

Management of Cambodia's mangrove forests and fisheries also suffers from a lack of financial resources, weak institutions and illegal activities. As stressed in Chapter 6, successful management of Koh Kong's mangroves will require the development of an integrated management plan. Therefore all the mangrove components valued should ideally be given the same high priority. Realistically, however, a piecemeal approach to the improved management and capture of resource components is more likely. Initially steps should be taken to remove distortions that result in resource degradation. Table 9.20 lists the capture mechanism that might be employed to realise the economic value of Koh Kong's mangroves.

Table 9.20. Koh Kong, Cambodia - Capture Mechanisms

Resource Value	Capture Mechanism / Ranking	Requirements / Comments
Fuelwood	(Communal) ownership (B) Impact / access fees (B)	Government support and institutional structures currently lacking
Charcoal	Sustainable charcoal production under licence for subsistence purposes (B)	More information needed to set sustainable production levels Requires good enforcement system
Fishing	Controls of fishing equipment, season and area recommended under current law (B) Customary territorial rights (B)	Institutions need to be strengthened so that fisheries law is enforced
Biodiversity	Conservation concessions (B) Purchase of nature (B) GEF funding (B)	Value needs to be estimated International transfer would be a good way of securing conservation values within core zone Requires involvement of local people
Aquaculture	Pollution / effluent taxes (B)	Introduction of social cost pricing Institutional strengthening and involvement of local people important

Fuelwood could be better managed through the granting of communal ownership to local people. There is however no evidence of Government support for such an initiative at present. Fees to control fuelwood collection might also be introduced, but this would require the development of monitoring and administrative structures, information on the appropriate fee level and the support of local communities.

Charcoal production licences have been introduced in other parts of the country. Given the limited employment options in Koh Kong, sustainable charcoal production under licence could be a viable component of an integrated mangrove management plan. The development of a sustainable charcoal production plan would however require a more detailed inventory, information on appropriate harvesting practices and the introduction of a good monitoring system.

The existing Fishery law, if implemented, would provide a sound base for resource conservation. The Law strictly regulates fishing gear and equipment, fishing seasons and fish sanctuaries. However, the Department of Fisheries (DoF) lacks the budget¹⁴⁰, equipment and political support to enforce the law. Fisheries in Cambodia are said to have turned into an exclusive preserve for the profit of the nation's elites (De Lopez, 2002). The continuing exploitation of coastal ecosystems in Koh Kong threatens the livelihoods of local communities who are dependent on the fisheries resource. Customary territorial rights (e.g., leasehold arrangements, franchises, allocation of ownership over an area or stock) could result in a more equitable distribution of the resource, and encourage sustainable management. There is however no political support for such an initiative at present. Such rights would also need to be backed by appropriate institutional structures. Given the current lawlessness associated with Cambodia's fisheries the introduction of economic instruments (e.g., taxes on catch or effort and fishing licensing schemes) is not currently an option.

Biodiversity values for Koh Kong were not estimated but are considered to be high. As for Ratanakiri, international transfers are likely to be the most viable mechanism for capturing biodiversity values. Successful conservation of areas within an integrated management plan would need to involve local people. A possible approach is to pay local people a wage to become guardians of the mangrove forest, as practised in Vietnam.

At present there are no controls on aquaculture production resulting in high social and environmental costs. As a priority social cost pricing needs to be enforced through

¹⁴⁰ The existing law budget is chronically inadequate, averaging under \$200,000 a year.

the administration of appropriate taxes and charges. Such approaches are likely to be resisted by farm owners, and weak institutions hamper their implementation. Furthermore, local community hostility needs to be overcome by greater involvement of local people in the management and profits of the aquaculture ventures.

As with Ratanakiri, implementation of the majority of capture mechanisms in Koh Kong is limited by weak government and institutions. While many of the capture mechanisms therefore have potential, Government support for their implementation and strong institutions are a pre-requisite. Given the significance of capturing global values, donor confidence in the ability of Cambodia to manage its natural resources is key. Initiatives taken at the national level towards sustainable resource management are likely to encourage donor assistance and private investment (Box 9.3).

Box 9.3 'Good' Governance and International Assistance

In Cambodia, Land Law and Forest concession reforms are of serious concern for donors. Under the full reform scenario, the Asian Development Bank expects Cambodia to be able to attract official grants and loans of up to \$1,046 million per year by 2002, compared to \$71 million per year under a no reform scenario. The international response to forest management in Cambodia is evidence of the increasing trend towards the linking of aid to good governance.

The World Bank, 1988, states that development assistance should focus on countries with good political frameworks and sound economic management. The Secretary-General's report on financial resources and mechanisms for sustainable development (1995) observes: 'Policy performance is rapidly becoming the single most important determinant of countries' access to financing from all sources. The application of economic instruments will help countries create a favourable climate to attract and absorb international investments from public and private sector. Economic instruments can help countries in rectifying the economic distortions and mobilise additional national and international resources.'¹⁴¹

Correction of internal policy and market failures can encourage international assistance. However such reforms and initiatives in developing countries are often restricted by their relatively weak capacity in the field of institutions, insufficient finance and unfavourable financial conditions (e.g., underdeveloped capital markets and high discount rates), and the lack of qualified human resources. Furthermore, mechanisms that restrict or constrain economic growth or conflict with developing countries priorities are likely to be unpopular.

¹⁴¹ Commission on Sustainable Development, Third Session.

Malaysia

In order for Johor to realise the mangrove values demonstrated in Chapters 7 and 8 for its 19 sites, mangrove forest management plans, policies and strategies need to be reformed accordingly. As a first step distortionary incentives need to be removed. Possible capture mechanisms for individual mangrove forest components are summarised in Table 9.21 and discussed below¹⁴².

¹⁴² The key values associated with each site are summarised in Table 7.2. Priority would be given at each site to the capture of these key values.

Table 9.21. Johor-Malaysia - Capture Mechanisms

Resource Value	Capture Mechanism / Ranking	Requirements/ Comments
Poles	Licence fees / Royalties (A) Competitive tender system (B)	Introduction of social cost pricing required Production needs to be based on sustainable yield
Charcoal	Licence fees / Royalties (A) Competitive tender system (B)	As above
Fishing	Reform of Comprehensive Licensing Policy (A) Customary territorial rights (B) Quantitative controls (e.g., catch quotas) (B) Area controls (B) Taxes on catch or effort (B)	Better monitoring and enforcement required More information needed to set sustainable harvesting levels
Aquaculture	Pollution/effluent taxes (A)	Strong institutions required General acceptance of taxes important
Tourism	Introduction of tourism fees and charges (A)	Requires development of sustainable tourism operations, and training of local communities
Biodiversity (Existence values – Benut)	Conservation concessions (A) Purchase of nature (A) GEF funding (A) Tourism charges (e.g., Panda stamp) (B)	High priority for Benut mangroves Government support of conservation efforts required

As described in Chapter 7, JSFD collects royalties on the basis of the number of poles extracted and charcoal produced, as well as licence fees. However, licence owners

enjoy significant economic rent. In order to improve resource management, licence fees and royalty systems need to be revised in order to increase rent capture. Mangrove wood production should also be based on sustainable production quantities as estimated in Table 7.20. The introduction of a tender system however is likely to be the best way to create an efficient market in logging rights and charcoal production. This would hopefully both improve the competitive performance of the companies and the equitable allocation of the forestry resource. The acceptability of a tender system among concerned parties and the changes to the institutional framework needed to introduce such a system need to be explored.

At present the Fisheries Comprehensive Licensing Policy attempts to reduce fishing effort through a licence limitation scheme. This scheme is however ineffective and over-fishing is evident. Better monitoring and enforcement is therefore required. In areas where local dependence on fisheries is high, customary territorial rights would be a good solution. This would address equity concerns. However, the political will to confer additional rights to local communities is low given the current trend toward large-scale commercial fishing and the conversion of mangrove sites. Other possible mechanisms to improve fisheries management include taxes on catch or effort, and area controls (e.g., closed areas and seasons). Such approaches would however face the same obstacles confronting the present system - they would require good administration and monitoring, and information on sustainable harvesting levels.

Aquaculture production as currently practised is resulting in many adverse impacts on the environment. As a first step, subsidies offered to small and medium sized farms need to be removed. Further to this pollution taxes could be introduced in order to move towards social cost pricing. Introduction of such taxes would require good administrative arrangements and monitoring systems, and the support of parties involved. Resistance to such charges are likely to be high. This suggests a role for government in the development of institutions (legal and regulatory) and in the promotion of public awareness and support.

Tourism, though currently underdeveloped in Johor, has potential at some sites. The introduction or increase in entrance fees is an obvious way to capture ecotourism values. Training of local communities in management, development and marketing of

eco-tourism ventures is likely to be required. More information on sites is also needed to determine demand and carrying capacities.

As a first step to realising biodiversity values perverse incentives need to be removed, e.g., incentives to promote industrial estates in biodiverse rich areas. Possible approaches for capturing the high non-use, global values associated with Benut's biodiversity include international funding (e.g., through the GEF), higher levies on international tourists, and conservation concessions.

In order to capture existence values in China it has been suggested that visitors could be given the option of paying \$1 for a 'panda stamp' in their passports which would go towards panda conservation (Swanson and Kontoleon, 2000). Such an approach might be appropriate to protect the existence values associated with Benut's mangroves (Chapter 8). If all eco-tourists visiting Malaysia (12.5 million per year) were to pay \$1 towards the conservation of Benut's biodiversity, \$12.5 million could be generated (\$7,400 per hectare per year). This is, coincidentally, the value estimated in the international CV survey for Benut (Chapter 8) and would provide a considerable boost to conservation efforts. Adoption of such an approach would require the development of appropriate administrative structures and the commitment of the Government to set aside the area for conservation and to earmark funds accordingly for its management.

Generally the prospects for successfully implementing natural resource capture mechanisms in Malaysia are much more encouraging than in Cambodia. Malaysia has some experience with economic instruments, for example, the Malaysian Environmental Quality Act, 1974, includes provisions for using economic incentives and disincentives in the form of effluent charges in support of regulatory controls on discharges. The act requires that all dischargers pay a fee to obtain a licence to discharge waste into public water bodies. Because the licence fee varies with the level of waste discharged, it is effectively a discharge fee (Panayotou, 1998). In 1978 a rubber and palm oil effluent charge with a water quality standard was introduced. This was a pioneering system for a developing country. There is then the potential to introduce taxes and charges to capture the benefits of poles, charcoal and aquaculture.

Sabah, Malaysia, is the site of the worlds first large-scale forestry based carbon offset project¹⁴³. Malaysia is therefore experienced in dealing with international (funding) organisations. This suggests that international transfer mechanisms such as conservation concessions and GEF funding would be appropriate to capture the global values of Benut mangroves. These global values were estimated to account for 84% of the resource value, and their capture would therefore be a priority within a conservation strategy. Successful conservation of the area would require support from the Malaysian Government.

Turkey

The institutional arrangements pertinent to the management of Turkey's forests, along with options for reform are discussed in detail in Chapter 5. The study concludes that a revision of current policies and institutional arrangements is needed, at the local, national, and global level to provide incentives for sustainable forest utilization (coupled with disincentives for destructive practices), before the current and potential values of the forest resource can be fully captured. Table 9.22 provides a summary of capture mechanisms thought to most applicable to the estimated forest values.

¹⁴³ The project is a co-operative venture between the Sabah Foundation, a semi-government forestry organisation in the State of Sabah, and the FACE Foundation of the Netherlands who have invested US\$15million. The objective of the project is to rehabilitate 25,000 ha of degraded areas by enrichment planting and forest reclamation, using indigenous tree species. The project is expected to sequester at least 4.25 million tonnes of carbon (15.6 million tonnes of CO₂) during its life-time, at an average cost of US\$3.25 per ton of carbon.

Table 9.22. Turkey - Capture Mechanisms

Resource Value	Capture mechanism / Ranking	Requirements / Comments
Timber	Fees / licencing (A)	Introduction of social cost pricing
	Concession bidding (B)	Development of Multi-functional Management Plans
NTFP	Ownership (property rights) (B)	Comprehensive inventory process
	Impact / access fees (A)	Support to local co-operative organisations in production and marketing Inclusion of NTFP in wood production management plans
Tourism/ Recreation	Tourist fees and charges (A)	Development and implementation of well defined zoning plan
	Tradeable development quotas (B)	Incorporation of local communities in planning and management process
	Pollution taxes and charges (B)	Strong institutions
Wildlife	Impact / access fees (A)	Improved public awareness
	Hunting licences / permits (A)	Resources and training of Department of Game and Wildlife
	Hunting rights (property rights) (A)	Improved monitoring and management of reserves Comprehensive inventory
Watershed benefits	Market in grazing rights (B)	Introduction of integrated watershed management plans
	Water rights (B)	Adoption of a participatory approach including all stakeholders
	Water pricing (B)	

Resource Value	Capture mechanism / Ranking	Requirements / Comments
Genetic resources for agriculture	Conservation concessions (A) Purchase of nature (A) GEF funding (A)	More information given that potential value of genetic resources found in forest unclear Strong institutional arrangements
Carbon storage	GEF funding (A) CDM (A) Carbon offset (A)	High priority

At present timber production in Turkey does not take account of the associated social and environmental values. The existing fee and licencing system therefore needs to be reformed so as to fully account for social and environmental costs. Concession bidding would further improve the efficiency of this sector and could be piloted at selected locations to develop acceptance of, and expertise in, this process.

Improved tenure arrangements (legal rights) to NTFP in certain locations would encourage sustainable resource use (see Boxes 5.5 and 5.4). Production plans need to be based on sustainable harvest rates, this would require more detailed inventory of NTFP. Government support for such initiatives is uncertain.

Potential returns from the development of tourism are considered to be high. As discussed in Chapter 5 management of most tourism sites is weak or non-existent. Eco-tourism plans need to be developed for most protected areas which give due emphasis to local community involvement. Entrance fees to tourism sites need to be introduced and/or enforced in nearly all cases. Increased levies on international tourists visiting protected areas is a practical way of capturing a greater share of the global value of biodiversity. An increased differential between domestic and foreign entrance charges (which is currently small to non-existent) would further bolster returns from tourism. This can be justified on efficiency grounds (higher foreign recreational value) and on equity grounds (average per capita incomes of foreigners are likely to be higher than domestic levels).

In terms of managing the impact of tourism developments on forests, social cost pricing needs to be introduced. Incentives offered to tourism developments need to be stopped and further to this pollution taxes and charges enforced to encourage sustainable use of the resource. Tradeable development quotas might be used to control the pace and standard of new developments and/or to upgrade existing establishments in tourist centres. A maximum allowable development (or construction) quota, measured in say, cubic metres of available space (or numbers of rooms) for each year, in each area or zone could be set. The aggregate quota in each area would then be allocated according to some equitable and accepted formula. For example, quotas could be allocated according to the proportion of land ownership in the tourist zone. Under this arrangement each recipient of a quota has the choice of using it in his own land, selling it to others or simply banking it for future sale or use. The quotas thus gravitate to those with the most profitable development plans and projects. The feasibility of such an approach would need to be explored, and the institutional framework needed to support it developed.

Game hunting and fishing is currently practiced under licence. In order to fully capture wildlife values the current system needs to be improved through the development of management plans, improved monitoring, and a comprehensive inventory so that licencing can be based on sustainable catch.

In terms of watershed management there is a lack of integrated management (i.e., at eco-basin level incorporating forestry, agriculture and grazing concerns). Appropriate tenure arrangements and other incentives for community participation in watershed rehabilitation is needed. At present there is a general distrust of forestry organisations which needs to be overcome. Free grazing is closely linked with watershed degradation. A nascent market in grazing rights is evident and could be built on (in some areas villagers charge nomads for grazing). A market in grazing rights might be piloted in areas where communities are supportive of the idea and cohesive enough to manage such a system. More information on watershed benefits and current management per site would be required in order to determine the applicability of other possible capture mechanisms.

The global value of Turkey's forest associated with carbon storage accounts for 82% of the total resource value¹⁴⁴. Capture of carbon values would therefore provide a strong incentive for resource conservation / sustainable use. The potential for CDM and carbon offsets for the capture of carbon values should therefore be considered a priority. Conservation areas with high carbon values should be well placed to secure international transfers.

The potential for conservation concessions, purchases of nature and GEF funding could be explored for areas of high biodiversity value considered important for the conservation of plant genetic resources for agriculture. However, more information is required in order to determine the potential value of plant genetics residing in forests.

9.5.3 Conclusions on Capture

The analysis presented on capture represents an initial assessment of the potential for the introduction and development of capture mechanisms at the study sites based on the findings of the valuation studies, local knowledge and insights from the currently limited literature on the effectiveness of natural resource capture mechanisms. The analysis highlights the complexities associated with the introduction of capture mechanisms, and the fact that valuation studies in themselves do not typically provide enough information to enable the selection of appropriate mechanisms. Ideally, a capture component should be factored into valuation studies to facilitate the capture of the demonstrated values. This capture component is likely to involve detailed inventory / scientific information, institutional analysis, and stakeholder analysis related to the priority resource values estimated.

Structured and functioning institutional arrangements and strong and supportive government are considered to be crucial for the successful implementation of capture mechanisms. Not surprising therefore, the scope for capturing resource values is much more limited for Cambodia than for Malaysia and Turkey which are more politically developed (Section 10.2 presents general conclusions on capturing the value of forest functions)

¹⁴⁴ The remaining 3% relates to the value of genetic resources for agriculture.

9.6 Distributional Equity

Regardless of the stage of development, distributional concerns are central to the resource management process. In all of the cases studied local people have neither benefited adequately from conservation initiatives nor been fairly compensated for their losses as a result of development. For example, fishermen in Sg. Kim Kim, Malaysia were offered inadequate compensation by developers for their lost productivity (see Box 7.3), while local communities in Ratanakiri, Cambodia were offered a low cash price for their customary forest lands (see Section 4.6.4).

While dependence on the natural resource base is more acute in Cambodia it is still significant for the middle income countries studied. For example, 94% of respondents in Koh Kong, Cambodia state that they are totally dependent on the mangroves or that they are very important to them, compared with 44% in Benut, Malaysia. In both of these countries it is evident that damage to the mangroves has important implications for both productivity and equity, since a high proportion of poor households are located in villages in or close to the mangroves.

10 Summary and Conclusions

10.1 Summary

This thesis has illustrated through case study examples, literature reviews, and analysis how the two-stage approach of economic valuation and capture design can greatly contribute to the optimal management of natural resources. The valuation exercise seeks to reveal the economic value of a natural resource, such as a forest, in order that more reliable land use assessments might be made. However, even when the demonstrated value of a forest is high, valuation by itself is unlikely to promote changes in land use policy in favour of conservation. This fact is supported by the low impact that economic valuation measures of forest functions have had to date in counteracting deforestation worldwide. The fundamental reason for this is that a significant proportion of conservation values are not reflected in cash flows and therefore have remained external to the decision making process. For example, demonstrating that the biodiversity value associated with Turkey's forest or Malaysia's mangroves surpasses the value of using the land for alternative commercial uses has had no impact on policy to date because this biodiversity value is not being captured. Ways need to be found of converting demonstrated conservation values into cash benefits. This is particularly important in poor countries such as Cambodia where conservation budgets are virtually non-existent.

The key broad conclusions of this thesis are presented below (see chapters 4 - 8 for more specific conclusions and recommendations relating to the individual case study examples).

10.2 Key Conclusions

Demonstrating the Value of Forest Functions

On the balance of existing information there is a concern that forest ecosystems are turning out to be less valuable than previously hoped. Bioprospecting values are now considered to be low and are no longer seen as a route to conserving large tracts of forest. In addition, the growing understanding and dissemination of forest

hydrological functions has dispelled the myth that this forest function is unambiguously positive. This highlights the need to emphasize the benefits of multiple use forest management. The prospects for carbon storage and sustainable timber harvesting, for example, remain particularly promising.

It is important to bear in mind that while studies to date suggest that conservation values have difficulty competing with commercial activities, a number of conservation values remain unaccounted for. For example, the intrinsic value of biodiversity and the option value associated with forest ecosystems are not known but are considered to be significant. In addition, there are promising areas of new research such as the valuation of forest soils and canopies. Future studies of these values are likely to bolster the conservation argument. More generally, social and cultural values, historical claims, distributional impacts and other political factors need to be given due weight alongside economic efficiency within the assessment process.

A holistic 'ecosystem approach' to economic valuation remains an elusive objective (typically due to a lack of resources and time). Few, if any, studies look at both the on-site and off-site aspects of alternative land uses, despite the fact that an understanding of such interactions and linkages can be central to the setting of appropriate incentive mechanisms for sustainable resource management.

A lack of biophysical data is a limiting factor to many valuation exercises. For example, in most watersheds there is little or no credible data on basic hydrological functions. This highlights the need for a multi-disciplinary approach to resource valuation. Such an approach also has the benefit of increasing the acceptability of research findings.

The valuation of natural resources has a key part to play in informing the design of capture mechanisms. Without an understanding of the economic costs and benefits of alternatives, poor policy choices (perverse incentives) and misallocation of funds can occur. Few studies however simultaneously incorporate valuation estimates into the

design of incentives¹⁴⁵. The design of appropriate capture mechanisms requires an understanding of the 'incentives' facing stakeholders for and against alternative land uses. These incentives will be embedded in existing market, political and institutional structures, both on and off site. Such an analysis can indicate how conservation values might be made explicit through, for example, the creation of new markets, institutions and enabling policies and legislation. Ideally therefore, a capture component should be factored into valuation studies.

Capturing the Value of Forest Functions

Information on the economic significance of forest goods and services is rarely incorporated in private property rights, forestry regulations and pricing policy due to political and institutional barriers and to a lack of reliable information on the use of (and changes in) non-timber benefits.

Global values are often highly relevant to the conservation argument and are assets that countries can strive to realise using a variety of economic instruments. However, most international capture mechanisms are under-developed and require a much greater commitment by the international community if the desired conservation objectives are to be achieved (e.g., the Kyoto Protocol).

An integrated approach to management is needed given the interdependence of resource systems. The middle-income countries studied are yet to introduce multi-purpose development plans. A rather narrow view of resource (forest) management is therefore currently dominant.

There is not much information on the effectiveness of the range of capture mechanisms that have been applied in developing countries. This is due to the fact that such approaches are at an early stage of development. Of particular concern is a lack of understanding of what market creation means to the poor (Landell-Mills *et al*, 2002). This fact accentuates the need for stakeholders to participate in the

¹⁴⁵ A preliminary analysis was undertaken for Turkey (see chapter 5). See Aylward *et al*, 1999 for a detailed analysis of market and policy incentives affecting land use decisions made by land-holders in an upland tropical watershed in Costa Rica. Such examples are rare.

development of financing mechanisms. Incentives for sustainable forest management and conservation can only be effective if property rights are well defined and if land users are entitled to receive benefits arising from the ecological services they maintain.

To be successful, capture mechanisms need to be supported by effective regulations and a sound policy framework. Weak policies will reduce both domestic returns and access to international transfers and private capital, which are increasingly being linked with good governance. The political health of a country is therefore central to the success of capture mechanisms. Without the 'political will' sustainable and equitable forest management remains an elusive objective.

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Appendix 1: DIRECT USE QUESTIONNAIRE

Johor Mangrove Study

Respondents Number:

Interviewer initials:

Date / Time:

1. HOUSEHOLD CHARACTERISTICS

Village	
Name of Person Interviewed	
Relationship to hh head	
Age	
Size of hh	
How long has hh head been here	1. Born in area 2. Moved to area _____ years ago
Ethnicity	

2. HOUSEHOLD COMPOSITION (hh members normally present)

Relation	male/female	age (years)	school (years)	married (yes/no)	Occupation
Head of hh					
Spouse					
Spouse					
Child					
Child					
Child					
Child					
Other					
Other					

MEMBERS OF HOUSEHOLD NORMALLY ABSENT

No of hh members normally absent	
No. in school	
No. moved away to work	
No. absent for other reasons	No: Reasons:

3. HOUSEHOLD INCOME AND ASSETS

Household income estimate (per year / month) <i>[Note: try to indicate if this is gross/net; is this taxable]</i>	
Main source of income	
Other sources of income (including gifts from absent families)	
What alternative jobs are available for villagers (part-time or full-time)	
Is the household self sufficient	YES/NO

4. VIEWS ON MANGROVES

How important are the mangroves to you?	Unimportant / Low / Important / Very Important / Totally Dependent
Why to you think mangroves are important	

Comments:

5. FISHING

PRICE AND QUANTITY DATA

Name of species	No. of months fish	Quan. Kg / month <i>range</i>	Quan. used at home kg/month	% sold to middleman / market	Price / kg middleman	Price/kg Market
1						
2						
3						
4						
5						
Other						

Describe seasonal changes in catch:

TRAVEL / TIME COST INFORMATION

Area fish Estuary/ Offshore	Name of area	Distance (km)	Travel time (hrs /mins)	Average Duration of trip (hours/day)	No. of people per trip	No. of times visit/ month	Petrol costs per trip/ Month
	1						
	2						
	3						
	4						
	5						

EQUIPMENT COSTS

Boat	Own / Rent
If own: Price (state size) Average maintenance costs (month) Life time	
If rent – RM / month Conditions of rent agreement:	
Type of net used	
Cost of net Life time of net	
Bait used	Yes/No
Price of bait / kg Quantity of bait used/ month	

OTHER COSTS

Do you have a license	YES / NO
Category / duration / price of license	
Have you borrowed money to fish (e.g., for equipment)	YES/NO
Amount borrowed	
Who did you borrow money from	
Conditions of loan	
How many people in you family go with you when you fish	
Do you employ any help to fish	YES / NO
If Yes, how many people do you employ Salary / month	
Transport costs to market / distance / travel time	

GENERAL QUESTIONS

5 years ago how was productivity different	
Why has productivity changed?	
How have prices changed in last 5 years	
How have the conditions for fishermen changed in the past 5 years?	
What improvements would you like to see	
How many household in the village are dependent on fishing	
What other villages fish in this area? [name of villages; number of people; frequency]	

Comments:

6. MIDDLEMEN

No. of middlemen working in area	
Main species traded	
Quantity of fish purchased (kg/ month) <i>List for main species</i>	
Buying Price (kg)	
Selling price (kg)	
How many fishermen do you buy from	
Arrangements with fishermen	
Where / who do you sell products to	

Comments:

7. OTHER PRODUCTS COLLECTED FROM THE MANGROVES (mud crabs, molluscs, nypa, fuelwood)

What other products do you collect from the mangrove?	

PRICE AND QUANTITY DATA

Name	No. of months collect /yr	Quan. kg/month <i>Range</i>	Quan. used at home kg/month	% sold to middleman / market	Price / kg middleman	Price/kg Market
1						
2						
3						
4						
5						
Other						

Describe seasonal changes:

TRAVEL / TIME COST INFORMATION

Name of product	Name of area where collect	Distance (km)	Travel time (hrs /mins)	Average Duration of trip (hours/ day)	When collect Day / Night	No. of people per trip	No. of trips / month	Petrol costs (per trip/ month)
1								
2								
3								
4								
5								

EQUIPMENT COSTS

Name of product	List equipment used / if purchased or manufactured. If purchased price: lifetime; number used etc.,

GENERAL QUESTIONS

How important are these products to the household (Domestic use)	NOT AT ALL / LOW / MEDIUM / HIGH / HH DEPENDENT ON PRODUCTS
From five years ago is there a change in the availability of these products? If yes, why?	YES / NO
Do people from other villagers come to collect products from mangrove? Name of villages; products collected; frequency; amount.	
Other comments	

8. MANUFACTURED GOODS BASED ON MANGROVE RELATED RESOURCES (e.g., Fish paste / crab nets)

List goods manufactured	

For each product

Materials and quantity used to manufacture products	
Where are materials collected from	
Time to collect materials	
Time to make products	
Quantity used for domestic use	
Quantity sold	
Price (middleman / market)	

9. LOGGERS**A. EMPLOYED WORKER****B. LICENSE OWNER****C. WORKER & LICENSE OWNER****A. EMPLOYED WORKER**

How many years have you been working as a logger?	
How many months a year do you work as logger?	
If not full time, what work do you do the rest of the year?	
Number of poles cut per day / week (average and range)	
What is your salary (per week, month) <i>Note: maybe paid on number of poles cut</i>	
Are you provided with a boat and chainsaw by employee	YES / NO
Main species in the area	
Harvesting technique	
How have the conditions for loggers changed in the past 5 years?	
What improvements would you like to see?	
How many households in the village are involved in logging?	
How many loggers are there working in this reserve?	

PRICE AND QUANTITY DATA (A, B & C)

Quantity of wood harvested / ha / concession period / m ³	Total quantity harvested	% sold as poles	% sold as charcoal	Price of wood sold for poles	Price of wood sold for charcoal

TRAVEL / TIME COST INFORMATION (A, B & C)

Compartment no	Size of compartment	Distance from village	Travel time (hrs /mins)	Travel cost (e.g., petrol) / month	No. of workers per compartment	Time to harvest/ha (days)

EQUIPMENT COSTS (A, B & C)

Boat	OWN / RENT
If own: price (state size); average maintenance costs (month); life time	
If rent - rent / month; conditions of rent agreement:	
Chainsaw	OWN / RENT
If own: Price (state size); average maintenance costs (month); life time	
If rent - rent / month. Conditions of rent agreement:	
Other	

B. LICENCE OWNER

Area of concession	
Main species in area	
Cost, duration and conditions of concession	
Is this your only source of income?	
If no, what other jobs do you have?	
How many workers do you employ?	
Harvesting Technique:	
What salary do you pay (per week, month) <i>Note: maybe paid on number of poles cut</i>	
Do you provide workers with a boat and chainsaw?	YES / NO
What is your net income (per concession period)	
What are your average costs per hectare	
What royalty and other payments do you have to make to Government?	
Are you responsible for replanting?	
If yes, cost / ha (labour, time, inputs, etc)	
How have the conditions for loggers changed in the past 5 years?	
What improvements would you like to see?	
How many households in the village are involved in logging?	
How many loggers are there working in this reserve?	

10. CHARCOAL PRODUCTION

Charcoal kiln workers

How long have you been working at the kiln?	
How many months per year do you work at the kiln?	
Do you have any other jobs? If yes, what	
What is your salary from charcoal production (week/month/year)?	
Quantity of mangrove wood burnt per kiln /per cycle (kg)	
Production cycle -How long does it take to: fill the kiln; Length of burn period; Length of cooling period.	
Total quantity of charcoal produced per kiln (kg)	
% of each class: Class 1; Class 2; Class 3	
Price of charcoal (middleman) / kg: Class 1; Class 2; Class 3	
Price of charcoal (market price) / kg: Class 1; Class 2; Class 3	
Who owns the charcoal kiln	
How many workers are employed at each kiln?	
How much does it cost to build a kiln (size of kiln / price)	
How long does the kiln last for?	
How many kilns are there in the site?	
How many of these kilns are in operation?	

How has the market for charcoal changed over the past 5 years	
What are the main problems facing charcoal workers?	
What management improvements if any do you think are necessary?	

11. CHARCOAL KILN OWNER

How many kilns do you own	
Do you have any other source of income?	
What is your income from charcoal production (month/year)?	
Costs, duration, condition of license	
Taxes and royalty payable	
Quantity of mangrove wood burnt per kiln /per cycle (kg)	
Production cycle How long does it take to fill the kiln? Length of burn period? Length of cooling period?	
Total quantity of charcoal produced per kiln (kg)	
% of each class Class 1 Class 2 Class 3	
Price of charcoal (middleman)	

Class 1	
Class 2	
Class 3	
Price of charcoal (market price)	
Class 1	
Class 2	
Class 3	
How many workers are employed at each kiln?	
How much does it cost to build a kiln (size of kiln / price)	
How long does the kiln last for?	
Identify other costs - e.g., transport, land rent / purchase	
How has the market for charcoal changed over the past 5 years	
What are the main problems facing charcoal producers?	
What management improvements if any do you think are necessary?	

12. AQUACULTURE (Interview owners and workers as appropriate)

Pond culture / cage culture / rafts

Type of species cultivated	
Year when operation started	
No of ponds / cages / rafts	
Size of ponds	
Output per cycle per pond/cage/raft	
Describe cycle	
Change in output over past 10 years	
Reasons for change in output	
Price of output 1/ Middleman 2/ Market	
Market for products Local/JB/Singapore/Other	
Number of people employed and their jobs	
Construction costs (include land prices if relevant):	
Operating Costs: Cost of permits (conditions/duration) Larvae Feed salaries of employees	
Subsidies from the State	

Main problems facing aquaculture	
Description of any environmental protection measures	
Opportunities for aquaculture in the area	

13. SPORTSFISHING (Interviews with hh involved in trips)

Kg. Asli Pontian Besar

How long have you been involved in sports fishing?	
Is this you main source of income?	
If NO, what is your main source of income	
How many months a year do you take guests fishing?	
How many trips do you do per month	
How much do you charge (per person/per trip)?	
How many people on average do you take per trip?	
Where do you go fishing?	
On average how long do you go fishing for?	
Main species caught	
COSTS Boat (hire; maintenance per month /year; lifetime) Fuel (per trip / month) Other	
How is the demand for sports fishing	
How many other families are involved in sports fishing in he village	
Are there other villagers offering sports fishing?	

CHALETS / SPORTS FISHING

Number of chalets	
Cost per night	
Number of visitors (per month / year)	
Where do visitors come from	
Operating costs	
Construction costs	

14. General Information on Survey Sites

Information to be collected from district officials. Copies of official statistics

Area of forest reserve	
Number of villagers nearby site:	<i>List</i>
Estimated population of each village:	
Ethnic composition:	
Main jobs/activities	<i>List</i>
Survey Villages	
List main types of activities/jobs and number / % of workers for the area	
Development proposals for the area	
No. of forest compartments	
No. of current concessions	
No of licenses	
No of charcoal kilns in the area	
No. of charcoal licenses	
No. of aquaculture ponds	
Cage culture	
No. of licensed boats in area	
Pressures on mangrove resource	
Main / special characteristics of the area	
Other remarks	

Appendix 2: CVM Questionnaire

CV: MANGROVES OF BENUT

(Version A)

- INSTRUCTIONS TO INTERVIEWERS ARE IN CAPITALS
- NOTE SOME QUESTIONS DEPEND UPON PREVIOUS ANSWERS
- CARE MUST BE TAKEN TO ASK RELEVANT QUESTIONS
- IN THE CASE OF A REFUSAL TO RESPOND NOTE THIS WITH A CAPITAL 'R'. DO NOT MERELY LEAVE BLANK.
- NEED RESPONDENTS WHO ARE AT LEAST 21 YEARS OLD AND DECISION MAKERS IN THE HOUSEHOLD

INTRODUCE YOURSELF AS FOLLOWS:

Good morning / afternoon, sir/madam. My name is..... I am involved in a study being conducted by the Johor State Forestry Department (JSFD) on the mangroves of Johor. [I work for a private research company and] We are carrying out a survey to find out how much households value the mangroves between Pontian and Rengit, and would like to ask you a series of questions. All answers are confidential and there are no right or wrong answers. Your opinion is what counts. I must warn you that the questionnaire is quite lengthy and may take 20-30 minutes of your valuable time, but we will be most grateful for your co-operation. If you do complete the interview, we would like to offer you a small gift as a token of our appreciation.

IF NOT INTERESTED THANK THEM AND LEAVE. IF INTERESTED CONTINUE.

Respondent:.....

Serial number:

Address:.....

Date :.....

.....

Time interview starts:

Telephone no.:.....

Time interview ends:.....

Language :

Interviewer Name:.....

Area: 1. Inland 2. Coastal

A. GENERAL ATTITUDES AND BEHAVIOUR

A1. To start the interview, suppose that the Malaysian government is going to invest money to help with one of the problems listed below. Which of these problems do you consider to be the most important one to solve in Johor State? And which of the problems do you consider the second most important to solve?

CIRCLE ONE ANSWER FOR MOST IMPORTANT AND ANOTHER FOR SECOND MOST IMPORTANT

Problem	Most important	Second most important
Increasing agricultural productivity	1	1
Inflation	2	2
Reducing water pollution	3	3
Protecting natural habitats & wildlife	4	4
Improving quality of education	5	5
Other, specify_____	6	6

A2. What problems concerning the natural environment are you most worried about?

CIRCLE ONE ANSWER FOR MOST IMPORTANT AND ANOTHER FOR SECOND MOST IMPORTANT

Problem	Most worry about	Second worry about
Air pollution	1	1
Water pollution	2	2
Logging	3	3
Landslides / Floods	4	4
Wildlife preservation	5	5
Other, specify _____	6	6

A3. I am going to read out a few statements. Please indicate your opinion on a scale of 'strongly agree' to 'strongly disagree'. There is no right or wrong answer; I only need your frank opinion.

SHOW CARD FOR EACH QUESTION

	Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree
(i). We have a duty to protect the environment from development regardless of the cost	1	2	3	4	5
(ii). We should reduce our use of the environment now so that our grandchildren may benefit from it	1	2	3	4	5
(iii). Malaysia needs to develop her forests, seas, and land to increase jobs and incomes, regardless of the environmental damage	1	2	3	4	5
(iv). Because rare birds depend on the mangroves, they should be protected regardless of the costs	1	2	3	4	5
(v). I should pay for the protection of parks and nature reserves even if I do not visit them	1	2	3	4	5
(vi). Even if I don't use the mangroves now, I am prepared to pay now to protect them in case I want to use them in the future	1	2	3	4	5
(vii). It is worth spending money to protect the mangroves because they help to protect agricultural productivity in the area	1	2	3	4	5
(viii). We have more important things to think about than the loss of the mangroves	1	2	3	4	5

**B. USE OF MANGROVES BETWEEN PONTIAN AND RENGIT
AND BACKGROUND INFORMATION**

B1. Have you heard of the mangroves between Pontian and Rengit?

Yes	1
No	0

SHOW MAP 1: This map shows the major mangrove areas in Johor State. You can see that the mangroves from Pontian to Rengit are one of these areas.

SHOW MAP 2: MANGROVES OF PONTIAN AND RENGIT: Mangroves cover an area of nearly 2,000 hectares along the coastline.

B2. Have you ever visited the mangroves between Pontian and Rengit?

Yes	1
No	0

B3. What benefits, if any, do you currently get from using the mangrove area and its natural resources?

B4. Are you likely to visit the mangroves in the next 5 years?

Yes / Likely	1
No / Unlikely	0

I am now going to introduce the concept of biodiversity.

SHOW INFORMATION CARD A AND READ INFORMATION ON MANGROVE BIODIVERSITY

I am now going to give you some information about the mangroves between Pontian and Rengit and introduce you to some of the environmentally sensitive issues that these mangroves face today.

SHOW INFORMATION CARD B AND READ BACKGROUND INFORMATION ON THE MANGROVES BETWEEN PONTIAN AND RENGIT

B5. Is this information new to you?

Yes, very new	1
Only some of it is new	2
I know all this already	3

PRESENT SHOWCARD C:

READ SCENARIO A

B6. How severe in your opinion is the likely damage to the mangroves between Pontian and Rengit if the trend highlighted in scenario 'A' continues?

Very severe	1
Severe	2
Not so severe	3
Not at all severe	4

Don't know 99

READ SCENARIO B

C. WILLINGNESS TO PAY SECTION

As described management and protection of the mangroves between Pontian and Rengit is necessary to:

- protect the areas rare bird species;
- enhance the quality of life of the local populations by providing a continuous source of seafood and by protecting agricultural land

Obviously, the implementation of this mangrove protection project would cost money and people would have to pay their share of the costs on a continuing basis if they want to enjoy the benefits protection of the mangroves will offer.

As such, suppose that in order to protect the mangroves, your household would be asked to pay a monthly fee to A BIODIVERSITY FUND, which will be established and managed by the government to help protect the mangroves between Pontian and Rengit. Please think for a second about how much this would be worth to you and your household.

(IF RESPONDENTS EXPRESS DOUBTS ABOUT THE MANAGEMENT PLANS EFFICIENCY, TELL THEM TO ASSUME THAT THE SYSTEM WILL WORK WELL).

[IF NECESSARY SHOW CARD D WHICH LISTS POSSIBLE PROJECTS WHICH COULD IMPROVE BIODIVERSITY].

Please keep in mind:

1. The issues discussed here are only a few among many other environmental problems Johor and Malaysia faces.
2. This interview is on the mangroves between Pontian and Rengit only, not on other environmental issues or other mangrove areas around the country that you may be concerned about.
3. Your own personal income is limited and has important alternative uses.
4. There is no right or wrong answers and you should answer for your household.

PAYMENT LADDER: SHOW PAYMENT CARD

C1: Now on this payment card is a range of different amounts of money, from RM0 to RM40. Let's start at the top of the list and move down. Ask yourself, 'would I pay 50 sen a month to protect the mangroves?'. Or 'would I prefer the new management proposal not to be implemented and for mangroves to continue to deteriorate and for biodiversity to be lost?' And would I pay RM1? And RM2? And so on? If you are ALMOST CERTAIN you would pay some of these amounts to protect the mangroves, then let's place a tick in the space next to the amount. Please do not agree to pay if you cannot afford it, if you feel you have other, more important, things to spend your money on, or if you are not sure about being prepared to pay or not. If you are not sure whether you would pay or not, or if you think that you would not pay then let's stop.

INTERVIEWER EITHER YOURSELF OR THE RESPONDENT TICK THE AMOUNTS THE RESPONDENT IS CERTAIN TO BE PREPARED TO PAY. IF THE RESPONDENT IS NOT WILLING TO PAY ANYTHING GO TO QUESTION C2

Ok, now I would like you to look at the value at the bottom of the list, RM40. Please ask yourself 'would I pay RM40 to protect the mangroves?' And what about RM35? And RM30? If you are ALMOST CERTAIN you would NOT pay these amounts to protect the mangroves between Pontian and Rengit, let's place a cross in the space next to that money amount. If you are unsure whether you would pay these amounts, then let's stop and leave it blank.

INTERVIEWER EITHER YOURSELF OR THE RESPONDENT CROSS THE AMOUNTS THE RESPONDENT IS CERTAIN NOT TO PAY.

So this means that you are sure that you would pay (last amount ticked), not sure (amounts with blanks) and would not pay (first amount crossed) for sure. Is that correct? Do you want to revise your answer?

IF RESPONDENT WANTS TO REVISE, PLEASE DO SO. OTHERWISE, MOVE TO QUESTION C-4.

C-1. PAYMENT LADDER

<i>RM</i>	$\checkmark, \times$
0	
0.5	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
15	
20	
25	
30	
35	
40	

TO ANSWER ONLY IF RESPONDENT STATED A ZERO WILLINGNESS TO PAY

C2. People have different reasons for saying that they are not willing to pay anything to protect the mangroves, or for saying that they don't know or can't answer the question. Please read the following statements, and tell me which one best describes your views.

CIRCLE ONE ANSWER ONLY.

I have no spare income but would otherwise contribute	1
I don't believe the system would bring the changes you described	2
It is the government's responsibility	3
I feel that environmental protection of the mangroves between Pontian and Rengit is unimportant	4
I'd rather have the current situation than pay more	5
The user should pay	6
I believe that this improvement will take place without my contribution	7
I fail to understand the question	8
We cannot place a monetary value on biodiversity	9

C3. Under your current circumstances instead of paying anything to the biodiversity fund, would you be prepared to volunteer some of your time to help with projects and/or fund raising to protect the mangroves between Pontian and Rengit? Projects might include: (A) work at an information centre giving information about the mangroves between Pontian and Rengit to visitors and students (B) Policing the area to ensure that visitors are not damaging the assets of the park and harming the animals. (C) Conducting guided tours, etc. Would you be willing to act as such a volunteer? Please remember that your time has several competing uses.

Yes	1
No	0

Go to C3a

Go to C7

C3a. If yes, how many hours per month on a continuous basis?

None	0
Hours per month	
Do not know	999

C3b. Why are you willing to spend your time in the mangroves between Pontian and Rengit?

GO TO QUESTION C7

TO ANSWER ONLY IF THE RESPONDENT STATED A POSITIVE WTP

C4. People have different reasons for being prepared to pay for the protection of these mangroves. Out of the statements below, which one best describes your personal reasons?

CIRCLE ONE ANSWER ONLY

I think the management plan is a good one	1
I feel this is a reasonable amount to pay	2
I am concerned about the loss of mangroves / biodiversity	3
It is what I can afford to pay	4
I am not sure I could pay what I said but I wish I could	5

C5. Would you increase the amount specified for the biodiversity fund if in addition to the conservation of the mangroves between Pontian and Rengit other mangrove areas would be restored?

Yes	1
No	0

C5a. If Yes, what would be your maximum willingness to pay?

C5b. If NO, what is your reason?

C6. Imagine you were to migrate from this area, but otherwise your lifestyle and income remain unchanged. After leaving you will never make any use of the mangrove resource again. Would you still be willing to pay for the protection of the mangrove area?

Yes	1
No	0

C6a. IF YES. What would you be willing to pay

Same as before	1
Other amount, specify _____	2

C6b. If NO, Why are you NOT willing to pay anything?

TO BE ANSWERED BY ALL RESPONDENTS

C7. Do you think that a biodiversity fund managed by the government is the best management method?

Yes	1
No	0

C7a. If NO, what method would you prefer?

C8. Do you think that there would be any direct benefits to you from this project?

Yes	1
No	0

C8a. IF YES, do these direct benefits relate to your current use of the mangroves between Pontian and Rengit listed earlier as B3 or are there other benefits to you

Direct benefits due to current uses listed at B3	1
Other, additional direct benefits. LIST AS DESCRIBED: _____	2

C9. Do you feel the information presented to you so far in this interview has:

READ THE FOLLOWING. NOTE ONLY ONE CATEGORY TO APPLY

Changed your preferences about whether extra resources should be spent on mangrove protection	1
Merely given you more information than you had before	2
Both informed you and changed your preferences	3
Had no effect	4

D. SOCIO ECONOMIC BACKGROUND

Finally I have just a few questions about your background that will only be used for statistical purposes

D1. Record sex.

Male	0
Female	1

D.2 Which of these age groups do you fit into?

< 21	1
21 – 30	2
31 – 40	3
41 – 50	4
51 – 60	5
61 – 70	6
> 70	7

Refuse 99

D3. Please record your race.

CIRCLE ONE ANSWER ONLY

Malay / Bumiputera	1
Chinese	2
Indian	3
Orang Asli	4
Other, specify _____	5

D4. What is the highest level of education you have obtained?

No formal education	1
Primary School	2
SRP/PMR	3
SPM/SPVM	4
STPM	5
Diploma/Professional certificates	6
Degree	7

D5. What is your occupation _____

D6. How many members are there in your household? _____

D7. Could you estimate for us your total household's gross monthly income? Choose from one of the categories below. Your answer will be completely confidential. It will be used only for statistical analysis.

No income	0
RM500 and below	1
RM501 - RM1000	2
RM1001 - RM1500	3
RM1501 - RM2000	4
RM2001 - RM3000	5
RM3001 - RM4000	6
RM4001 - RM5000	7
RM5001 - RM6000	8
RM6001 - RM7500	9
Above RM7500	10

Don't know/ refusal 99

D8. Last of all, what did you think of this questionnaire?

INTERVIEWER READ EACH STATEMENT TO RESPONDENT:

CIRCLE ONE ANSWER FOR EACH STATEMENT

	Yes	No
1. Interesting	1	2
2. Too long	1	2
3. Difficult to understand	1	2
4. Educational	1	2
5. Unrealistic / not credible	1	2
6. Other, specify _____	1	2

END INTERVIEW, THANK RESPONDENT AND PRESENT GIFTS (CAR STICKERS /BADGES AS APPROPRIATE.)

[Thank you for your time and effort.

Your responses will help our research efforts]

E. TO BE COMPLETED BY INTERVIEWER

E1. Were other people present and listening when you interviewed this individual?

Yes	1
No	0

E2. How interested did the respondent appear to be during the interview?

Extremely interested	1
Very interested	2
Somewhat interested	3
Slightly interested	4
Not interested at all	5

E3. Did the respondent have difficulties in understanding the questions in each section?

E3. Did the respondent have difficulties in understanding the questions in each section?

	Not at all									Extreme Difficulty
SECTION A	1	2	3	4	5	6	7	8	9	10
SECTION B	1	2	3	4	5	6	7	8	9	10
SECTION C	1	2	3	4	5	6	7	8	9	10
SECTION D	1	2	3	4	5	6	7	8	9	10

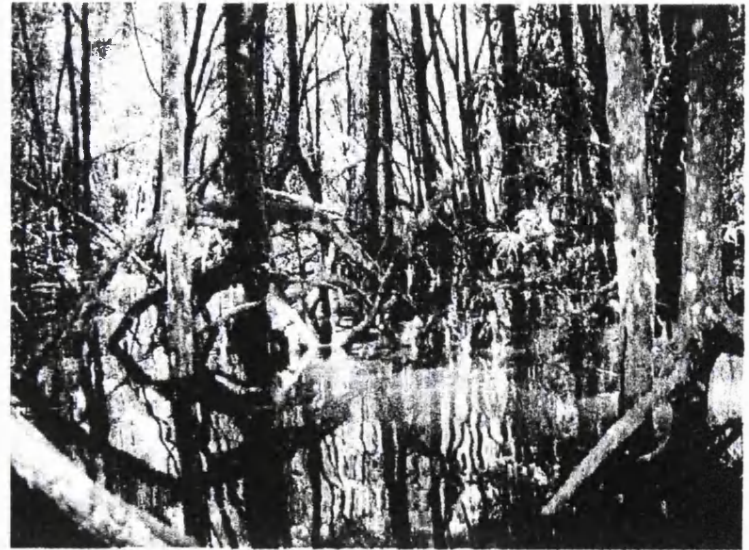
E4. How confident do you feel about the sincerity of the respondent's answers to the questions?

Very confident	1
Not so confident	2
Not at all confident	3

E5. Other comments:

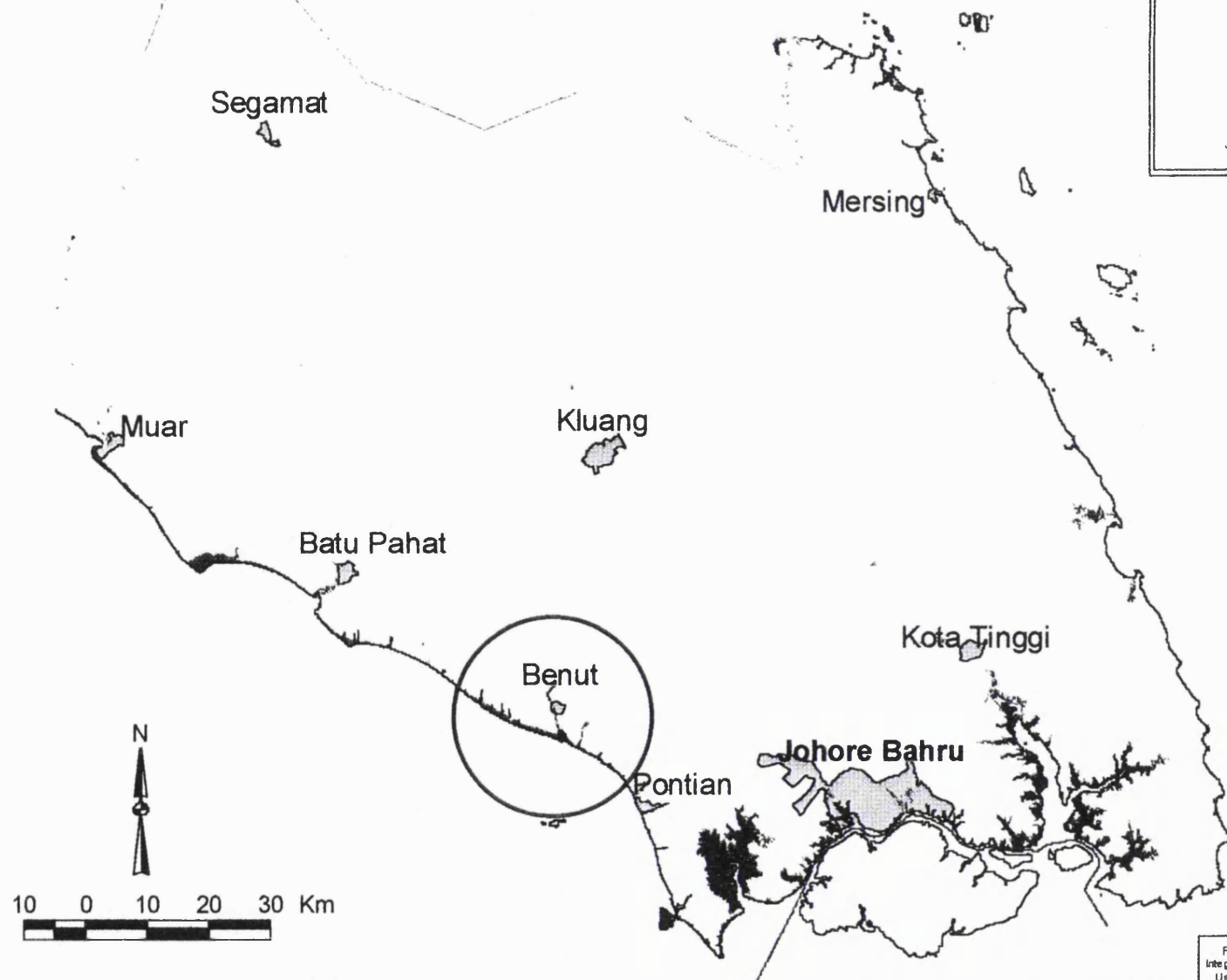
Mangrove in Good Condition

496



Mangroves & Study Area in Johor State

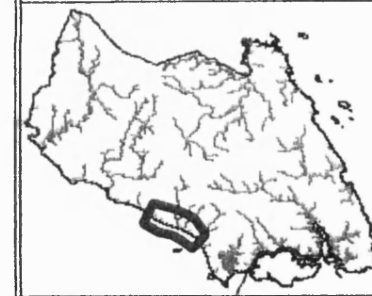
Peninsular Malaysia



FD/Danced Project: Preparation of an
Integrated Management Plan for Sustainable
Use of the Johor Mangroves, 1997-1999

Mangroves of Benut

Johor State



Study area

Rengit

Kg. Sg
Bagan

Kg. Merlong

Pekan Tompok

Benut

Kg. Parit Tengah

Sanglang

Kg. Pt. Daing

Kg. Jawa

Kg. Pulau
Sebatang

Kg. Pulau
Sebatang

Kg. Api-Api

Pontian

Kg. Tenun Rimba



2000 0 2000 4000 Meters



FD/Danced Project: Preparation of an
Integrated Management Plan for Sustainable
Use of the Johor Mangroves, 1997-1999

SHOWCARD A

MATLUMAT LATAR MENGENAI KEPELBAGAIAN BIOLOGI HUTAN PAYA BAKAU

红树林生物多元化

BACKGROUND INFORMATION ON MANGROVE BIOLOGICAL DIVERSITY

Kepelbagaian Biologi Hutan Paya Bakau (atau biodiversiti) merujuk kepada keseluruhan **BILANGAN** dan **KEPELBAGAIAN** tumbuhan, haiwan dan ikan yang boleh dijumpai di kawasan hutan paya bakau. Tumbuhan, haiwan dan ikan paya bakau ini hidup dan bergantung di antara satu sama lain di persekitaran hutan paya bakau yang berlainan.

Hutan paya bakau di Johor kaya dengan pelbagai jenis tumbuhan dan haiwan. Terdapat 90 jenis tumbuhan paya bakau di dalam dunia dan lebih kurang **25%** (lebih $\frac{1}{4}$) ditemui di Johor. Paya bakau Johor juga merupakan tempat bagi ketam, kerang serta lain-lain binatang yang tidak bertulang belakang dan mamalia. Tambahan pula, terdapat lebih daripada **100 jenis** burung menggunakan hutan paya bakau Johor ini.

Perlindungan alam sekitar hutan paya bakau adalah perlu untuk melindungi setiap jenis tumbuhan dan haiwan ini.

红树林生物多元化是指红树林内的植物、动物和鱼类的全部品种和数量。这些植物、动物和鱼类分别在不同的红树林环境下生长，同时又互相依赖。

柔佛州的红树林拥有丰富的植物和动物种类。全世界90种红树林植物中，有大约25种（超过 $\frac{1}{4}$ ）可以在柔佛州的红树林找到。这里的红树林同时是螃蟹、贝类和其他软体及哺乳动物等的温床。除了这些，还有超过100种的鸟类栖身在柔佛红树林中。

要保护这种种的动物和植物，首先必须保护的是红树林。

***Mangrove Biological Diversity** (or 'biodiversity') refers to the **total NUMBER** and **VARIETY** of plants, animal and fish species found in the mangroves. These mangrove plants, animals and fishes live and interact within different mangrove environments.*

*Johor mangroves are rich in both plant and animal species. There are 90 species of mangrove plants in the world, around 25 of which (over $\frac{1}{4}$) are found in Johor. Johor mangroves are also a home to crabs, shellfish and other invertebrates, and mammals. In addition over **100 species** of birds make use of Johor mangroves.*

To protect the individual species diversity, of both plants and animals, it is necessary to protect the mangrove environment.



Burung Penyambar
Serangga Biru
蓝食虫鸟
Mangrove Blue
Flycatcher

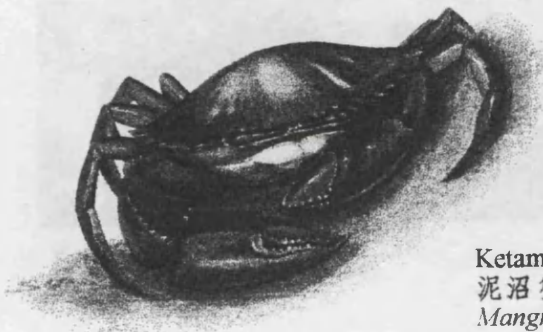
Beberapa contoh
kepelbagaian
biologi paya bakau
yang terdapat di
Benut.

文律红树林
生物多元化的
一些例子。



Memerang Licin
水獭 Small dawed Otter

A few other
examples of the
rich mangrove
biodiversity in
Benut.



Ketam Liat Paya Bakau
泥沼蟹
Mangrove Mud Crab



Ketam Fiddler
招潮蟹
Fiddler Crab



Burung Pacat
八色鸟
Mangrove Pitta

SHOWCARD B

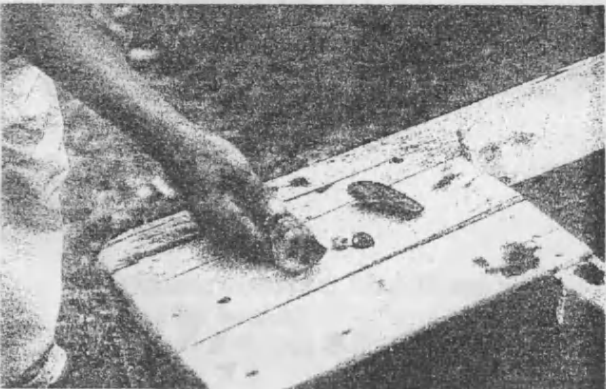
MAKLUMAT MENGENAI LATAR BELAKANG HUTAN PAYA BAKAU DI ANTARA PONTIAN DAN RENGIT

从笨珍到龙引一带的红树林背景

BACKGROUND INFORMATION ON MANGROVES BETWEEN PONTIAN AND RENGIT



Ikan Masin 咸鱼 Salted Fish



Kerang 贝类 Shellfish

红树林是生长在隐蔽的海岸线、沼泽和河岸上的树木和灌木，它提供多种不同的天然产物和任务，组成海岸生物循环系统一部分。

Mangroves are trees and shrubs that grow on sheltered coastlines, mudflats and riverbanks. They are part of a rich coastal ecosystem which provide a range of natural products and services.

Hutan paya bakau terdiri daripada pokok-pokok dan semak-semak yang tumbuh di persisiran pantai, dataran lumpur dan dan tebing sungai. Ia merupakan sebahagian daripada ekosistem pinggir pantai yang menyediakan pelbagai keluaran dan perkhidmatan semulajadi.



Kayu bakau untuk dijadikan arang
供制火炭的红木 Mangrove wood used as charcoal



Kawasan rekreasi 休闲地区 Recreational area



Hutan paya bakau yang kering akibat pembangunan padang golf 红树林因建高尔夫球场而遭毁坏
Mangroves dying due to siltation from golf course project



Pembangunan leburaya di Johor (Di tepi bekas hutan simpanan Sg. Jonglak)
柔佛州内的高速公路建设 (位于 Sg. Jonglak 前森林保护区旁)
Highway development in Johor. (on the side of a former forest reserve, Sg. Jonglak)

Kini, hutan paya bakau di Malaysia, termasuk hutan paya bakau di Johor, mengalami pengurangan akibat daripada perindustrian, pembandaran, penukaran penggunaan tanah untuk pemeliharaan ikan dan pertanian.

Negeri Johor mempunyai seluas 25,000 ha (152,650 ekar) sumber hutan paya bakau di sepanjang persisiran pantai. Namun, kurang daripada 3% hutan paya bakau di Johor terpelihara.

Hutan paya bakau di Benut merupakan tumpuan bagi kajian ini. Ia terletak di pantai barat Johor. Lingkaran hutan paya bakau ini semakin kecil akibat daripada membina benteng untuk pertanian dan pembasmian hutan.

目前, 马来西亚 (包括柔佛州) 的红树林已因工业化、城市化及转换成鱼塘和农业用途而渐渐消失了。

柔佛州的整个沿海地区拥有 25,000 公顷 (152,650 依格) 丰富的红树林资源。而只有少过 3% 的红树林是受保护的。

这项考察的重点, 即文律的红树林位于柔佛西海岸。由于建筑堤岸以助发展农业及森林逐渐消失, 这些红树林的占地已被“削”成一条细细的腰带状了。

Currently mangrove habitat in Malaysia, including the mangroves of Johor, are being lost due to industrial and urban development, and conversion to fish-ponds and agriculture land.

Johor State has 25,000 ha (152,650 acres) of rich mangrove resources all around its coastline. However, less than 3% of Johor's mangroves are protected.

The mangroves of Benut, which are the sole focus of this study, are located on the west coast of Johor. They have been reduced to a narrow belt due to bunding for agricultural development and deforestation.



Burung Botak
 鹤鸟
Lesser Adjutant Stork

Benut dianggap sebagai **tumpuan kepelbagaian biologi hutan paya bakau**. Ia mempunyai jumlah dan kepelbagaian spesies yang banyak.

Kawasan ini berkecualan sebagai **Kawasan Burung Antarabangsa Yang Penting**.

- Lebih 1% daripada jumlah **Burung Botak** di seluruh dunia didapati di Benut. Setakat ini hanya lebih kurang 5,000 burung botak tinggal di dunia.
- Koloni sarang burung pucung kelabu (hanya tinggal 2 tapak lain yang sebegini di Semenanjung Malaysia) dan koloni bangau putih juga terdapat di Benut.
- Tambahan pula, pantai barat negeri Johor juga merupakan laluan bagi penghijrahan 2 juta burung pantai dari Asia Timur.

Jika hutan paya bakau di Benut semakin mengurang, burung-burung hutan paya bakau dan lain-lain hidupan di hutan paya bakau akan lenyap dari Johor selama-lamanya.

文律的红树林拥有大量和多种的生物，它是生物多元化的首要地点。

这里有资格成为世界首要鸟类生长地区：

- 如今，全世界只剩下约5000只鹤鸟，其中超过1%生长在文律。
- 全马来西亚半岛三个苍鹭巢居处中的其中一个就在文律的红树林内。这里也是白鹤集居的地方。
- 另一方面，柔佛州的西海岸也是东亚候鸟迁徙的航线，每年会有2百万只候鸟掠过。

如果文律的红树林继续减少，这些依赖红树林为生的鸟类及其他红树林生物种类就会永远在柔佛州消失了。



Bangau Putih 白鹤
Milky Stork

Benut is a **mangrove biodiversity hotspot**. That is an area with a high number and variety of species.

The area qualifies as an **Internationally Important Bird Area**:

- More than 1% of the world's population of **Lesser Adjutant Storks** is found in Benut. There are only 5,000 Lesser Adjutant Storks left in the world.
- A colony of nesting Grey herons (there are only 2 other such sites left in Peninsular Malaysia) and a milky stork colony are also found in Benut.
- In addition, the west coast of Johor is part of the East Asia Flyway where 2 million shorebirds pass on migration.

If the Benut mangrove is further reduced, these mangrove-dependent birds and other mangrove species may disappear from Johor forever.

SHOWCARD C

KAEDAH PENGURUSAN:

管理方案:

MANAGEMENT SCENARIO:

A

KEADAAN TERKINI - Tiada Perlindungan

- Hutan paya bakau di Benut terdedah kepada kegiatan pembasmian dan pencerobohan
- Pengurangan kawasan hutan paya bakau untuk pembangunan pertanian
- Kemungkinan kepupusan spesies burung yang penting
- Pengurangan peranan pemeliharaan benteng pertanian
- Pencemaran bertambah dan kehilangan pengeluaran ikan
- Kemudahan rekreasi dan keindahan semulajadi yang semakin buruk

现有情况 -- 毫无保护

- 文律的红树林已逐渐的减少并受到非法侵占
- 农业发展导致红树林地区日渐缩小
- 珍禽逐渐减少
- 逐渐失去保护农业堤岸的作用
- 污染提高，鱼产减少
- 休闲设备逐渐毁坏和失去吸引力

PRESENT STATE OF AFFAIRS --No Protection

- *Benut Mangroves vulnerable to illegal encroachment and deforestation*
- *Loss of mangrove areas to agricultural development*
- *Potential loss of globally important bird species*
- *Reduction in the protective functions of agricultural bunds*
- *Increased pollution and loss of fish productivity*
- *Deterioration of recreational facilities and aesthetic beauty*

KAEDAH PENGURUSAN:**管理方案:****MANAGEMENT SCENARIOS:****B****RANCANGAN PENGURUSAN YANG DICADANGKAN :****Perlindungan Hutan Paya Bakau Di Benut Sebagai Hutan Simpanan Terpelihara**

- Perlindungan burung dan haiwan liar serta tempat penginapan yang penting yang kini terancam
- Pemeliharaan bekalan ikan dan kerang untuk faedah penduduk tempatan
- Peningkatan perlindungan ke atas benteng dan tanah pertanian
- Peningkatan kemudahan untuk tujuan rekreasi dan pendidikan bagi penduduk tempatan dan pelancong
- Pengurangan pencemaran
- Perlindungan daripada kegiatan haram

建议中的管理计划:**保护文律的红树林地区以使它成为受保护森林保留地**

- 保护目前受危害的珍禽和其他野生动物及他们的居所
- 维持鱼类和贝类产量以让当地人民受惠
- 给予农业堤岸和耕种土地更好的保护
- 为居民和游客改善休闲和教育设备
- 减少污染
- 抵御非法活动

PROPOSED MANAGEMENT PLAN:***Protection of the Benut Mangroves As A Protected Forest Reserve***

- *Protection of globally significant birds and other wildlife and habitat currently under threat*
- *Maintenance of fish stocks and shell fish of benefit to local communities*
- *Increased protection of agricultural bunds and hence agricultural land*
- *Improved recreational and educational facilities for residents and tourists*
- *Reduced pollution*
- *Protection from illegal activities*

Perlindungan Pinggir Laut
岸线保护
Shoreline Protection

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Kayu dan tayar digunakan untuk menahan ombak kerana paya bakau sudah ditebang.
当红树林被砍伐后，人们使用木材与轮胎来阻挡巨浪。
Woods and tyres are used to confront the waves because the mangroves have been cut down.



Paya bakau melindungi benteng daripada dihakis laut.
红树林保护及避免堤岸遭海水侵蚀。
Mangroves protect the coastal bund from the sea.

SHOWCARD D

PROJEK-PROJEK YANG MUNGKIN DIJALANKAN UNTUK MENINGKATKAN KEPELBAGAIAN BIOLOGI DI BENUT

增加文律红树林生物多元化的可行计划

POSSIBLE PROJECTS TO INCREASE BIODIVERSITY IN BENUT

- Pemulihan hutan paya bakau (contohnya tanam semula di depan benteng untuk melindungi aktiviti pertanian)
 - Mendirikan pusat pelawat / pusat maklumat
 - Promosi aktiviti pelancongan alam sekitar (contohnya melihat burung dan naik bot)
 - Mengawal kawasan hutan paya bakau daripada kegiatan haram
 - Mengawasi hidupan ikan, tumbuhan dan paya bakau
 - Menggalakkan pembuangan sampah sarap dan lain-lain sisa dengan cara yang betul untuk mengurangkan pencemaran
 - Pelaksanaan program-program dan kegiatan-kegiatan pendidikan
-
- 重新种植红树(例如在堤岸前种植以保护农作物)
 - 建立旅游／资讯中心
 - 推广环保旅游活动(例如观鸟和游船河等)
 - 巡查红树林地区，阻止非法活动
 - 检察鱼类和植物生态及红树林的生长
 - 鼓励正确的废物处理方法以减少污染
 - 施行教育计划及活动
-
- *Rehabilitation of mangroves (e.g., in front of bunds in order to protect agriculture)*
 - *Establishment of visitors center / information center*
 - *Promotion of environmental sensitive tourism activities (e.g., bird watching, boat trips)*
 - *Patrolling of mangrove area to prevent illegal activities*
 - *Monitoring of fish, plant life and mangroves*
 - *Encouragement of proper disposal of garbage and other waste to reduce pollution*
 - *Implementation of educational programs and activities*