EMDI Environmental Reports, 8

Mangrove Management: An Economic Analysis of Management Options with a Focus on Bintuni Bay, Irian Jaya

prepared by

H. Jack Ruitenbeek

for the

Environmental Management
Development in Indonesia Project (EMDI)

Jakarta and Halifax
1992

Environmental Management Development in Indonesia

EMDI is a joint project of the Ministry of State for Population and Environment, Government of Indonesia, and the School for Resource and Environmental Studies, Dalhousie University, Halifax, Nova Scotia, Canada. It is funded by the Canadian International Development Agency (CIDA).

EMDI Project
School for Resource
and Environmental Studies
Dalhousie University
1312 Robie Street
Halifax, Nova Scotia
B3H 3E2

Proyek EMDI
Menteri Negara Kependudukan
dan Lingkungan Hidup
Jl. Medan Merdeka Barat 15
Jakarta 10010
Indonesia

This work was completed in 1991.

Published 1992 2d pr. 1993 3rd pr. (as PDF document) 1997
Printed in Canada by Dalhousie University Printing Centre
Edited by: Shama Vethamany
Word processing by: Debbie Brown

About the Author:
H. Jack Ruitenbeek is President of H.J. Ruitenbeek Resource Consulting Ltd.
RR2 - Site 52 - C21, Gabriola, B.C. Canada V0R 1X0

Canadian Cataloging in Publication

Ruitenbeek, H. Jack (Herman Jack), 1958-

Mangrove management

(EMDI environmental reports, ISSN 1181-6457 ; 8)

Prefatory material in Indonesian and English.
ISBN 0-7703-0461-3

1. Mangrove swamps -- Economic aspects -- Indonesia -- Bintuni Bay. 2. Mangrove swamp conservation -- Indonesia -- Bintuni Bay. 3. Forest management -- Indonesia -- Bintuni Bay. 4. Forests and forestry -- Indonesia -- Bintuni Bay -- Multiple use. I. Dalhousie University. School for Resource and Environmental Studies. II. Environmental Management Development in Indonesian (Project) III. Title. IV. Series.

SD397.M25R84 1991 333.75'15'09951 C91-097636-8

1. INTRODUCTION

1.1 BACKGROUND

Mangroves in Indonesia are under intense pressure from competing resource uses. Their exploitation for charcoal, wood, fish ponds, or similar 'productive uses' is often done on the grounds of narrow economic evaluations which focus on only a single use of the mangroves. Economic analyses which focus on the multiple-use aspects of mangroves will prescribe management practices which have lower rates of conversion and exploitation; some level of 'conservation' makes economic sense. This study relies on such a 'multiple-use' focus to develop – and apply – a framework which assists in selecting an economically optimal mangrove management strategy for any given area.

Indonesia's mangrove resources are significant both in their areal extent and in their importance to economic production. Of 144 million hectares of forest in Indonesia, wetland forests comprise almost 30 million hectares, and mangrove forests account for over 4 million hectares of these forests. As shown in Table 1.1, the most extensive mangrove forests are found on the islands of Irian Jaya, Sumatra, and Kalimantan. Although Java and Sulawesi also at one time had extensive natural mangroves, they have been increasingly depleted by human population growth and other pressures.

The resource conflicts which occur in mangrove use are by no means peculiar to Indonesia: experience in other tropical countries, those in Southeast Asia in particular, has shown that proper management of the resource can avoid conflict and ensure long-term sustainability of the mangrove ecosystems. It is equally clear, however, that no *single* solution to proper mangrove management can be applied to all mangrove areas in Indonesia; both the problems, and solutions, are quite diverse. But failure to find and implement the appropriate management strategy can lead to substantial economic losses, ecological degradation, and – where mangroves support important traditional livelihoods – increased social and political instability.

Table 1.1
Mangrove Areas in Indonesia

Irian Jaya	2 943 000	hectares
Sumatra	391 335	
Kalimantan	383 450	
Riau	276 000	
Maluku	100 000	
Sulawesi	72 800	
Java	50 000	
Nusa Tenggara (East and West)	5 500	
Bali	2 000	
Total Indonesia	4 225 000	hectares

Both the economic and ecological importance of mangroves is becoming well recognised within Indonesia. A National Mangrove Committee exists which has the function of identifying critical mangrove areas. Indonesian Forestry Departments, which in most cases have authority over mangrove exploitation, are seeking technical solutions for sustainable mangrove use. Where mangrove areas have been proximate to industrial sites, they have at times been the focus of environmental impact research. More recently, the Ministry of State for Population and Environment (KLH), has started to assess the role of mangrove management in a broader programme of Marine and Coastal Environmental Management. This latter focus has been one component of the Environmental Management Development in Indonesia (EMDI) Project, which is funded by the Canadian International Development Agency (CIDA) and is jointly designed and implemented by KLH and Dalhousie University, Halifax, Canada.

Interest in mangroves in Indonesia stems from a number of reasons, but two stand out as being particularly important in the broader context of developing a mangrove management strategy: (i) the *economic value* of some single component of the resource is often very significant, although not always obvious; (ii) the *ecological linkages* between different components of the mangrove are also very significant, although often fraught with uncertainty. These two factors alone imply that improper management of one component of the resource, such as forestry, can result in significant economic losses elsewhere, such as offshore fisheries. This suggests that the use of some form of economic analysis, one capable of incorporating the ecological linkages, can provide important information on the optimal use of the entire resource base.

Such analyses are not uncommon (see Hodgson and Dixon [1988], Dixon [1989], Ruitenbeek [1990a;1990b]) for establishing the conditions under which conservation of some parts of a critical area are economically justified. Key aspects of such analyses, however, include recognising that some components have economic value even if there are no ‘marketed’ goods or services involved, and establishing the ecological linkages between the various resource components. A review of traditional uses of non-timber forest products in Southeast Asia (de Beer and Mcdermott [1989]) shows, for example, that traditional untraded uses of forest products can be a substantial component of local economies. Further, in the case of mangroves, broad-based correlation studies such as that in West Java (Naamin [1987]) and the Philippines (Eusobio, Tesoro, and Cabahug [1987]), and specific studies of linkage mechanisms (Robertson, Alongi, and Boto [1988]; Robertson, Dixon, and Daniel [1988]; Robertson and Daniel [1989]; Robertson and Duke [1990]; Williams and Cappo [1990]), demonstrate the dependencies which exist between different parts of the ecosystem. An important conclusion of this work is that – although the precise linkage mechanisms may differ from one site to the next – offshore fishery productivity is strongly correlated to the area of mangroves; declines in mangrove area – through reducing fish or shrimp nursery habitats or losses in other ecological functions – decrease near-shore and off-shore fishery yields. In areas of Sumatra this linkage is so strong and so obvious that local fishermen are voluntarily replanting mangroves – in places where they have been depleted – in an attempt to re-establish fishery productivity which has been lost.

In summary, it is suggested that, where economic analyses recognise the untraded goods and services associated with mangrove ecosystems, and also recognise the linkages existing between their various components, they can provide important information to decision-makers in selecting optimal management strategies.

1.2 PURPOSE

The general objective of this study is to contribute to a mangrove management framework which is adequately flexible to be applied to different mangrove areas in Indonesia. This framework essentially consists of the following five steps:

I. Identifying Key Productive Uses and Functions of Mangroves
II. Identifying the Linkages between the Uses and Functions
III. Selecting Management Options
IV. Specifying Management Objectives
V. Evaluating Options

It is clear that significant scope is provided within this framework for addressing many problems of 'optimal' resource use where multiple uses are available. Step IV and Step V, in particular, can become quite complex where multiple management objectives dealing with scientific, ethical, political, economic, or social factors arise. This study focuses primarily on the economic dimension of the evaluation task in prescribing optimal resource use.

In applying this framework, empirical work focuses on approximately 300,000 ha of mangroves in the Bintuni Bay area of Irian Jaya, in eastern Indonesia. Figure 1.1 shows the location of Bintuni Bay. The bay supports an important shrimp export industry, and coastal areas support some 3000 households in a mixed economy of farming, wages, and traditional mangrove uses. Pressures from a woodchip export industry pose a direct threat to the mangrove ecosystem. Recent interest in the area has led to a proposed Bintuni Bay Nature Reserve which would protect approximately 267,000 ha of the ecosystem, 60,000 ha of which is in the bay itself. Also, in early 1991, KLH initiated a pilot Integrated Regional Environmental Development Program (INREDEP) in the area which is intended to provide a basis for integrated management of all components of the resource base.

The specific objectives of the empirical work relating to Bintuni Bay were:

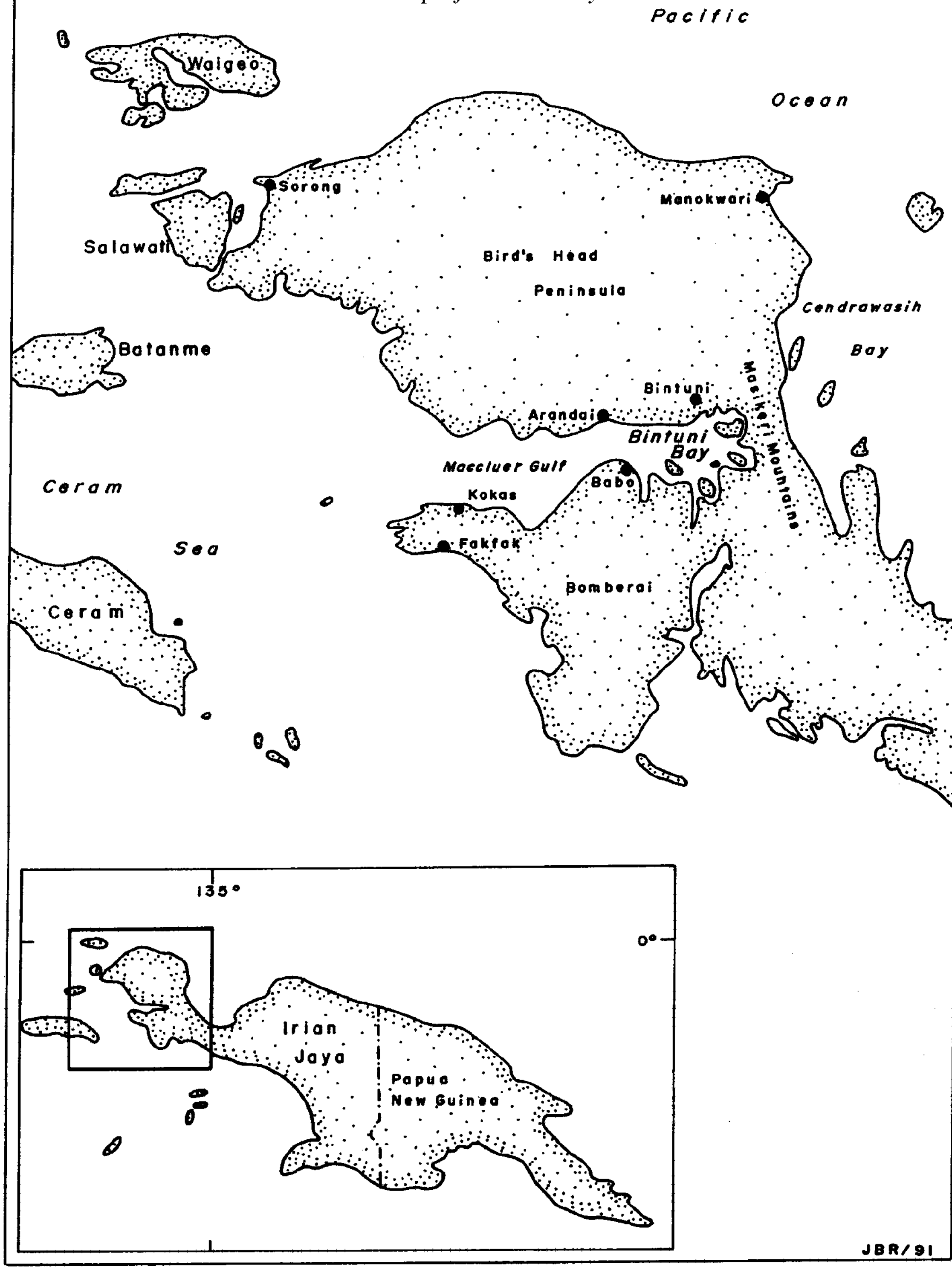
- to conduct a household survey which would assist in providing a quantification of the value of traditional uses of mangroves in the Bintuni Bay area;
- to conduct correlation studies to describe the 'economic linkages' between the formal sector economy and the traditional economy; and,
- to conduct cost benefit analyses which incorporate 'ecological linkages' and appropriate constraints to evaluate different management options for the forestry component of the mangrove resource.

Specific recommendations relating to Bintuni Bay and general recommendations relating to mangrove management elsewhere in Indonesia are based on these analyses.

It is important to note that the study does not attempt to prescribe a single mangrove management strategy which can be applied to all mangrove areas in the country. The framework which is used, however, can be used elsewhere and, moreover, some of the general conclusions arising from the analyses can be applied to other mangrove areas.

It is also important to realise that, although studies elsewhere demonstrate the linkages between the productivity and functioning of various mangrove ecosystem components, no such analyses have been conducted at Bintuni Bay. Furthermore, the work undertaken here conducts no such analyses. The approach used here, rather, is to rely on evidence elsewhere that such linkages exist, and to conduct 'sensitivity' analyses under different types of linkage assumptions.

Figure 1.1
Location Map of Bintuni Bay



1.3 INFORMATION SOURCES AND METHODOLOGY

Experience with mangrove management in Indonesia and in other Southeast Asian countries has provided a rich literature which describes the potential uses for mangrove areas. A summary of the Indonesian situation is provided in Soemodiharjo (1987) and in Silvius, et.al. (1987); other Southeast Asian countries are addressed in reviews by Umali, et.al. (1987) and Chua and Pauly (1989). Work in the Bintuni Bay area builds on earlier conservation site identification work conducted by Petocz and Raspada (1984) and a preliminary resource inventory by Erftemeijer, Allen and Zuwendra (1989) which led to a proposal to establish a conservation site – the Bintuni Bay Nature Reserve – in the area.

To supplement published work, extensive discussions were held with government departments in Jakarta and the regions. In particular, this involved collecting up-to-date data from departments of forestry, fishery, trade, industry, statistics, as well as local government authorities. It should be noted that, in addition to the analytical work conducted at Bintuni Bay, mangrove sites were visited in West Java and South Sulawesi to ensure that the general framework had broad applications.

Although significant amounts of information were available for traded goods – such as shrimp and chipwood exports – few data were available on the value of the local uses. A household survey, consisting of 101 households in 6 villages, was therefore conducted to provide primary data estimating the scale and value of traditional mangrove uses in the Bintuni Bay area.

The household data are analysed, along with other information on traded goods, to estimate both the traded and untraded value of goods and services associated with Bintuni Bay mangroves. In addition, correlation studies using qualitative dependent variable techniques of econometric analysis are conducted to identify some of the key economic linkages which exist. In particular, these techniques attempt to address whether individuals' reliance on traditional mangrove hunting, gathering and fishing will be affected by increased development in the area. These analyses were all undertaken with a view to providing input to a cost benefit analysis (CBA) of different forestry management options. The CBA reflects both economic and ecological linkages, and assesses forestry options ranging from clear cutting the mangroves to the imposition of a complete cutting ban. Because ecological linkages have often been ignored in past decisions, a key component of the CBA is to assess the 'economically optimal strategy' under different assumptions of ecological linkages; this captures some of the uncertainty inherent in ecosystem behaviour, while also providing decision-makers with information about the potential economic losses associated with an 'incorrect' decision.

Finally, the preliminary results of the analysis were discussed extensively at two workshops held in Jakarta. The workshop participants consisted of individuals with scientific or management interests in the various mangrove resource components, as well as specialists in resource valuation and data collection involved with Indonesia's current efforts in the area of natural resource and environmental accounting (NREA). A common concern raised at both of these workshops was the lack of consistent data within Indonesia's information system. While this problem is likely to persist for some time, it is relevant to note that, for this study, the general approach was to acquire and cross-check information from multiple sources Where conflicting information still existed (such as discrepancies between physical and monetary accounts, or discrepancies between fishery production and exports) and could not be reconciled, the actual source used was the one that had involved the least amount of analysis or second-hand interpretation.

1.4 OUTLINE OF REPORT

Chapter 2 focuses on the five steps in the mangrove management framework, addressing some of the general concerns which must be considered in each step, and then illustrating how Bintuni Bay and two other sites fit into the overall framework. Chapter 3 addresses a number of issues relating to cost benefit analysis and the economic valuation of mangroves, including: the meaning of 'environmental functions' in an economic context; ecotourism potential; biodiversity; the role of resource accounting; and, macro-economic policy. The specific results of the Bintuni Bay case study are presented in Chapter 4. Chapter 5 then provides some general recommendations and follow-up actions. It is important to note that – because there is still uncertainty in the extent of ecological or environmental impacts which will arise from different mangrove management strategies – the type of follow-up actions actually taken by the Indonesian government will depend significantly on their degree of 'risk aversion'. The recommendations and actions described in Chapter 5 are premised on a relatively conservative or 'safe' approach.

To supplement the material in the these chapters, a separate compendium of annexes provides additional statistical information on Bintuni Bay (Annex 1), copies of the household survey instrument (Annexes 2 and 3), and household survey and CBA results (Annexes 4 and 5); Annex 6 provides a more detailed discussion on the use of economic instruments for mangrove management.

2. OUTLINE FOR A MANGROVE MANAGEMENT FRAMEWORK

2.1 BACKGROUND

As mangroves in Indonesia fall under the jurisdiction of the Forestry department, most management responses to date have involved working within a system which designates mangrove areas either as “protection forests”, “production forests”, or “conversion forests”, the latter involving permanent conversion to some other land-use. Management strategies have thus focused on establishing conservation areas, undertaking selective cutting, promoting replanting of mangroves, or enforcing “greenbelt” regulations. The purpose of the greenbelt is to ensure that a belt of mangrove is maintained between open water and the production or conversion area. Proposed reforms in greenbelt regulations will require that the actual width be a function of the tidal variation in any given mangrove area; in Bintuni Bay, for example, the greenbelt would need to be almost one kilometre wide because of the high tidal variation. In addition to these purely “forest-based” management options, there has been some attempt to promote “multiple uses” of mangroves, especially those involving forestry and aquaculture. In most cases, however, no formal assessment of the management options has occurred. Indeed, quite often the “management” options are very restricted because they are introduced only after much of the resource has been cleared; replanting may in such cases be the only viable option.

Given the importance of the mangrove resource, and given that there is a need to do forward planning to ensure that the resource is used sustainably, it is appropriate to develop some formal – yet relatively simple – procedure for selecting the optimal management option. As stated previously, it is not expected that a single management response will be appropriate for all mangrove areas. It is, however, appropriate to outline a management *framework* which can be applied to any given area and which will, in the end, offer decision-makers an objective method of selecting an appropriate mangrove management response. This chapter outlines such a framework and illustrates how it can be applied to three quite different sites in Indonesia.

2.2 GENERAL FRAMEWORK

The general framework consists of the following five steps:

- I. Identifying Key Productive Uses and Functions of Mangroves
- II. Identifying the Linkages between the Uses and Functions
- III. Selecting Management Options
- IV. Specifying Management Objectives
- V. Evaluating Options

The procedure involves, in a sense, an expansion of the typical “single-resource” management problem which normally addresses only the last three steps. In a “conventional” forestry project, for example, different management options are selected (Step III) and these are evaluated (Step V) to achieve some management goal (Step IV) such as profit maximisation consistent with a sustainable harvest. While these steps are still critical in a “multiple-use” context, it is also – for mangroves – necessary to enumerate all of the potential uses and functions of mangroves (Step I) and the linkages between them (Step II).

This method can be characterised as a “building block” approach, because it requires that the manager explicitly recognises all of the “blocks” (forestry, fishery, traditional use, erosion control, etc.) in the mangrove ecosystem, as well as the interdependences and linkages between these blocks. Only when all of the blocks have been specified can the manager be assured that some optimal resource use will be achieved. The following sections describe in further detail how each of these steps is accomplished, and what factors should normally be considered at each step.

2.3 IDENTIFYING THE USES AND FUNCTIONS

Most conventional approaches to mangrove management focus entirely on the different marketable uses of the mangrove wood: timber, poles, firewood, charcoal, or woodchips for pulp. This first step must, however, also recognise that mangroves support other productive uses (such as fisheries or traditional activities) or perform important functions (such as preventing coastal erosion or maintaining biodiversity). In particular, it must be recognised that not all of these uses or functions flow through formal markets and have some price attached to them. Even where some market transactions occur, the market prices do not necessarily reflect the value of the particular good or service being provided by the mangroves.

Examples of potential uses and environmental functions of mangroves are shown in Table 2.1. The categories are similar to those enumerated by McNeely (1988), in that they distinguish between productive uses of goods (some of which are sustainable and some of which involve conversion to a different land-use) and the production of some service in terms of regulatory, carrier, or information functions. Although in principle each of these uses or functions might be attributed to *any* mangrove area, in practice the first step in the mangrove management framework will involve selecting those key uses and functions which appear *a priori* to be economically or ecologically most important for that area.

Table 2.1
Examples of Uses and Environmental Functions of Mangroves

Sustainable Production Functions Timber Firewood Woodchips Charcoal Fish Crustaceans Shellfish Tannins Nipa Medicine Honey Traditional Hunting, Fishing, Gathering Genetic Resources	**Regulatory or Carrier Functions** Erosion Prevention (Shoreline) Erosion Prevention (Riverbanks) Storage & Recycling of Human Waste & Pollutants Maintenance of Biodiversity Provision of Migration Habitat Provision of Nursery Grounds Provision of Breeding Grounds Nutrient Supply Nutrient Regeneration Coral Reef Maintenance & Protection Habitat for Indigenous People Recreation Sites
Conversion Uses Industrial/Urban Land-use Aquaculture Salt Ponds Rice Fields Plantations Mining Dam Sites	**Information Functions** Spiritual & Religious Information Cultural & Artistic Inspiration Educational, Historical & Scientific Information Potential Information

2.4 IDENTIFYING THE LINKAGES

Once the primary uses and functions are identified, the next step involves identifying the linkages between the different components. If possible, this step should also describe the nature of the impact and how changes in one component might affect changes in other components. To provide some guidance in defining the types of linkages which might arise, Table 2.2 broadly classifies two types of linkages: "biogeophysical" linkages; and, "socio-economic" linkages. A third category – macro-economic policy linkages – is not included here although it is discussed in the following chapter.

The term "biogeophysical linkage" refers to a growing concern in Indonesia that – in evaluating environmental impacts of projects – attention must be paid to those impacts which are basically biological in nature (such as fishery productivity) as well as to those which are geophysical in nature (such as erosion). Table 2.2 distinguishes further between four different types of impacts which might arise from these types of linkages: (a) direct pre-emptive use; (b) partial or delayed impact; (c) direct or immediate impact; and, (d) catastrophic impact. Pre-emptive linkages are relatively straightforward in that they reflect a linkage where one land-use directly conflicts with another land-use; conversion uses such as those described in Table 2.1 fall into this category. Direct immediate linkages are also relatively straightforward in that they reflect instances where changes in one "building block" of the mangrove (forest area, for example) immediately affects another "building block" (such as fishery productivity) because of the ecological ties which exist between these two components. Where these ties are relatively weak, or involve substantial response delays, a "partial" linkage may be specified. The last category – that involving a catastrophic impact – might arise because of the non-linear behaviour of ecosystems; it might be characterised, for example, by the complete collapse of one component as a result of only an apparently small change in some other component. If, for example, mangrove cutting eliminated a relatively small but critical fish breeding or nursery habitat, and the entire offshore fishery collapsed as a result, this could be described as a catastrophic impact.

The distinction between "partial", "direct" and "catastrophic" impact is – at best – a simplification of the complex ties which might exist between ecosystem components. The distinction is offered here primarily to assist policy-makers in understanding how different parts of ecosystems might interact. Much of the correlation work undertaken in Indonesia, for example Naamin (1987), suggests that there is a direct and immediate relationship between mangrove area and off-shore fishery productivity.

The second type of linkage – that involved with socio-economic adjustments – is potentially much more important than the biogeophysical linkages; response times for socio-economic adjustments can often be expected to be quite rapid. These linkages may be particularly pronounced in areas where there is high population density. We distinguish between two types of impacts which might occur through socio-economic adjustments: one involving interactions between traditional uses of the mangrove and an "external" formal sector economy; and, one involving a substitution of activity between different mangrove components. The first of these is often presumed to be important and is regularly put forward as a rationale for disregarding traditional uses of mangroves. It is argued, for example, that "economic development" through expansions in the wage sector economy will decrease dependence on traditional uses, and it is thus inconsequential if the mangroves are destroyed in the process. Rather than taking this as an assumption, however, evidence should be gathered to support the actual degree to which this linkage exists. The analysis presented in Chapter 4, for example, suggests that this is argument would not hold in Bintuni Bay.

Table 2.2
Examples of Linkages between Mangrove Components

TYPE	NATURE OF IMPACT	EXAMPLE
BIOGEOPHYSICAL LINKAGES	DIRECT PRE-EMPTIVE USE	One mangrove use immediately pre-empts other use because they are incompatible uses which share same land area: Conversion to fishpond pre-empts land for sustainable wood production.
	INDIRECT PARTIAL OR DELAYED IMPACT	Activity in one component of mangrove partially affects productivity of some other system component: Conversion to fishpond increases erosion which, over a number of years, increases siltation and destroys coral reef habitat offshore.
	INDIRECT LINEAR IMPACT	Activity in one component of mangrove has immediate affect on productivity of some other system component: Conversion to fishpond destroys nursery ground and reduces offshore fishery production in proportion to lost area of mangrove.
	INDIRECT CATASTROPHIC IMPACT	Activity in one component of mangrove irreversibly destroys critical ecosystem component: Conversion to fishpond of a critical area of breeding ground causes collapse of offshore fishery.
SOCIO-ECONOMIC LINKAGES	ACTIVITY SUBSTITUTION OUTSIDE MANGROVE ECOSYSTEM	Availability of external income causes changed local use patterns of mangroves: Expanded wage economy reduces traditional reliance on mangrove harvesting.
	ACTIVITY SUBSTITUTION INSIDE MANGROVE ECOSYSTEM (ECONOMIC DISPLACEMENT)	Change in availability of one mangrove component causes local substitution for other mangrove component: Loss of onshore productivity for hunting and gathering due to mangrove conversion forces increased reliance on offshore fishing.

The second socio-economic linkage relates to adjustments between different ecosystem components. Planners should pay close attention to this if traditional uses of mangroves are highly diversified. The most obvious case of such displacement is where a strong near-shore fishery exists in conjunction with a strong on-shore fishery in the mangrove areas. As mangrove areas are depleted and on-shore catch declines (because of biological linkages), a process of economic displacement may drive more fishermen into near-shore areas and increase the pressure on those areas. If this leads to subsequent collapse of the near-shore fishery because of over-fishing, it is clear that this "socio-economic" linkage can be quite strong even if there are weak or delayed biological ties between the mangrove forest and the near-shore fishery. Indeed, this underlines the fact that *people* are in such cases an integral part of the ecosystem, and that they can in fact be a strong "link" in any part of the stress-response chain.

2.5 SELECTING MANAGEMENT OPTIONS

As with the process of specifying the major building blocks in the mangrove ecosystem, the procedure of selecting management options will often rely on some judgment about what is both technically and politically feasible. Forest management options such as replanting, selective cutting, zoning, cutting bans, or designation of greenbelts all provide potential options. In addition, however, the management options might also extend to other parts of the resource base, and might consider, for example, conferring certain local use rights for traditional uses, or regulating commercial fisheries to ensure that conflicts between artisanal and commercial fisheries are minimised. The precise options selected, and eventually evaluated, will differ considerably from one site to the next.

One category of management option which has been used to only a very limited degree in Indonesia is the "economic instrument". Economic instruments involve the use of economic incentives or disincentives to induce certain types of behaviour in companies or individuals. Annex 6 provides more detail on the subject, but one example of an economic instrument might involve the use of staggered royalty structures to induce companies to maintain wide green belts. Regular royalty rates would apply far from the greenbelt zone, but increasingly higher royalties would occur close to the greenbelt zone; annual monitoring and collection of the appropriate level of royalties is relatively straightforward, and the procedure provides an economic incentive for companies not to go near the greenbelt area. While such a royalty system has not been tested in Indonesia, other types of economic incentives are being used successfully to induce local fishpond operators in South Sulawesi to plant mangroves to prevent increased erosion.

2.6 SPECIFYING MANAGEMENT OBJECTIVES

The last step before the actual evaluation must involve a clear enunciation of what management objectives are being sought. These can also differ considerably among areas, and the objective of "economic return" is only one among many potential goals. There is, for example, increasing concern in some areas that local peoples' traditional uses of natural areas are not being adequately protected; protection of these uses could be an important management goal in its own right. In addition, various social, political, cultural or moral objectives might arise, all with the final objective of ensuring sustainability.

It is beyond the scope of this study to suggest how all of the different goals might be reconciled or addressed in any given decision process. The methods used here focus almost entirely on the economic dimension of the management objectives.

2.7 EVALUATING OPTIONS

The purpose of evaluating the management options in terms of how well they contribute to meeting the various objectives can involve different procedures or tools. The use of informed judgment is, in most countries, still the most commonly used approach. In Indonesia this judgment is often complemented by a process which attempts to achieve consensus on how well various options meet the specified objectives. Depending on the criticality of the problem, various types of formal analysis might also be undertaken. One example of a formal analysis is an environmental impact assessment which, in association with other information available to decision-makers, contributes to the evaluation of the various options and hence the ultimate decision.

The role of economics in the evaluation process has been relatively well established for investment projects. Similar procedures can, however, also be applied to evaluate mangrove management options. The procedures, described in more detail in the following chapter, involve looking at the various options in light of the specific *economic* objectives of the planner. Even concentrating on just the economic dimension, however, there are many potential objectives and evaluation techniques which can come to the foreground. Long-term sustainability of income, maximisation of total net worth, short-term income generation, and job creation, are all examples of potential economic objectives. The approach used in this study relies most heavily on cost benefit analysis procedures, which seek to maximise total social welfare. The one constraint imposed on the procedure in this study, however, is that income levels from the resource base as a whole be sustainable. This constraint was imposed primarily to ensure socio-economic and political stability in the given regions.

Whether simple or complex procedures are followed in the actual evaluation procedure, the last implicit step involves selecting a management strategy which consists of one management option or, in some cases, a combination of various options.

2.8 ILLUSTRATIVE APPLICATION TO THREE SITES

To provide a more concrete illustration of these procedures, Table 2.3 shows examples of how the various steps provide important information for undertaking an evaluation of the management alternatives. The three sites are: a 5,000 ha area of degraded mangrove in the Cimanuk River delta near Indramayu and Losarang in West Java; a 30,000 ha area of virgin mangrove in Kabupaten Luwu at the north end of Bone Bay in South Sulawesi; and the 300,000 ha virgin mangrove area of Bintuni Bay in Irian Jaya. The sites in Java and Sulawesi were selected to illustrate how the framework might be applied to areas where degradation is already well advanced (Java) and where it has not yet occurred but is imminent (Sulawesi). The purpose was not to collect or analyse detailed data for these two sites, but was rather to provide a qualitative and descriptive analysis of some of the factors which can arise in the course of assessing mangrove management options within this framework.

The first site at Indramayu was first described in some detail by Hehanussa and Hehuwat (1980), who highlighted how mangrove conversion to other uses contributes to increased sedimentation, erosion and accretion. These problems still persist today, as they do in many places on the north coast of West Java, as a result of more intensive land use for fishponds ("tambak"), salt production ponds, or plantation. The Forestry department is currently attempting to demonstrate the "Tumpangsari" system – which means "overlap" – involving sustainable coproduction of wood from the mangrove and fish or shrimp from ponds around the mangrove. The current focus

Table 2.3
Illustration of Mangrove Management Framework Applied to Three Sites

	INDRAMAYU/ LOSARANG, WEST JAVA	**KAB. LUWU, SOUTH SULAWESI**	**BINTUNI BAY, IRIAN JAYA**
	~5 000 HA	~30 000 HA	~300 000 HA
STEP I: KEY USES & FUNCTIONS	• Tambak • Salt Pond • Plantation • 'Tumpangsari' • Erosion & Sediment Control	• Tambak • Wood • Nipa Palm • Transmigration Site • Traditional Use • Coral Reef • Biodiversity • Nickel Mining	• Offshore Fishery • Woodchip • Traditional Use • Sago • Erosion Control • Biodiversity
STEP II: LINKAGES	• Forest/Fish • Forest/Erosion • Forest/Sediment	• Tambak/Forest • Upstream Development/Forest • Forest/Fish • Forest/Sediment • Sediment/Reef • Economic Displacement	• Forest/Fish • Forest/Traditional Uses • Forest/Erosion • Forest/Biodiversity
STEP III: MANAGEMENT OPTIONS	• Replanting • 80/20 Forest/Fish • Greenbelt • Ownership Reforms	• Replanting • Zoning • Greenbelt • Economic Incentives	• Greenbelt • Conservation Area • Selective Cutting • Economic Incentives
STEP IV: MANAGEMENT OBJECTIVES	• Sustainability • Prevent Erosion • Economic Return • Resolve Ownership Conflicts	• Sustainability • Prevent Sedimentation • Economic Return • Prevent Ownership Conflicts	• Sustainability • Optimise Mix of Multiple Uses • Minimise Social Disruption • Protect Biodiversity • Economic Return
STEP V: EVALUATE & SELECT (CURRENT FOCUS)	• Demonstrate '80/20 System'	• Replanting • Attempt Integrated Plan • Need EIA of Transmigration	• Evaluate Cutting Options • Attempt Integrated Plan • Recognise Ecosystem Linkages

involves a system of about 80% forest and 20% fishpond and, although there has been no forestry production from this area to date, fish and shrimp have been harvested sustainably and commercially for about 10 years. A major concern in this area is not so much commercial production, however, as it is the ownership and jurisdictional conflicts which are arising as a result of a very rapid accretion/erosion process. Resolving these conflicts is a necessary pre-condition to stabilising land-use in the region. As such, the decision to focus on demonstrating the technical viability of one system – such as the 80%/20% mix of forestry and fishery – is quite valid. It is anticipated that, once ownership issues are settled and the technical viability of such a system has been demonstrated, some "fine-tuning" will occur in an effort to select the optimal mix of fishery and forestry in such a system.

The second site – located in Kabupaten Luwu – is considerably more complex. At 30,000 ha in size, it is the largest mangrove area in South Sulawesi and represents about 75% of the untouched mangrove in the province. Much of the rest of the province's mangrove have been converted to tambak; South Sulawesi was therefore identified as one of the four critical mangrove provinces in Indonesia. The area in Kabupaten Luwu is under increasing development pressure; about 2000 ha have already been converted to tambak and, with the opening of a new all-weather road over the past two years, it has been identified as a target area for about 600 households in Indonesia's transmigration program.

The area is ecologically important both for its own biological resources as well as for an offshore reef area which supports an important commercial fishery. The dominant management approach is currently to allow conversion to tambak in one part of the area while promoting replanting in another area; this is believed to be more politically viable than prohibiting conversion. There is, however, a strong desire on the part of local authorities to attempt an integrated development plan. It is believed that the mangrove conversion will inevitably outpace the replanting because of budget constraints on replanting and – more significantly – the added pressures which the proposed transmigration will impose. A high evaluation priority is therefore to initiate an AMDAL process (leading to an environmental impact analysis and environmental management and monitoring plan) for the proposed transmigration programme.

The situation in South Sulawesi is of key economic interest for two other reasons: (a) it demonstrates the potential role of "socio-economic linkages"; and, (b) it provides a number of interesting insights into how economic incentives can contribute both to degradation and protection of mangroves.

With respect to linkages, it has been observed that, although mangrove area has declined substantially over the past ten years, local near-shore fishing catch has remained relatively constant. If near-shore catch is indeed biologically dependent on mangrove area, why has near-shore productivity not fallen? The answer appears to be that, concomitant with the destruction of mangrove, there has been a substantial reallocation of *time* to near-shore fishing effort. If there is any decline in ecological productivity, it is thus being masked by this economic displacement. This illustrates both the potential importance of the socio-economic linkage, as well as the danger in relying only on gross catch or productivity as an indicator of sustainable production from an ecosystem.

With respect to economic incentives, these have worked both in favour of and against mangrove management. Through the Land Rehabilitation and Conservation Agency (BRLKT), for example, replanting incentives have induced some tambak operators to plant mangroves to re-establish a greenbelt zone which had been previously destroyed. On the other hand, economic distortions are also creating strong incentives to destroy virgin mangrove. The land price for new tambak production, for example, is effectively zero and, when coupled with low land taxes, provides little incentive to maintain some of it in its natural state. Further, implicit hatchery subsidies have driven down PL20 fry prices from Rp50 five years ago to Rp10 in early 1991; whereas fry were at one time harvested from natural mangrove areas, there is no longer an incentive to maintain such areas intact for this purpose. Finally, in the interests of "good aquaculture management", permits were issued in 1990 to local companies to purchase cleared mangrove wood from tambak operators *only*; this effectively provides an additional subsidy to unsustainable mangrove clearing. All of these cases illustrate how economic instruments can provide powerful mechanisms for promoting both proper and improper mangrove management.

The third site, and the subject of the detailed evaluation in subsequent chapters, is Bintuni Bay in Irian Jaya. As noted in Table 2.3, the key uses and functions of the resource in Bintuni Bay involve an offshore fishery (primarily shrimp), chipwood production, traditional uses, sago production, erosion control, and biodiversity maintenance. The key linkages which are investigated involve those between forest area and other ecosystem components. Management options are still relatively straightforward in that they involve primarily different forest use options; as the forestry resource is still largely in its virgin state, the potential exists for a sustainable management plan to be implemented. A key feature of the management will involve attempts to coordinate a number of activities in the area through a recently initiated INREDEP project. This project was initiated by KLH and will be coordinated at the regional level through the local planning authority (BAPPEDA). It is anticipated that the project, through identification of development options for all components of the resource base in the area (not only mangrove), and through recognition of the interdependences of many of these components, will develop a long-term plan for sustainable development of the area.

2.9 SUMMARY

This chapter introduced a general outline for a mangrove management framework and demonstrated that it is adequately flexible to accommodate different situations in different parts of Indonesia. A key premise of the framework is that no single management option or management strategy will be appropriate for every area, and that a procedure must therefore be adopted which allows planners to identify and select the best strategy. The framework outlined here provides such a procedure.

The last step of the procedure actually requires that the different management options be evaluated and compared before a final decision is made. The following chapter describes how economic cost benefit analysis, when applied in a manner which recognises the different "building blocks" and "linkages" identified in the mangrove management framework, can provide an *economic* valuation of the different management options.

3. COST BENEFIT ANALYSIS AND RELATED ECONOMIC ISSUES

3.1 FIVE PERSPECTIVES ON COST BENEFIT ANALYSIS: CHOOSING AN APPROACH

Cost benefit analysis (CBA) is a well developed technique of economic appraisal which is designed to identify projects or policy reforms which improve social welfare. Descriptions of the theory and practice of CBA can be found in Drèze and Stern (1987) and Little and Mirrlees (1974). In theory, the approach is adequately flexible to incorporate many aspects of social welfare: economic efficiency, economic risk, income distribution, subsistence consumption constraints, political aspirations, and even aspects of moral or immoral actions. In practice, however, it is usually restricted to applications which address economic efficiency and risk; the other aspects are then expected to enter the decision process through different channels. CBA thus provides only one of many potentially important inputs into the decision process.

The basic idea behind CBA is that a "project" is defined, and social welfare is estimated both with and without that project. If the benefits of going ahead with the project outweigh the costs, then the project is socially desirable from an economic efficiency perspective. Multiple mutually exclusive projects can be specified with a view to selecting the best project. The most critical step in the CBA process is not so much estimating the benefits and costs, but in properly defining the "project". A proper definition of a project involves estimating *all* of the changes in production which occur as a result of a given activity. Historically many cost benefit analyses would either disregard environmental services or assign arbitrarily low values to them. As a result, projects were funded which, in hindsight, would appear to have decreased social welfare when all of the impacts were included. This underlines the importance of defining all of the changes in production which arise from a given project: a project defined as "use labour and machines to clear mangroves" may look perfectly reasonable until it is perhaps more completely defined as "use labour and machines to clear mangroves and create mass erosion and fisheries losses."

A primary purpose of formally going through the steps in the mangrove management framework, as described in the previous chapter, is to ensure that the project is properly identified. By identifying the key uses and functions, and describing the interactions between them, the most critical step in the CBA is completed.

To illustrate the potential scope of CBA, Table 3.1 outlines five different perspectives as follows:

- Optimisation for a Single Operator
- Narrow CBA of Key Resource Uses
- Traditional Production of Local Populations
- Broad (regional) CBA of All Uses/Functions
- Broad (international) CBA of All Uses/Functions

The most appropriate approach for any given mangrove area is likely to differ from one application to the next. That used in the following chapter relies most heavily on the fourth approach: the "broad regional" perspective. Because traditional uses are substantial, the valuation in Chapter 4 also addresses the benefits to local populations of keeping the mangrove ecosystem intact.

Table 3.1
Five Perspectives on Cost Benefit Analysis

SCOPE	ROLE OF CBA	EXAMPLE
SINGLE OPERATOR	OPTIMISE PRODUCTION	Evaluation of Forestry Profitablity under Different Forest Management Options (eg., Selective Cutting, Clear Cutting)
KEY RESOURCE USES	OPTIMISE JOINT PRODUCTION OF TWO OR MORE TRADED COMMODITIES	Evaluation of Joint Profitability of Fisheries and Forestry under Different Forest Management Options, Taking into Account Linkages between Forestry and Fishery
TRADITIONAL PRODUCTION OF LOCAL POPULATIONS	VALUATION OF PRODUCTION	Accounting of Physical Flows of Hunting and Gathering and Valuation of these Flows at Local and Shadow Prices
ALL RESOURCE USES AND ENVIRONMENTAL FUNCTIONS IN REGION	OPTIMISE VALUE OF ALL USES AND FUNCTIONS IN REGION	Evaluate Joint Value of Fishery, Forestry, Traditional Uses and Erosion Control under Different Management Options, Taking into Account Linkages between Forestry, Fishery, and Other Ecosystem Components
ALL RESOURCE USES AND ENVIRONMENTAL FUNCTIONS	OPTIMISE VALUE OF ALL USES AND FUNCTIONS	Evaluate Joint Value of Fishery, Forestry, Traditional Uses, Erosion Control, and International Benefits of Biodiversity Maintenance or Climate Control under Different Management Options, Taking into Account Linkages between Forestry, Fishery, and Other Ecosystem Components

The simplest of the five perspectives, involving just a single component of the resource which ignores all other components and linkages to them, addresses the optimal production strategy for a single operator. An example in forestry would be assessing the optimum rotation period for a given stock area, or determining whether clear cutting a forest is more profitable than attempting some sustainable form of selective cutting. This approach is useful in that it shows what is likely to happen in a situation where the production decisions are unregulated and left entirely up to the single operator. The analysis in the following chapter demonstrates, for example, that a concessionaire in the Bintuni Bay mangrove area would have strong economic incentives – in the absence of any restrictions – simply to clear cut the mangrove.

The second, more complex, form of CBA involves identifying two or three key traded and interacting uses of the resource base, and designing an optimal management strategy for one or both of them. In some instances, such as that in the Tumpangsari system in West Java where there are two marketed outputs (wood and fish), this approach would be adequate to indicate the optimal mix of forestry and fishpond production. Where substantial untraded traditional uses or other environmental functions exist, however, a broader scope is required.

The third potential scope for CBA involves what is primarily a valuation procedure of traditional uses of the mangrove. In practice, this can become quite complex if there is a large number of untraded goods, if local prices of these goods are not representative of their values, or if complex socio-economic adjustments are thought to exist which involve substitutions between goods. Where decision-makers are interested primarily in the scale of this production, rather than what will happen to that production under different management scenarios, the valuation procedure might be adequate by itself. Such a procedure is strictly not a CBA, but it would provide important input into a CBA.

The fourth scope for CBA involves a broad analysis of key traded and untraded goods and services, within a well-defined region. The task of the CBA is, in its most complex mode, to develop an optimal development strategy for all components of the resource base. While in principle this is possible to do, in practice the approach is usually more tractable if one concentrates on an optimal development strategy for one or at most two of the key components. Environmental functions are valued *only* if they provide some benefit or cost to the region. If a given mangrove area in Sumatra protects an offshore fishery which provides some benefit to Malaysia, for example, the benefits accruing to Malaysia would be excluded from such an analysis. Similarly many of the "biodiversity" or "global climate control" benefits from tropical forests, which are asserted to benefit the international community, would be excluded from this analysis.

The broadest scope, that which captures *all* benefits and costs, regardless of where they accrue, is most appropriate if an investment or policy involves contributions from outside of the country. Such an analysis may be useful, for example, if a project is marginal from a regional perspective but would confer significant benefits onto the international community. In that event, the analysis would form a basis for seeking foreign participation in the project through aid or some other type of financial assistance.

3.2 VALUATION OF ENVIRONMENTAL FUNCTIONS

A basic theoretical principle of evaluating any environmental "function" in economic terms is that one must define what type of production it protects or what type of utility it provides. In the context of erosion, for example, erosion control benefits of a mangrove system on an uninhabited island would be nil. A mangrove system which protects tambak production behind it, or which protects public roads or other infrastructure, could be credited with an erosion control benefit if the integrity of the road or production from the tambak were tied to the erosion protection provided by the mangrove. In the context of "existence value" – an idea which asserts that natural places have some utility attached to them irrespective of whether they produce anything tangible – it is necessary to estimate the value of the "utility" which people get from knowing that a particular natural place exists. To evaluate a function, therefore, requires valuing the production or the utility.

The literature in environmental economics provides a rich thirty year history of important practical approaches to estimating environmental benefits; detailed reviews are provided by Johansson (1987) and Pearce and Turner (1990). Techniques involving direct polling to determine the demand for environmental functions have been used extensively, for example, to estimate recreational or tourism benefits associated with environmental resources, as well as the utility associated with "existence values". Other approaches are to estimate the value of environmental goods or services by observing individual demand for related private goods or services.

For many of the "ecological functions" of mangroves, however, neither of these approaches are applicable. Two commonly used methods in such circumstances involve estimating either the "avoided costs", or estimating the impacts on production if the particular service is lost. For example, to estimate the erosion control benefits, the avoided cost approach might involve estimating the construction and operating costs of a system of dams, weirs, artificial reefs, or other "engineered" solutions to avert erosion. The "production impact" approach involves estimating the value of lost production when erosion actually does occur. Where land is a traded commodity, this might involve estimating the land area lost due to erosion and valuing that loss at the current land price. Where land is not regularly traded, as is the case in most of the study areas here, an appropriate technique involves valuing the production (of agriculture, for example) from that land and then estimating the lost net output if erosion persists.

Strictly speaking, the actual benefit of erosion control is the lesser of the "avoided cost" estimate and the "production impact" estimate. In practice, however, the actual analysis will involve an *a priori* assessment of which is likely to be lower, and that approach is then used. In areas of low population density or low land use, the "production impact" approach would normally be most applicable; in areas where there is high agricultural intensity or there are dense concentrations of population, the avoided cost approach might be more appropriate. As the Bintuni Bay area is characterised both by high development costs for engineering works (due to its isolated location) and relatively low population density, the "production impact" approach is used in the evaluations.

3.3 ECOTOURISM

Indonesia is well aware that tourism is both a strong source of foreign exchange and a sustainable source of income if appropriate tourist sites can be developed and maintained in good condition. Recent growth in "ecotourism" worldwide, that associated with interest in ecologically or environmentally important areas, prompted Indonesia to establish in late 1990 an Ecotourism Committee to establish ways in which this growth can be tapped.

For many mangrove areas of Indonesia, therefore, ecotourism potential should be regarded as one of the "building blocks" to be evaluated in the mangrove management framework. Hodgson and Dixon (1988) demonstrated for the Philippines, for example, that tourism benefits coupled with fishery production benefits substantially outweighed the short-term benefits which might accrue from increased logging in Palawan. Similarly, in the Bone Gulf area of South Sulawesi, it is expected that an ecotourism industry associated with the mangrove system and the off-shore reefs could readily be developed; these sites are only three hours drive from excellent existing tourist facilities in Tanah Toraja.

In the case of Bintuni Bay, the "ecotourism block" was not included because, although the area has strong potential, it will not likely be developed to the scale required to generate "net tourism income" within the foreseeable future. The current proposed tourism plan for that area of Irian Jaya (JCP and Gubah Laras [1990]) focuses on development in Biak and on the Cendrawasih marine reserve over approximately a 20 year planning horizon, although even this is contingent on a simplification of the travel permitting procedure for the area. Effective tourism development in the Bintuni Bay area would require substantial infrastructure development, and, more important, complementary sites in the region (such as Biak and Cendrawasih) before substantial net income would be generated. Even so, experience in Africa with ecotourism suggests that the first 10 years are economically marginal, although significant long-term benefits might accrue. Given both the current lack of infrastructure and the uncertainty in future tourism development in this region, however, the cost benefit analysis in the Bintuni Bay area excluded this potential source of “mangrove value”.

3.4 BIODIVERSITY

Biodiversity has come to refer to the different types of biological diversity – species, habitats, or traits – which exist in any given system. Tropical forests, mangroves, and coral reefs are all regarded as exhibiting high levels of biodiversity in their undisturbed state. McNeely (1988) argues that such biodiversity can have substantial economic value for the genetic feedstock which it provides for pharmaceutical, foodcrop, cashcrop, or other products. For example, the pharmaceutical value of natural products in OECD countries has been estimated to be up to US$2,000 billion annually.

Although the value of biodiversity can be substantial to the world as a whole, developing countries are – for numerous reasons – not able to capture this entire value. International patent systems provide little protection for products based on natural goods, and the ability of modern laboratories to synthesise products once information has been collected on natural products makes it difficult for developing countries to realise these benefits. While theoretically one might argue that the entire value of the biodiversity should be attributed to any valuation of a mangrove programme, in practice the amount that a country can “capture” is significantly less than this.

Historically, the “capturable biodiversity benefit”, defined as the potential benefit which the country might be able to obtain from the international community in exchange for maintaining its biodiversity base intact, was essentially zero. A number of institutional arrangements over the past five years have changed this situation. Some aid programmes (USAID, for example) have explicit grant funds available for biodiversity conservation projects. International NGOs such as the World Wide Fund for Nature have been actively transferring money through debt-swaps to developing countries in exchange for protection of biodiversity. A recently established Global Environment Facility (GEF) is – at a pilot level – earmarking up to $1 billion in direct grant funds for projects in developing countries which are intended to combat global environmental concerns such as biodiversity loss.

As the institutions and funds are becoming better established, it is now more likely that countries such as Indonesia can capture some of the biodiversity benefit by attracting foreign funding for projects which promote conservation initiatives. In an analysis of transfers over the period 1987-1990, Ruitenbeek (1990a) estimated that this capturable benefit for an ecologically important and “diverse” ecosystem such as rainforests could reach as high as US$3,000 per square kilometre per year; typical values were approximately one half this amount. In the CBA for Bintuni Bay, a value of $US1,500 per square kilometre per year is thus ascribed as a capturable biodiversity benefit *if* the mangrove were maintained intact. Similar values would apply to other mangrove areas in the country if they were ecologically important and if they were maintained in a relatively virgin state.

3.5 NATURAL RESOURCE AND ENVIRONMENTAL ACCOUNTING

The field of natural resource and environmental accounting (NREA) has moved ahead significantly both internationally and in Indonesia. The driving impetus stems from the fact that conventional measures of economic output, such as GNP or GDP, do not provide any allowance for degradation of the environment or the natural resource base. Standard procedures in the System of National Accounts (SNA), for example, might show a high level of income for a country which was "mining" its forests unsustainably, yet low levels for a country which was selectively and sustainably cutting its forests. Procedures being developed by the United Nations Statistical Office (UNSO) and the OECD propose changes to the SNA which would provide decision-makers with information on the value of the resource base in their respective countries.

As Indonesia's economy has a very strong dependence on both renewable and nonrenewable resources, an active programme is underway in the Central Bureau of Statistics (BPS) and KLH with a view to developing an NREA system for Indonesia. It is anticipated that – in this field – Indonesia will be at the leading edge of developing countries during the 1992 UN Conference for Environment and Development (UNCED) in Brazil.

While current efforts to undertake cost benefit analyses cannot take advantage of an NREA system, the availability of data which has a consistent estimating basis will be useful for natural resource and environmental management in the future. Mangrove management efforts will also be simplified as better data are made available. As Indonesia is still in the process of selecting its priority areas for developing the NREA system, one of the purposes of the cost benefit analysis undertaken in the following chapter is to highlight some of the key data areas and indicators which are critical to making sound mangrove management decisions. In particular, it will be argued that gathering and presenting data for both the forestry and the fishery components of the resource, will be important for addressing the overall mangrove management challenge.

3.6 MACRO-ECONOMIC POLICY LINKAGES

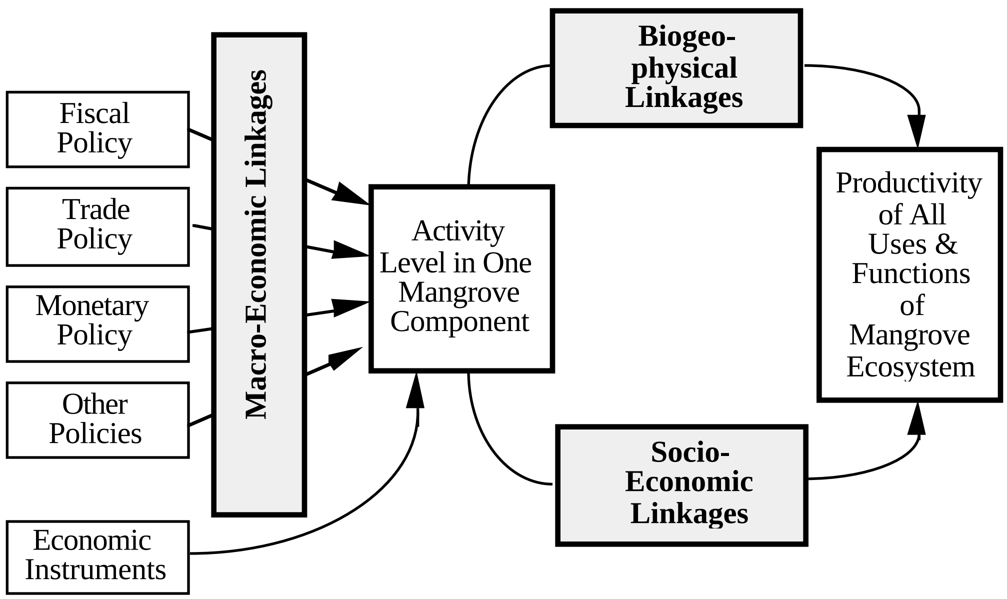
The final general issue we address, before presenting the specific assumptions and results of the evaluation in the following chapter, deals with the potential role of macro-economic linkages. Chapter 2 described how biogeophysical linkages or socio-economic linkages could cause activity in one component of the mangrove ecosystem to affect the productivity or functioning of another part of the ecosystem. The mangrove management framework required that any such linkages be identified and, if possible, quantified.

A potentially important set of linkages also exists completely *outside* of this system, however, relating to the linkages between broad macro-economic policies and productive activities in the mangrove. Trade policy, fiscal policy, monetary policy, foreign exchange rate policy, and most other macro-economic policies can have an effect on mangrove systems. Figure 3.1 shows the general picture: a broad policy initiative has an effect on some single activity in the mangrove ecosystem and then, through other biogeophysical or socio-economic linkages, the productivity of the entire ecosystem can be affected by such a policy. A shrimp export subsidy would, for example, provide an incentive for increased shrimp trawling in mangrove areas; this might in turn disrupt traditional fisheries. Promoting woodchip exports could, similarly, increase mangrove cutting and thereby disrupt other components of the ecosystem through ecological linkages. A specific example is shown in Figure 3.1 to depict a potential scenario occurring in the South Sulawesi mangrove areas: low land taxes induce conversion to tambak which, through both ecological and socio-economic linkages, eventually causes degradation of near-shore fisheries.

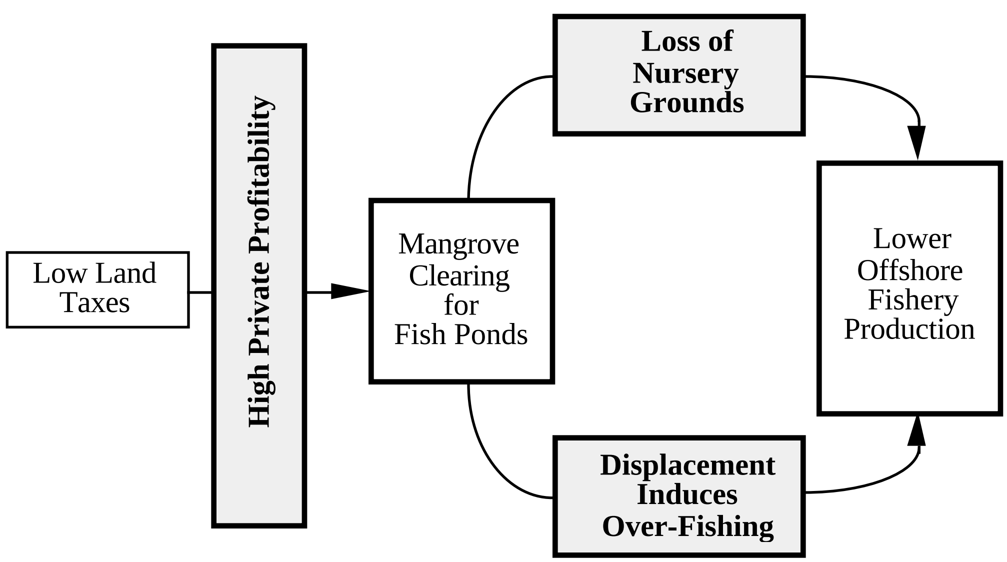
The lesson from this is that fiscal macro-economic policies are potential targets for mangrove management options. It is not expected that national macro-economic policies will be changed simply to suit mangrove management requirements. What is feasible, however, is to evaluate which policies are creating undesirable distortions and then to devise appropriate mitigative policies using specifically targeted economic instruments to offset the undesirable impacts of the broader policies. In the specific example shown in Figure 3.1, such a remedial economic instrument might include a land tax surcharge for land converted to tambak.

Figure 3.1
Macro-Economic Policy Linkages

THE GENERAL CASE



AN EXAMPLE



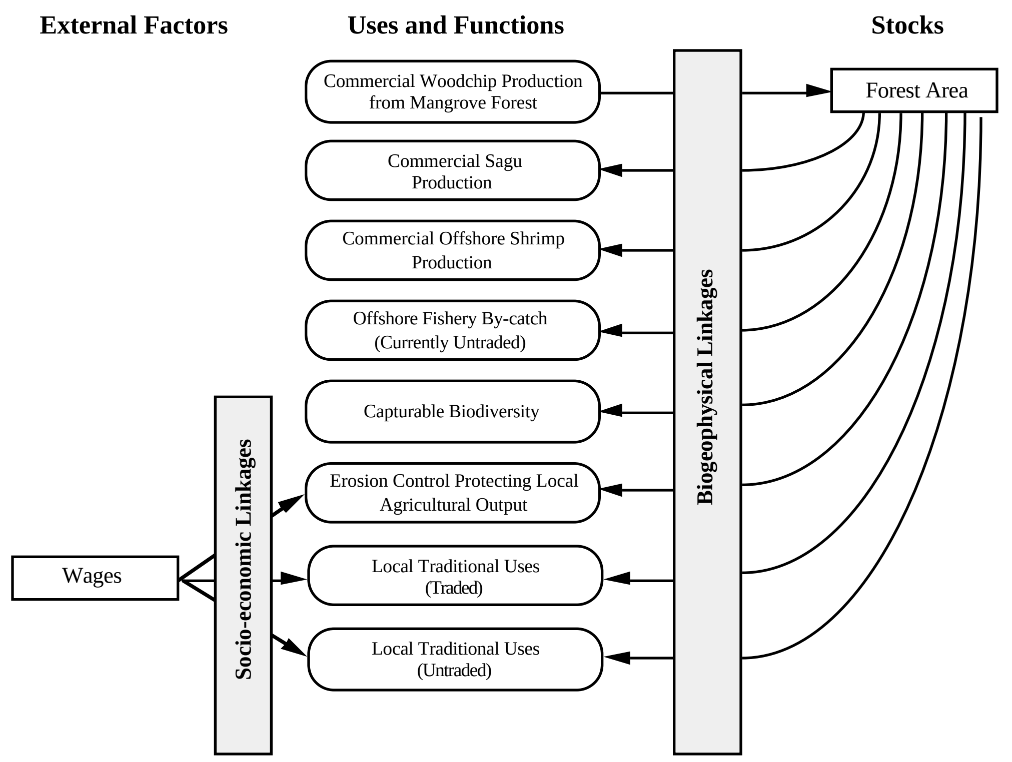
4. CASE STUDY OF BINTUNI BAY, IRIAN JAYA

4.1 INTRODUCTION

In relation to the mangrove management framework discussed in Chapter 2, the key uses and functions ascribed to the Bintuni Bay mangrove resource, and the linkages between them, are shown in Figure 4.1. As the evaluation is intended to concentrate on selecting optimal forestry development strategies, and as most of the biogeophysical linkages are conjectured to relate to the mangrove area left intact, potential linkages between other parts of the resource base are not considered (such as between traditional and commercial fisheries, or between fishery by-catch and shrimp productivity). The primary socio-economic linkages which are investigated relate to the linkages between external sector wages (as a proxy for "external development") and local production from farming and traditional mangrove uses.

Although estimating the value of each of the different components in the absence of any linkages is relatively straightforward, significant uncertainty exists relating to both the nature and degree of the socio-economic and ecological linkages. Empirical work on the socio-economic linkages is conducted for this study, but no data specific to the Bintuni Bay area exist for providing estimates of the extent of the ecological linkages. To address this problem, "linkage scenarios" are developed which describe potential ecological linkages ranging from "no linkages" to "very strong" linkages similar to those which have been demonstrated on the north coast of Java. Specification of such

Figure 4.1
Key Uses, Functions and Linkages in Bintuni Bay Mangrove



scenarios is also useful because they demonstrate what happens if development decisions are based on an assumption that no linkages exist when, in fact, very strong ecological ties might exist between components.

Within this framework, the specific objectives of the evaluation work relating to Bintuni Bay are:

- to conduct a household survey which would assist in providing a quantification of the value of traditional uses of mangroves in the Bintuni Bay area;
- to conduct correlation studies to describe the "socio-economic linkages" between the formal sector economy and the traditional economy; and,
- to conduct cost benefit analyses which incorporate "ecological linkages" and appropriate constraints to evaluate different management options for the forestry component of the mangrove resource.

In addition, the household survey work allowed analyses which provide insights into potential Women in Development (WID) initiatives and children's education initiatives.

4.2 EVALUATION OF BINTUNI BAY: HOUSEHOLD SURVEY RESULTS

4.2.1 DESCRIPTION OF SURVEY

In general, a systematic and detailed socio-economic household survey of an area will provide necessary and valuable information for designing a management plan. The execution of such a *detailed* survey is typically done over two or three time periods to provide a cross-section of information and panel data which allow monitoring of development initiatives as they are undertaken. The research undertaken here did not include such a detailed survey, but did include a "spot survey" to provide key information at the critical stages of developing the management model for Bintuni Bay.

A total of 101 households were surveyed in Kecamatan Babo and Kecamatan Bintuni in March, 1991. Six villages were surveyed with a view to obtaining information on household demographics, income sources, and uses of both traded and untraded goods from the mangroves. This size sample, covering approximately 3% of the households in the region, is an adequate statistical basis for providing the required information. The survey was designed to take approximately one hour, and detailed maps were made of the area in the event that the area needs to be resurveyed at some future date. Details of the survey are provided in Annexes 2 to 4.

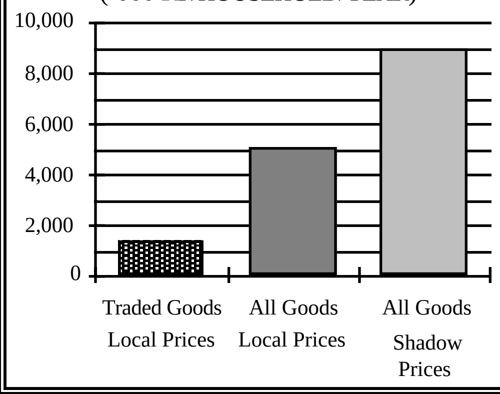
4.2.2 LOCAL USES OF MANGROVES

One of the most striking conclusions from the household survey was that the value of untraded production in the region is substantial. In valuing production, three steps were undertaken. First, the total income from all traded goods was estimated from the household survey to be approximately Rp1.4 million annually per household. Second, based on estimates provided by respondents of how much production was sold, bartered, or used for subsistence, an estimate was made of the total production; this is approximately Rp5.1 million annually per household. Finally, to reflect the fact that, because some local prices are not reflective of free market prices, a conversion factor was applied to certain traded goods. The specific conversion factors calculated are summarised in Table 4.1. They are based on typical commodity prices in Manokwari, local prices in Bintuni Bay, and a transportation cost of approximately Rp500/kg. Essentially, where prices in Bintuni Bay are less than the Manokwari price net of transportation costs, a conversion factor is applied to reflect the difference. It is noted that, because of relatively low prices and high transport costs, farm produce would not be expected to move between these two market areas and hence no adjustment is made. For hunted meat, however, local prices are substantially less than those in external market areas and an adjustment is thus appropriate. When these adjustments are applied, the total value of all production, at imputed "shadow prices", is approximately Rp9.0 million

Table 4.1
Household Income Conversion Factors

Income Source	Conversion Factor
Farming	1.00
Livestock	1.80
Hunting	3.40
Fishing	1.87
Gathering	1.50
Manufacturing	1.00
Wage Income	1.00
Absentee Transfers	1.00
Other Income	1.00

Figure 4.2
Value of Household Production
('000 RP/HOUSEHOLD/YEAR)



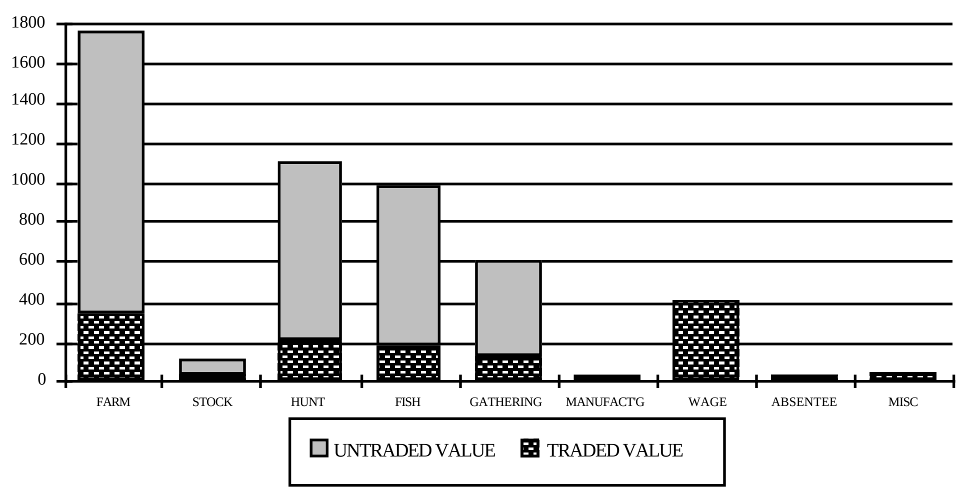
annually per household. As shown in Figure 4.2, the traded value represents only about 15% of total household production in the area.

The actual sources of income (at local prices) are shown in Figure 4.3. The value of production from the mangrove areas (traditional fishing, hunting, and gathering) exceeds that from both cultivated crops and from formal sector wage income. A key observation from the household survey was that transfers arising from compensation payments from commercial forestry or fishing operations was very small; it represented less than 2% of cash income to the household.

4.2.3 INCOME DISTRIBUTION LINKAGES

As shown in Figure 4.4, traditional mangrove use contributes proportionately more to low income households, but absolute levels of mangrove use are substantial even for richer families. The income quintiles were defined based on increasing per capita household income. It is often asserted

Figure 4.3
Estimated Value of Household Production at Local Prices
('000 RP/HOUSEHOLD/YEAR)



that, as an economy develops and more families obtain wage income, income inequality in the region will go down as well. This is thought to occur through what is sometimes called a 'trickle-down' effect in which those individuals with wages start to increase purchases from others in the region who rely on sales of foodcrops or gathered products for their income sources. In the case of Bintuni Bay, although the wage sector has been growing steadily, there is no evidence of this 'trickle-down' effect. Standard measures of inequality in the region are high, and a major contributor to the inequality levels is actually the formal sector.

Figures 4.5 and 4.6 provide summaries of one inequality index, the 'Gini' coefficient (see Atkinson [1970] or Anand [1978]). The Gini coefficient is based on a Lorenz curve and is the ratio of the area between the heavy 'income distribution' curve and the 'perfect equality line' (the 45^{o} line) to the area below this perfect equality line. A coefficient of zero represents perfect equality where everyone has the same income level; unity represents perfect equality. The aggregated statistic for the Bintuni Bay area of 0.487 indicates that the region has relatively high inequality; most regions in developing countries display indices between 0.4 and 0.5.

Although information about the aggregated index has limited applications, it is possible to disaggregate this index to demonstrate how different activities contribute to equality or inequality. The disaggregation details are provided in Annex 4, and the summary in Figure 4.6 illustrates that mangrove related activities generally contribute to greater equality in the region. As the wage sector expands, or if mangroves are destroyed, income inequality would be expected to increase and this, in turn, could lead to both socio-economic difficulty as well as political unrest. It is thus quite important that any development in the region be 'balanced'; a focus on just the formal sector will likely be destabilising economically and politically.

Figure 4.4
Cash Income Source by Household Income Quintile

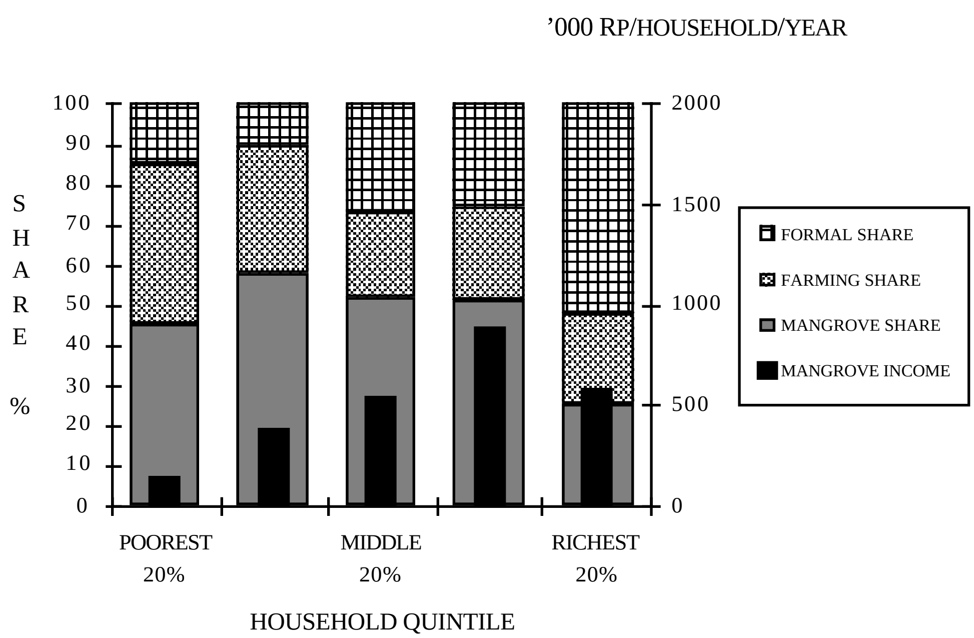


Figure 4.5
Lorenz Curve of Cash Income Distribution in Bintuni Bay

GINI INDEX=0.487

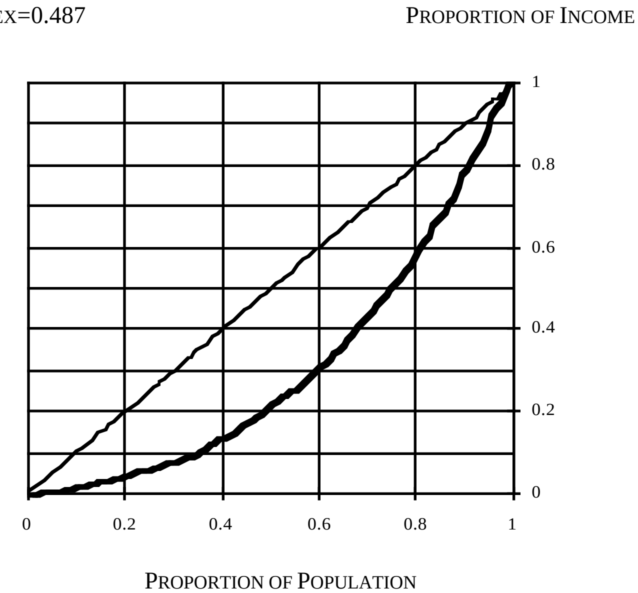
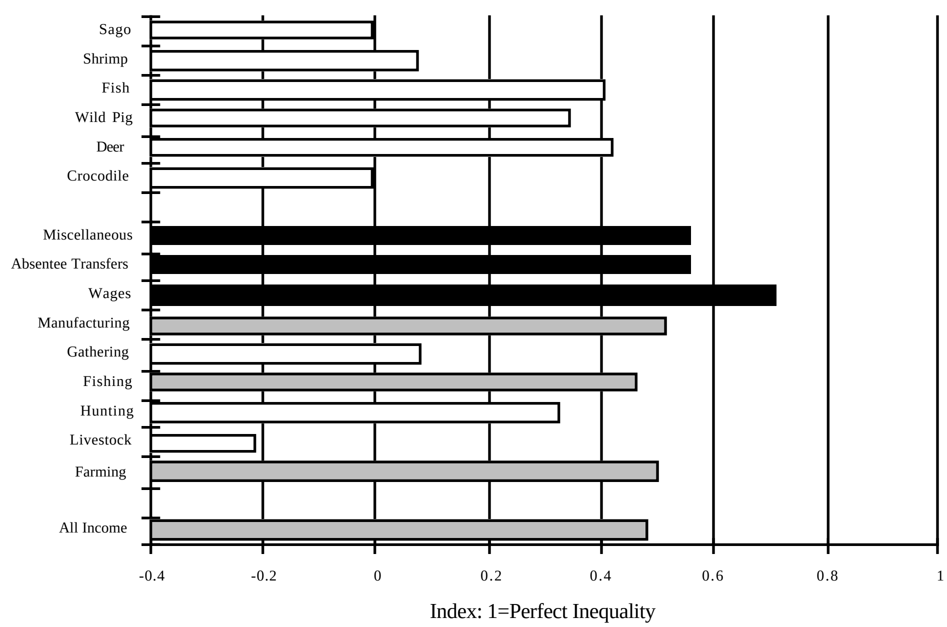


Figure 4.6
Decomposed Income Inequality Index



Legend
Black – Contributes to Greater Inequality
Grey – No Impact on Inequality
White – Contributes to Less Inequality

4.2.4 LINKAGES OF INCOME TO MANGROVE HARVESTING

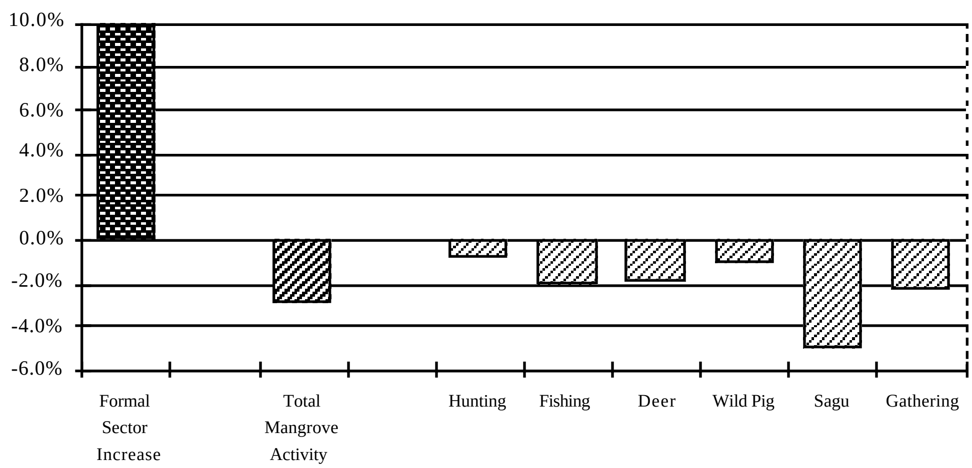
The most important linkage which was investigated using the household survey data involves that between formal sector wage income and traditional mangrove harvesting activity. It is often asserted that people's reliance on traditional sources of income and subsistence will decrease as they have access to formal sector income. To test this hypothesis, the cross-section of household data was analysed using limited dependent variable techniques (see Maddala [1983] and Ruitenbeek [1990a]). These techniques are particularly useful for qualitative data sets. They attempt to answer questions such as: What is the probability that an individual, given their age, sex, education, household composition, and other income opportunities, will hunt deer or crocodiles? Multivariate analysis of activities and the potential explanatory variables allows one to isolate what would happen if just one single factor – such as external wage income – changed.

An analysis of the household data set (see Annex 4 for detailed models) showed that mangrove harvesting activity does indeed decline as the formal sector increases, but the response is relatively inelastic. As shown in Figure 4.7, a 10% increase in formal sector activity is expected to result in only a 3% drop in mangrove harvesting activity. Sago gathering has the most substantial drop (5%) and the analysis showed that no significant change would occur in crocodile hunting activity. This implies that, even if substantial development occurs in the area, mangrove harvesting will persist as an important contributor to the local economy.

4.2.5 WOMEN, CHILDREN, AND EDUCATION

Sustainable development in the Bintuni Bay area will, in addition to promoting sustainable use of the natural resources, require balanced development of human potential. Development efforts in most countries – Indonesia among them – have thus been paying closer attention to the role which different members of the household play in overall production. The role of women and children is of particular interest.

Figure 4.7
Impact of Formal Sector Expansion on Traditional Mangrove Harvesting Activity



The household data showed that, although women comprise 50% of the population, they are responsible for only 22% of the cash income to the household. Most of their productive output, as shown in Figure 4.8, is related to products from farming and gathering. When this output is valued at local prices, women's production represents 49% of total output. This suggests that women do play an important and equal economic role in the total production process. If a WID programme is to be initiated in the region to enhance their role further, it could be targeted to formalising the farming and gathering activities to increase their role in collecting cash income.

Concern often exists that children are not getting access to education because of discriminatory economic factors. The household data provide a set of 183 school age children; this forms the basis for multivariate econometric analyses to determine which factors do and do not contribute significantly to children's education in the sample. The modelling results are provided in Annex 4, and Table 4.2 shows the impact of various factors at the means of the sample. The most notable conclusion is that economic factors (such as household income or time spent on subsistence production) are *not* important determinants of how much education a child will receive. Predictably, a child's age is the most significant variable, and sex, location, and education of the household head also play a role in this region. While boys receive more education than girls, the difference of less than 1 year is not critical by most developing country standards. What is of greater concern, however, is the observation that a child who is one year older is likely to have only 0.4 additional years of education. This implies, for the sample as a whole, a very high drop-out rate that would warrant specific actions to promote continued enrolment.

4.2.6 SUMMARY AND IMPLICATIONS FOR REGIONAL DEVELOPMENT

A systematic household survey of 101 households in the Bintuni Bay area concluded that (a) non-market traditional uses of mangroves are significant; (b) traditional mangrove use contributes proportionately more to low income households; and, (c) expansion in the wage economy will not be directly offset by decreased traditional reliance on mangroves.

The total value of household income from marketed and non-marketed sources is about Rp9 million/yr/household, of which about 70% can be attributed to traditional uses. For the region as a whole, traditional uses from hunting, fishing, and gathering would account for a value of about Rp20 billion/yr.

An analysis of income inequality, and contributions to income inequality, concluded that there is little evidence for any trickle down effect which might occur from increased formal sector wage activity. Income inequality is comparable to that in most developing countries, but formal sector activities in the Bintuni Bay area tend to enhance inequality, while hunting and gathering activities tend to decrease inequality. Fishing and farming have no significant effect on income inequality.

Econometric analyses using qualitative dependent variable techniques were used to conduct correlation studies between income sources and mangrove traditional uses. They suggest that there is a substitution effect between activity in the formal sector and activity in the traditional sector, but the effect is quite weak. An elasticity of traditional mangrove based activities (including hunting, fishing, and gathering) to formal sector income of –0.3 was estimated; a 10% expansion in the formal sector will thus decrease traditional uses by only 3%.

There are two substantive implications for regional development in the Bintuni Bay region. First, traditional mangrove use will continue to be important in the region even if formal sector development occurs. Second, degradation of the mangroves is likely to affect the poorest sectors of the population the most; unbalanced development could lead to an increase in social problems in the region.

Figure 4.8
Female Share of All Household Production at Local Prices

('000 RP/HOUSEHOLD/YEAR)

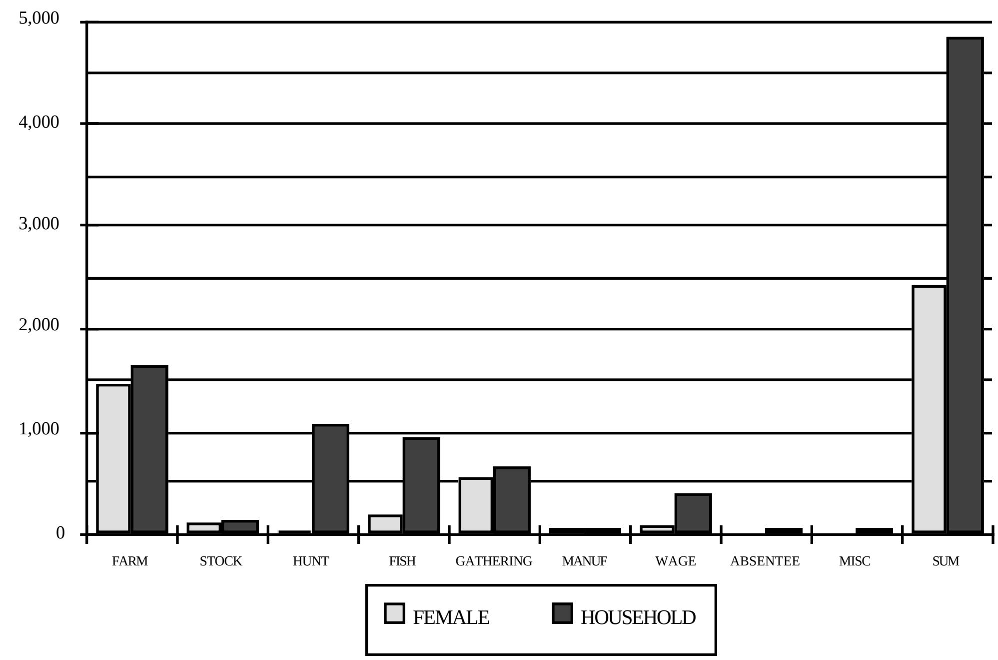


Table 4.2
Determinants of Education for School Age Children – Tobit Multivariate Analysis

EXPLANATORY VARIABLE	SIGNIFICANT?	IMPACT ON YEARS OF EDUCATION
Child's Age	**YES** (t=6.4)	**+0.39 Years** for every Year Older
Child's Sex	**YES** (t=2.5)	Boys **0.79 Years** more than Girls
Family Income	NO (t=1.2)	**NONE**
Household Location	**YES** (t=3.1)	Kecamatan Babo **0.64 Years** more than Kecamatan Bintuni
Education of Household Head	**YES** (t=2.6)	**+0.06 Years** for every Year of Education by Household Head
Time Spent by Household on Own Production	NO (t=0.4)	**NONE**

4.3 EVALUATION OF BINTUNI BAY: CBA ASSUMPTIONS

4.3.1 FORESTRY RESOURCES

The purpose of the cost benefit analysis is to select an economically optimal development strategy for the forestry resource which also considers the impacts which mangrove conversion will have on other resource components. Six different clearing options were thus developed, ranging from a cutting ban on all of the harvestable area, to a clear cut of the entire mangrove resource. Table 4.3 provides a summary of some key mangrove statistics and the six cutting options which are evaluated. It is important to note that the areas summarised exclude any lowland areas which are currently in timber concession for wood other than mangrove.

The analyses generally assume a thirty year rotation for the selective cutting, as well as for one of the clear cutting scenarios. A 30 to 35 year rotation is typically regarded as technically feasible for mangrove resources if replanting and selective cutting is followed. In Bintuni Bay, as elsewhere in Indonesia, most concessions have been granted for a 20 year period; a 20 year clear cut is therefore also evaluated. In the absence of any regulations or controls, it will be demonstrated that this "accelerated clear cut" would often be the strategy selected by a concessionaire which focuses purely on maximising profits.

In both of the clear cut scenarios, it is assumed that a once-only cut occurs and that no further stock is available after the clear cut is completed. This reflects the idea that such cutting is usually not sustainable in a mangrove ecosystem. The selective cutting scenarios are, however, assumed to be sustainable *from a forestry perspective* and thus allow cutting in perpetuity on a 30 year rotation. The "80% selective cut" approximates the maximum sustainable yield from the resource. The "40% selective cut", as indicated, is meant to approximate harvesting of the entire harvestable area outside of the proposed Bintuni Bay Nature Reserve.

The "25% selective cut" represents a more conservative strategy involving the clearance of only about 60,000 ha outside of the reserve area. As shown, this scenario was designed in a way that it ensures that the current concessionaires will have adequate mangrove stock to keep the woodchip plant operating at 80% of capacity for the 20 year life of the concession (without any extension to the life of that concession). If the plant operates at a higher capacity factor, it implies that the concessionaire would need to be limited to between 16 and 20 years of operation. Given that some shutdowns will be inevitable for even routine operations, it is expected that this scenario provides a realistic compromise between strict conservation and uncontrolled cutting.

In addition to the mangrove area, commercial sago production in the Bintuni Bay area commenced in late 1990. A total of 15,000 ha of concession has been allotted, and it is assumed that this amount will neither increase nor decrease. Production characteristics and input requirements for processing virgin sago palm to a starch product are based on Flach and Schuiling (1989). It is projected that production will reach a sustainable level of 225,000 tonnes per year by 2001.

The analysis assumes that real chipwood export prices stay constant over the period at a level of $40 per cubic metre, and that sago prices also stay constant at a price of Rp300/kg. Production costs were based on investment costs provided by the companies, and on operating costs estimated from typical operations elsewhere. Royalties, taxes, and compensation payments were excluded from the costs in the cost benefit analysis as they represent a direct transfer and are not regarded as a drain on society's resources.

Table 4.3
Mangrove Area and Clearing Options Evaluated

Total Area ~364,000 ha
Total Mangrove Area ~304,000 ha
Total Area in Bintuni Bay to 10 Metre Depth ~60,000 ha

Total Mangrove Area ~304,000 ha
Total Harvestable Area ~240,000 ha
Total Unharvestable Area ~64,000 ha

Total Harvestable Area ~240,000 ha
Total Harvestable Area within Proposed Nature Reserve ~143,000 ha
Total Harvestable Area outside Proposed Nature Reserve ~97,000 ha

Proposed Size of Nature Reserve ~267,000 ha
Total Harvestable Area within Proposed Nature Reserve ~143,000 ha
Total Unharvestable Area ~64,000 ha
Total Area in Bintuni Bay to 10 Metre Depth ~60,000 ha

Mangrove Stock Rate ~80m^3/ha
Chipwood Plant ~300,000 m^3/year
Current Concession Length = 20 Years
Stock Requirement for 20 Year Life at 100% Capacity = 6,000,000 m^3
Stock Requirement for 20 Year Life at 80% Capacity = 4,800,000 m^3
Area Requirement for 20 Year Life at 100% Capacity = 75,000 ha
Area Requirement for 20 Year Life at 80% Capacity = 60,000 ha

OPTION	DESCRIPTION
20 Year Clear Cut	Total Harvestable Area is Cut Over 20 Year Period Once Only Cut
30 Year Clear Cut	Total Harvestable Area is Cut Over 30 Year Period Once Only Cut
30 Year Rotation 80% Selective Cut	80% of Total Harvestable Area (=192,000 ha) is Cut in Perpetuity on 30 Year Rotation
30 Year Rotation 40% Selective Cut	40% of Total Harvestable Area (=96,000 ha) is Cut in Perpetuity on 30 Year Rotation **(Equivalent to 100% of Total Harvestable Area outside Proposed Nature Reserve)**
30 Year Rotation 25% Selective Cut	25% of Total Harvestable Area (=60,000 ha) is Cut in Perpetuity on 30 Year Rotation (Equivalent to 62% of Total Harvestable Area outside Proposed Nature Reserve) **(Equivalent to Operating Current Chipwood Plant at 80% capacity for 20 Years)**
Cutting Ban	Entire Mangrove Area is Maintained in Virgin State

4.3.2 FISHERY RESOURCES

Although the mangrove concessions in the Bintuni Bay area have been licensed for only 3 years, the commercial shrimp fishery has been operating in Bintuni Bay since approximately 1970. Production at historical levels has shown no evidence of falling off, and, although no estimates have been made of the size of the resource stock, popular opinion is that current levels of production are probably approaching the maximum sustainable yield. Output is currently frozen and packaged in one of four cold storage facilities in Sorong, or in a new facility recently opened in Wimbro in Kecamatan Babo. Most of the output is exported to Japan.

It is assumed that the fishery can still support a modest expansion to support one more cold storage facility. An inventory of current cold storage sites is provided in Annex 1. This expansion would involve an increase of output of about 15%, and allow for a sustainable shrimp harvest of approximately 5500 tonnes annually. Based on recent average prices (see Annex 1), the CBA assumes that the shrimp value remains constant in real terms at US$6.25/kg. As with forestry, fishery costs are based on investment and operating costs provided by the companies to government authorities. Royalties, taxes, and compensation payments are excluded from the costs in the cost benefit analysis.

In addition to the commercial shrimp harvest, boats harvest a substantial by-catch which is currently thrown back into the bay or, on some occasions, eaten by the ships' crews or traded to local people. This by-catch represents more than 90% of the trawling catch by weight and, although it is currently not used, it does offer commercial opportunities as fish meal or fertiliser. Recent identification of the disposal practice has prompted local authorities to consider promoting the commercial use of this by-catch. In this cost benefit analysis, it is assumed that some commercial development will eventually occur, although the by-catch is assigned an imputed value of only Rp300/kg. Even so, given that it represents a substantial share of the total catch by weight, the imputed value of this catch is projected to exceed Rp30 billion per year.

4.3.3 LOCAL USES AND EROSION CONTROL

The valuation of local mangrove uses was based on traditional household production from hunting, fishing, gathering, and manufacturing, as estimated through the household survey. Wages, transfers, farming income, livestock sales, and other miscellaneous income was excluded from this category. The resultant value in 1991 from the mangrove based sources was thus Rp6.5 million per household. Population estimates and projections for the area were based on recent census observations that there are 2677 household in the region and that population growth has averaged 4.22% per year over the past ten years. The CBA assumes that this level of growth will continue for 20 years and then taper off to 2% per year thereafter. This growth is largely in response to anticipated real income growth in the region. This has been assumed to be 6% annually in real terms, implying real per capita income growth of 1.8% annually.

As was noted earlier, however, socio-economic linkages will cause some modest shift away from mangrove dependence as real incomes rise. Using the estimated elasticity of –0.3, and given real income growth of 1.8% annually, the per household reliance on mangroves is forecast to decline by approximately 0.5% annually. Concomitantly, there is expected to be approximately a 0.5% increase annually in per household agricultural output as a result of development in the area. Both of these results were taken into account in the cost benefit analysis.

One important component of the cost benefit analysis is the imputed benefit of erosion control. In this study, the benefit is based on the value of agricultural output from local production. In 1991 this was estimated from the household survey to be Rp1.9 million per household.

4.3.4 CAPTURABLE BIODIVERSITY

Chapter 3 provided a discussion of capturable biodiversity benefits, and explained that a value of US$1500 per square kilometre per year of mangrove area was imputed. Because some of the mangrove area is in very isolated areas and is not expected to be harvested even if there were no controls on cutting in the region, this benefit will never totally disappear even if the 'accelerated clear cut' scenario is followed. One attribute of the modelling in the CBA, however, is that in some of the linkage scenarios which are modelled, it is assumed that this benefit is only capturable if there exists an expectation that the area will remain intact in the future. For example, if there are 300,000 ha in 1991, and if there are expected to be only 150,000 ha in the year 2000, the imputed value in 1991 is that which would accrue only to the 150,000 ha. This assumption is made primarily in light of existing institutions which are likely to transfer funds to protect biodiversity. It is expected, for example, that international conservation groups or the GEF will provide funds to an area only if there exists some reasonable expectation that the area will be protected.

4.3.5 EVALUATION ASSUMPTIONS

In addition to the above assumptions, the cost benefit analysis generally assumes that there will be no real increase or decrease in costs or prices. Cost and benefit streams are extended over a 90 year time horizon to allow three full rotations in the forestry evaluations, and to accommodate potential delays in linkage effects among ecosystem components. All future costs and benefits are discounted to 1991 at a real discount rate of 7.5%. This discount rate was selected based on discussions with planning authorities in Indonesia, and it reasonably reflects the opportunity cost of risk-free investments. Sensitivity tests are undertaken at a higher (10%) and lower (5%) rate.

4.3.6 LINKAGE SCENARIOS

A key feature of the cost benefit analysis is its treatment of the linkages between various ecosystem components. Five different linkage scenarios are defined to illustrate what would happen to total economic value under various assumptions of linkages and cutting options. Annex 5 provides a complete description of the linkage assumptions for all ecosystem components, but Table 4.4 provides a summary of the different scenarios for the very important forestry-fishery linkage.

The basic procedure in specifying the linkage involves both an impact intensity parameter (α) and an impact delay parameter (τ). An impact parameter of α=1 would imply that a 50% reduction in mangrove area would yield a 50% reduction in fishery production. This is the result typically found in Java. From the formula in Table 4.4, it is clear that an impact parameter of α=0.5 would imply that fishery output varies as the square root of mangrove area; a 50% reduction in mangrove area would result in only a 30% reduction in fishery production. This would occur if only "partial" ecological linkages existed, or if

Table 4.4
Linkage Scenarios – Fisheries

Linkage Scenario	Linkage Parameter α	τ
No Linkages	0.0	—
Weak	0.5	10
Moderate	0.5	5
Strong	1.0	5
Very Strong	1.0	0

For fisheries productivity in year t, the linkage to mangrove cutting is defined as follows:

$$\left(\frac{\text{PRODUCTIVITY}_t}{\text{PRODUCTIVITY}_{t=0}}\right) = \left(\frac{\text{MANGROVE}_{t-\tau}}{\text{MANGROVE}_{t=0}}\right)^{\alpha}$$

where MANGROVE is the area of undisturbed mangrove, and α and τ are, respectively, intensity and delay parameters as specified above.

stresses on the fisheries were somehow buffered by other factors. The specification of this relationship does not, however, constrain α to being less than or equal to unity. Indeed, if a particularly critical habitat were being threatened, it is quite conceivable that α would take on a value greater than unity. An impact parameter of $\alpha=2$, for example, implies that fishery output varies as the square of mangrove area; a 50% reduction in mangrove area in this case would result in a 75% drop in fishery output.

The time at which events occur is, because of the discounting procedure, of critical importance in cost benefit analysis. An ecological linkage which takes 20 years to manifest itself is, other things equal, far less serious in economic terms than one which occurs immediately. The delay parameter τ is thus specified with a view to showing how delayed impacts might affect the optimal management choice. In the case of fisheries, most analyses suggest that the most serious consequences (for adjacent fisheries) of mangrove depletion would occur in under five years.

In principle, the "severity" of impacts leading from the linkages must also be considered. Cost benefit analysis can only be applied if costs and benefits are finite. A linkage which leads to multiple "infinite" costs or benefits could not be evaluated using CBA; other decision criteria must be used in such instances.

Although results are presented in the following sections for all of the scenarios, most of the discussion concentrates on comparing the "strong linkage" or "very strong linkage" scenario (representing a "most likely" range) to the "no linkage" scenario. The no linkage scenario is a useful reference point because it represents that which is often implicitly assumed in single sector resource management decisions. It is also that which would be assumed by a private company making investment decisions without regard to externalities.

4.4 EVALUATION OF BINTUNI BAY: CBA RESULTS

Annex 5 provides a complete summary of the cost benefit analysis results under each of the cutting options, linkage scenarios, and discount rates used in the analysis. Annex 5 also provides cash flow summaries for selected scenarios to illustrate how the annual cash flow changes with time as different linkage effects manifest themselves. The following sections provide highlights of the CBA results to illustrate some of the major conclusions which arise from the analysis.

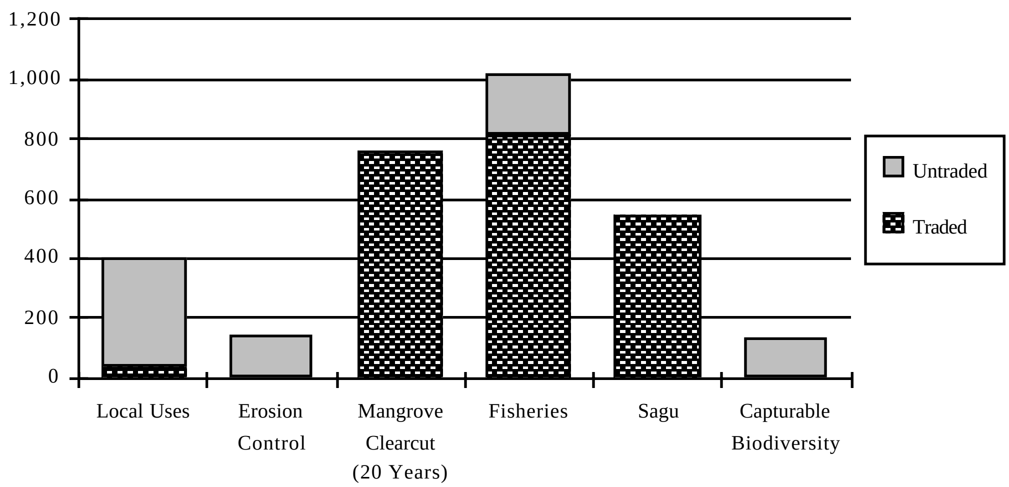
4.4.1 THE REFERENCE CASE WITH NO LINKAGES

A useful starting point, or reference case, involves the "no linkage" case where each resource component is assumed to function independently. Figure 4.9 illustrates the net present value of the benefit and cost flows of each component. For illustrative simplicity, the two fisheries components (shrimp and by-catch) have been aggregated. This reference scenario also shows the "accelerated clear cut" as the option which would be selected by forestry companies in the absence of any controls; other options have lower values, as will be demonstrated later.

Taking into account all of these components, the total asset value of the resource approaches Rp3 trillion (approximately US$1.5 billion). This is substantial and, given this high value, the resource represents a natural target for proper resource management. Two things stand out from this presentation: the commercial forestry and fishery resource have the same order-of-magnitude value of approximately Rp800 billion; the traditional local uses have a substantial, although untraded, value of approximately Rp400 billion.

Figure 4.9
Total Economic Value of Reference Case with No Linkages

(NET PRESENT VALUE IN BILLIONS OF 1991 RP; 7.5% DISCOUNT RATE)



4.4.2 CLEAR CUTTING OR CUTTING BAN: WHICH IS OPTIMAL?

In selecting an optimal cutting strategy, it is useful to demonstrate first what the total economic value of the resource is under three different cutting scenarios. Figure 4.10 illustrates the results under the "no linkage" assumption for a clear cutting case, an 80% selective cut case, and a cutting ban. These cases are revealing, because they also provide an interesting lead in to the question: "What is sustainability?"

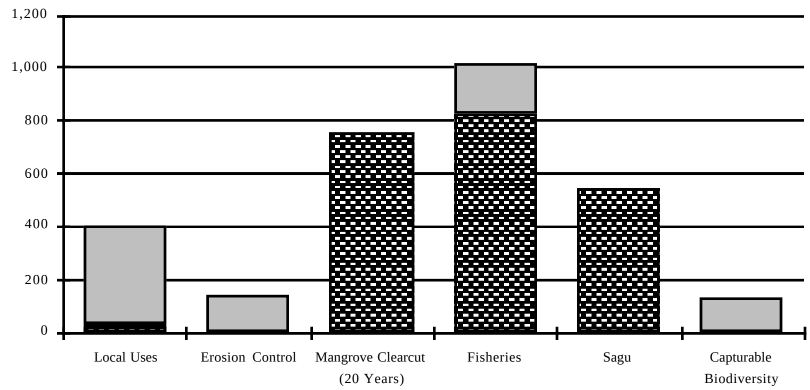
Of the three examples given, it is obvious that the clear cut example provides the greatest net benefits if one ignores linkages. This result is quite common for biological resources when the growth rate of the resource stock is less than the discount rate. The optimal short-term economic strategy under such circumstances is to "mine" the resource. Forestry departments realise, however, that although this approach might maximise the net present value, it does not provide sustainable income from forestry. A preferred management option is therefore often to cut close to the forest's maximum sustainable yield, as shown in the "80% selective cut" case. Under this option, the NPV appears less than the clear cut although, strictly speaking, this implies that the resource managers are imputing some other value to resource sustainability which is not obviously reflected in the NPV calculations. In any event, if there are no linkages, or if linkages are ignored, the cutting ban option does not appear to be optimal.

If we take into account the linkages, however, the situation changes dramatically. Figure 4.11 illustrates that, under the "very strong" linkage scenario which involves linear and immediate impacts on other resource components, the clear cut option is manifestly the worst of the alternatives, and the cutting ban option provides benefits which are Rp160 billion greater than the 80% selective cut option, *even accounting for the lost forestry revenue*. Furthermore, it is clear that the 80% selective cut can not be regarded as a sustainable option; the impacts which it has under this linkage scenario are substantial. Figure 4.10 illustrates that if a selective cut were selected under an incorrect "no linkage" assumption, the expected returns would be Rp2770 billion

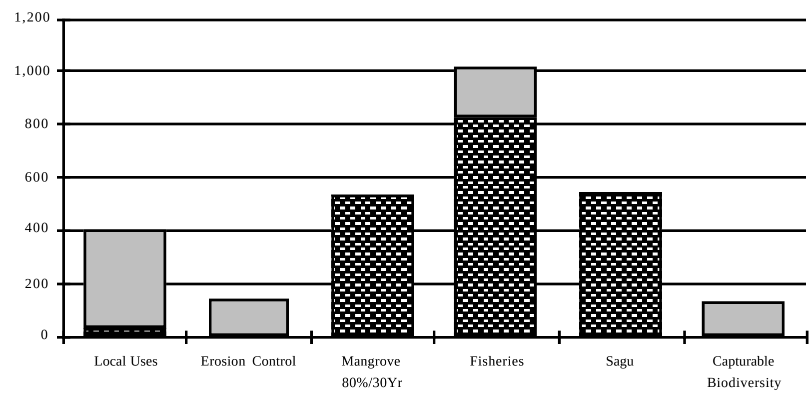
Figure 4.10
Total Economic Value of Mangrove System Assuming No Linkages

(NET PRESENT VALUE IN BILLIONS OF 1991 RP; 7.5% DISCOUNT RATE)

Clear Cut (NPV = Rp 2990 Billion)



80% Selective Cut (NPV = Rp 2770 Billion)



Cutting Ban (NPV = Rp 2240 Billion)

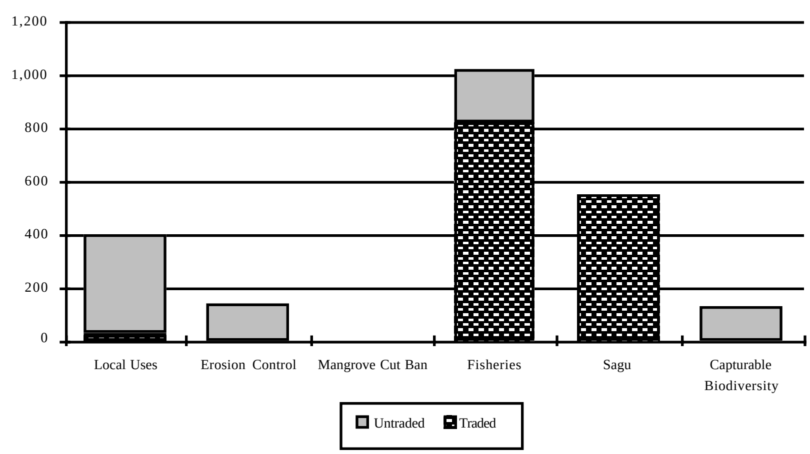
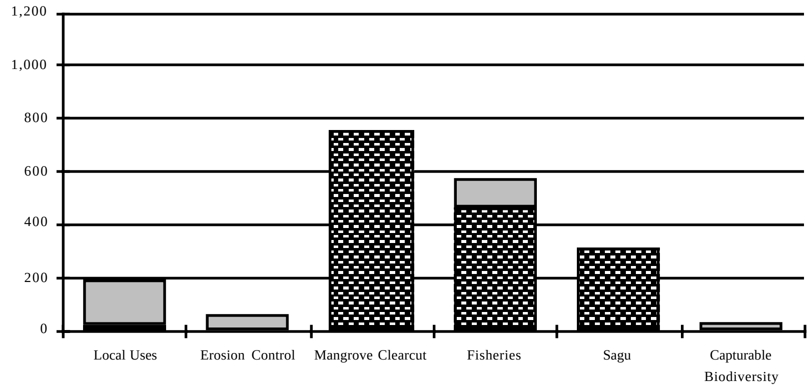


Figure 4.11

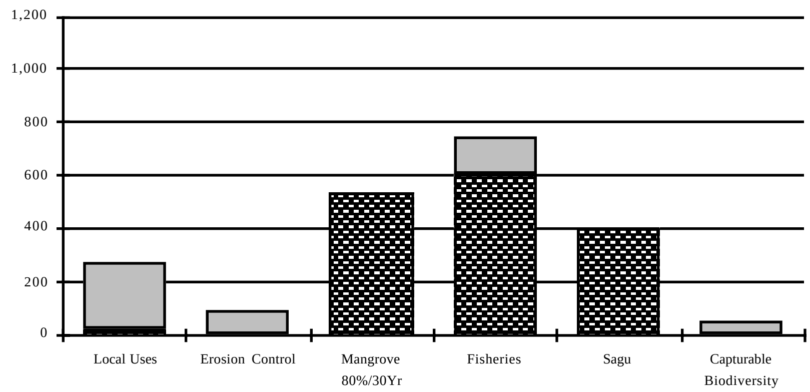
Economic Value of Mangrove System Assuming Very Strong Linkages

(NET PRESENT VALUE IN BILLIONS OF 1991 RP; 7.5% DISCOUNT RATE)

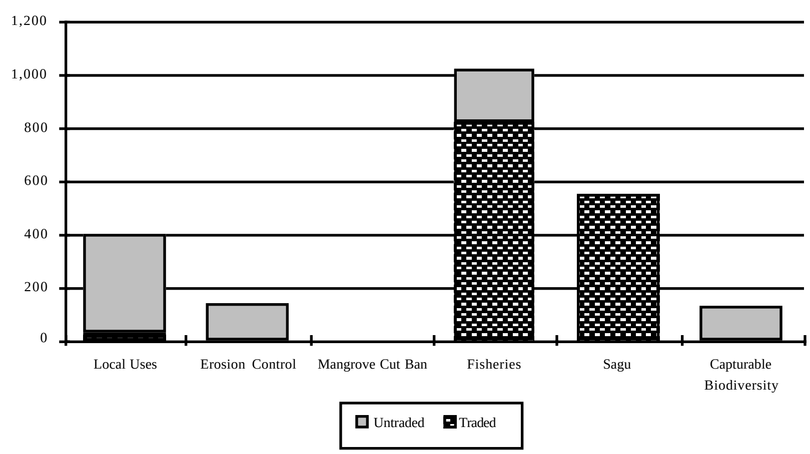
Clear Cut (NPV = Rp 1922 Billion)



80% Selective Cut (NPV = Rp 2080 Billion)



Cutting Ban (NPV = Rp 2240 Billion)



whereas the actual returns would be only Rp2080 billion. An incorrect decision in this case yielded returns which were Rp690 billion less than expected, and Rp160 billion less than the optimal amount which would be realised from a cutting ban.

Another striking result of the analysis is that the value of the traditional mangrove harvesting component would be reduced by approximately 50% as a result of an incorrect selection. As noted previously, this would have its greatest impact on the poorer segments of the population in the area, and could be expected to lead to increased economic hardship, increased social problems, and potential political unrest.

4.4.3 THE ROLE OF LINKAGES

A simple lesson from the previous example is that knowledge of the extent of the ecological linkages is important in the selection of an optimal strategy. A similar conclusion can be drawn from the total of 26 cases which were investigated for the CBA. Figure 4.12 provides a summary of these cases, and Table 4.5 provides a matrix for selecting an optimal strategy by stepwise comparisons of different strategies. Inspection of these results provides a number of important indications of what an optimal strategy would be for the Bintuni Bay area.

First, it is clear that cutting bans are optimal if very strong linkages occur, and clear cut options are optimal if one totally ignores linkages. If one rejects the "accelerated clear cut" option as unsustainable out of hand, and if one accepts that there are even weak linkages (α=0.5 with a 10 year delay) at play, then selective cutting options are preferred even over the 30 year clear cut. If moderate linkages exist (α=0.5 with a 5 year delay) then such selective cutting is no worse than even the accelerated clear cut case.

Second, a striking result is that, even in the "strong" linkage case (α=1 with a 5 year delay) there is no economic advantage to proceeding beyond a 25% cut of the harvestable area. If linkage effects occurred more rapidly than 5 years, or if the intensity parameter α exceeded unity, then it would be optimal to select an even more conservative cutting strategy than one involving a 25% harvest.

4.4.4 DISCOUNT RATE SENSITIVITY CASES

The procedure of selecting an optimal strategy depends, to some degree, on the discount rate used in the analysis. Table 4.6 illustrates what the optimal cutting strategy is under different linkage scenarios. In general, lower discount rates place a higher weight on future income streams, and in this case they result in more conservative cutting strategies. It is interesting, however, that at a 5% discount rate the clear cut option is *never* the option of choice. Under higher discount rates, less weight is placed on future benefit streams and, predictably, clear cut strategies dominate where substantial delays of the linkage effects occur. A notable result is that, at all discount rates investigated, the cutting ban is the optimal strategy if immediate linear linkages exist.

4.4.5 DECISION-MAKING UNDER UNCERTAINTY

It must be recognised that there is still considerable uncertainty in the dynamics of specific mangrove ecosystems. The previous sections have demonstrated that *if we know* the nature of these interactions, an economically optimal strategy can be selected. The analysis also demonstrates that *if we do not know* the nature of the interactions, an incorrect guess can have substantial economic penalties. If for example we *assume* that there are weak delayed interactions and select an 80% selective cut on that basis, and if it turns out that the *actual* interactions are immediate and linear, then the economic value of such a decision in the Bintuni Bay case would be about Rp500 billion *less* than what was expected, and Rp160 billion *less* than the optimal strategy.

Figure 4.12
Summary of Net Benefits – 26 Cases

(NET PRESENT VALUE IN BILLIONS OF 1991 RP; 7.5% DISCOUNT RATE)

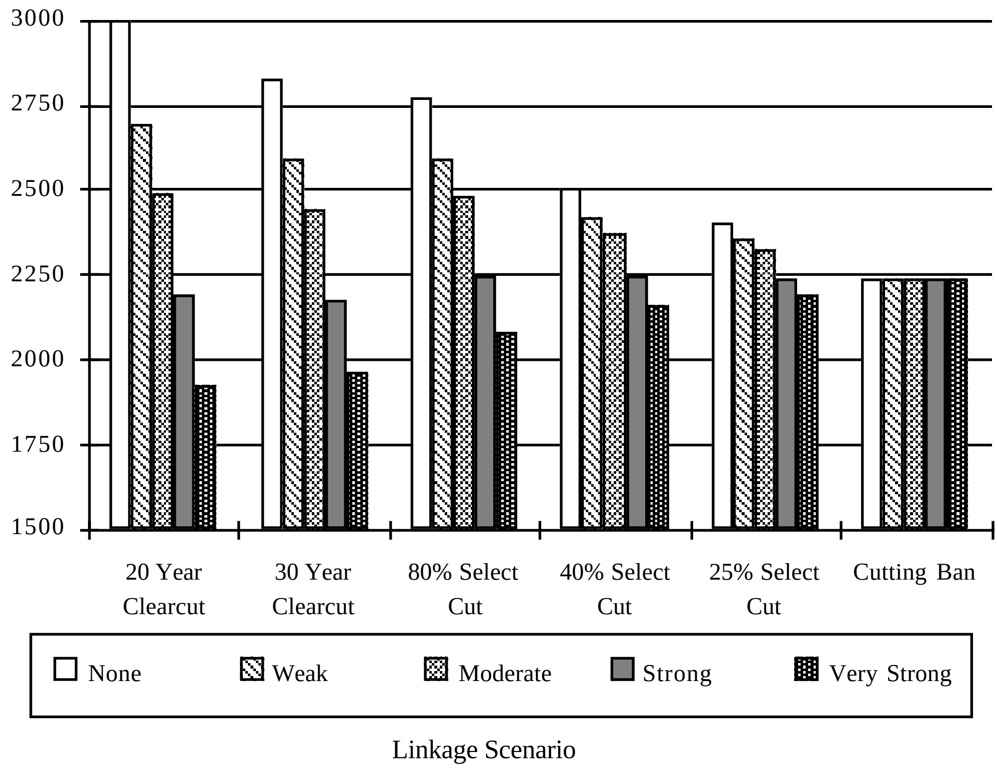


Table 4.5
Determination of Optimal Mangrove Management Strategy

(NPV=NET PRESENT VALUE IN BILLIONS OF 1991 RP; 7.5% DISCOUNT RATE)

Option I	Option II	NPV(Option I)–NPV(Option II)				
		Linear (α=1)		Non-linear (α=.5)		No
		τ=5 Yr	τ=10 Yr	τ=5 Yr	τ=10 Yr	Linkage
25% Selective Cut	Cutting Ban	–50	<5	+80	+120	+170
40% Selective Cut	25% Selective Cut	–30	~0	+50	+70	+100
80% Selective Cut	40% Selective Cut	–80	~0	+110	+170	+270
Clear Cut	80% Selective Cut	–120	–80	–40	~0	+60
Optimal Strategy		Ban	~25% Cut	80% Cut	80% Cut	Clear Cut

Table 4.6
Optimal Strategy and Maximum Penalty as a Function of Discount Rate

OPTIMAL STRATEGY	**Discount Rate**		
Linkage Scenario	**5%**	**7.5%**	**10%**
None	80% Cut	Clear Cut	Clear Cut
Weak	80% Cut	80% Cut	Clear Cut
Moderate	80% Cut	80% Cut	Clear Cut
Strong	Ban	25% Cut	80% Cut
Very Strong	Ban	Ban	Ban

	Discount Rate		
NPV	**5%**	**7.5%**	**10%**
With Ban	Rp 3 498 Billion	Rp 2 237 Billion	Rp 1 625 Billion
With Optimal Strategy if No Linkages Assumed	Rp 2 953 Billion	Rp 1 962 Billion	Rp 1 573 Billion
Maximum Potential Loss	Rp 545 Billion	Rp 275 Billion	Rp 52 Billion
	US$272 Million	US$138 Million	US$26 Million

Table 4.6 also shows the "maximum potential penalty" of an incorrect decision under different discount rate assumptions, assuming that decisions are made on the basis that "no linkages" exist when in fact "very strong" linkages exist. At a 7.5% discount rate, this penalty is Rp275 billion. Such penalties are substantial; the entire GDP of Kabupaten Manokwari is estimated to be less than Rp100 billion annually. Decision-makers must be aware of what the potential losses of incorrect decisions might be – even when information is incomplete or uncertain – and act accordingly.

Finally, the current situation of uncertainty raises two further issues: (a) that there is a need for information relating to the linkages between ecosystem components; and, (b) that policies which mitigate the effects of the linkages will have economic as well as ecological merit. Where ecosystem dynamics are uncertain, programmes reducing linkage effects – such as greenbelts, replanting, or selective cutting – will minimise potential economic losses. In terms of our linkage framework, such policies effectively reduce the linkage effects either by reducing α or increasing τ.

4.5 SUMMARY

When linkages between ecosystem components are not taken into account, or when mangrove cutting is left unregulated, mangrove resources will often be over-exploited. The existence of linkages between mangrove area and overall ecosystem productivity means that strong economic arguments can be made for conservative mangrove clearing. In instances where strong ecological ties occur, severe restrictions on clearing activities will be economically optimal. This generic result will apply to many situations in Indonesia where resource development needs place conflicting demands on mangrove resources.

In the Bintuni Bay area, the analysis provides additional rationale for setting aside some of the mangrove area in a conservation area. If strong ecological interactions exist, the analysis showed that the optimal amount of cutting was less than 25% of the harvestable area. Given the proposed area of the reserve and characteristics of the mangrove outside of the reserve, to achieve a

'25% target' for the area as a whole would require that cutting outside of the reserve not exceed 60% of the harvestable area. This would be consistent with allowing the current chipwood plant to operate to the end of the 20 year concession life, although if capacity factors substantially exceeded 80%, then shortening the concession life by up to 4 years may be warranted. Even so, if further research shows that ecological interactions are quite rapid, or if critical habitats are being disturbed, then it would be economically justified to reduce cutting below this 60% threshold.

5. RECOMMENDATIONS

5.1 INTRODUCTION

The results of the household survey and cost benefit analysis have implications for development of the Bintuni Bay mangrove area, as well as mangroves elsewhere in Indonesia. This final chapter provides some summary recommendations in a number of key areas, and concludes with specific actions which might be taken to promote sound mangrove management practices in Indonesia.

It is important to note that – because there is still uncertainty in the extent of ecological or environmental impacts which will arise from different mangrove management strategies – the type of follow-up actions actually taken by decision-makers in the Indonesian government will depend significantly on their degree of 'risk aversion'. The recommendations and actions described in this chapter are premised on a relatively conservative or 'safe' approach. Such an approach recognises that, given the potential economic losses from an incorrect decision, it is prudent to be conservative about mangrove management in Bintuni Bay and elsewhere.

Although some of the recommended immediate actions are quite specific, it must be recognised that – in the Bintuni Bay area – an INREDEP process is commencing which aims to bring together the various stakeholders in the local resource base, with a view to ensuring that regional development proceeds on a sustainable basis. It is expected that the INREDEP process will, for example, establish action priorities for the area based on discussions between these stakeholders. A number of the recommendations in this chapter for near- to medium-term action (2-5 years) are thus intended to provide some initial direction to the INREDEP process; it is not the intent of this study to usurp that process, but rather to complement it and provide information to decision-makers which are involved in it.

5.2 NEEDS FOR INTEGRATED DEVELOPMENT

Perhaps the most striking feature of the analysis in this study is that it underlines the need for an integrated development program. Failure to take into account the interdependences among different components of the mangrove ecosystem can lead to substantial economic losses. In particular, it is clear that there is a need for balanced development which recognises:

- potential conflicts between resource development initiatives; and,
- potential conflicts between resource development and local traditional interests.

The interface between resource development and traditional interests can be addressed through a process such as INREDEP if programmes are specifically targeted to local people. As there is no empirical support for a 'trickle-down effect' in Bintuni Bay, this suggests that targeted local development must complement any broad development initiatives to ensure that socio-economic distortions do not arise. Specifically, this could be achieved through promoting small-scale enterprises based on mangrove harvesting activities, and through ensuring that conflicts between commercial interests and local uses are minimised.

5.3 POTENTIAL POLICY REFORMS: THE ROLE OF ECONOMIC INSTRUMENTS

The potential distorting influences which broad-based macro-economic policies have suggest that targetted economic instruments can have a positive influence on mangrove management. Economic instruments such as land tax surcharges, tiered royalties, sales taxes on hatchery fry, replanting incentives, and ownership reforms all provide potential mechanisms for promoting sustainable mangrove use. Many policies in the past have inadvertently caused unsustainable mangrove use because these same instruments were not effectively used: low land taxes promoted conversion to tambak; subsidies to fish hatcheries discouraged gathering of wild fry from mangrove sites; unclear or open access to mangrove areas resulted in over-exploitation.

It is thus recommended that work commence on developing a charge system to promote mangrove management. This is discussed in further detail in Annex 6, and consists of the following steps:

- identification of key resource areas;
- identification of key resource conflicts in these areas;
- identification of inadvertent subsidies or incentives which contribute to these conflicts;
- identification and evaluation of corrective measures;
- implementation of preferred measures on a pilot basis; and,
- broad application of measures.

In all instances – especially important in Indonesia where local resource management is becoming more decentralised – economic incentives or charges must be seen as fulfilling two key functions:

- providing adequate incentives to private operators to develop the mangrove ecosystem sustainably; and,
- providing adequate funds to local or regional authorities to monitor and, where necessary, regulate mangrove development.

Economic charges provide an opportunity to fulfil both of these functions concurrently.

5.4 DATA/INDICATOR NEEDS FOR MONITORING

5.4.1 PRICES AS INDICATORS

Although some data are available on physical stocks and flows in mangrove areas, inadequate attention is being paid to the role which *prices* can play as an indicator of unsustainable mangrove use. During the data gathering process for this study, the poorest quality data were invariably the prices. A common problem was that for most resource flows the actual measurement is in physical units and no record is kept of traded prices; when estimates of "values" are required, arbitrary prices are assigned which do not necessarily have any relation to the actual prices. The problem is especially acute with historical data; information which is represented as historical traded values is actually historical traded physical volumes multiplied by an approximated *current* price.

If price data are more consistently recorded and reported, they can play two potentially useful roles as indicators. First, they can in some circumstances provide an early sign of impending stress on mangrove ecosystems. The PL20 fry prices in South Sulawesi provide such an example: an 80% decline in prices over 5 years is expected to place escalated pressures on mangrove clearing. Second, they can serve as an indicator of the quality of production. Shrimp prices vary by shrimp size and quality, for example, and a decline in average sales prices while international prices remain firm could signal a change in shrimp size or quality which in turn indicates unsustainable harvesting practices or ecosystem degradation. It is therefore recommended that price data, of both inputs and outputs, be more regularly recorded and reported for various commercially harvested products from mangrove areas.

5.4.2 LINKAGES

The analysis in this study illustrated the importance of having information about the ecological linkages which exist between mangrove ecosystem components. If longer term correlation studies are to be done, the *minimum* data which are required involve indicators of the following items:

- changes in mangrove area within the greenbelt zone;
- changes in mangrove area behind the greenbelt zone;
- fishery productivity or yield; and,
- fishery effort.

If one of these pieces of information is in fact missing, grossly incorrect conclusions can be drawn. For example, some argued in South Sulawesi, based on only mangrove area and offshore fishery productivity data, that there was no correlation between them because area was falling dramatically while total catch remained constant. What was not measured was the fishery effort which, as it turns out, was increasing as local people were driven away from traditional areas in the mangroves to areas just offshore.

5.4.3 OTHER INDICATORS

The NREA exercise being undertaken by BPS is a substantial effort in gathering data which can be used as indicators. Although priority areas are still in the process of being selected, it appears likely that petroleum resources and forestry resources will form the foundations of the first sets of experimental accounts. It is also likely that one level of disaggregation of the forestry account will involve mangrove area, even though mangroves represent only about 3% of Indonesia's total forested area. There is a danger in this exercise that, if mangrove forestry statistics are taken in isolation, they will not provide a good indicator of the value of the functions of the resource base. This study showed that, if one looks at the resource in isolation, a sustainable yield policy might appear to be quite sensible when, in fact, an optimal policy might involve considerably less clearing to ensure that the ecological functions provided by the mangrove are not threatened. For this reason, it is recommended that the mangrove accounts *not* be disaggregated from other forestry accounts *until* an experimental account of the fisheries resource is also introduced. To that end, it is also recommended that high priority be placed on introducing an experimental fisheries account into the NREA at the earliest possible opportunity.

5.5 FOLLOW-UP REQUIREMENTS

5.5.1 BINTUNI BAY

The cost benefit analysis demonstrated that the selection of the optimal development strategy depended on the extent of the ecological linkages. Where those linkages are not precisely certain, the chosen strategy actually depends on the decision-makers' degree of risk aversion. A decision-maker who is not concerned with the potential losses of a bad decision may well be willing to take a chance that clearing large areas of mangrove will have no effect on offshore fisheries. On the other hand, given the evidence elsewhere, and given that substantial losses might result from an incorrect decision, a risk-averse decision-maker will select a strategy which is more conservative. The specific follow-up requirements recommended for Bintuni Bay are based on such a conservative strategy, and stem from the cost benefit analysis which indicated that there is little economic advantage to going beyond the "25% selective cut" of the mangroves. The reader will recall that this involves gazetting the proposed Bintuni Bay Nature Reserve, and limiting the cut to off-reserve areas to that which would sustain the current woodchip plant for a period of 16 to 20 years. In support of this, Table 5.1 summarises other actions which would be undertaken as part of such a "conservative" strategy; Table 5.2 identifies a number of complementary actions in other areas of Indonesia.

Table 5.1
A Conservative Action Plan for Mangrove Management in Bintuni Bay

COMPLETION TIME FRAME	ACTION	RESPONSIBLE PARTIES
IMMEDIATE (<6 MONTHS)	Gazette Proposed Bintuni Bay Nature Reserve (267,000 ha)	Government of Indonesia
	Initiate Forestry Management Plan for Off-Reserve Lands (incl. zoning)	Companies/Forestry
	Commence Seeking Foreign Aid Support for Biodiversity Maintenance	KLH/INREDEP (GEF)
NEAR TERM (<2 YEARS)	Commence Review of Economic Incentive Mechanisms for Mangrove Management	Forestry/KLH
	Complete Forestry Management Plan for Off-Reserve Lands (incl. zoning)	Companies/Forestry
	Identify Sustainable Community-Based Projects for Traditional Mangrove Use	INREDEP/Local Communities
	Establish Investment Procedures for External Investment in Area	INREDEP
	Commence Enforcement of Fisheries Limitations inside 10 Metre Depth	Fisheries (Agriculture)
MEDIUM TERM (<5 YEARS)	Implement Economic Incentive Mechanisms for Mangrove Management	Forestry/KLH
	Complete Research Summary of Ecological Linkages in Area	LIPI/PSL/Universities/ (Foreign Assistance)
	Initiate WID Programme Targeted to Farm and Mangrove Products	INREDEP
	Identify and Implement Education Reforms to Address Drop-out Rate	INREDEP/Education
ON-GOING (ANNUALLY)	Monitor Forest Cut, Fishery Productivity, Fishery Effort	BAPPEDA
REVIEW (~15 YEARS)	Mangrove Forestry Concession Renewal or Termination	Forestry/KLH/BAPPEDA

Table 5.2
Potential Complementary Actions for Mangrove Management in Indonesia

COMPLETION TIME FRAME	ACTION	RESPONSIBLE PARTIES
IMMEDIATE (<6 MONTHS)	Commence Communication of Results in Other Jurisdictions	KLH/BAPPEDA
	Commence Project Identification in S. Sulawesi	KLH/PSL
	Commence Identification of Economic Incentives for Mangrove Management	Forestry/KLH
NEAR TERM (<2 YEARS)	Identify Other Critical Mangrove Sites in Indonesia	KLH/BAPPEDA
	Identify Other Sites with Coral Reef/Mangrove Links	KLH
	Commence Macro-economic Policy Review	KLH/BAPPENAS
	Commence Establishing NREA Account on Fisheries & Mangroves	BPS/KLH/Agriculture/ Forestry
MEDIUM TERM (<5 YEARS)	Conduct Research on Ecological Linkages	LIPI/PSL/Universities/ (Foreign Assistance)

Immediate priorities in Bintuni Bay focus on gazetting the reserve, initiating a forestry management plan for off-reserve lands, and commencing activities to seek foreign donor support for biodiversity maintenance. The forestry management plan should incorporate the following key features: a greenbelt consistent with current guidelines that the width be equal to 130 times the tidal variation and that the area be measured from the high water mark; a zoning structure allowing the harvesting of approximately 60,000 ha behind the greenbelt zone which will minimise the physical disruption of the surrounding ecosystem; and, monitoring plans.

In the near term (<2 years), high priority should be placed on commencing a review of economic incentive mechanisms for mangrove management. In the Bintuni Bay area, it is recommended that this should concentrate on the design of staggered royalties or cutting fees in association with a zoning system. The principle would be that areas close to the greenbelt would incur higher fees if they were cut. Consideration should be given to returning a fixed proportion of incremental fees (above the regular royalty rate) to local authorities to assist in the financing of monitoring other parts of the ecosystem and for the payment of compensation to local communities.

Other near-term non-forestry actions should include the establishment of investment procedures for external investment in the area and the identification of sustainable community-based projects for traditional mangrove use. Some projects, such as crocodile farming, are already well under way in Bintuni. It is expected that the INREDEP process will contribute significantly to this effort of project identification.

Medium-term actions are identified which either have a lower priority or, because of their nature, require longer lead times before completion can be reasonably expected. Implementation of a staggered royalty structure should, for example, be targeted within the next five years. In addition, research groups such as universities, PSLs, and LIPI should present – in approximately five years – preliminary findings of ecological linkage studies in the Bintuni Bay area. This will require the establishment of research priorities and a research action plan for the region; it would be appropriate to initiate this work with a workshop held sometime in the next year. Foreign assistance in this aspect would be appropriate because the research findings will be of interest to the international community as a whole.

Longer term efforts should be directed to monitoring the forest cut, fishery productivity and fishery effort in the bay, with a view to establishing the extent to which linkages exist between the forestry and fishery components. Near the end of the mangrove concession life, in approximately 15 years, these data and other relevant information should be reviewed to determine the impact which forestry has had on the ecosystem's productivity. If there is little evidence of ecosystem disruption and if concessionaires have followed the forestry management plan, the concessions might be renewed for another period. If there is evidence that other parts of the ecosystem are substantially declining in productivity, cutting operations should be terminated indefinitely at that time.

5.5.2 COMPLEMENTARY ACTIONS

The complementary actions enumerated in Table 5.2 have, for the most part, been described earlier in this chapter. It should be noted, however, that the most important single priority is communicating a general conclusion of this study – that conservative mangrove cutting strategies or even complete cutting bans can be economically optimal – to various decision-makers involved in mangrove management. This will need to be addressed at both the national and regional level, and should be directed first to regions which have been previously identified as critical mangrove areas. South Sulawesi, for example, is one such area and managing the Kabupaten Luwu mangrove in that province is a high priority.

Other complementary actions involve primarily continued identification of critical sites and application of the general five step mangrove management framework to those sites. It should be stressed, however, that it is not necessary to repeat the type of study undertaken here for every site. Many of the general lessons here can be applied at other sites using informed judgment, *if* there is a local political will to manage the mangrove areas sustainably. One of the purposes of the broader communication task is to nurture that political will.

5.5.3 ROLE OF FOREIGN INVOLVEMENT IN BIODIVERSITY CONSERVATION

Sustainable management of Indonesia's mangroves is not only in Indonesia's economic interests but also in the interests of the broader international community as a whole. Indonesia's mangroves are among the most diverse in the world, and thus represent a significant biodiversity asset for both current and future generations. While in some cases it is expected that Indonesia will have the resources available to manage these mangroves sustainably, in other cases increasing population and development pressure will prompt managers and decision-makers to forego conservation options. The international community, through international protocols and institutions such as the GEF, now has mechanisms in place which can provide financial conservation incentives to countries such as Indonesia. The incentives should be regarded neither as levers of foreign will, nor as development aid. They are, quite simply, trade in a commodity which hitherto has not had a market. Neither Indonesia nor the international community should hesitate to initiate such trade to each other's mutual benefit.

BIBLIOGRAPHY

Ahmad, Y.J., S.E. Serafy, and E. Lutz. eds. 1988. *Environmental accounting for sustainable development*. Washington, D.C.: World Bank, 100 pp.

Anand, S. 1978. *Inequality and poverty in Malaysia: Measurement and decomposition*. D.Phil. dissertation. Oxford: Oxford University.

Atkinson, A.B. 1970. "On the measurement of inequality." *Journal of Economic Theory* 2: 244-263.

Balai Rehabilitasi Lanan dan Konservasi Tanan. 1990. *Pengembangan hutan mangrove rakyat di Sulawesi Selatan: Peta kerja*. Ujung Pandang: Departemen Kehutanan.

Balai Rehabilitasi Lanan dan Konservasi Tanan. 1990. *Pengembangan hutan mangrove rakyat di Sulawesi Selatan: Rencana*. Ujung Pandang: Departemen Kehutanan.

Chua, T.-E. and D. Pauly. eds. 1989. *Coastal area management in Southeast Asia: Policies, management strategies and case studies*. ICLARM Conference Proceedings 19, Ministry of Science, Technology and the Environment, Kuala Lumpur; Johore State Economic Planning Unit, Johore Bahru, Malaysia; and International Center for Living Aquatic Resources Management, Manila, Philippines. 254 pp.

de Beer, Jenne H. and Melanie J. Mcdermott. 1989. *The economic value of non-timber forest products in Southeast Asia: With emphasis on Indonesia, Malaysia, and Thailand*. Amsterdam: Netherlands Committee for IUCN.

Dinas Perikanan Daerah. 1990. *Laporan tahunan*. Sorong: Dinas Perikanan Daerah.

Dixon, J.A. 1989. “Coastal resources: Assessing alternatives.” In *Coastal area management in Southeast Asia: Policies, management strategies and case studies*, edited by T.-E. Chua and D. Pauly. ICLARM Conference Proceedings 19, 254 p. Ministry of Science, Technology and the Environment, Kuala Lumpur; Johore State Economic Planning Unit, Johore Bahru, Malaysia; and International Center for Living Aquatic Resources Management, Manila, Philippines. Pp. 153-162.

Drèze, J.P. and N.H. Stern. 1987. “The theory of cost-benefit analysis.” In *Handbook of public economics Vol. II*, edited by A. Auerbach and M. Feldstein. North Holland.

Erftemeijer, P., G. Allen, and Zuwendra. 1989. *Preliminary resource inventory of Bintuni Bay and recommendations for conservation and management.* Bogor: PHPA/AWB.

Eusebio, M.A., F.O. Tesoro, and D.M. Cabahug, Jr. 1987. “Environmental impact of timber harvesting on mangrove ecosystem in the Philippines.” In *Mangroves of Asia and the Pacific: Status and management*, edited by R.M. Umali, P.M. Zamora, R.R. Gotera, R.S. Jara, A.S. Camacho and M. Vannucci. Technical Report of the UNDP/UNESCO Research and Training Pilot Programme on Mangrove Ecosystems in Asia and the Pacific. Manila: Natural Resources Management Center and National Mangrove Committee, Ministry of Natural Resources. Pp. 337-354.

Flach, M. and D.L. Schuiling. 1989. “Revival of an ancient starch crop: A review of the agronomy of the sago palm.” *Agroforestry Systems* 7: 259–281.

Hehanussa, P.E. and F. Hehuwat. 1980. “Morphogenesis of the northern coastal plain of west Java between Cirebon and Jakarta: Its implications for coastal zone management.” In *Proceedings of the Jakarta workshop on coastal zone management*, edited by C.E.F. Bird and A. Soegiarto. Jakarta: LIPI-UNU.

Hodgson, G. and J.A. Dixon. 1988. *Logging versus tourism in Palawan: An environmental and economic analysis*. Honolulu: East-West Environment and Policy Institute. 95 pp.

Hufschmidt, M.M., D.E. James, A.D. Meister, B.T. Bower, and J.A. Dixon. 1988. *Environment, natural systems, and development: An economic valuation guide.* Baltimore: Johns Hopkins University Press, 338 pp.

Jamil. 1989. *Hutan mangrove sebagai suatu agroekosistem: Studi kasus kawasan hutan mangrove di Muara Sungai Pangkajene Kabupaten Pangkep*. Ujung Pandang: Universitas Hasanuddin.

JCP Inc. and PT. Gubah Laras. 1990. *Tourism sector programming and policy development*. Draft.

Johansson, Per-Olov. 1987. *The economic theory and measurement of environmental benefits.* Cambridge: Cambridge University Press, 223 pp.

Kantor Statistik. 1990. *Manokwari dalam angka*. Manokwari: BPS.

Kantor Wilayah Departemen Perdagangan. 1990. *Laporan tahunan*. Manokwari: Kantor Departemen Perdagangan.

Lavalin International and PT. Hasfarm Dian Konsultan. 1987. *Regional development planning for Irian Jaya*. Government of Indonesia and United Nations Development Programme.

Little, I.M.D. and J.A. Mirrlees. 1974. *Project appraisal and planning for developing countries*. Heinemann.

Maddala, G.S. 1983. *Limited-dependent and qualitative variables in econometrics.* Cambridge: Cambridge University Press. 401 pp.

McNeely, Jeffrey A. 1988. *Economics and biological diversity: Developing and using economic incentives to conserve biological resources.* Gland: International Union for the Conservation of Nature. 236 pp.

Ministry of Forestry Indonesia. *Indonesian mangrove forests*. Jakarta: Ministry of Forestry Indonesia. 20 pp.

Naamin, Nurzali. 1987. "Impact of 'tambak' aquaculture to the mangrove ecosystem and its adjacent areas with special reference to the north coast of West Java". In *Mangroves of Asia and the Pacific: Status and management,* edited by R.M. Umali, P.M. Zamora, R.R. Gotera, R.S. Jara, A.S. Camacho and M. Vannucci. Technical Report of the UNDP/UNESCO Research and Training Pilot Programme on Mangrove Ecosystems in Asia and the Pacific. Manila: Natural Resources Management Center and National Mangrove Committee, Ministry of Natural Resources. Pp. 355-365.

Organisation for Economic Cooperation and Development. 1989. *Economic instruments for environmental protection.* Paris: OECD.

Pearce, D. and R.K. Turner. 1990. *Economics of natural resources and the environment*. Hertfordshire: Harvester Wheatsheaf, 378 pp.

Pearce, D. ed. 1991. *Blueprint 2: Greening the world economy*. London: Earthscan, 232 pp.

Petocz, Ronald G. and George P. Raspada. 1984. *Conservation and development in Irian Jaya: A strategy for rational resource utilization*. Bogor: PHPA.

Robertson, A.I. and D.C. Duke. 1990. "Mangrove fish-communities in tropical Queensland, Australia: Spatial and temporal patterns in densities, biomass and community structure." *Marine Ecology* 104: 369-379.

Robertson, A.I. and P.A. Daniel. 1989. "The influence of crabs on litter processing in high intertidal mangrove forests in tropical Australia." *Oecologia* 78: 191-198.

Robertson, A.I., D.M. Alongi, P.A. Daniel and K.G. Boto. 1988. "How much mangrove detritus enters the Great Barrier Reef lagoon?" In *Proceedings of the 6th international coral reef symposium*. Townsville: Australian Institute of Marine Science. Pp. 601–606.

Robertson, A.I., P. Dixon, and P.A. Daniel. 1988. "Zooplankton dynamics in mangrove and other nearshore habitats in tropical Australia." *Marine Ecology* 43: 139-150.

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

Ruitenbeek, H.J. 1990b. *The rainforest supply price: A step towards estimating a cost curve for rainforest conservation*. London: Suntory-Toyota International Centre for Economics and Related Disciplines.

Shorrocks, A.F. 1982. "Inequality decomposition by factor components." *Econometrica* 50: 193-211.

Silvius, M.J., A.P.J.M. Steeman, E.T. Berczy, E. Djuharsa and A.W. Taufik. 1987. *The Indonesian wetland directory: A preliminary compilation of existing information on wetlands of Indonesia.* Bogor: PHPA, AWB/INTERWADER, EDWIN.

Soemodiharjo, S. 1987. “Indonesia.” In *Mangroves of Asia and the Pacific: Status and management*, edited by R.M. Umali, P.M. Zamora, R.R. Gotera, R.S. Jara, A.S. Camacho and M. Vannucci. Technical Report of the UNDP/UNESCO Research and Training Pilot Programme on Mangrove Ecosystems in Asia and the Pacific. Manila: Natural Resources Management Center and National Mangrove Committee, Ministry of Natural Resources. Pp. 89-130.

Umali, R.M., P.M. Zamora, R.R. Gotera, R.S. Jara, A.S. Camacho and M. Vannucci. eds. 1987. *Mangroves of Asia and the Pacific: Status and management.* Technical Report of the UNDP/UNESCO Research and Training Pilot Programme on Mangrove Ecosystems in Asia and the Pacific. Manila: Natural Resources Management Center and National Mangrove Committee, Ministry of Natural Resources. 538 pp.

White, K.J. 1987. “SHAZAM: A general computer program for econometric methods (Version 5).” *American Statistician* 41:80.

Williams, D.McB. and M. Cappo. 1990. “Life-histories of clupeids in north-eastern Australia: Preliminary data.” In *Tuna baitfish in the Indo-Pacific region*, edited by S.J.M. Blaber and J.W. Copland. Honoria, Solomon Islands: ACIAR. Pp. 70-74.

World Commission on Environment and Development. 1987. *Our common future*. London: Oxford University Press.