Assessing the Value of Krabi River Estuary Ramsar Site Conservation and Development*

Penporn Janekarnkij**

ARE Working Paper No. 2553/4
(December 2010)

*A paper presented at the ninth biennial conference of the International Society for Ecological Economics on "Ecological Sustainability and Human Well-Being" held in New Delhi, India, 16-18 December 2006.

** Department of Agricultural and Resource Economics, Faculty of Economics, Kasetsart University. Tel: +66 2942 8649 to 51 Fax: +66 2942 8047 e-mail: penporn.j@ku.ac.th

Agricultural and Resource Economics (ARE) Working Paper is a peer-review work. It is aimed at disseminating academic writing of the staff members and students of the Department Agricultural and Resource Economics in the fields of agricultural economics, agribusiness, and natural resource and environmental economics.

Department of Agricultural and Resource Economics
Faculty of Economics, Kasetsart University
Jatujak, Bangkok, 10900, Thailand
Tel: +66 2942 8649 to 51
Fax: +66 2942 8047
www.agri.eco.ku.ac.th

Janekarnkij, P. 2010. "Assessing the Value of Krabi River Estuary Ramsar Site: Conservation and Development." **ARE Working Paper No. 2553/4.** Department of Agricultural and Resource Economics, Faculty of Economics, Kasetsart University, Bangkok.

ISSN 1905-6494

ราคา 100 บาท

ABSTRACT

Krabi River Estuary, a ramsar site located in southern Thailand, is dominated by two major natural vegetation assemblages, i.e. mangrove forests and seagrass beds. According to the cluster development strategy, the cabinet has approved in principle to develop Krabi as the global marine tourism center and economic gateway of Asia. This study aimed to assess the economic value of the site, using market price and benefit transfer. The impact on economic activities with the 5% annual decline of mangrove forests was evaluated. The estimated annual use value of the site was $9.7 million for recreation and tourism. The economic value of mangrove forests was $758/ha. The net present value of mangrove forests was $73.1 million based on 7% discount rate and 15-year time line. An approximate impact of mangrove change follows the study of Ruitenbeek (1992). It was assumed that the impact on local direct resource extraction and loss in biodiversity would occur at the year after the depletion of the forest. The impact on the productivity of local fishery would occur in the fifth year and on tourism in the tenth year. Thus, value loss of mangrove at the annual rate of 5% in the net present term became $21.0 million or $2.3 million per year. The results imply that a development project that causes the same rate of mangrove destruction must generate a least an income of $2.3 million per year to be considered as an economically feasible project.

Keywords: Krabi River Estuary, ramsar site, wetland management, economic valuation, direct use values

JEL Classification: Q51, Q57

1. Introduction

With an increase in global demand for protection of wetland, Thailand has become the 110th contracting party to the Ramsar Convention in 1998. As a result, the protection and rehabilitation of wetlands and promotion of their sustainable use have been thus a national concern. The efforts to manage wetland resources for wise use and conservation have been strengthened. At present, Thailand has successfully included 10 ramsar sites into the list of international importance (ramsar list).

This study represents a part of economic outputs from the project "Implementation of the Ramsar Convention, Management and Protection of Wetlands (MPW project)" supported by Danish Agency for Development Assistance (DANIDA). Krabi River Esturary (KRE) ramsar site was selected as the pilot area to develop and implement participatory wetland management plan. The project has facilitated increased understanding of wetland values among local stakeholders, and brought government, communities and the private sector together to jointly prepare their integrated strategic wetland management plan.

The objectives of the study are: (1) to determine the economic value of resources in Krabi River Estuary ramsar site and its contribution to local communities, and (2) to demonstrate the use of total economic valuation result for the evaluation of the impact of ecosystem changes in decision making for the selection of the appropriate management options.

2. Krabi River Estuary Ecosystem

Krabi River Estuary, 1100th ramsar site, is located in Krabi Province,

southern Thailand. The ecosystem covers 21,299 ha from the 45 million year shell cemetery, mangrove forests, mudflats, sandy beaches, and canals in front of Krabi city to mangrove forests and seagrass beds of Sri Boya Island (Figure 1). The area includes 10,212 ha of mangrove and 1,200 ha of inter-tidal sand-flats, the remainder is mostly under beach forest, agriculture, and plantation.

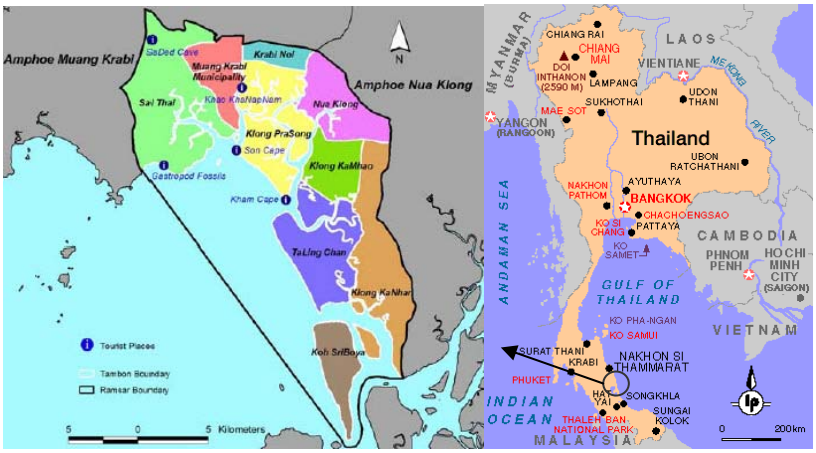

Figure 1. The boundary of Krabi River Estuary ramsar site

Krabi River Estuary ramsar site covers a part of two districts which are Muang and Nua Klong districts. The area comprises 45 villages/communities of eight sub-districts and two municipalities. The eight sub-districts are Sai Thai, Krabi Noi, Khlong Pra Song, Nua Khlong, Khlong Ma-Mhoa, Taling Chan, Khlong Ka-Nhan and Sri Boya as well as Muang and Nua Khlong Municipalities of Krabi (Table 1).

In 2002, the local population in the ramsar site was 90,481 with 22,620 households living in 45 villages and two municipalities

(Table 1). Livelihoods of people living in the coastal villages rely mainly on agriculture, fishing, aquaculture, trade, laboring in the tourism business, and the collection of non-timber products of mangrove forests.

Table 1. District, sub-district, and villages located in the ramsar site and resource utilization of Krabi River Estuary, 2002

District/sub-district in Krabi Estuary	Popu-lation	No.of village	No.of village in ramsar site	Major types of resource utilization[1]				
				Shrimp pond, fish cage	fishery	mangrove	Agriculture	tourism
Rural area								
1. Muang district								
1.1 Klong Prasong	3,948	4	4	✓	✓	✓	✓	
1.2 Sai Tai	10,492	7	7	✓	✓	✓	✓	
1.3 Krabi Noi	12,250	13	2				✓	
1.4 Ao Nang	6,238	8	0					
2. Nuaklong District								
2.1 Nuaklong	6,135	7	4			✓		
2.2 Klong Kamao	4,767	4	4	✓		✓	✓	
2.3 Talingchan	5,225	5	5	✓	✓	✓	✓	
2.4 Klong Kanhan	7,650	9	5	✓	✓	✓	✓	
2.5 Sri Boya	4,155	7	3	✓	✓	✓	✓	✓
Urban area								
1. Nuaklong municipality	5,732	1	1	✓	✓	✓	✓	
2. Krabi municipality	23,889	10	10		✓	✓		✓
Total	90,481	75	45					

Note: [1] Based on focus group meeting
Source: Krabi Provincial Office (2004)

Krabi River Estuary consists of the inter-tidal wetlands at the mouth of the Pak Nam Krabi and south-eastwards to the mouths of the Khlong Yuan, Khlong Taling Chan and south to the islands at the

mouths of the Khlong Pela. This zone is influenced by seasonal variations of freshwater entering the system from the river catchments during the wet season, September to October (Howe, 2003a).

The dominant mangrove species in the ramsar site are *Rhizophora apiculata* and *R. mucronata*, from at least 35 known species in the area. These include some of the species such as *Xylocarpus mekongensis (moluccensis)* and *Heritiera littoralis*. Nine species of sea grass are found in the area and the beds. They are dominated by *Halophila ovalis* and *Cymodocea serrulata*.

From a biodiversity perspective the area is important for birds. A total of 221 species have been recorded so far, including several threatened species. They are Chinese egret (*Egretta eulophotes*), Nordmann's greenshank (*Tringa guttifer*), Asian dowitcher (*Limnodromus semipalmatus*) and masked finfoot (*Heliopais personata*). The site is an important staging or wintering area for shorebirds within the East Asia-Australasian flyway, with single counts of over 2,000 birds, including more than 1% of the flyway population of Nordmann's greenshank and Mongolian plover (*Charadrius mongolicus*). The importance of the sub-tidal shelf and inter-tidal estuary as a spawning and nursery area for fish and shellfish is also recognized. The site is important for several species with high economic values (e.g., milkfish *Chanos chanos*, and barramundi *Lates calcarifer*).

Krabi River Estuary (KRE) represents a good example of an inter-tidal and sub-tidal tropical ecosystem dominated by mangrove forests and sea grass beds, the most critical areas for maintenance of the ecological linkages in the ramsar site (Howes, 2003a). Mixed mangrove forests on land ward fringe located around Khoa Khanab

Nam and in Khlogn Chilat are the critical habitats to maintain the fishery productivities and the biodiversity especially birds. Another critical ecosystem is sea grass beds, where the most critical areas is in the west of Ko Siboya. In terms of ecological linkages it maintains the fishery productivity especially dugong population and *Hoy Chuck Teen* (a type of mollusk) fishery. Both ecosystems play critical role in the maintenance of coastal water quality in terms of pollutants and sediments. These linkages relate significantly with the economy of people in the ramsar site.

The ecological zones of KRE ramsar site can be divided into four main zones as presented in Table 2. The sub-tidal inshore zone is the area that always covered by sea with less than 6 m. depth. The inter-tidal estuary zone, the most critical zone, is area with daily tides including sand-flats, mangroves and sea grasses. The upland zone is where the three major watersheds in Krabi is located with freshwater run-off. The last zone is where agriculture, plantations and urban areas is located. Understanding the functions and values of each zone is the key to understanding linkages and balancing the management needs of the ramsar site.

Table 2. Ecological functions and the contribution to economic values of each zone in KRE ramsar site

Zone	Ecological functions and significance	Economic function and values
Sub-tidal	Currents & sediment transportation	High fisheries productivity
	Sediment trap and toxin removal	Maintenance of high water quality
	> 200 species of marine/reef fish	Commercial in-shore fisheries
	20 species of marine mammals	Eco-tourism – Marine Park
	Critically endangered dugong	Eco-tourism – Marine Park
	2 Endangered Sea Turtles	Eco-tourism – Marine Park
	Coral reefs	High fish productivity, diving tourism
Inter-tidal estuary	Buffer zone between land and sea	Maintenance of freshwater-saltwater balance. Storm barrier – especially in monsoon.
	Trapping sediments & removing toxins (mangroves & seagrasses)	Maintenance of high water quality and high productivity
	Fish: 232 spp mangrove dependent	Local fisheries productivity

Table 2. (Continued)

Zone	Ecological functions and significance	Economic function and values
	Fish: 149 spp. seagrass dependent	Local fisheries productivity
	> 100 spp gastropod/mollusc	Local shell fishery – Hoi Chuck Teen
	Sandflats – Internationally Important for migratory shorebirds	Bird-based eco-tourism
	Seagrasses – Nationally important for dugong	Eco-tourism – Marine Park
	Mangroves – Nationally important for several birds	Bird-based eco-tourism
	Mangrove spawning ground for crabs, shellfish and fish	Maintenance of high fisheries productivity
Upland	Forested and non-forested water catchments	Forestry production, agricultural production and soil conservation
	Freshwater supply to mangroves and Krabi estuary	Maintenance of water balance and freshwater supply for coastal areas
Agriculture, plantations & urban	Low ecological values	High economic values for human development, cash crops and food production

Source: Howes (2003b)

Despite its protected status as the ramsar site, KRE is under enormous pressure. Continued decrease in area of mangrove forest has been caused by various activities including (Howes, 2003b and Upanoi, 2003):

1. Conversion to aquaculture ponds (since 1985, more than 9,375 ha have been converted)
2. Timber poaching / clear-felling of areas away from channels (since 1985 mangrove species composition has changed considerably)
3. "Land grabbing" / illegal land titles
4. Encroachment for infrastructure and tourism development (e.g., tourist chalets near Khao Knabnam and new passenger port development)
5. Development plans of Mangrove Management Units – boundary demarcation / ditch construction
6. Uncertainty over "community forestry" policy.

Increasing tourism development in terms of infrastructure development and support services have been focused in the provincial development strategy for world class eco-tourism development zone of Krabi province. If developed in an unsustained manner, this would have adverse impact to the mangrove ecosystem and other ecological linkages.

3. Methodological Framework

In this study, economic valuation and impact analysis are used as the main analytical tools. The usefulness of economic valuation with respect to conservation and management of natural resources has been well recognized and documented in many literatures. It also provides a compelling argument for the conservation of natural resources. At the same time, an analysis of economic impact can help to translate environmental impacts into monetary terms. This makes the comparisons between resource use and development more transparent.

3.1 Economic Valuation

In order to make better decisions regarding the use and management of wetland goods and services, their importance to the economy must be determined. The Millennium Ecosystem Assessment classifies the ecosystem services into four categories: provisioning services, regulating services, cultural services, and supporting services (Figure 2). These categories illustrate the ways in which wetland ecosystem contributes to human welfare and link with its economic value. As the ecosystem services are provided with free of charge, its significance is often overlooked (Pagiola *et al.*, 2004).

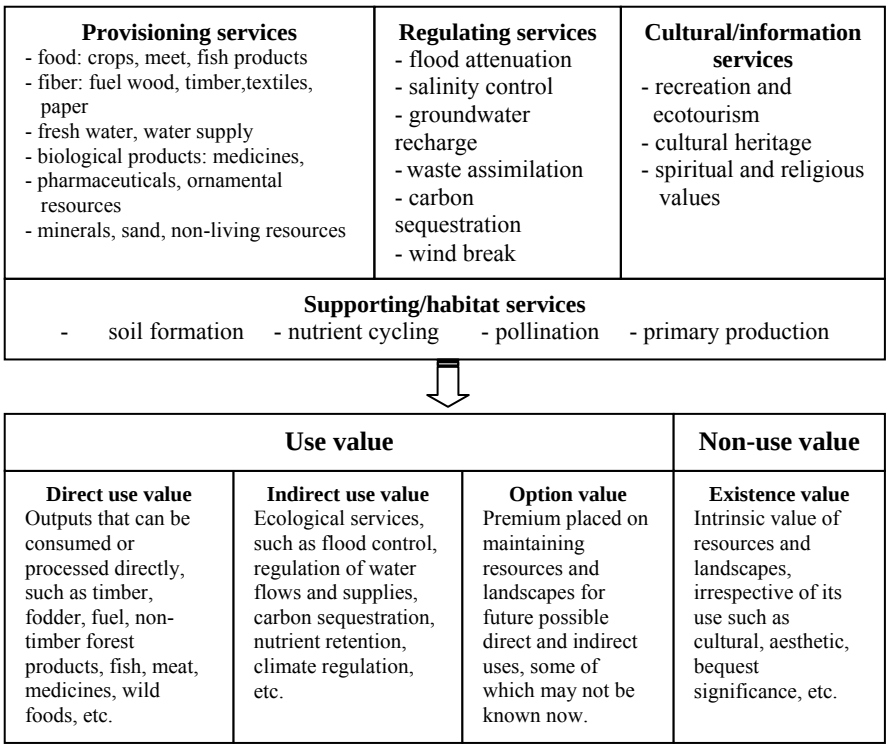

Figure 2. Four categories of ecosystem functions/services of wetland as distinguished by the Millennium Ecosystem Assessment linked to total economic value of wetland.
Source: Adapted from Bann (1998) and Pagiola *et al.* (2004).

3.2 Economic Impact Analysis

Economic decision for a choice between conservation and development of wetland areas is defined as a situation when net benefit from conservation is weighed against the net benefit from development. Being conserved as a ramsar site which provides benefits at the local, national, and international levels, its net benefit should be higher than the net benefit from development. To compare gains and losses of wetland conservation that occurs over different

time periods, the net benefit of competing options must be converted to the present values. Following Moran (2004), a decision to conserve rather than to develop (convert) wetland will be the right one if

(1) $$PV\,[B_{CON} - C_{CON}] > PV\,[B_{DEV} - C_{DEV}]$$

where

B_{CON} = the benefits of wetland conservation
C_{CON} = the costs of wetland conservation
B_{DEV} = the benefits of the development option
C_{DEV} = the cost of development option

and $$PV(x) = \sum_{t}^{T} x_t/(1+r)^t ;$$

where

x_t = the current value at time period t
t = time
r = rate of interest.

Wetlands that are registered as the ramsar sites indicate their significance to society both at the national and global levels. As many of the benefits accrued from wetland conservation are often not marketed, the return from wetland conversion may simply higher than the return from conservation. To account for all the benefits derived from a ramsar site conservation (B_{CON}), use value (UV_{CON}) and non-use value (NUV_{CON}), accruing both at the national (UV_{NAT} and NUV_{NAT}) and global (UV_{GLO} and NUV_{GLO}) levels that generates the total economic value (TEV_{CON}) of the site should be considered in the calculation. It is note that the benefits and costs of wetland conservation accrued to local people are included at the national level.

(2) $$TEV_{CON} = UV_{CON} + NUV_{CON}$$
$$= (UV_{NAT} + UV_{GLO}) + (NUV_{NAT} + NUV_{GLO})$$

Equation (2) indicates that both use value and non-use value of wetland conservation reside in the host nation and globally. From a national host country standpoint, ramsar site conservation is to be the preferred option if the national gains are greater than the costs and that those national gains will be larger still if the country can capture some of the global use and non-use values.

(3) $$PV[TEV_{CON} - C_{CON}] > PV[B_{DEV} - C_{DEV}]$$
or $$PV[TEV_{CON} - C_{CON}] - PV[B_{DEV} - C_{DEV}] > 0$$

In addition, from a national host country standpoint, equation (3) sets the requirement for ramsar site conservation that the benefits of conservation should exceed the direct costs of conservation and its opportunity costs, namely the forgone development benefits, $PV[B_{DEV} - C_{DEV}]$. It is also note that if the local people at the site do not get part of the national or global gains from conservation, then they have no incentives to act in accordance with equation (3). They will simply operate according to their own private gains and losses. This divergence between local, national, and international levels of benefit and cost distribution does much to explain the continuing degradation of ramsar site in any country.

In this study, the net benefits contributed to local economy from the current uses of KRE ramsar site are calculated. It is note that a current use of wetland may not be identified as a sustainable status. Applying the concept of TEV, the benefits of mangrove forests and mudflat are assessed, the use value of KRE to the local community is focused. The KRE ramsar site as a local economic resource is

evaluated. The direct use value at the household level can be explained as follows:

$$(4) \qquad DUV^T = \sum_i^n \sum_j^m [R_j - C_j]_i$$

where:

DUV^T = direct use value accrued to the total households in the ramsar site using resource in activity j, household i = 1,..., n.

R_j and C_j = return and cost of resource use by household i in activity j

Equation (4) is an economic analysis of each resource use activity in the ramsar. It is equivalent to the net benefit or gross margin calculation. This approach is to estimate the residual or netback value by deducting the costs of other input factors (x) from income derived from resource (s) to get the net benefit from using resource. Given NB is the net benefit from natural resource use (s) and other input factors (x) in an activity of community, for each activity 1, … to j, with beneficial household number 1, … to n. The direct use value of wetland in each activity can be calculated as follows.

$$(5) \qquad NB^T = \sum_i^n \sum_j^m [R_j(x,s) - C_j(x)]_i$$

Since direct use value involves type of activities and number of gainers in different places, this study collects field data to evaluate direct use value and converted it to present value by including other values and considering time horizon of benefits received by the society.

3.3 Scopes and Assumptions

In this study the economic value of wetland are assessed at the current situation of use ("business as usual" or base scenario) which may not be identified as the sustainable use. The analysis is scoped to the valuation of KRE ramsar site just to illustrate how significant of area to different local groups of beneficiaries. In the study, the total economic value of the most critical area of the ramsar site for maintaining the ecological linkages, the mangrove forests, is assessed.

In the impact analysis, the study compares the "business as usual" or base scenario with the "development scenario as the competing option. The present values of net benefits from the two options are compared, using the 15 year time horizon with the 7% interest rate. In the development scenario, the 5% declining rate of mangroves in the ramsar site is assumed. The study applied Ruitenbeek's framework which posits an approximate relationship between the mangrove ecosystem and other components. Based on the ecological linkages identified in Table 2, loss of mangrove forests leads to the declining in the productivity of inter-tidal sand flats, biodiversity of the ecosystem, fisheries productivity and coastal water quality which consequently impacts eco-tourism benefits.

In this study, the scientific information on the fish catch dependent on the specific zones of wetland are not available. Location for capture fishery can be simply divided, the river estuary where most of the mangroves are located and the near or off shore within or outside the ramsar. To identify the local use values of the ramsar site, the researchers separated two groups of fishermen based on fishing location by asking them to identify their fishing location in the map during the interview. In this way, two types of local use

value for fisheries could be roughly differentiated. Direct use value can be the benefits derived from fisheries operating on-site of the mangrove area. To capture the indirect use value of mangrove resource in the ramsar site in terms of their ecological support as breeding ground, the benefits of local fisheries derived near or off shore but outside the mangrove areas are estimated. However, it is not possible to know the proportion of these values allocated between the mangrove and sea grass systems.

Main methods for this valuation study are market price and benefit transfer. For the price-based valuation, direct market price method is applied to assess the value of ecological products which partly or informally traded. With the limited availability of data, the benefit transfer method is applied for an assessment of other types of indirect benefit and non-use benefit of the natural resources. The method is applied for the transfer and adjustment of values only with the selected ecological functions/services defined by ecological experts. The researchers realized that the information provided by the survey and related literatures were able to value only a portion of the full range of the wetland resources.

4. Data Collection

Participatory rapid appraisal and stakeholder survey were the main tools to collect the general information about the ramsar site. With the very limited availability of data at the local level, the focus group meetings were conducted at each selected village/community to gather general information including number of households and land use and to identify the significance of natural resource uses in the ramsar site. Tools such as resource use calendars and resource use maps were employed. Questions related to what, when, where, how, and how much regarding the resource utilization were performed

during the group meeting. These helped the researchers in identifying the direct resource users and the design for household survey. In the household survey, eight villages and two municipalities were selected and in-depth survey of the total 175 households who were different resource users in the area were conducted in 2003. The survey was necessary to provide the information needed to quantify the importance of the mangrove area for traditional uses. Secondary data on biophysical and socio-economic characteristics of the ramsar site were collected from official statistics, Krabi Provincial Office, Department of Fisheries, Tambol Administrative Organizations, and the MPW project office.

5. Results

5.1 Krabi River Estuary and Local Economy

Krabi River Estuary ramsar site provides many economic benefits to local people living inside and surrounding the estuarine areas. The site generates resources as natural products for direct consumption and provides ecological services that link directly with local economy. It also provides the current and future economic uses and services and has cultural and historical significance regardless of its uses. Location of main activities in the ramsar site can be observed as illustrated in Figure 3.

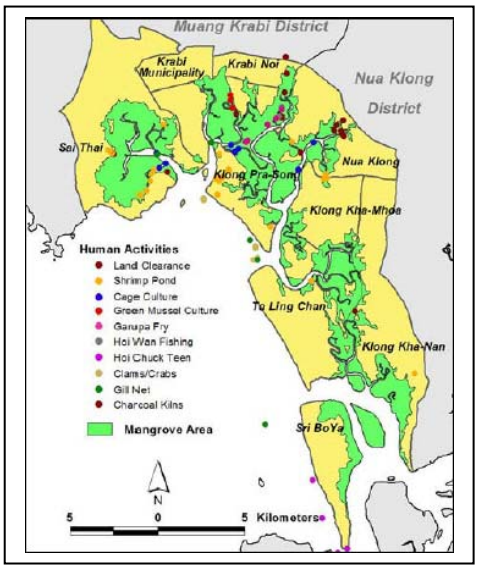

Figure 3. Location of mangrove forests and main economic activities in Krabi River Estuary ramsar site

Local use of natural products in the mangrove area

In the mangrove forests, a wide range of community utilization is allowed, except for cutting the standing trees. For the collection of wood and non-wood products from the mangroves, these products include fuelwood, wild foods, plant-based medicines, and materials for house construction and fishing poles. Most of them are used for subsistence (about 86%) and the rest are sold for income earning. Wood collection is from dead plants including *Avicennia, Mai boon, Mai koon, Mai Jark and Melaleuca.* The average distance to collect wood and non-wood products is about 2.5 km away from the residential area (ranging between 0-12 km). On average, the total

value of mangrove products utilized by each household is $223.4/year. The costs of resource collection from mangrove forests, which are mostly costs of family labor, is about $85.9 /household/year. When subtracting costs from benefits, the net benefit of mangroves derived from wood and non-wood products become $137.5 /household/year. With the approximated total households of 2,262 in the ramsar site who collect wood and non-timber products from the mangrove forests, the net benefits became $311,025.0 /year. With the total 10,212 ha of mangrove forests, the net benefit from collection of plant resources is estimated at $30.5/ha/year.

For the collection of fishery products in the mangrove forests, these activities are undertaken within the estuary area where the mangrove forests are located. Numerous aquatic animals collected from the mangrove forests and mud flats, e.g., blue swimming crab, giant mud crab, threadfin bream fish, giant seaperch, red snapper, grouper, grey mullet, banana prawn, banana shrimp, and giant tiger prawn. The average distance to the collection places is about 3 km (ranging between 3-10 km) from the residential area. With the assumed number of households who rely directly on the mangrove forests, the total benefits to them are estimated to be $1,555.7 /household/year. The household's costs of resource collection are $1,061.8 /household/year. Therefore, the net benefits from collection of fishery products inside the estuary are $493.9/household/year and $1,117,244.6/year for the total area. With the total area of 10,212 ha of mangrove forests, the net benefit becomes $109.4/ha/year.

In conclusion, the net benefits of Krabi estuary as a source of plant resources and aquatic animals from mangrove forests are at least equal to $1,428,270/year. This comprises 22% from plant resources and 78% from aquatic animals (Table 3).

Table 3. Summary of net benefits from resource collection in the mangrove area of KRE ramsar site

Item	Net benefit per year		
	US$/ha	US$/household	US$
Plant resources	30.5	137.5	311,025.0
Aquatic animals	109.5	493.9	1,117,244.6
Total net benefit	140	631.4	1,428,269.6

Small-scale fisheries

Small-scale fisheries are the main activity of local people living in the KRE ramsar site. These fishermen catch fish in the sub-tidal inshore zone. Although this zone is covered by the sea water less than 6 m depth, some part of the area is located outside the boundary of the ramsar site.In determining the value of the ramsar site derived from fisheries in the sub-tidal zone, the shallow waters beyond mangrove forest, only sampled fishermen who operate in this zone are included. A wide range of species have important commercial value, including mullet, snapper, grouper and crustaceans such as shrimp, are harvested including many types of mollusks (*Hoi Wan* and *Hoi Chakteen)*. There were 2,422 registered fishermen reported in the ramsar site (Krabi Provincial Office of Fishery, 2004). Results from household survey of fishermen found that the total value of fisheries received by a fisherman is $1,55.7 /year with the variable cost of $1,062.8/year and the gross margin at $493.9/year. Therefore, the net benefits of ramsar site from the small-scale fisheries becomes $1,196,271.6 /year

Recreation and ecotourism

Krabi province is very famous for both national and international tourists visitors. Data from Krabi Provincial Administration Organization (2003) show that the number of visitors of Krabi was about 1.458 million persons in the year 2003. The famous tourism places in Krabi province are Pi Pi and Lanta islands. However, they are located outside the boundary of the wetland (Krabi Provincial Administration Organization, 2003). It is estimated that about 30% or 437,400 visitors stay in the wetland area during the tourist season. Each visitor generates income or spends at least $280/trip ($282.8/person in 2001 and $288.9/person in 2002). The average number of days visitors stayed overnight in Krabi is 4.5 days. An estimate of expenditure for each visitor is $68.1/day. When considering the distribution of tourist expenditures to different service businesses in the wetland, it is assumed that the proportion of expenditure for accommodation, food, as well as inland and water transportation are allocated at 30, 20, 30 and 20 % respectively.

To calculate the recreation benefit distributed to hotels and resorts, the number of rooms available in the ramsar site were counted at 1,354 rooms. With the assumed occupancy rate of approximately 40% all year round, the net benefits to hotel and resorts are estimated at $2,204,444.7/year. In addition, net benefits accrued to food service and other services are estimated at $4,492,847.7/year and transportation (mostly serviced by local community) at $591,243.2 /year.

Krabi estuary is the famous place for bird watching. The recreational benefits to visitors in the wetlands occur in terms of eco-tourism in the mangrove forests and water-based activities. In addition, mangrove forests of KRE have a special characteristic of a green area

surrounding the town. When assuming a minimum willingness to pay by a tourism at 200 baht (Moran's report, 2004), the net benefit to the tourist visitors is estimated at $2,364,324.3/year and the total net benefits to the wetlands in terms of recreation are summed up to be $9,652,858.0 /year (Table 4).

Table 4. Recreation value from Krabi River Estuary obtained by various target groups

Item	Value in US$/year	Percentage
Tourists	2,364,324.3	24.49
Hotels and resorts	2,204,444.7	22.84
Food, souvenir and other shops	4,492,847.7	46.54
Car and boat businesses	591,243.2	6.13
Total	9,652,858.0	100.00

Aquaculture

Main types of aquaculture are available in the KRE ramsar site including shrimp farming, fish cage culture, and green mussel culture. Shrimp farming was used to be the prevailing activities during the late 1990's especially the black tiger shrimp and later white shrimp. Shrimp production activities had been declined as most of shrimp ponds have their productive life on average about five years and the activities were discouraged by local communities. Abandon shrimp ponds were observed in the area. Fish cage culture is located along the river mouth. During the time of survey, only few farmers have been produced green mussel and sold to the local market.

During the time of survey, there were 165 shrimp farms operating with the production area of 345.2 ha (Department of Fisheries, 2004). According to the survey, the average productivity of shrimp is 6.68 ton/ha/year with the total gross value of $34,160.5/ha and the

operating cost of $23,233.1/ha. Thus, the gross margin or net private benefit becomes $10,927.4/ha/year or $22,856.1 /farm/year. The contribution of shrimp production to the areas becomes $3,771,252.2/year

Regarding the fish cage culture, there were total 99 farmers registered to Krabi provincial office of Fisheries, with the total number of 767 fish cages (Department of Fisheries, 2004).

Grouper and giant seaperch were the most popular fish species for cage culture. Most of caged fishes are exported directly from farms to Hong Kong and Taiwan. Some farmers caught fingerlings from the wild and others bought from local fishermen. On average, a cage of $27m^3$ produces about 100 pieces of fish. The gross value obtained per farmer is $3,287.7/year with the operating cost of $1,856.4/year. The net benefit from cage culture becomes 1,431.3/farm/year or $184.7/cage/year. Hence, the net benefit from the use of the wetland resources in cage culture is estimated at $141,695.8 /year.

Table 5. Contribution of aquaculture in Krabi River Estuary to local economy

Aquaculture activity	Net benefit (gross margin)[1]
Shrimp pond culture	
US$/ha/year	10,927.4
US$/farm/year[2]	22,856.1
Total (US$)	3,771,252.2
Fish cage culture	
US$/cage/year	184.7
US$/farm/year	1,431.3
Total (US$)	141,695.8
Aquaculture activity	3,912948.0

Note: [1] The environmental costs are not calculated in the cost items.
[2] The value might be overestimated as taking the average per farm from the number of registered farms only.

Agriculture

Main agricultural activities at the inner part of the ramsar site are rubber and oil palm plantation, operating at the commercial level for local and national markets. Coconut plantation is available in some part of the area close to the coast, which mostly for home consumption and sold in local market. Fruit tree cultivation is mainly produced for home consumption and partly for local market. Most of them are produced outside the ramsar site.

From the land use and production data on agriculture obtained from Krabi provincial office of agriculture, it is estimated that the gross margin or net benefit for fruit tree cultivation are at least $15,684.86/year, $74,312.97/year for oil palm, and $270,270.27/year for rubber. Accordingly, the total net benefit from main agricultural activities in the ramsar site is approximately $360,448.10/year.

5.2 Economic Value of Mangrove Ecosystem

Mangroves play an essential role on many tropical coasts. They support a diverse heterotropic food chain, including fishes, crustaceans, birds, small mammals and numerous invertebrates. Mangroves also serve as a breeding ground and nursery habitat for marine life, which is an essential ecological support function for many costal and off-shore fisheries. A coastal fringe of mangrove offers substantial protection from storm waves and tides, including the control of coastal soil erosion and flooding (Sathirathai and Barbier, 2001; Howes, 2003a). Bann (1998) presented all the possible range of direct and indirect use values of mangroves that can contribute to the society.

In this section, valuation of mangrove goods and services are undertaken as basis for the evaluation of economic impacts of alternative uses. In assessing the total economic value of 2,112 ha of mangrove forests in KRE ramsar site, the estimates are as follows.

Direct use value

Three main economic benefits related to local beneficiaries presented in the previous section are associated with the direct use value of mangrove forests in KRE ramsar site. Results show that the net benefits of wood and non-wood products from the mangrove forest are valued at $30.5/ha/year. The natural products in terms of aquatic animals collected in the mangrove areas are valued at $97.9/ha/year. The tourism benefits to the KRE ramsar site are estimated at $9,652,858/year. Simply taking the per ha basis, for 21,299 ha of ramsar site, the tourism benefits to the site becomes$453.2/ha/year. With the mangrove areas of 10,212 ha, the direct use values from these components become $5.9 million/year (Table 6).

Indirect use value

Ecological services derived from KRE ramsar site contributes mainly from the inter-tidal zone especially the mangrove forest and sea grass bed. Those natural function services that create the indirect use value are: (1) off-shore fishery linkage, (2) shoreline protection and stabilization, (3) storm protection, (4) carbon sequestration, (5) water quality improvement, (6) carbon sequestration, and (7) saltwater intrusion prevention or maintenance of coastal freshwater table. From ecological aspects and physical location of the resources, all these indirect use benefits are crucial. As indicated above, most of the indirect values estimated here are based on other similar studies and are indicative only.

Mangrove forest and sea grass bed provide the habitat, nursery, and breeding ground for fishery resources. Of the estimated 2,422 small-scale fishermen who received income from fishery resources, the forest mangroves provide the net benefits for this function to be $117.14/ha or $1,196, 272/year.

The benefits of mangrove forests in terms of coastline protection and stabilization were estimated by Sathirathai and Babier (2001) in Ban Don Bay, southern Thailand, with the value of $76.5/ha/year. According to the physical and ecological attributes, mangrove forests at KRE ramsar site may have less function on shoreline protection and stabilization. Therefore, it is assumed that the net benefit of the mangrove forests at KRE ramsar site is about $38.25 /ha/year or 390,609/year in total.

The economic benefit of mangrove in term of storm protection is approximately only one portion of the mangroves in Koh Kong province which have been valued at $32/ha (Bann, 1997). It is assumed that this specific benefit of the mangrove forests at the site in terms of coastline protection and stabilization is valued at $16.0/ha or 163,392/year.

The study by IUCN (2003) and others show that the carbon sequestration benefits have been valued at $2.2/ha for the mangrove area including at Ream National Park, Cambodia. According to the project ecologist, the same value can be conveyed to the mangrove at Krabi estuary which is estimated to be $2.2/ha or $22,466/year for the total mangrove area.

The benefits of mangroves and sea grasses of KRE ramsar site in terms of trapping sediments and removing toxins from mainland to maintain the high water quality are stressed by Howes (2003a). In

Lal (1990), the value of water purification for mangroves in Fiji, using the construction of a sewage treatment plant as a proxy, was reported at $5,820/ha. As it is intended to interpret the lower bound value with conservative estimates, this specific value is not transferred to the mangroves in KRE ramsar site in this study.

The economic value for the function of mangroves in maintaining of coastal freshwater table or saltwater intrusion prevention is not estimated in this study. This is due to the limitation of data and knowledge on it.

Non-use value

A review by Ruitenbeek (1992) shows that mangrove system creates biodiversity benefit ranging between $0.1-61/ha. Bann (1999) estimates the existence value of Benut mangroves in Johor, Malaysia using contingent valuation approach. The study found that it is valued at $7,500/ha.

Under certain assumptions, the biodiversity benefits can range from zero to infinity (Moran, 2004). However, in Reitenbeek's study for Bintuni Bay, Irian Jaya (1992), the capturable biodiversity benefits of the mangrove system was calculated to be $2.4/ha ($1,500/km^2). Using this unit value and transferring to the mangroves in Krabi estuary, the non-use benefit is assumed to be the same and estimated to be $24,509/year for the total area.

In conclusion, with the total area of 10,212 ha in KRE ramsar site, the mangrove forests generate the total economic value at least equal to $7,74 million/year. The total use value obtained from the mangroves is equal to $7.71 million while the non-use value is at least $24,509 (Table 6).

Table 6. The total economic value of mangrove forests in Krabi River Estuary ramsar site

Items	Net value (US$/ha)	Net value in US$/year
Direct use value	**581.56**	**5,938,896**
Direct extraction of mangroves	30.46	311,025
Resource collection in mangroves	97.90	999,764
Tourist benefit from mangroves	453.20	4,628,107
Indirect use value	**173.59**	**1,772,739**
Fishery linkages	117.14	1,196,272
Shoreline protection and stabilization	38.25	390,609
Storm protection	16.00	163,392
Carbon sequestration	2.20	22,466
Non-use value	**2.40**	**24,509**
Total economic value	**757.55**	**7,736,144**

Note: US$ 1 equals approximately 37 Baht. One ha equals 6.25 rai.

5.3 Economic Impacts of Mangrove Conversion

Upanoi (2003) studies a change of mangrove forests in Krabi province and found that over 26 percent of mangrove area at Krabi estuary was converted to other land use types during the past 17 years (1985-2002). Severe destruction of mangrove coverage was found during 1985-1995. Approximately 25 percents of a total mangrove in 1995 were destroyed by aquaculture activity (Upanoi, 2003). Most of changes in mangrove area were found at terrestrial fringe. Based on the recent data of mangroves in Krabi province, 31,125 ha reported in 2000 has been declined to 29,375 ha in 2002, the average declining rate at 5.62%.

Impact analysis of mangrove forests in KRE ramsar can be used to support the decision making on wetland management. To facilitate this decision, the net benefits of current resource use are calculated to compare with the benefit gains from other alternative options. The

study employs the conservative estimates by assuming that the development will result in a reduction of mangrove forest at 5 % per year, started from the current status with the mangrove area of 10,212 ha in 2003. A discounted rate of 7% and time span of 15 years are used for the analysis of present value.

This impact study applied the ecological linkage developed by Ruitenbeek (1992) which posits an approximate relationship between the economic activities and mangrove forest area using the following equation.

$$\frac{\text{Productivity}_{t+n}}{\text{Productivity}_{t}} \Leftrightarrow \left[\frac{\text{Mangrove}_{t+n}}{\text{Mangrove}_{t}}\right]^{\alpha}$$

where α is the severity level of the impact which is valued between 0-1.

The activity in one component of mangrove partially affects productivity of some other system component (Ruitenbeek, 1992; Howes, 2004). In a very simple case, $\alpha = 1$ is comparable to clear cutting of mangrove forest. The immediate loss of forest products to the community and the loss in biodiversity may occur at the year after the forest is depleted (n=0). This is compatible to the strong ecological linkage with immediate impact. In the case of fisheries, most analyses suggest that the most serious consequences (for adjacent fisheries) of mangrove depletion would occur within five years (Ruitenbeek, 1992). Therefore, in this study, under the moderate impact, loss of local fisheries may occur within 5 year after mangrove cutting (n=5). In addition, after clear cutting of mangrove forests, the impact on tourism industry may occur in the 10^{th} year (n=10). This delayed response, may occur through the change in water quality and the loss in biodiversity as a result of mangrove cutting that may have an impact on recreation activities within 10 years.

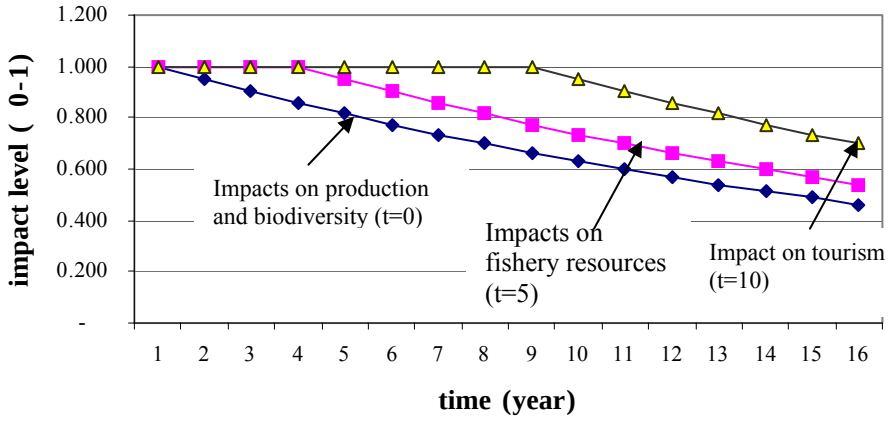

Figure 4. Impact of mangrove forest losses on various associated activities

Based on the above assumption on ecological linkages with economic activities, the study compared two scenarios. In the base scenario under the current situation, it is assumed that the total mangrove areas of KRE ramsar site remains at 10,212 ha over the study period. In the unsustained management scenario, mangrove forest is declined at 5% annual loss from clear cutting throughout the study period. Based on the total economic value of mangrove forest at $758/ha, the net present values of the two options are calculated and compared with 7% interest rate over 15 year period (Figure 5). It is found that under the "status quo", the present value of social benefit is estimated at $73.08 million, while the present value under the "unsustained management" scenario is estimated at $52.11 million (Table 7).

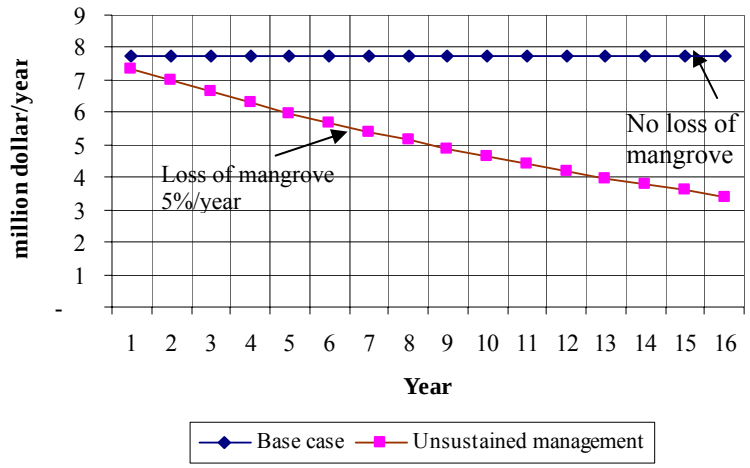

Figure 5. Comparison of values between the status quo situation of mangrove forest and the situation of reduction in mangrove forest

It is note that in the "status quo" scenario, conserving mangrove area to remain at a steady stage may not necessary mean the sustainable management status. With a 5% annual loss, there will be the welfare loss to the society by$20.97 million. The result indicates that to maintain the social benefit as if with the non-declining mangrove areas, any development project that may convert mangrove forest for other activities (at 5% annually) must generate income at least equivalent to $2.30 million/year. As such, the proposed project would be economically feasible (Table 7).

Table 7. Comparing the present value of mangrove forest conservation and alternative option

Item	Value
NPV Base case (US$)	73,080,632
NPV Unsustained management (US$)	52,113,771
Loss to society (US$)	**20,966,862**
Annual loss (US$/year)	**2,302,049**

6. Discussion and Conclusion

This study assesses the value of KRE ramsar site contributed to the local economy. Using part of the indicative results, the total economic value of mangrove forests, the key resource in the area, is assessed. The value of mangrove conservation is then evaluated against the alternative option that resulted in a 5% annually loss of mangroves. The results provide a simplified picture of how significance of the ramsar site to the local economy and of the mangrove forest, to the local, national, and international levels. Nevertheless, some points regarding the results can be discussed.

The economic benefits of KRE ramsar site for local economy could be higher than presented. The values of other direct uses in the upland and urban zones could have been estimated. If the relevant physical and economic data are available, goods and services from the upland zone such as the forest production and the maintenance of water balance and freshwater supply for coastal areas could be included. Using the area as a site of human settlement is also a significant item in the benefit estimation to local people.

The non-use value of KRE ramsar site is crucial in all aspects. The 45 million year shell cemetery in the ramsar site is culturally and historically important globally. It is also important to know the

allocation of value at the local, national, and international levels, if the total economic value of KRE ramsar site is evaluated.

In the valuation of mangrove ecosystem, the estimated benefits would have been higher if other use and non-use benefits had been estimated. For example, water is important resource in the mangrove area to local people for domestic purposes and public transportation. Mangroves also provide key functions in water quality improvement. The direct and indirect use values would have been increased significantly if these functions are valued. In addition, the figure on non-use value of mangrove ecosystem at $2.4/ha should have been much higher with the better improvement of biodiversity benefit estimation. Several economic studies have shown the 'existence value' of mangrove ecosystems constitutes a significant percentage of total economic value. As indicated above, this study takes the conservative estimates.

The total economic value of mangrove ecosystem at $758/ha is relatively low compared with other studies (see Sathirathai and Barbier, 2001 and the reviewed results in Bann, 1997). Availability and quality of secondary data may affect the results, in addition to the reasons indicated above. For example, an under valuation of local fisheries may be caused by the under reported number of fishermen as many of them are not registered. An overestimates may also occur for valuing the local fisheries, as many fish species are sea grass dependent.

The estimated benefits of shrimp farming activities in KRE ramsar site are relatively high (US$10,927/ha) compared with the result reported in Sathirathai and Barbier (2001). This is due to the fact that the average shrimp yields in two locations are different. In this study only private operating costs are considered which

overestimates the aquaculture values. Further, the benefits are expected to be much lower if negative environmental impacts are taken into account.

The remaining limitation in this research is based on the valuation methodology. Taking market based approach and benefit transfer may not reflect the true value of ramsar site and its ecosystem. The market prices may be distorted by market imperfection and government intervention especially the products that are traded internationally such as fish and shrimp. The benefits derived from natural function services received from wetland need the relevant physical data to estimate the function and relationship. As such, the market based and the value transfer techniques may be less preferable.

As mentioned in the methodological framework, it is necessary to consider the cost of mangrove resource conservation in the cost-benefit analysis when making decision about development projects. Sensitivity analysis on different interest rates and time horizons should also be undertaken to reflect the uncertain situation and provide greater inputs for decision making.

In conclusion, despite the methodological and data limitations, the results in this study shed light for local people to realize how significance of their local resources. As part of the MPW pilot project, the researchers were able to present their preliminary results to the community. Because of the renewable nature of mangrove resources and their abundance in the community, many villagers did not realize how significant of resources in monetary terms and their possibility of resource depletion in the near future if not managed in the sustainable manner.

Results of this study also lend support to the management planning process in KRE ramsar site under the MPW project. The valuation results can demonstrate how significant of the wetland ecosystem in economic terms. The results of the economic valuation pose some kinds of additional economic concerns and measures that would have to be incorporated into the socio-economic development plan. Considering the development of Krabi to be the global marine tourism center and economic gateway of Asia, the results of impact analysis has demonstrated and enabled policy makers to pose important questions about the rationality of resource use decision in planning process for sustainable management of ramsar site.

Acknowledgments

The author would like to thank Dr. Dominic Moran, the project's international economist, for his valuable inputs and guidance in the concepts and the development of methodology in this study. Mr. John Howes, the project's international ecologist, provided valuable information and comments regarding ecological aspect in the analysis. Comments on preliminary results were provided by many individuals, especially the villagers in the ramsar site and Mr. Barry Hall, the project's chief technical advisor. Funding of this work was provided by MPW project.

References

Bann, Camille (1997) **An Economic Analysis of Alternative Mangrove Management Strategies in Koh Kong Province, Cambodia**. EEPSEA Research Report, November 1997

_____ (1998). **The Economic Valuation of Mangroves: A Manual for Researchers**. EEPSEA Special Paper, International Development Research Centre, Ottawa, Canada.

_____ (1999). **A Contingent Valuation of the Mangroves of Benut, Johor State, Malaysia.** Johor State Forestry Department /DANCED/Darudec:

Preparation of an Integrated Management Plan for the Sustainable Use of the Johor Mangrove Forest, June, 1999

Howes, John (2003a) **Ecological Linkages in Krabi River Estuary – an Overview**, Presentation for the Multi-stakeholder Workshop, December 16th 2003, Krabi. MPW Ramsar Wetland Project, Thailand

_____ (2003b) **An Ecological Perspective on the Main Issues relating to Ramsar Site Management in Krabi Estuary and Bay** and some notes on their underlying causes.

_____ (2004). **Draft Final Report, Implementation of Ramsar Convention inThailand**. Management and Protection of Wetland Area Project, Thailand.

Krabi Provincial Office (2003) **Executive Summary Krabi Development Strategy 2003-2007** Prepared by Development Strategy Group, Governor Office, November 2003

Lal, Padma N. (1990) **Conservation or Conversion of Mangroves in Fiji**. Occasional Paper No. 11.
East-West Environment and Policy Institute: Honolulu.

Millennium Ecosystem Assessment (2003) **Ecosystems and Human Well-being: A Framework for Assessment**. Washington: Island Press.

Moran, Dominic (2004) **Economic Analysis Framework, Draft Report of Work In Progress (Visit 2)** MPW Ramsar Wetland Project.

Pagiola, Stefano, Konrad von Ritter, and Joshua Bishop (2004) **Assessing the Economic Value of Ecosystem**. The World Bank Environment Department, Environment Department Paper No.101. In collaboration with The Nature Conservancy and IUCN—The World Conservation Union October 2004

Ruitenbeek, Jack (1992) **Mangrove Management: An Economic Analysis of Management Options with a Focus on Bintuni Bay, Irian Jaya** (online). Available: http://www.island.net/~hjr/

Sathirathai, S and E. Barbier (2001) **Valuing mangrove conservation in southern Thailand, Contemporary Economic Policy**: pp 109-122

Upanoi, Tipamat (2003), **Development of A Mangrove Management Information System**, MSc thesis, Asian Institute of Technology.