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The World Conservation Union

Environmental and Socio Economic Value of Mangroves in Tsunami Affected Areas

Rapid Mangrove Valuation Study, Panama Village in South Eastern Coast of Sri Lanka

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Acknowledgement

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List of Acronyms

CCD	Coast Conservation Department
CZMP	Coastal Zone Management Plan
DS	Divisional Secretariat
DUV	Direct Use Values
GMSL	Green Movement of Sri Lanka
GN	Grama Niladhari
IUCN	The World Conservation Union
IUV	Indirect Use Values
kg	Kilogram
NGOs	Non Government Organizations
NPV	Net Present Value
NTFP	Non Timber Forest Products
NUV	Non Use Value
OV	Option Values
PEV	Participatory Environmental Valuation
Rs.	Sri Lankan Rupees
TEV	Total Economic Value
UNEP	United Nations Environmental Programme
US$	US Dollars
UV	Use Values
WTP	Willingness to Pay
Yr	Year

Executive Summary

The results achieved in the rapid valuation of Mangrove study conducted in Panama, shows the importance of mangroves to the mangrove-associated communities. The study clearly highlights that coastal communities are dependant on a range of mangrove products. Fish, shrimp and fuel wood are the main mangrove products providing cash income and subsistence requirements of the community in the location. Timber and poles, herbs and vegetables and fuel wood are important for their subsistence use. The economic value of mangrove was estimated at Rs. 119,438 (US$ 1,171) per household per year and Rs. 938,502 (US$ 9,201) per ha per year. The direct use benefit of mangrove products (Gross Value) per household is Rs. 9,953 per month, which is significantly high in comparison to mean household income per month in the Eastern province[1], (Rs. 7,640 per household per month).

Households of all income categories poor, medium and high-income groups are dependent on mangrove products, however, highest foregone benefits accrued to poor in conversion or degradation of mangroves. Total benefits to income groups poor, medium and high are 42 %, 37% and 21% respectively. Poor and middle-income categories depend mainly on fish, timber and wooden poles and vegetables obtained from the mangrove ecosystem. The high-income category depend more on high value shrimps and crabs.

Mangroves also perform a large number of regulatory ecological functions, which support economic activity. Nutrient retention, flood control, ground water recharge, microclimate stabilization and shoreline stabilization etc. are the important ecological functions of mangroves that are largely unrecognized. The study attempted to derive indirect use value in terms of mangrove fishery linkages and the value in terms of coastline protection based on the tsunami impacts on coastal ecosystems and the community. The study estimated that mangroves generate a value ranging from US$ 1,77.9 to US$ 4,74.3 per hectare of mangroves per year for fish breeding and value of US$ 392.5/ha/yr for coastline protection respectively for mangroves providing fish breeding habitats for coastal fish and providing protection from extreme weather.

[1] Household Income and Expenditure Survey 2002, Basic Information at District Level Department of Census and Statistics Sri Lanka. The estimates given in the bulletin are based on the survey conducted in the Eastern province during the six months September, 2002 to February 2003.

1. Introduction and Overview

1.1 The context

Mangroves are trees and shrubs of the genera *Rhizophora*, *Brugiera*, *Sonneratia* and *Avicennia* or communities dominated by these genera including biotic components. Mangroves are well known for their high biological productivity and their consequent importance to the nutrient budget of adjacent coastal waters. Mangroves possess a range of features, which make them adaptable to their stressful environment. Accumulation of organic matter provides beneficial impact on them and the fauna thrive in the mangrove ecosystem. Mangroves also provide many ecosystem services such as coastal protection from storm, reduction of shoreline and riverbank erosion, stabilizing sediments and absorption of pollutants etc. In addition, they provide ecosystem goods such as mangrove products and breeding ground for coastal fish.

As an Island nation, the density of Sri Lanka has always been closely tied to the sea and its coastline is a critical lifeline that anchors the county's social, economic and environmental development. The coastal zone accounts for 33% of the population of Sri Lanka possessing 24% of the total land area of which approximately about 10,000 ha is under mangrove forests. Majority of the coastal population depends on fishing and agriculture; thus directly or indirectly depending on the coastal ecosystems.

Coastal communities heavily depend on mangrove products directly as well as indirectly either for subsistence use or commercial purposes. Many mangrove ecosystem resources are harvested for subsistence purposes such as fuel wood, shellfish species and fish species, medicinal herbs, vegetables, poles and posts for fences, collection of timber, vines and production of handicrafts. Most people are engaged in commercial activities like fishing, shrimp farming, and collecting timber. In addition, mangroves also provide services such as protection of shoreline from coastal erosion and buffering of storm and extreme weather events, thereby indirectly sustaining a wide range of social and economic activities. However, the enormous contributions made by the mangrove ecosystems in terms of the indirect ecosystems functions and wider inter linkages to the coastal economy are still not properly understood.

In the Asian Tsunami of 26th December 2004, there are evidences of mangroves acting as a protective barrier. A survey along the Tsunami affected coast, identified that in 24 lagoons and estuaries along the south-west, south and south-east coasts the damage to the existing mangrove ecosystems were minimal (UNEP-WCMC, 2006). One important key feature that is to be taken into consideration is, mature mangroves are typically very resistant to water surge, and in many areas were apparently unaffected by the tsunami, but there are limits to this resilience and in some areas large mangrove trees were uprooted and were found inland, at a distance away from the beach. As identified in the studies, some of the front-line mangroves were badly damaged while deeper mangroves were left intact.

Major environmental issues related to the post-tsunami resettlements are haphazard clearing of natural coastal vegetation for reconstruction sites, haphazard disposal of tsunami related debris, selection of new resettlement sites closer to the ecologically sensitive areas, and clearance of mangroves for reconstruction activities etc.

1.2 The rationale of the study

The need for valuing mangroves arises in many respects apparently in the identification of numerous benefits to the coastal community. As a result of the human dominated maritime features, many mangrove ecosystems in Sri Lanka have been, and to a large extent still are, indiscriminately exploited for commercial, aquaculture, agricultural, residential, tourism, mining and industrial development, at an increasing pace, as dumping grounds for domestic, agricultural and industrial waste. Recent development activities including the development of the tourism sector and the population pressure have created unbearable threat to mangrove systems in Sri Lanka in recent past. The reason is the under valuation of role of mangroves consistently in decisions to use coastal mangrove ecosystems. Mangrove resources harvested for subsistence purposes (fruits, medicine, fish, and vegetables) and ecological functions are good examples for undervalued mangrove products.

The economic decisions are taken based only on their direct goods and services of mangroves (e.g. forestry resources), but this represents only a minor part of the total value of mangroves. One reason for accounting for only the benefits of productive uses are the easiness to illustrate as the output is marketed. By comparison, the economic value of many mangrove components escapes traditional economic analysis because they do not have a market priceas they are not bought and sold in the market place.

In keeping mind the above aspects, this study attempted to generate information to realize the value of mangrove in monetary terms in the context of post tsunami situation. A rapid mangrove valuation study was conducted in the southeastern coast of Sri Lanka.

1.3 Aim and objectives

The study aims to explore the role of mangrove ecosystem in providing livelihoods, ecosystem services and the protective role against extreme weather events based on the experience of tsunami. The objective is to “document and share policy and technical information and lessons learned in order to promote the integration of mangrove conservation and restoration into post-tsunami reconstruction and coastal management processes”.

The rapid assessment of the environmental and socio-economic values of mangrove ecosystems conducted in associated with buffer zone communities of Kumana National Park led to documentation of the environmental and socio-economic values of mangrove ecosystems. An attempt was made to compare market value study with the expressed values of the community on their own perceptions and priorities.

Overall questions that the economic assessment addressed include:

a. What are the direct values of different mangrove goods (e.g. fuel wood, shrimp and fish)?
b. What are the indirect values of different mangrove ecosystem services (e.g. coastal protection and breeding grounds for fish)?
c. How, overall, are the economic and financial benefits of different mangrove goods and services distributed between different beneficiaries (e.g. poor and rich local communities, regional/ province economy, National economy etc)?
d. What would be the economic and livelihood impact over time of continued mangrove loss?
e. What is the economic rationale for mangrove rehabilitation and management?

1.4 Report structure

The report consists of seven sections. Section one describes the context and rationale of the project. The section two outlines the mangrove ecosystems in Sri Lanka in terms of ecological, economical and livelihood aspects. The section three describes the studies to reveal the value of mangroves in Sri Lanka. Methodology and key principles adopted for this study is described in section four, beside that, the concept of Total Economic Value (TEV), data collection methods such as focus group discussions, personal interviews and Participatory Environmental Valuation (PEV) are illustrated in the section four. Section five covers the description on the study site. The section six elaborates the results of the mangrove valuation study in terms of direct and indirect values of the mangrove eco system. The final section proceeds to the conclusion followed by the results and discussion and the recommendations, based on the study findings.

2. Background to the Study

2.1 Mangrove ecosystems in Sri Lanka

The coastline of Sri Lanka is 1,620 km in length, inclusive of bays and inlets, but excluding lagoons. The coastal region comprises of 74 Divisional Secretariats. Of the entire land area 65,510 sq km, the coastal region counts 24% accounting for 33% of the population, 70% of the tourist hotels, 67% of industrial units, 17% of agricultural lands and 20% of home gardens. The coastal regions contribute 80% of the total annual fish production. It is also home to a large number of high priority archaeological, historical, religious, cultural, scenic and recreational sites. The coastal region consists of economically valuable sites for coastal and marine fishery and additionally supports habitats that are vital for ecological functions and maintaining biodiversity (CCD, 2006). Estuaries and lagoons, wetlands, mangroves, salt marshes, sand dunes, beaches, marsh and sea grass beds, mudflats, coral reefs and other water bodies, which make up the coastal environment.

Table 1. Extents of the components of coastal region in Sri Lanka

Habitat	Extent
Estuaries and Lagoons	158 ,017 ha
Mangroves	12 ,500 ha
Salt Marshes	23 ,819 ha
Sand Dunes	7 ,606 ha
Beaches	11 ,788 ha
Marsh	9 ,754 ha
Other Water Bodies	18 ,839 ha
Coral Reef	68, 000 ha

Source: GMSL (Green Movement of Sri Lanka), 2005.

Sri Lanka has approximately about 10,000 hectares of mangroves. Patches of mangroves are discontinuously distributed along the coastline in Sri Lanka. Among many, the most extensive mangrove areas are in Puttalam district, with over 2,000 hectares and similarly Batticaloa and Trincomalee districts also have extensive mangrove stretches, each with over 1,000 hectares. Ten mangrove habitats can be found to the south of Colombo (Kaluwamodara, Ollewa, Meegama, Ittapana, Galatara, Hikkaduwa, Madu Ganga, Magalla, Rekawa and Kahandamodara) and ten North-West of Colombo (Wanathavillu, Seguvntivu, Etthala, Kalpitiya, Mundalama, Merawala, Pambala, Talawila and Munnakara). These mangrove areas are under the purview of the Forest Department as identified in their management plans.

Mangrove ecosystems play an important role in coastal economies and livelihoods of the coastal community. In terms of economic benefits, mangroves leading to the upliftment of livelihood of the surrounding coastal community can be summarized as follows. Many mangrove resources are harvested for subsistence purposes that can be detailed as fuel wood, aquatic products for food; shellfish species and fish species, medicinal herbs, vegetables, poles for fences and posts. Most people are engaged in commercial activities like fishing, shrimp farming, collecting timber, vines for handicrafts, production of masks and small ornaments using 'kaduru' wood. People in the west coast of Sri Lanka use twigs and branches of *Rhizophora mucronata*, *R. apiculata* and *Lumnitzera racemosa* to form ‘brush piles’ or ‘brush parks’ in a specially devised fishing method (AIMS 2005). Additionally some mangrove tree bark is use to produce tannin in curing fishnets.

The ecological functions of mangroves are vital to safeguard the coastal livelihoods. Mangroves prevent or reduce erosion of coastlines, and act as source of sediment and nutrient retention. Mangroves provide important habitats for the life cycle of important plants and animal species. Some species may depend on the mangrove area for part of their life cycle. For an instance many aquatic animals like fish and prawn depend on mangrove areas for spawning and development. Ground water discharge and recharge are other most important ecological functions. Mangroves also sequester carbon, and provide storm protection and shoreline stabilization functions. Flood and flow control; the process by which excess amounts of water enter a mangrove and are stored is helpful in reducing the sudden impact of floods.

2.2 Regulation of coastal zone activities of Sri Lanka

"Coastal zone" is part of the coast that falls within the jurisdiction of the Coast Conservation Department. It has been defined under section 42 of the Coast Conservation Act No. 57 of 1981 as amended by CCD Act no. 64 of 1988. According to the definition, the Coastal Zone is the area lying within a limit of three hundred meters landwards mean high water line and a limit of two kilometres seawards of the mean low water line. One of the main functions of Coast Conservation Act is to regulate and control development activities in the coastal zone. The Coast Conservation Department has taken many legal actions and plans aiming at integrated management to conserve, develop and sustainable use of the coastal resources. Under the regulations, any activity that is likely to alter the physical nature of the coastal zone includes the construction of buildings and works, deposit of waste or other material from outfalls, vessels and by other means, the removal of sand sea shells, natural vegetation, sea grass and other substances, dredging and filling, land reclamation and mining.

Despite development of regulations, the coast is constantly affected due to human induced actions. The problems in the coastal zone are coastal pollution, cluttered construction of dwellings (population pressure), unsustainable fishery, beach based tourism, river sand mining and mining of beach sand and sea corals leading to coastal erosion. The human interventions in the coastal zone have created pressures on mangroves. One of the reasons for destruction of mangroves is the poor tenurial arrangement in coastal environments, as it has paved the way to conversion of mangroves by the private sector mostly various other users such as construction of prawn ponds.

The Sri Lanka Coastal Zone Management Plan (CZMP) was prepared in 1990, and revised in 1997 and 2004. CZMP-2004 approved in July 2005 provides broad policy direction for the next five years. The policy emphasises the need for adoption of an integrated approach for law enforcement, implementation of planned activities and also emphasizes the need for complying with other policies such as Caring for the Environment, Biodiversity Conservation Action Plan and other planning activities. The aim, of the coastal zone management policy is to identify coastal problems, assess the status of problems and needed interventions, present the management programme for coastal zone, identify the role of other stakeholders and identify research requirements for the management of coastal zone.

2.3 Tsunami impacts on coastal zone

The tsunami that struck Sri Lanka on the 26th of December 2004 had varying degrees of impacts to the coastline of the island. It resulted in more than 35,000 human deaths, and destroyed more than 100,000 houses, and large-scale damage to coastal infrastructure. Overall, the tsunami affected two-thirds of the coastline of Sri Lanka, over 1,000 km in total. With the catastrophe of tsunami, eastern,

northeastern and south-eastern coast of Sri Lanka was particularly hard hit. The livelihoods of the coastal communities were severely affected. About 27,000 victims were fishermen, and two-thirds of the nation's fishing boats were wrecked. Similarly tsunami formed large impact on the front line mangrove stripes.

3. Literature Review

Among large number of studies on mangroves, a few studies have been undertaken to identify the economic value of mangrove ecosystems in Sri Lanka. The literature on valuing mangroves is summarized below. The first paragraph describes international experience while the rest is from Sri Lankan experience.

Sathirathai undertook a case study (2000) in Surat Thani, South of Thailand, a location consisting of 1,120 ha of mangroves, and has calculated the benefits of mangroves to the villagers using the Total Economic Value methodlogy. He has estimated the direct use value of the mangrove generated to the locals at a mean annual value of US$ 1,422.48 per household. In calculating the direct use value, market prices are used to value mangrove products sold in the market. Surrogate prices are used for the products used for subsistence purposes. The indirect value is calculated using the offshore fishery linkages and values for coastline protection and stabilization. In estimating the indirect value generated by off-shore fisheries, the Ellis-Fisher-Freeman model was applied in considering two scenarios; open access scenario and managed off-shore fisheries. Annual net returns from off-shore fisheries generated a value of US$ 3.45 and US$ 5.54 per ha of mangrove for open access and managed off-shore fisheries respectively. The replacement cost method was adopted to assess the net benefits of the mangrove for coastline stabilization. The replacement cost to protect the shoreline when there is destruction of a strip of one ha of mangrove with a 75 meter-width along the coastline is approximately US$ 4,778.66. The annualized value is US$ 239 per ha. Finally the study concludes with the economic value of mangrove being estimated to be in the range of US$ 82.09 to 105.37 per ha. Based on the value estimates, foregone benefits of mangroves compared to the net returns from converting the areas into shrimp farms have also been calculated.

B. M. S. Batagoda in 2003 has undertaken an economic valuation study for mangrove forest sites of Kiralakele, Maduganga and Ranweli village in order to estimate total economic values of mangroves. The valuation studies were focused on quantifying the benefits of non-wood forest resources, local recreation, global recreation, global option, local option, global bequest, local bequest, global existence, local existence, provision of breeding ground for fish, erosion control, biodiversity maintenance, carbon sequestration, storm protection and pollution treatment. In addition to total economic valuation results, financial cost benefit analyses, economic cost benefit analyses and environmental cost benefit analyses have been undertaken to evaluate whether the conversion of mangroves in three sites into shrimp farms is desirable in financial, economic and environmental points of view. The study has estimated the Net Present Value (NPV) of benefits to be generated through the conservation of the mangroves in the concerned sites. The major findings of the study are illustrated in the Table 2.

The results revealed that converting a mangrove into a shrimp farm is profitable in financial and economic stand point when considering as single measure while it is not beneficial according to environmental cost benefit analyses results.

Table 2. Major findings of three mangrove study sites

	Kiralakele	Maduganga	Ranweli village	General value
The NPV of benefits	US$ 223,760/ha	US$ 259,896/ha	US$ 255,230/ha	
Values for converting a hectare to a shrimp farm				
Economic cost benefits analysis	1.6	1.42	1.45	
Environmental B/C ratios	0.74	0.71	0.71	
Financial cost benefits analysis, the NPV of costs				1.74
Total economic value of the NTFRs	US$ 86.96 to 93/ ha/year			
The recreation valuation study		US$ 933/ha/year		
The global recreation benefits			US$ 1,196/ha/year	
The total economic value (TEV) of preservation of a mangrove forest				US$ 12,229/ha/year

The occasional paper on an Assessment of the economic value of Muthurajawela wetland by Emerton, L., and Kekulandala (2003) concludes the total economic value in Muthurajawela wetland in Sri Lanka per se at US$ 7,567,604 per year. The summary Table 3 shows the values of the economic components.

Table 3. Economic value of the Muthurajawela wetland, Sri Lanka

Economic Benefit	Economic Value Rs / year	Economic Value US$ / year
Flood attenuation	485,510,000	5,057,396
Industrial wastewater treatment	162,310,000	1,690,729
Agricultural production	30,290,000	315,521
Support to downstream fisheries	20,000,000	208,333
Firewood	7,960,000	82,917
Fishing	6,260,000	65,208
Leisure and recreation	5,280,000	55,000
Domestic sewage treatment	4,320,000	45,000
Freshwater supplies for local populations	3,780,000	39,375
Carbon sequestration	780,000	8,125
Total Economic Value	726,490,000	7,567,604

Source: Emerton, L., and Kekulandala, L.D.C.B. (2003).

IUCN (2003) had undertaken a study in the Kala Oya estuary to identify different economic benefits of mangrove ecosystems and thereby calculating the economic value. Considering all possible direct benefits, the direct use value of mangrove habitat was calculated at Rs. 859,792/year or US$ 8,956/ha/year. According to estimates of indirect values; mangroves functioning as breeding grounds for fish attributed an indirect benefit of 625,481 kg of Dermasal fish and 43,412 kg of Shell fish. This

study estimated Rs. 552,960/year as the mitigation cost for pollution attributable to Kala Oya mangroves. Having the ability to absorb water's energy mangroves prevents erosion. Accordingly it was estimated that approximately 0.01 Rs. million has to be spent to protect 1 m of shoreline. It was also identified that the particular mangrove habitats help to stabilize 1-4 km stretch along the Kala Oya estuary towards inland. As mangroves having higher potential for sequestration of carbon is estimated at Rs. 11.27 million. In terms of flood water control the value of damage avoided for agriculture was estimated at Rs. 813,930. Mangrove habitats prevent saline water intrusion into inland water ways thus the replacement cost avoided was calculated at Rs. 193,450. The study estimated the total economic benefit of mangroves in Kala Oya Delta, at Rs. 427 million/year.

A study carried out in the Kala Oya basin by Mahaweli Authority of Sri Lanka had calculated the value ofmangrove ecosystem in Kala Oya at Rs. 215,434,350. The valuation study had incorporated mangrove ecosystem functions such as coastal protection, waste treatment, biological control and non consumptive activities such as recreation.

M. Gunawardena and J. S. Rowan (2005) conducted an economic assessment for proposed shrimp culture development for the Rekawa Lagoon system in the South of Sri Lanka. The study had undertaken cost-benefit analysis taking both external and internal costs and benefits for the proposed shrimp project. The study had also calculated the total economic value of mangrove system. The internal benefit cost analysis derived benefit cost ratio at 1.5:1. This implies that the internal benefits of developing the shrimp farm are higher than the internal costs involved. Conversely, extended benefit cost analysis taking environmental costs and benefits into account estimated the benefit cost ratio ranging between 1:6 and 1:11. This implies that the external benefits are lower than the external costs if the environmental impacts are incorporated in the analysis.

Table 4: Summary of mangrove valuation studies

	Study 1	**Study 2**	**Study 3**	**Study 4**
Direct Values Total mangrove value/ hectare/ year	US$ 92 (Total flow value) US$ 4535(Total Stock value)	US$ 8,956		US$ 9,201
Total mangrove value/ household/ year	US$ 108.21	-	US$ 1,422.48	US$ 1,171
Indirect values				
Shore line protection/hectare/year	US$ 3.6	US$ 440	US$ 239	US$ 392.5
Fish breeding function/ hectare/year	US$ 218	US$ 640	US$ 9	US$1,77.9 to US$ 4,74.3

Note:

Study 1: Batagoda, B. M. S. (2003). The economic valuation of alternative uses of mangrove forests in Sri Lanka. A report submitted to UNEP-GPA coordination office in Netherlands

Study 2: IUCN (2003). Regional technical assistance for coastal and marine resources management and poverty reduction in South Asia (ADB RETA 5974). An economic evaluation of mangrove ecosystem and different fishing techniques in the Vanthavilluwa Divisional Secretariat in Puttalam district of Sri Lanka

Study 3: Sathirathai, S., (2000). Economic Valuation of Mangroves and the Role of Local Communities in the Conservation of Natural Resources: Case Study of Surat Thani, South of Thailand. International Development Research Centre, Ottawa, Canada.

Study 4: Environmental and Socio Economic Value of Mangroves in Tsunami Affected Areas

4. Key Principles and Methodology

4.1 The conceptual framework for economic valuation

The total economic value (TEV) approach is probably the most commonly used methodology in economics to measure the economic value of the environment and natural resources (R. Rosales, 2005). Conceptually, the total economic value (TEV) of a resource consists of its use value (UV) and non-use value (NUV). Use values are further classified into direct use values (DUV), the indirect use values (IUV) and the option values (OV).

Direct use values refer to values derived from actual use of the good either for direct consumption or production of other commodities. Market prices are used for valuing goods that are traded. Value of the goods or services that are not traded without market prices are more difficult to estimate. In the case of mangroves, direct use values would include the value of fuel wood, timber, wild vegetables, herbs, shellfish species and fish species directly being collected from mangroves.

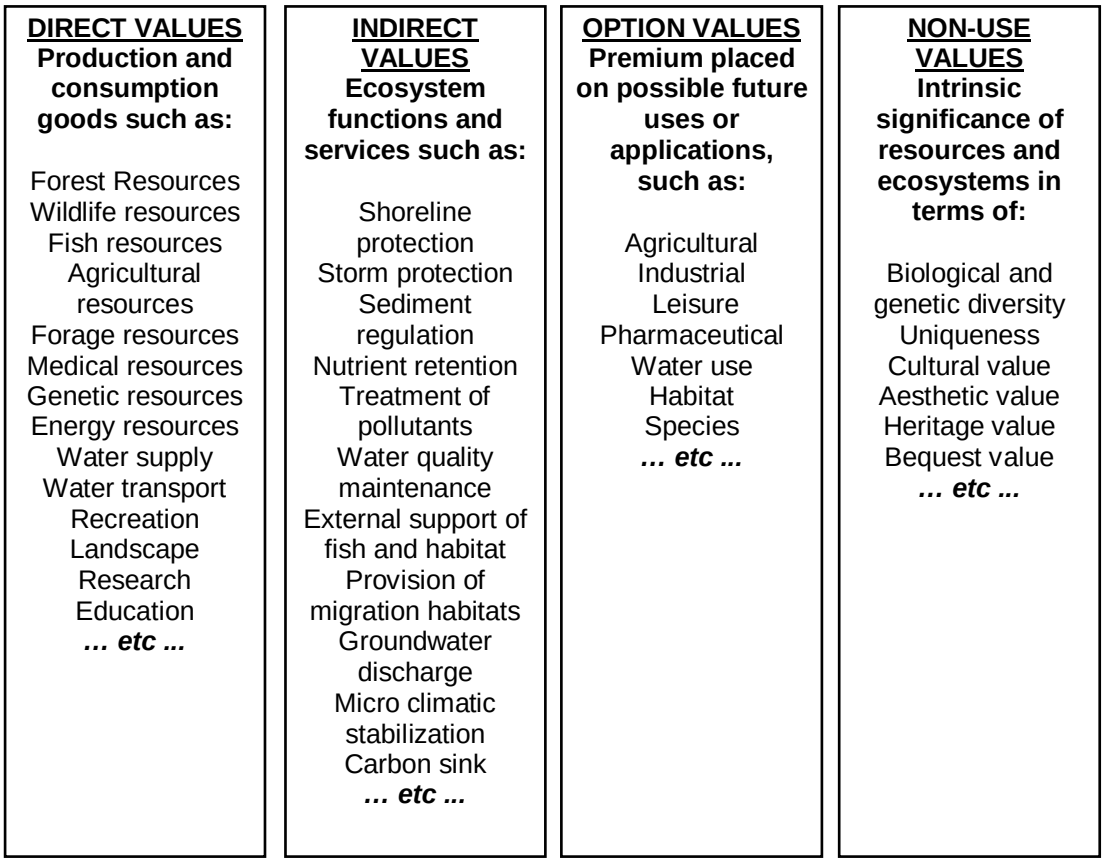
Indirect use values are benefits derived from ecosystem functions, such as the mangrove's functions for shoreline protection, breeding ground for fish and shellfish species, carbon sequestration, habitat for birds and other wild animals and biodiversity conservation. These are values derived from resources and services that are not consumed.

Option values are those that approximate an individual's willingness to pay (WTP) in order to ensure that the goods can be accessed at a later date. OVs are some sort of insurance values, in which people assign values to risk aversion in the face of uncertainty. Mangroves provide potential insurance for future natural disasters like sea level rise and other natural threats associated with climate change. Forests provide an option for potential discoveries of microorganisms or genetic resources that may prove beneficial in the future.

Economic valuation of environmental resources such as mangroves should be done on neoclassical economic welfare analysis (Grigulas & Congar 1995; Gregerson 1995; Dixon et al 1997; Bann 1997). The concept of 'economic value' is defined in the standard economic theory as the measurement of changes in personal well-being. The theory has been further extended to measure changes in the prices and quantities of marketed goods as well as public and other non-market goods and services. A key concept used in this analysis is the economic surplus, which consists of consumer's surplus and producer's surplus. Consumer surplus is the difference between the maximum amount that a consumer would pay and the amount that they actually pay, and producer's surplus refers to the difference between the revenues received and the cost of production for specific goods.

The Total Economic Value framework is the monetary measure of the incremental change in an individual's well being due to an incremental change in environmental quality. It is not environmental quality that is being measured, but people's preferences for changes in that quality. Economic valuation of environment is anthropocentric and it tries to assess the preferences held by people, and the value determines by an exchange or transactions in the market. The TEV of the mangrove ecosystems is the sum of direct use value, indirect use value, option value and non-use value (bequest value and existence value). The Total Economic Valuation (TEV) framework below highlights the full range of economic goods and services that mangroves provide.

Figure 1. Total economic value of mangrove ecosystem



source: Emerton, L., and Kekulandala, L.D.C.B. (2003).

4.2 Environmental valuation techniques

Economic valuation offers a way to compare the diverse benefits and costs associated with ecosystems by attempting to measure them and expressing them in a common denominator typically a monetary unit. All benefits and costs are valued in terms of their effects on humanity. Economic valuation methodology involves the monetary measures of a change in individual's wellbeing due to a change in environmental quality. Most economic valuation methods (Table 5) can be adapted to better reflect local values of mangroves, although different techniques have varying degrees of potential. Many techniques are survey based, which means that a local assessment step can be quite easily added to the process. Local values can be assessed by focusing on resources of value to livelihoods assessing non-market as well as market values, and involving communities in survey design and analysis. The economic valuation techniques commonly used are given in the box 1.

Box 1: The economic valuation techniques

- **Replacement costs:** Even where mangrove goods and services have no market themselves, they often have alternatives or substitutes that can be bought and sold. These replacement costs can be used as a proxy for mangrove resource and ecosystem values, although usually represent only partial estimates, or under-estimates.
- **Effects on production:** Other economic processes often rely on mangrove resources as inputs, or on the essential life support provided by wetland services. Where they have a market, it is possible to look at the contribution of mangrove goods and services to the output or income of these wider production and consumption opportunities in order to assess their value.
- **Damage costs avoided:** The reduction or loss of mangrove goods and services frequently incurs costs in terms of damage to, or reduction of, other economic activities. These damage costs avoided can be taken to represent the economic losses foregone by conserving mangroves.
- **Mitigative or avertive expenditures:** It is almost always necessary to take action to mitigate or avert the negative effects of the loss of mangrove goods and services, so as to avoid economic damage. These mitigative or avertive costs can be used as indicators of the value of conserving mangroves in terms of expenditures avoided.
- **Hedonic pricing:** Hedonic methods look at the differentials in property prices and wages between locations, and isolate the proportion of this difference that can be ascribed to the existence or quality of mangrove goods and services.
- **Travel costs:** Mangrove forests typically hold a high value as a recreational resource or destination. Although in many cases no charge is made to view or enjoy natural ecosystems and species, people still spend time and money to reach mangrove forests. This spending such as on transport, food, equipment, accommodation, time, etc. — can be calculated, and a demand function constructed relating visitation rates to expenditures made. These travel costs reflect the value that people place on leisure, recreational or tourism aspects of mangrove forests.
- **Contingent valuation:** Even where wetland goods and services have no market price, and no close replacements or substitutes, they frequently have a high value to people. Contingent valuation techniques infer the value that people place on wetland goods and services by asking them their willingness to pay for them (or willingness to accept compensation for their loss) under the hypothetical scenario that they would be available for purchase

Source: Emerton, L., and Kekulandala, L.D.C.B. (2003)

Table 5. Valuation techniques commonly used to value the different value components of mangrove resources

TEV	Valuation Technique
Direct Use Value	Market analysis
Timber	Market analysis, price of substitutes, indirect
NTFPs (e.g., fish, nipa, medicine, traditional hunting and gathering)	substitution approach, indirect opportunity cost approach, value of changes in productivity, barter exchange approach
Educational, recreational and cultural uses	Travel cost method, hedonic prices
Human habitat	Hedonic prices, [replacement cost]

TEV	Valuation Technique
Indirect Use Value Erosion prevention (shoreline) Erosion prevention (riverbanks) Storage and recycling of human waste and pollutants Maintenance of biodiversity Provision of migration habitat Provision of nursery grounds Provision of breeding grounds Nutrient supply Nutrient regeneration Coral reef maintenance and protection	Damage costs avoided Preventive expenditure Value of changes in production [relocation costs] [replacement costs]
Option Value	Contingent valuation method
Existence Value	Contingent valuation method

Source: EEPSEA manual

Direct use surveys can identify a wealth of information about local values as well as data for economic analysis. However, intangible components such as cultural or spiritual values, which can be as or more significant for local people, are difficult to quantify in economic terms, though not impossible. Approximate values can be assigned using survey based methods such as contingent valuation or ranking to elicit willingness to pay.

Participatory approaches offer an alternative approach to derive the values accorded by the communities. While economic assessment may be needed for policy decisions and for communities to defend their rights, participatory approaches are best suited for deriving local values and knowledge, including multiple perspectives and local complexities needed to fully understand resource use. They can generate vital information on seasonal variation and social differentiation in resource use, and qualitative information on the importance of indirect and non-use values (e.g. environmental functions and cultural values). Participatory approaches often yield information that is relative rather than absolute measurement. It combines PRA techniques etc. with more conventional economic valuation methods (contingent valuation and contingent ranking). However, criteria of rigor can be applied to show that technically the information is just as good as any other method.

The study mainly used the market price method to calculate the value of mangroves. Participatory valuation method was also used along with the market study to reveal value of certain mangrove products to the local community.

Categories of valuation techniques comprise of price based, related goods approach, indirect approaches, surrogate markets approach, direct approaches and cost based methods.

Market price method

In this study the price-based approach was considered in estimation of direct use values of mangroves. It uses the market price of mangrove goods and services.

The market price method estimates the economic value of ecosystem products or services that are bought and sold in markets. This method can be used to value changes in either the quantity or quality of a good or service. It uses standard economic techniques for measuring the economic benefits from marketed goods, based on the quantity people purchase at different prices, and the quantity supplied at different prices.

Concerns of the market price method

This method is used if primary resource or ecosystem affected has a commercial market and prices, and quantities and cost are easy to obtain. The method uses standard, accepted economic techniques and is relatively easy to apply. The method uses observed data of actual preferences and Seasonal variations and other effects on price have to be considered in estimating the values.

Usually the costs of transport to bring goods to the markets is not included and benefits may be overstated

The steps followed in the study are as follows.

The mangrove products collected form the mangrove ecosystem by the households and the related market prices were collected. Then the actual market values of each good was determined by multiplying the price by the quantity, there by generating the gross benefits. The seasonal variation was captured by gathering data on harvest levels through out the year.

Participatory Environmental Valuation (PEV)

The technique Participatory environmental valuation (PEV) was used whereby local villagers express the value of NTFPs (Mangrove products) within the context of their own perceptions, needs and priorities rather than through conventional cash-based techniques[2]. Nevertheless, the result should be taken to reflect relative amounts, and can be used for providing bases for policy recommendations, but not to calculate and extrapolate values for the whole country[3]. In absence of market prices, participatory valuation method was used in this study as complementary to the economic study to capture the value of mangrove products used only for subsistence use by the community.

The steps adopted in the PEV include, recording of all mangrove products collect by households, deciding a enumeraire to translate people's own values in to monetary value through ranking, preparing cards depicting all mangrove products and administering a ranking exercise of those cards by the households and distributing the number of counters for each mangrove goods in the card according to their economic importance.

Effect on production method

Effect on production method was used to estimate the fish breeding function of mangroves.

In this method, the values of eco system services can be estimated even when they do not have a market price but taking other marketed products rely on them as basic inputs. This method uses differences in output/production as basis for valuing mangrove services. The study estimated the ecosystem function of mangroves providing nurseries for fish breeding taking the near shore fisheries depending on mangroves.

This method is applicable to a wide range of goods and services however, difficult to collect data to accurately predict bio-physical response relationships

The contribution of ecosystem services to the related source of production was determined and the relationship between changes in the quantity of the particular service and out put was specified. Assuming the dependence of the near shore fish catches on South-eastern coast mangroves of Sri Lanka is in average range of 30% to 80% the market value of the change in production was estimated

[2] Emerton, L. Participatory Environmental Valuation: Subsistence Forest Use Around the Aberdares, Kenya. African Wildlife Foundation Discussion Paper Series. September 1996.

[3] R. Rosales, M. Kallesoe, P. Gerrard, P. Muangchanh, S. Pomtavong and S. Khamsomphou, 2005, Balancing the Returns to Catchment Management: The Economic Value of Conserving the Natural Forests in Mekong, Lao PDR.

Damage cost avoided method
This method estimate values of natural resources based on costs avoided from the destruction of economically valuable assetsBy the ecsystems. This method remains hypothetical in most cases, often difficult to relate damages to changes in ecosystems. As in case of coastal ecosystems, mangroves are cited their ability to protect from extreme events of weather and climate such as storms.

This method was used for estimating the shore line protection functions of mangroves in the context of Tsunami. . Information on personal properties damage/destroyed, livelihood damage/ loss ,physical injuries, hospitalizations and deaths due to tsunami incidence were obtained for the study site and for a control site. The selected control site was not sheltered directly by the mangroves. The difference of the costs of damages in the two sites was assessed.

4.3 Data collection

Household survey and focus group discussions (FGDs) are the two data collection methodologies adopted while undertaking the study in Panama. The sample in total is 141, which represents 10.11 % of the total households (1395) in the village. The surveyed sample was random in getting unbiased data, whilst representing the whole village.

Focus groups discussions
Four focus group discussions were undertaken in the study village. The main objective of those focus group discussions was to understand the different kinds of benefits obtained from mangroves in the study area and different kinds of mangrove products being extracted by the mangrove dependent communities. The FGDs helped idenitfy background information for the design of the study. The discussions helped to determine market prices for mangrove products, sample selection for household survey, design of questionnaires for household survey and preparation of data recording templates for PEV.

Household survey
Household interviews were conducted to assess the direct use values of mangrove products by the mangrove dependent communities in the selected four villages. 109 households (Categorized as per the FGD: 24 poor, 34 medium and 51 rich) were interviewed from the four GN Divisions in Panama. The questionnaire (See Annex 1) comprises of three main sections. First part comprises of the questions capturing NTFP as well as timber, which were to calculate direct use value and near shore fisheries related questions which were used to generate breeding functions as indirect use value. First section was prepared to cover all kinds of goods collected from the mangroves, including mangrove forests products like fuel wood, wild vegetables, herbs, timber, fish and shellfish species and data on quantity of different mangrove products collected, amount consumed, amount sold. All most all types of fish species, shell fish types and shrimp types were set into the questionnaire in order to generate fish breeding functions.

The second part outlines questions, to reveal information on damages caused by the Tsunami. Information were collected on the damage caused by the tsunami on the the lives, properties and economic activities in the study area. Information were collected on the damages for hotels, houses, fisheries equipments, agricultural crops and livelihood activities of the area. Information related to injuries and disabilities cased as a result of tsunami disaster were also gathered.

The aim of PEV was to derive the values of the community for the mangrove products that are used for subsistence use. These products do not have a market price since they are not sold in the local market. The annex three consists of a template to gather information for the PEV (???). A range of mangrove products use for subsistence use were used in obtaining values for the PEV(???). Each household interviewed was asked to rank the products according to their importance to the community and place counters on each product. In this study, rice was used as a numeraire, given that it is the staple food of Sri Lanka, and an essential commodity for households. The value of mangrove products was calculated relative to the price of rice. The survey was conducted covering 30 households in the site.

4.4 Calculation procedure

Valuation of mangrove forest for fuel wood and timber uses is based on benefit valuation on using market prices and quantities of fuel wood and timber collected. The value of fuel wood was calculated using market prices outside the location. Valuation of mangrove related fish and shellfish species was done using local market prices and by calculating the gross benefits.

A range of values of near shore fish was calculated assuming the dependence of the near shore fish catches on South-eastern coast mangroves of Sri Lanka is in average range of 30% to 80%. The market value of the change in production was estimated. The net value was derived by deducting the cost of effort for fish harvest.

Comparing actual damage between the panama site and the control site the shoreline protection value of mangroves was calculated. A village namely Medilla located in southern coast without a mangrove cover, where a huge damage is reported in the Tsunami was taken as the control. The data revealed in valuation study conducted by IUCN was used in calculations (Ranasinghe T and Kallesoe, 2006).

The economic value of mangroves being measured refers to direct and a component of indirect use values only. The report does not try to capture option and non-use values, due to limitations such as funds and time. The value of mangroves derived in this study captures only a part of the total economic value of mangroves. The TEV of mangrove ecosystems is higher than the estimate if full range of value components is covered in a comprehensive valuation.

Table 6. The valuation techniques applied to assess the economic value in the study

Economic value	Valuation Technique
Direct Use Value	
Timber	Market analysis
NTFPs (Shell Fish, Fish, Timber & Poles, Herbs and Vegetables, Fuel-wood, and Other)	
Indirect Use Value	
Shore line protection	Damage costs
Fish breeding function	Market analysis

Monetary values of mangrove products were calculated using quantities collected and local market prices. The shoreline protection benefits were calculated taking the value of damage caused to the community. The data was analyzed based on the assumption that if there were good healthy intact mangroves, the damage done by the tsunami would be at zero level.

5. Study Area

5.1 General information

The study was conducted in Panama village situated on the banks of the mouth of the Wila Oya River. It belongs to Lahugala Pradeshiya Sabha situated in Ampara district of eastern Sri Lanka adjacent to the Kumana National Park. The Lahugala Divisional Secretariat comprises of 5 G.N. divisions namely Shasthrawela, Panama South, Panama West, Panama Central and Panama North altogether 1395 of families and 5900 population. Closest village to the North is Arugam Bay (15 km), and closest to the south is Okanda (11 km). The village is highly affected by the North-east conflict thus; the community is confined to this location. Three communities are present in this area (Sinhala, Tamil and Muslims) with the majority being Sinhala. The village has a school (about 1200 students), pre school, playground, hospital and telecommunication facilities, access to water and electricity. However, road infrastructure is very poor. About 97% of the people in the village are literate and most of them have passed the G.C.E. ordinary level examination.

5.2 Livelihoods of the people

Most of the Panama population depend on agriculture for their livelihood followed by fishing. People practice near shore fishing and lagoon fishing both as the area possesses five lagoons. About 450 people have engaged in fishing (Prawn, lagoon and sea fish) and about 100 families depend on lagoon fishing. Paddy cultivation is the main income generating activity, which contributes to 70% of the village total income and nearly 2000 acres area under cultivation. As alternative cultivations other field crops such as chilli contribute significantly to the income while sorghum, cowpea, brinjal and other vegetables are grown as mixed crops. People adopt slash and burn agricultural practices as well. In addition, hired labor and livestock provide considerable employment opportunities to the community. Labor work includes working in the paddy fields during the harvest time together with masonry and carpentry work. Livestock is another economic activity of the people with them rearing around 5000 cattle in the area. Pottuvil is the market place for fresh milk. Women engage in the minor income generating activities such as coconut fiber industry and weaving coconut leaves for thatching and also helping the fishing related activities. Very few people are employed in the government and in the corporate sector. Of the entire, population most of them can be categorized as poor as they receive less than Rs. 2,000 per month, meanwhile 90% receive government assistance (Samurdhi[4] recipients).

5.3 Ecosystem and resource use

There are five lagoons in the vicinity of Panama, they are; Solambe, Hellawe, Kunukala, Panakale, and Panama lagoons. The lagoons are fringed by mangroves. The village is situated adjacent to the Kumana National Park and is rich in biodiversity and scenic beauty. However, tourism is not popular in the area due to the conflict during the past decades. The area is covered with an undisturbed mangrove cover, and sand dunes. Sand dunes that are large in size can be seen and one of the sand dune that is considered as the longest dune in Sri Lanka; is approximately 500 meters wide and 15-20 meters high. Though the human intervention on the National Park is minimal, there have been incidents human elephant conflict and loss of life and damage to crops have been reported.

The Panama lagoon consists of large mangrove vegetation. The areas above the Kumana river, such as Poththana, Mahirawa, Gajabawa and Bakurei areas have rich mangrove vegetation extending to

[4] Samurdhi is the name of the Sri Lanka government's major poverty alleviation program that transfer funds to poor.

10-15 acres situated half a kilometer from the village. In the vicinity, there is about seven hectares of mangroves. Among mangrove species Mal Kadol (*Bruguiera gymnorhiza*), Heen Kadol (*Aegiceras corniculatum*), Manda (*Avicennia marina*), Nilla, Govinda, Katu Ikiliya/Kibul Ikiriya (*Acanthus illicifolius*), Karankoku (*Acrosticum aureum*) are common. Fuel wood, logs, wooden poles, stuff for cooking purpose ("Karankoku", "Lunuvila"), medicinal plants ("Kothalahimbutu") are the usual primary forest products that are derived from the surrounding mangroves for household needs whereas the usage of other forest products are minimal. Fishing is the commonest direct use associated with mangrove ecosystem. As with the observations, associated ecosystem has good biodiversity and scenic value. Except providing direct benefits, mangroves provide fish breeding functions, buffering functions for adverse weather events or disasters etc.

Figure 2: Location of the study area-Panama

Fish industry associated with mangroves

There are about 45 small boats and 100 fishing nets used in all five lagoons. People owned 26 large fishing boats and about 70 small boats for marine fishing. The fisheries society consists of 237 registered members engaged in both lagoon and sea fishing.

As near shore fishery, in "Shasthrawela" area, villages are engaged in beach seining together with the migratory fishermen who arrive from Southern coastal areas where 7 beach seines exists. The main species commonely found in the pelagic zone are Thora, Paraw, Mora, Hurulla, Bolla, Galmalu, Pokirissa and Mudilla. Fishing gears use in offshore are found to be Lobster nets (4 ½") and Lobster traps to fish lobsters while 3 ½" bottom set nets (Padala), shark nets, skate nets to catch other fish varieties.

Lagoon fishery is being carried out through out the year. The main species found are, Godaya Reththala Japan korali, Angulu and Shrimp types (Kirissa, Walissa, Kara anduissa) Crabs (Kakuluwa), and Parava. Nylon bottom set nets (No. 2), Nylon drift nets (2 ½" and 4"), rod and line and cast nets are used for fishing in the lagoon. Fish produce is used for local consumption and also part of the produce is sent to the Colombo market. The main fish market is in Arugam Bay. Having high market value, lobsters and high value fish are transported to the hotels at Arugam Bay and sent to Colombo as well. Women engage in fishing related activities and assist in agricultural activities.

5.4 Tsunami impacts on livelihoods and mangrove ecosystem

The tsunami, catastrophe had impacted adversely on the economic condition of the communities with the majority being engaged in agriculture and fishing. During the tsunami 70 small boats and 45 traditional crafts were damaged while an approximated 500 acres of paddy land was damaged by salt water intrusion. Moreover, the destruction of lands with crops such as cashew, banana and other vegetables has created significant distress to the villagers. There were minor damages to properties

and vehicles (i.e. 5 houses and 2 motor bicycles) and only one loss of life was reported from this village.

A key prominent feature that should bring into attention is mangroves and sand dunes have acted as buffer to tsunami waves. The causalities and damages were minimal due to the buffering effect of the ecosystem. The destruction of mangroves due to the tsunami was evident in the vegetation surrounding the Panama lagoon (60% destruction), Ragamwila lagoon (100% destruction) and Shastrawela lagoon (75% destruction) that accounts for about 250 ha of mangroves. Mangrove forest cover remain in the area at present is about 70 ha. Under tsunami reconstruction programmes new houses have been constructed with communities being provided fishing gear. Excess boats have been distributed in the area, which mayl exert pressure on coastal fish resources.

6. Study Results & Discussions

The households were divided into different income categories to assess the dependency of different income groups on mangrove products. The grouping was done according to the criteria as defined by the villagers. Accordingly, the population in the village appears to have a higher poor percentage, which is 41% with 20% being categorized as rich according to the criteria decided by the villagers (Table 7).

Table 7. Factors determining a household's income category

	Income Category		
	Poor	**Medium**	**Rich**
Categorization of families by the community themselves according to income per month	"Samurdhi Recipients" (income < Rs. 2,000)	Agricultural lands, Income Rs.2000 - 5,000	Government jobs, Multi day boats, business & other income sources (Income > Rs. 5,000)
Number of families in Panama	575	540	280

The conversion rate of the Rupees into US Dollars in all the calculations at the time of the study was at the rate of US$ 1 equals 102 Sri Lankan Rupees.

6.1 Direct use values

Mangrove products: commercial use, subsistence use

The study attempted to value direct use value and indirect use values of mangroves in this tsunami affected South-eastern coastal zone area. The communities in the area depend on following mangrove products as reflected in the table below (Table 8). Communities depend mainly on lagoon and near-shore fish, shellfish, fuel wood, vegetables, inputs for rural industries such as coir fiber (yarn production), coconut leaves and timber and wooden poles for house construction, wooden poles for fences. Lagoon and near shore fish are harvested mainly for cash income and part of the fish produce is consumed by households. Many mangrove resources are harvested for subsistence purposes (e.g., firewood, coconut leaves for house construction, vines for handicrafts, aquatic products for food) while some of the products are used for commercial purposes. Almost all households derive mangrove products such as firewood, wooden poles and vegetables only for their subsistence use. The amount of different mangrove products collected by house holds and their value derived using market valuation method is given in table 9.

Table 8. Categories of mangrove products

Shell Fish:	Fish:	Timber & Poles:	Herbs and Vegetables:	Fuel-wood:	Other:
Shrimp (Kirissa) Shrimp (Walissa) Shrimp (Kara anduissa) Crabs (Kakuluwa)	Godaya Reththala Japan korali Angulu Parava	Timber Wooden poles (fencing)	Kerenkoku Kothalahimbutu Lunuvila vegetables		Coir industry Coconut leaves Fodder

Table 9. Market value of mangrove products

Mangrove Associate Products	Average Quantity Collected per Household	Units	Average Price Per Unit (Rs.)	Mangrove Products Value Per Household Based on Price (Rs.)
Godaya (fish)	292.64	kg	120	35,117
Reththala (fish)	295.30	kg	100	29,530
Japan korali (fish)	181.80	kg	60	10,908
Angulu (fish)	36.42	kg	50	1,821
Shrimp (Kirissa)	45.10	kg	400	18,040
Shrimp (Walissa)	20.25	kg	200	4,051
Shrimp (Kara anduissa)	8.08	kg	600	4,850
Crabs (Kakuluwa)	28.25	kg	250	7,063
Parava (fish)	6.24	kg	200	1,248
Fuel wood	454.20	kg	10	4,542
Timber	5.00	kg	15	75
Wooden poles(fencing)	4.74	Poles	50	237
Vegetables	40.91	kg	15	614
Karankoku	0.07	kg	15	1
Lunuvila	0.21	kg	15	3
[1]Coir industry	1.24	Bundle	10	12
[1]Coconut leaves industry	265.36	Leave	5	1,327
Total Mangrove Products Value Per Household/ year (Rs)				**119,438**
Total Mangrove Products Value Per Household/ year (US$)				**1,171**

Note 1: coir products and coconut leaves are not direct mangrove products. They are only mangrove associated products.

Note 2: Technical information on the breeding of fish species directly associated with mangroves is limited. All the fish species mentioned here may not be directly associated with mangroves.

Average mangrove related fish catch per household per year by mangrove product collection for poor, medium and rich groups are 947.13 kg, 1175.13 kg, 356.14 kg respectively. Most valuable mangrove product for mangrove resource dependent families are mangrove related shellfish species, shrimps and crabs catches being 131.89 kg, 52.08 kg and 103.69 kg per household per year for poor, medium and rich households respectively. Collection of mangrove fuel wood is 852.6 kg, 52.94 kg and 534.12 kg per family per year in each household in each income group respectively and the fuel collection by poor income group is comparatively high. Analysis shows that the rich families collect 33.88 kg of mangrove related vegetables, poor families collect 107.44 kg and medium income category families collect 5.27 kg of mangrove related vegetables per household per year.

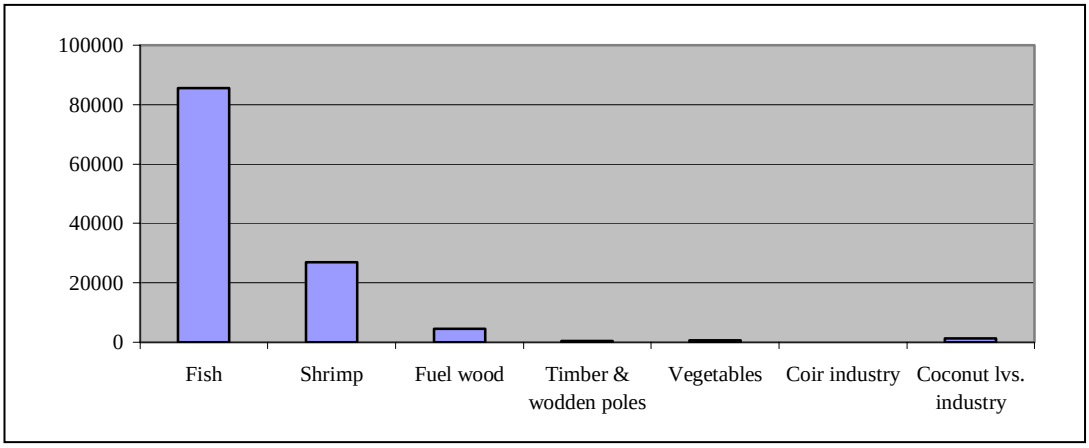
The study results with regard to direct use value of mangroves are summarized below in table 10. The results reflect the importance and contribution of mangrove forest products for the subsistence use and commercial uses of the mangrove dependent community in eastern coastal zone communities in Sri Lanka

Table 10. The summary of direct use values (survey values) using market prices

Indicator (per year)	Value in US$	Value in Rs.
Value per household	1,171	119,438
Benefits to poor households in the village	907,057	92,519,800
Benefits to medium income households in the village	772,984	78,844,320
Benefits to rich households in the village	225,680	23,019,360

Based on the results using the market value method, the collective mangrove products represent a total gross value of US$ 1,171 (Rs.119,438) per household per year (Table 9), for a household that collects mangrove products. The direct use benefit of mangrove products per household is Rs. 9,953 per month (Gross income). Even though the mean household income per month in Batticaloa district is unavailable, with the closest available mean household income per month in the Eastern province[5] being Rs. 7,640 per household per month this infers the higher significance of mangrove products to the income of the community. This figure alone is enough to justify the need for mangrove protection, because it shows that the mangrove direct use benefits can be on par with other sectors of the economy.

Figure 3. Mangrove products market value per household based on price (Rs.)



The figure 3 shows the market value of considered mangrove products categories for households based on average market price (Rs.) throughout the year. Accordingly, fish, shrimp and crabs and fuel wood are the most important mangrove products to the community in terms of their economic value.

Table 11 below shows the flow of mangrove products benefits to each income group.

[5] Household Income and Expenditure Survey 2002, Basic Information at District Level Department of Census and Statistics Sri Lanka. The estimates given in the bulletin are based on the survey conducted in the Eastern province during the six months September, 2002 to February 2003.

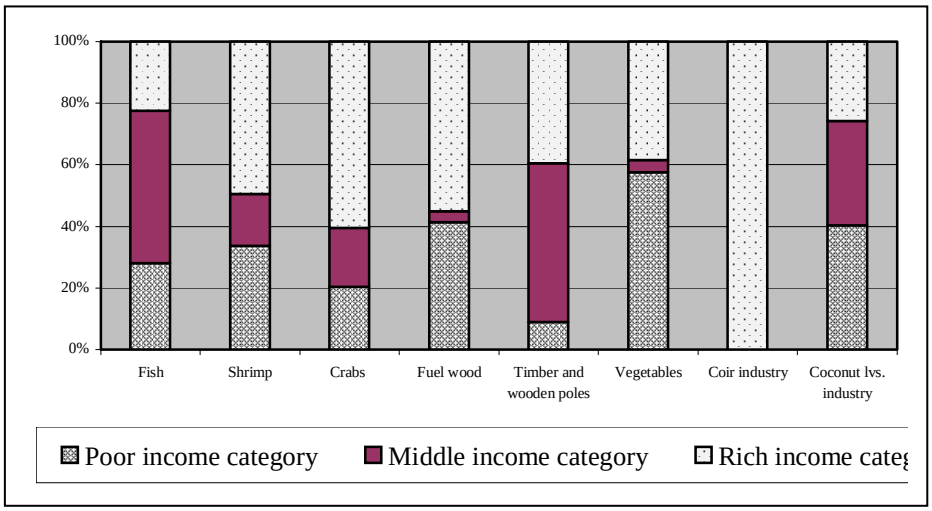
Table 11. Total mangrove dependence /household/year

Mangrove Products	Poor income category	Middle income category	Rich income category
Godaya (fish)	728,400	2,018,400	1,080,960
Reththala (fish)	1,065,400	2,018,400	135,000
Japan korali (fish)	391,200	170,160	627,600
Angulu (fish)	88,500	28,200	81,750
Shrimp (Kirissa)	660,000	276,000	1,030,400
Shrimp (Walissa)	240,000	41,200	160,400
Shrimp (Kara anduissa)	90,000	178,800	259,800
Crabs (Kakuluwa)	157,500	146,000	466,400
Parava (fish)	136,000	0	0
Fuel wood	204,630	18,000	272,400
Timber	1,000	7,200	0
Wooden poles(fences)	2,080	10,300	13,425
Vegetables	38,620	2,340	25,920
Karankoku	60	0	0
Lunuvila	0	345	0
Coir industry	0	0	1,355
Coconut leaves industry	58,300	48,910	37,410
Total mangrove dependence Per HH/ year in Rs.	160,904	146,008	82,212
Total mangrove dependence Per HH/ year in US$.	1,577.49$	1,431.45$	806.00$

According to the results (Table 11) the total mangrove dependence per year per household is US$ 1,577.49 for poor income category, US$ 1,431.45 for middle-income category and US$ 806 for the rich income category.

The figure 4 shows the value of each mangrove products categories to three income groups, rich, medium and poor.

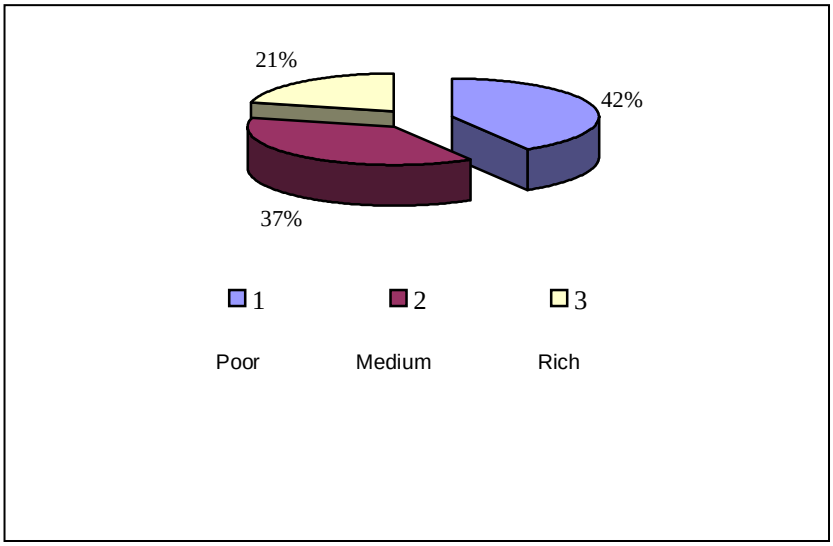
Figure 4: Mangrove dependence by different income groups



Moreover, it is evident that all most all income groups are dependent on mangrove products. More importantly, poor and middle-income group depend more on mangrove products such as fish (Parava), leafy vegetables, timber and poles, fuel wood and coconut leaves. Reththala and Godaya are the major fish types that they depend on from the eight fish types harvested in the area. The rich income group is involved entirely in the coir industry and derives higher economic benefits from crabs and prawns. To a large extent, the middle-income and high-income groups harvest timber and wooden poles from mangroves.

The figure below represents the contribution of mangroves to each income category based on the market value of mangrove products. 42% of benefits derived from mangroves contribute to income of poor category, 37 % of total benefits derived from medium income communities and, the benefit to rich community is 21%. Hence, the poor communities in the coastal zone are benefited more from mangroves than the rich in the area.

Figure 5. Ranked total value of mangrove product by income category



Participatory valuation

Values of fish and shellfish and other products reflect their market values, because they are exchanged in the market and there is market-determined price for those products. However vegetables, wooden poles, fuel wood etc derived from mangroves by almost all households in the location for subsistence use and not sold, where market prices assigned in market valuation method may not represent the actual values of those products to the community. Therefore, participatory valuation techniques were used to derive actual values of those products to the community.

Table 12 summarizes the relative importance of different mangrove products according to different income groups as obtained using the participatory valuation methodology. It explains the average benefit derived from mangrove products by each income group.

Table 12. Ranked importance of different mangrove product categories by income category

Product Categories	Poor		Medium		Rich	
	Survey	PEV	Survey	PEV	Survey	PEV
Timber & Poles	1.26$	113.42$	5.05$	33.02$	2.58$	113.33$
Herbs and Vegetables	15.80$	69.7$	0.77$	14.55$	4.98$	147.06$
Fuel wood	83.59$	94.63$	5.19$	58.47$	52.36 $	170.59$

Fuel wood, herbs and vegetables, timber and poles which are derived from mangrove forests for the communities subsistence use has received proportionately high value in participatory valuation compared to market value. This implies that those mangrove products are very important to local community for their day-to-day living, where the market for these products is absent.

6.2 Indirect Uses

Even though there are different kinds of indirect use values of mangroves, this study attempted to value shoreline protection function and support to offshore fisheries of mangroves in tsunami affected area due to limitations of time, money and necessary data to capture other indirect use values.

Indirect use value is determined by the contribution of resources in terms of their environmental and ecological services to support current production and consumption. One important ecological service of mangroves is the support to fisheries by serving as a nursery ground. There has been considerable work and debate on the link between mangroves and fishery catches. However, in most cases, valuation of the impacts of mangroves on catches in off-site fisheries is based on somewhat arbitrary assumptions, rather than on detailed scientific information. This is probably due to inadequate knowledge regarding the ecological linkages between mangrove ecosystem and fish populations.

According to report of Batagoda (2003)'s study conducted in Kiralakele, Maduganga and Ranweli villages, the economic value of the fisheries function of mangrove has been estimated by several authors, Hamilton & Snedker, (1984); Ruitenbeek, (1991); Gren & Soderqvist, (1994); Hambrey, (1997); Gilbert & Janssen, (1997) and Costanza et al, (1997) whose values ranged from US$ 66 to almost US$ 3,000/ha. Christensen (1982) estimated the fisheries function in Thailand at 130/ha/yr. Lal (1990) estimated the fisheries function of mangroves in Fiji at US$ 100/ha/yr while Ruitenbeek (1992) estimated the same in Indonesia at US$ 117/ha/yr. Jansen and Padilla (1996) estimated the mangrove fisheries function in Philippines at US$ 60/ha/yr. Giesen et al (1991) have calculated a net value of US$ 600/ ha/ yr. for open water fish catches. According to the findings of Sivakumar & Fernando (1997), the cost of Replacing 1 ha of mangrove is Rs. 840,000 and the benefit from increased fish yield is Rs. 75,000/yr. According to Amarasinghe (1996) one hectare of mangroves will generate about 750 – 2,500 kg of fish, prawns, crabs, and mollusks per year.

The provision of fish breeding function of the mangrove forest in Sri Lanka is also estimated to be US$ 218/ha/yr in the study of Batagoda (2003) using benefit transfer method. In his study, the methodology followed by Bann (1999) to estimate the direct use value of capture fishery in Malaysia was transferred to Sri Lanka using benefit transfer method. In his study, it was also assumed that biogeographically Sri Lanka and Malaysia are similar.

In the most recent comprehensive review, Ronnback (2001)[6] highlights that according to various studies, between 30% and 80% of fish catches and up to 100% of shrimp catches have been attributed in some way to mangroves.

Near shore fisheries:

In this study, the estimates are based on the measures of changes in net returns of fishery as indicators of change in social welfare as a measure of the role of mangrove contribution to fishery.

Assuming the dependence of these fish catches on South-eastern coast mangroves of Sri Lanka is in average range of 30% to 80%, and based on there being seventy hectares of mangroves, the approximate net benefit value of near shore fisheries would be in the range of US$ 1,77.9 to US$ 4,74.3 per hectare of mangroves per year (Table 13). When considering the three income categories namely, poor, middle and rich, calculated benefits for a family who engage in near shore fisheries is estimated at US$ 1,441.17, US$ 4,379.26 and US$ 3,793.16 respectively per year.

Table 13. Total near shore fishery value/household

Income category	Poor income category	Middle income category	Rich income category
Income from near shore fishing	Rs. 147,000	Rs. 446,685.29	Rs. 386,903.13
	US$ 1,441.17	US$ 4,379.26	US$ 3,793.16

Shoreline protection function

The storm protection and shoreline stabilization functions of a wetland may have indirect use value through reducing property damage, yet often coastal or riverine wetland systems are drained in order to develop the waterfront areas. From time to time, local people suffer from large waves and storms that destroy these properties. There are experiences that the damage due to tidal surges and storms is much less with the presence of mangrove. The similar experience was revealed in South Asian tsunami incident where mangroves acted as barriers to reduce the damage in some locations. Based on this assumption, the study is using actual damage estimates on properties and livelihood damage including tourism related hotel and cost of injuries as a measure of storm protection benefits of mangroves.

Using benefit transfer method, Batagoda (2003) had estimated, US$ 76.8/ha/yr as a proxy for the storm protection function of mangroves in Sri Lanka. Shoreline protection benefits of mangroves can also be estimated in terms of erosion control benefits. Batagoda (2003) had calculated a value of US$ 3.6/ha/year as the value of mangroves in terms of erosion control using the benefit transfer method with reference to some of the relevant studies in the other countries

Similarly in this study, storm protection function of mangroves was calculated. Using the cost of tsunami damages to property and livelihood. The actual value of damage in control site was US$ 213.825 without the mangrove cover present in the location. Therefore damage cost avoided in

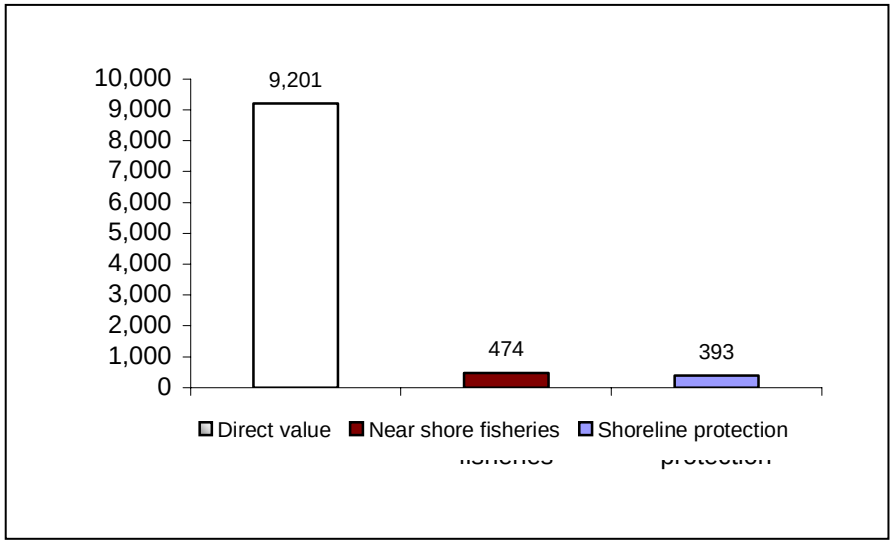
[6] Rönnbäck P. (1999). The ecological basis for economic value of seafood production supported by mangrove ecosystems. Ecological Economics 29 (1999) 235-252.

Panama is calculated at 125,613 US$. the protective value of mangroves is calculated at 392.5 US$/ha.The value derived in the study is relatively high compared with the estimates of the previous studies. The assumption is that the mangrove ecosystems are fully acted as a barrier for Tsunami and capable of avoiding the damage to valuable assets.

Table 14. Cost of tsunami damages to property and livelihood

	Rs.	US$
Houses & build.	260,000	2,549
Vehicles	121,000	1,186
Boats & fish. gears	5,917,150	58,011
Veg.& crops	854,000	8,373
Paddy	890,600	8,731
Livestock	1,048,500	10,279
Other	66,400	651
Total	**8,997,650**	**88,212**

Figure 6: Direct and indirect economic value (US$ ha/Yr)



Both direct and indirect mangrove resources make significant contribution to total economic value of mangrove forest. Above figures represent the percentages of indirect values in contrast with direct values. The study resulted in US$ US$ 9,201 direct value per hectare per year (???). The economic value of the near shore fisheries function of mangrove has been generated at a value of U3S$ 474.3 per ha per year (maximum value) while shoreline protection was 392.5 per hectare per year. Figure 6 depicts the relative importance of direct use, and indirect use values to the total value of mangroves.

7. Conclusions And Policy Implications

Coastal wetlands-mangroves are particularly under severe threat and remain under valued despite their economic and ecological importance. Under valuing of mangroves is a serious problem where outright conversion of the mangrove area is at stake at present in Sri Lanka under severe pressure from anthropogenic activities. Loss and degradation of these vital ecosystems impact heavily on the coastal population traditionally dependent on mangroves for food production such as fish, vegetables, fuel wood, medicines, and construction materials etc. as well as through the provision of vital life support and protection services.

The results derived in this rapid mangrove valuation study undertaken in the context of post Tsunami in Panama, southeastern coast of Sri Lanka shows the importance of mangroves to the mangrove associated communities including coastal protection. As revealed in this study, the coastal community in the location depends on range of products. Fish, shrimp and fuel wood are the main mangrove products providing cash income and subsistence requirements of the community in the area. Timber and poles, herbs and vegetables and fuel wood are important for almost all income categories for their subsistence use. In this study, the economic value of mangroves was estimated to be Rs. 119,438 (US$ 1,171) per household per year.

The local people tend to experience loss of mangrove degradation or conversion, in terms of the net foregone of above benefits. The results further justify the need for mangrove protection for the benefit of the mangrove-associated communities. According to estimated benefits, the direct use benefit of mangrove products (Gross Value) per household is Rs. 9,953 per month, which is significantly high in comparison to mean household income per month in the Eastern province[7], (Rs. 7,640 per household per month). Protection of mangrove forest ensures food security of the coastal dependent vulnerable community even during difficult periods such as droughts, marine fisheries off-season. It provides seafood needs, wild vegetables and fuel wood for cooking purposes for the local community. This may reduce the burden on the government and pressure on other natural resources like corals, sand dunes and terrestrial forests.

Households of all income categories poor, medium and high-income groups are dependent on mangrove products. However, according to results of the study of Panama Village, highest foregone benefits accrued to poor in conversion or degradation of mangroves. As revealed in the study, mangroves provide higher proportion of benefits to the poor income households. Total benefits to income groups poor, medium and high are 42 %, 37% and 21% respectively. Mainly poor and middle-income categories depend on fish, timber and wooden poles and vegetables derived from mangroves. The high-income category depend more on high valued shrimps and crabs.

Mangroves supply us with a number of important resource outputs (fish, fuel wood, timber and poles etc.), but they also perform a large number of *regulatory ecological functions*, which support economic activity. Nutrient retention, flood control, ground water recharge, microclimate stabilization and shoreline stabilization etc. are the important ecological functions of mangroves that are largely unrecognized. The estimation of the value in terms of ecological benefits is a difficult task due to insufficient technical data on such ecological relationships and the resource and time limitations. Due to this fundamental issue, the value of mangroves is always underestimated. Therefore, the decisions regarding the coastal zone activities and mangrove forests, which may be taken based on limited

[7]Household Income and Expenditure Survey 2002, Basic Information at District Level Department of Census and Statistics Sri Lanka. The estimates given in the bulletin are based on the survey conducted in the Eastern province during the six months September, 2002 to February 2003.

information on mangrove ecosystems could end up with irrational decisions creating externalities in terms of mangrove destruction, water pollution and also further aggravating the problem of income distribution. This is especially true when the forest in focus is located along the coast and serves as a nursery ground for small fish and marine life. The study attempted to derive indirect use value in terms of mangrove fishery linkages and the value in terms of coastline protection based on the tsunami impacts on coastal ecosystems and the community.

The study estimated that mangroves generate value ranging between US$ 1,77.9 to US$ 474. 3 per hectare of mangroves per year,for fish breeding functions and the estimated value of US$ 392.5/ha for mangroves acting as a protective barrier.

The study being a rapid assessment, has certain limitations. Moreover, there is a tendency towards an under or over estimation of the economic value of mangroves in terms of fishery linkages with mangroves providing nursery ground for fish breeding. All the fish species may or may not directly be associated with mangroves. The results are valid only with the assumption that 30-80% of all fish species are in someway attributed to mangroves.

In terms of coastline protection, the assumption is that the damage avoidance from tsunami was provided only from mangroves. It is also observed that the sand dunes and mangroves have acted in varying degrees as barriers in minimizing the effects of Tsunami in the country. The effects also vary depending on the other geographical factors as well. The estimated value of mangroves in terms of coastal protection in the context of tsunami could be an over estimation since the coastal protection benefits could be a combined effect of sand barrier, other geographical factors and the mangrove forest present in the area. In the assessment, the tendency towards an underestimation of the economic value of mangrove may come about because the study ignores other potential direct use value such as tourism and indirect use values such as the ecological functions of nutrient retention, flood control, ground water recharge, microclimate stabilization and shoreline stabilization etc. In the assessment, nonuse values are completely neglected.

Moreover, the results from the analysis also indicate that when coastal fisheries are well managed by local communities, the foregone benefits of mangrove in terms of support for coastal fisheries will be even greater considering the mangroves functioning as breeding grounds for near shore fish. Under the locally managed coastal fishery regime, converting mangrove forests into other options such as commercial shrimp farms is even less economically viable if the true values of mangroves are taken into consideration. According to results, there also seems to be an incentive for the local villagers to protect mangrove forests especially where the fisheries are well managed by local communities.

8. References

Bann, C. (1997). EEPSEA manual, The economic valuation of mangroves: A manual for researchers. International Development Research Centre, Ottawa, Canada.

Base and crisis mapping over Sri Lanka. http : //sertit1.u- strasbg. Fr / documents / asie / srilanka . html

Batagoda, B. M. S. (2003). The economic valuation of alternative uses of mangrove forests in Sri Lanka. A report submitted to UNEP-GPA coordination office in Netherlands.

CCD-Coast Conservation Department (2006). Presentation material.

Dahdouh-Guebas, F., Hettiarachchi, S., Lo Seen, D., Batelaan, O., Sooriyarachchi, S., Jayatissa, L.P., and Koedam, N. (2005). Transitions in ancient inland freshwater resource management in Sri Lanka affect biota and human populations in and around coastal lagoons. *Current Biology*. Vol. 15, 579-586. http:// www.current-biology.com

Dahdouh-Guebas, F., Jayatissa, L.P., Di Nitto, D., Bosire, J.O., Lo Seen, D., and Koedam, N. (2005). How effective were mangroves as a defence against the recent tsunami? *Current Biology*, Vol. 15, R443-R447.http:// www.current-biology.com

Dahdouh-Guebas, Kairo, J.G., Jayatissa, L.P., Cannicci, S. and Koedam, N. (2000). An ordination study to view vegetation structure dynamics in disturbed and undisturbed mangrove forests in Kenya and Sri Lanka. *Plant Ecology,* 161: 123–135, 2002. http://www.wiomsa.org/pub/downloadfile.asp?fid=267.

Emerton, L. (1996). Participatory environmental valuation: subsistence forest use around the Aberdares, Kenya. African wildlife foundation discussion paper series.

Emerton, L., and Kekulandala, L.D.C.B. (2003). Assessment of the economic value of Muthurajawela wetland. Occ. Pap., IUCN, Sri Lanka., 4:ii.

Foell, J., Harrison, E., and Stirrat, R.L. (1999). Participatory approaches to natural resource management: The case of coastal zone management in the Puttalam District. University of Sussex, Brighton.

GMSL-Green movement of Sri Lanka (2005). Environmental Impact Assessment; Dynamic environmental impact assessment report. Disaster management and information program.http://www.greensl.net/docs/dynamic_environmental_impact_assessment_repot.pdf

Gunawardena, M. and Rowan, J. S. (2005). Economic valuation of a mangrove ecosystem threatened by shrimp aquaculture in Sri Lanka, *Environmental Management*, Springer-Verlag:New York, Vol. 36, No 4: 535 – 550.

IUCN (2003). Regional technical assistance for coastal and marine resources management and poverty reduction in South Asia (ADB RETA 5974). An economic evaluation of mangrove ecosystem and different fishing techniques in the Vanthavilluwa.

Janssen, R. and Padilla, J.E. (1996). Valuation and evaluation of management alternatives for the Pagbilao mangrove forest, CREED Working Paper Series, No 9, IIED, London.

Jayatissa, L. P., Dahdouh-Guebas, F., and Koedam, N. (2002). A review of the floral composition and distribution of mangroves in Sri Lanka. *Botanical Journal of the Linnean Society*, 138:29–43.

Kairo, J.G., Dahdouh-Guebas, F., Bosire, J., and Koedam, N. (2001). Restoration and management of mangrove systems – A lesson for and from the East African region. *South African journal of botany*, 67: 383-389.
http://www.mangroverestoration.com/restmmnt.pdf

Kala Oya Basin. Executive summary. Mahaweli Authority of Sri Lanka.
Http://www.mahaweli.gov.lk/Divisions/RBMS.htm#top

NORAD, UNEP and The Government of Sri Lanka, (2001). Sri Lanka state of the environment-2001. Klong Luang, Thailand:UNEP.
http://www.rrcap.unep.org/reports/soe/srilanka_coastal.pdf

Pearce, D. W., and Pearce, C. G T. (2001). Background document: The value of forest ecosystems. A report to the secretariat convention on biological diversity.
Http://www.cserge.ucl.ac.uk/Value_of_Forests.pdf

Rönnbäck P. (1999). The ecological basis for economic value of seafood production supported by mangrove ecosystems. *Ecological Economics*, 29:235-252.

Rosales, R., Kallesoe, M., Gerrard, P., Muangchanh, P., Phomtavong, S., and Khamsomphou, S. (2005). Balancing the returns to catchment management: the economic value of conserving natural forests in Mekong, Lao PDR.

Sathirathai, S., (2000). Economic Valuation of Mangroves and the Role of Local Communities in the Conservation of Natural Resources: Case Study of Surat Thani, South of Thailand. International Development Research Centre, Ottawa, Canada.

Sathirathai, S., and Kittiprapas, S. (2000). Conflict management for environmental and social sustainability. Good governance for social development and the environment institute (GSEI). Bangkok, Thailand.

Schuyt, K. and Brander, L. (2004). Living waters: Conserving the source of life. The economic values of the world's wetlands. Gland, Amsterdam.

Spaninks, F., and Beukering, P. van. (1997). Economic valuation of mangrove ecosystems: Potential and limitations. CREED Working Paper, No. 14.

State of the Environment (2001). Klong Luang, Thailand: UNEP.

Ransinghe, T., and Kallesoe, M. (2006). Valuation, rehabilitation and conservation of mangroves in tsunami affected areas of Hambanthota, Sri Lanka: Economic valuation of tsunami affected mangroves-The World Conservation Union, Ecosystems and livelihoods group Asia.

UNEP-WCMC (2006). In the front line: Shoreline protection and other ecosystem services from mangroves and coral reefs. UNEP-WCMC, Cambridge, UK 33

ANNEX 1: Data Collection Sheets

SURVEY ON "ECONOMIC VALUATION OF MANGROVES"

The project "Valuation Rehabilitation and Conservation of mangroves in tsunami affected areas" was implemented in Panama village in Eastern Province of Sri Lanka. The goal of the project is to reduce the vulnerability and improve livelihoods of coastal populations in Sri Lanka by rehabilitating mangroves that were affected by the tsunami, and to support environmentally friendly reconstruction (???). The project activities mainly focuses on restoration of tsunami affected mangroves (38 hectares), conducting awareness Programmes for the stakeholders and communities and conducting an economic valuation of mangroves study in the selected area.

Introduce yourself to the respondent: "I am doing a survey on behalf of the IUCN Sri Lanka. Your opinion and the information provided will be used to assess the economic value of mangroves in Panama of Ampara District. Your honest response is essential for the success of this project and the future of your mangrove resources". This research is solely for policymaking and academic reasons and all your responses will remain confidential. We will try our best to share the results of our research with you once completed. We will be extremely grateful if you s agree to collaborate with us and give some of your time to answer a set of questions we have. The questions are designed to help us understand how you and your family are benefited from mangroves and affected by tsunami. We thank you for your time and eagerly hope for your co-operation.

DATE: _____ QUESTIONARE NO: _____ ENUMERATOR NAME: _____

RESPONDENTS' NAME & ADDRESS: _____

TIME INTERVIEW STARTS: _____, TIME ENDS: _____

VILLAGE NAME: _____ INCOME CATEGORY: _____

DATA COLLECTION TEMPLATE FOR MANGROVE PRODUCTS

NTFP	JAN		FEB		MAR		APR		MAY		JUN		JUL		AUG		SEP		OCT		NOV		DEC		Unit Conversion		
	Amount collected	Unit price Rs.	Amount collected	Unit price Rs.	Amount collected	Unit price Rs.	Amount collected	Unit price Rs.	Amount collected	Unit price Rs.	Amount collected	Unit price Rs.	Amount collected	Unit price Rs.	Amount collected	Unit price Rs.	Amount collected	Unit price Rs.	Amount collected	Unit price Rs.	Amount collected	Unit price Rs.	Amount collected	Unit price Rs.	**Unit measurement**	**% Consumption**	**% Sold**
LAGOON																											
Godaya																											
Japan Korali																											
China																											
Calf																											
Bataya																											
Thatilla																											
Crabs (Kakuluwa)																											
Shrimps (Kiri Issa)																											
Shrimps (Gal Issa)																											
Fuel wood																											
Timber																											
Wooden Poles																											

NTFP	JAN		FEB		MAR		APR		MAY		JUN		JUL		AUG		SEP		OCT		NOV		DEC		Unit Conversion		
	Amount collected	Unit price Rs.	Amount collected	Unit price Rs.	Amount collected	Unit price Rs.	Amount collected	Unit price Rs.	Amount collected	Unit price Rs.	Amount collected	Unit price Rs.	Amount collected	Unit price Rs.	Amount collected	Unit price Rs.	Amount collected	Unit price Rs.	Amount collected	Unit price Rs.	Amount collected	Unit price Rs.	Amount collected	Unit price Rs.	Unit measurement	% Consumption	% Sold
Wild vegetables																											
Keren koku																											
other																											
Herbs																											
Kothalahimbutu																											
Walmidi																											
Kirala fruits																											
Gin pol leaves																											
Lunuvila																											
Coir industry																											
Coconut leaves																											
Fodder																											

DATA COLLECTION TEMPLATE FOR NEAR SHORE FISHERIES

NTFP	JAN		FEB		MAR		APR		MAY		JUN		JUL		AUG		SEP		OCT		NOV		DEC		Unit Conversion		
	Amount collected	Unit price Rs.	Amount collected	Unit price Rs.	Amount collected	Unit price Rs.	Amount collected	Unit price Rs.	Amount collected	Unit price Rs.	Amount collected	Unit price Rs.	Amount collected	Unit price Rs.	Amount collected	Unit price Rs.	Amount collected	Unit price Rs.	Amount collected	Unit price Rs.	Amount collected	Unit price Rs.	Amount collected	Unit price Rs.	Unit measurement	% Consumption	% Sold
Near shore																											
Hurulla																											
Gal malu																											
Penna																											
Marando																											
Halmessa																											
Bollu																											
Parati																											
Karawaduwa																											
Pokirissa																											
Kalanda																											
Ginnatiya																											
Thabuwa																											
Hebalawa																											

NTFP	JAN		FEB		MAR		APR		MAY		JUN		JUL		AUG		SEP		OCT		NOV		DEC		Unit Conversion		
	Amount collected	Unit price Rs.	Amount collected	Unit price Rs.	Amount collected	Unit price Rs.	Amount collected	Unit price Rs.	Amount collected	Unit price Rs.	Amount collected	Unit price Rs.	Amount collected	Unit price Rs.	Amount collected	Unit price Rs.	Amount collected	Unit price Rs.	Amount collected	Unit price Rs.	Amount collected	Unit price Rs.	Amount collected	Unit price Rs.	Unit measurement	% Consumption	% Sold
Galkossa																											
Pothubari																											
Karaandu issa																											
Other																											

COSTS OF NEAR SHORE FISHERIES

How many trips per month do you engage in near shore fisheries ……
How many hours do you spend to catch fish/ per trip ……..
What is the cost per trip?

Fuel: Rs ……

Other:
…… Rs……..
…… Rs……..
…… Rs……..

How many days do you spent to maintenance of boats and nets per month: ……
How much money do you spent to maintain boats and nets Rs……..

HOW WERE YOU AFFECTED BY THE TSUNAMI?

1. In this part, we try to gather information on personal properties damage/destroyed by the tsunami.

Property	Number/ Name/area	Damaged	Destroyed	Value	Compensation
House					
Other buildings					
Vehicles					
Land/ Commercial/ Residential					
Other					

2. Livelihood damage/ loss

Livelihood	Number/ Area/yield	Damaged	Destroyed	Value	Compensation
Boats					
Fishing gears					
Coconut					
Paddy					
Plantain					
Cattle					
Goats					
Poultry					
Other					

3. Physical injuries, hospitalizations and deaths

Any of your family members hospitalized due to injuries made by the tsunami?

Yes ☐ No ☐

If yes, what was the cost of hospitalization (medicines, traveling, etc.) Rs. ……..

Was the injury caused permanent disability? Y ☐ ☐

If yes, what is the cost of being disabling?

- Loss of salary (per month) Rs …….
- Expenses for medicines and treatments (per month) Rs…….

Any of your family members dead due to the tsunami

Yes ☐ No ☐

His /her age …….. Occupation……..

Monthly earning (Before): Rs……

DATA RECORDING TEMPLATE FOR PARTICIPATORY VALUATION

Deciding on an indicator of value that is relevant to the household/village and which: can be translated easily into a cash amount, has local and individual value, has a defined lifespan. Ranking the cards depicting different sources of livelihood according to their economic importance. Distributing a specified number of counters (this number should be the same for all interviews) between the cards (including the cash measure) according to their perceived economic importance to the household.

NTFP e.g.	Number of beans
Rice	
Fuel wood	
Timber and Wooden poles	
Shrimp (kiri issa)	
Shrimp(gal issa)	
Crabs (kakuluwa)	
Kerenkoku & greens	
Godaya	
Japan koraly (fish)	
Calf	
Vegetables	
Fodder	
Coir and coconut husks	

INTERVIEW WITH HOTEL OWNERS/ MANAGERS

Name of the Hotel/Cabana/Restaurant: _____

Value of damage: _____

Number of visitors before tsunami: _____

Tourism earnings before tsunami:

_____

Number of staff before tsunami: _____

Cost of rehabilitation: _____

PUBLIC INFRASTRUCTURE DAMAGE

Infrastructure	Number/ Name/	Damaged	Destroyed	Value	Cost of rehabilitation
Schools					
Roads					
Bridges					
Community halls					
Town halls					
Parks					
Temples					
Other					