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Final Report

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WWF for a living planet
Both ENDS Environment and Development Service
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By Thushara Ranasinghe and Mikkel Kallesoe

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Executive summary

Under the project “Valuation, Rehabilitation and Conservation of Mangroves in Tsunami Affected Areas” IUCN and SEEDO jointly undertook a valuation study assessing the economic values of mangroves in Hambantota district of Sri Lanka. A survey was undertaken in the four villages of Medagama, Medilla, Rekawa-west and Netolpitiya-south.

The study valued the environmental goods and services provided by mangroves and benefiting the local communities. The mangrove goods that were values included various NTFPs (fish, shellfish, fuelwood, wild vegetables, herbs, fodder, coconut leaves, husks, coir) as well as timber and poles, and the valued mangrove services included fish nurseries and breeding grounds, restocking of near-shore fisheries and shoreline protection. Due to time and resource constraints the study does not perform any statistical analysis to test for result significance.

The primary method used to calculate the direct use values of mangroves was Market Prices (MP), and Participatory Environmental Valuation (PEV), a technique where local villagers can express the value of different mangrove goods through a ranking exercise. PEV was used to verify the value derived from the MP method for goods primarily consumed within the household and was based on the premise that environmental goods, which are rarely traded, tend to be undervalued by the market. Therefore, identifying their “true” value requires the use of a more participatory valuation method. In the present study fuelwood, timber and poles and herbs and vegetables were the only mangrove goods used exclusively for subsistence and hence subject to PEV.

For valuing the indirect use values of mangroves expressed through the restocking of near-shore fisheries (supported by the services of providing fish nurseries and breeding grounds) and shoreline protection, the study adopted several methods. The value of mangroves to near-shore fisheries was calculated as a range based on the assumption that between 30% and 80% of the total annual value of near-shore fisheries can be credited to mangrove services based on the recommendation of (Rönnbäck, 1999). The value of shoreline protection was estimated based on the damage costs avoided.

The study shows that poorer households are more dependent on natural resources than richer households, and that market prices tend to undervalue environmental goods that are used exclusively for subsistence purposes. In the case of fuelwood market prices at best managed to capture 45% of the true value of fuelwood as expressed by the collecting households.

For the resource dependent households participating in this study mangrove goods generate gross economic benefits that are over and above the average household income recorded in Hambantota district. The annual net direct use values for households collecting mangrove goods have been estimated at US$ 1,638 for Medagama, US$ 1,389 for Medilla and US$ 1,360 for Rekawa-west. For Netolpitiya-south the net direct use value is only estimated at US$ 136, which is considerable lower than the three other sites. There are two main reasons for this, which are: 1) households in Netolpitiya-south have more restricted access to the mangrove compared to the other sites; and 2) households in Netolpitiya-south have other major income sources and livelihood options as the village is located near a large road and a number of government jobs are available near by.

In addition, the indirect values of mangroves in supporting near-shore fisheries have been calculated as: US$ 1,276-US$ 3,403 for Medagama; US$ 7,712-US$ 20,564 for Medilla; US$ 4,861-US$ 12,964 for Rekawa-west; and US$ 1,464-US$ 3,905 for Netolpitiya-south – these numbers represent annual per hectare values. In terms of shoreline protection the per hectare values have been calculated as: US$ 9,011 for Medagama; US$ 2,196 for Rekawa-west; and US$ 9,884 for Netolpitiya-south. These values underline the valuable role, which intact and healthy mangroves provide in buffering against extreme weather events such as a tsunami.

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List of acronyms

AIMS	Australian Institute of Marine Science
CCD	Coast Conservation Department
DCS	Department of Census and Statistics
DS	District Secretariat
DS	Divisional Secretariat
FAO	Food and Agriculture Organisation
FGD	Focus Group Discussion
GN	Grama Niladhari
Ha	Hectares
HICZMP	Hambantota Integrated Coastal Zone Management Project
IUCN	The World Conservation Union
IWMI	International Water Management Institute
Kg	Kilogram
MA	Millennium Ecosystem Assessment
MAP	Mangrove Action Project
MP	Market Price Method
NGO	Non Government Organisation
PEV	Participatory Environmental Valuation
PRA	Participatory Rural Assessment
Rs	Rupees
RUK	Rekawa Ussangoda Kalametiya
SAM	Sustainable Area Management
TEV	Total Economic Value
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programme
US$	US Dollars
WRM	World Rainforest Movement
WTP	Willingness to Pay

At the time of the study US$1 = 102 Sri Lankan Rupees

1. Introduction

Study background

The study on economic valuation of Tsunami affected mangroves is one component of the project "Valuation, Rehabilitation and Conservation of Mangroves in Tsunami Affected Areas". It was undertaken in the villages of Medilla, Medagama, Rekawa-west and Netolpitiya-south located in the South-eastern coastal zone of Tangalle District Secretariat (DS) division in Hambantota District in Sri Lanka and covered a total of 158 hectares of mangroves.

The mangroves in the study area are under intense pressure from over exploitation and clear cutting for alternative land uses. Conversion of mangrove forests for development activities such as for construction purposes, agriculture and shrimp farming are among the main threats in the area. The Indian Ocean Tsunami, which hit Sri Lanka in 2004, added further pressure on the mangroves, especially in the South-eastern coastal zone where severe destruction occurred.

The project was designed to address some of the issues related to the sustainable rehabilitation, management and conservation of tsunami affected mangrove ecosystems. The main objectives of the project are: a) to facilitate the restoration of local livelihoods in tsunami affected areas through mangrove restoration and sustainable use, and b) to improve awareness on the economic values of mangroves in order to justify mangrove rehabilitation and conservation as well as to minimize ecosystem damage in the tsunami reconstruction process. There are three main activities to be carried out during the project to achieve the above objectives, which are: 1) assessing the economic value of selected coastal mangrove ecosystems, 2) rehabilitation, restoration and conservation of tsunami affected mangrove areas, and 3) dissemination of mangrove valuation study results and advocacy. Furthermore a number of sub-activities where carried out including the establishment of a several small mangrove nurseries, replanting of damaged mangroves (4 hectares in Medilla, 4 hectares in Medagama, 24 hectares in Rekawa-west and 6 hectares in Netolpitiya-south), conducting training events on sustainable mangrove replanting and management, holding workshops and awareness meetings for community based organisations and local NGOs on the economic value of mangroves.

The primary target groups of the project and main beneficiaries of the proposed activities are the poor resource dependent households. The stakeholders including decision makers and ecosystem managers involved in the tsunami reconstruction process are expected to gain a better understanding of the values associated with conserving and rehabilitating mangroves. Emphasis was put on promoting local ownership in relation to all activities including the rehabilitation of mangroves.

Participatory approaches were adopted by the project to ensure continued commitment from all stakeholders – especially the poor households who stand to benefit the most from the rehabilitation of degraded mangroves in the study areas. Documenting the benefits and economic values of rehabilitating and conserving mangroves is expected to increase awareness and lead to more informed decisions about mangrove ecosystem management. 38 hectares of degraded and damaged mangroves will be replanted across the four study sites (villages) yielding tangible community benefits in the form of increased resource yields as well as improved mangrove and near-shore fisheries.

Mangroves are a specific type of evergreen forests that are found along the coastlines of tropical and subtropical regions, particularly along deltas and bays where rivers discharge freshwater and sediments into the sea. These mangroves provide important ecological and socio-economic functions to coastal dwellers. Mangroves provide habitats to a wide variety of marine and terrestrial flora and fauna and also provide a range of regulating, provisioning, cultural and supporting services (MA, 2005). In addition to their direct values, mangroves also support other ecosystems thereby indirectly sustaining a wide range of social and economic activities.

Mangrove ecosystems are valuable, both in terms of their direct use and indirect use values. Direct use values are represented by the goods provided directly by mangroves (e.g., fuelwood, fish and shellfish species, wild vegetables, herbs, construction materials). Indirect use values are represented by the ecological services provided by mangroves, which indirectly support economic activities. Potential services include serving as a nursery for near-shore fisheries; storing and recycling organic matter, nutrients and pollutants; regulating biological processes and functions; producing oxygen and storing carbon dioxide; and acting as barriers against coastal storms, tidal waves and also extreme events like tsunamis.

It will probably never be known how many lives were lost in the Indian Ocean Tsunami due to the destruction of mangroves and the damage to coral reefs, but it has been widely accepted that areas with more intact coastal ecosystems suffered less damage (MA, 2005). Unfortunately, the role of mangroves as living barriers was not well appreciated prior to the tsunami in December 2004 (Dahdouh-Guebas, 2006). Anecdotal evidences and initial observations following the aftermath of the tsunami indicate that the existence of healthy mangroves reduced the impact of the tidal waves (MAP, 2005). In addition, scientists believe that with climate change, further damage should be expected for small islands like Sri Lanka (AAS, 2006).

Assessing the economic value of mangroves is very important and will guide policy and decision makers towards more informed decisions. Development organisations and others involved in the post tsunami reconstruction process must also learn to fully understand the benefits provided by mangroves and incorporate mangrove rehabilitation and conservation as part of their reconstruction activities. The current mangrove valuation study is expected to provide this information.

The relative importance of Sri Lanka's mangroves

Sri Lanka, despite its small size, possesses a high level of biological diversity. Coastal and seashore vegetation covers a significant area of the coastline. Mangroves are found near river mouths and on the shores of lagoons. According to an inventory carried out by FAO/UNDP in 1983, the total area of mangroves at that time was about 8,000 hectares, but by 1992 the total area had decreased to 6,877 hectares (IUCN, 1993). Even though these figures show a gradual decline in mangrove area over time, the remaining mangroves still provide a wide array of benefits to local communities and deserve to be managed sustainable.

Similar to other natural ecosystems, mangroves have been exposed to both human and naturally induced interventions. The increase of migration to coastal regions since Sri Lanka's independence in 1948 has resulted in severe degradation of the coastal vegetation, particularly mangroves (Global Oceans, 2005). In Sri Lanka, the use of mangrove forests for economic activities such as shrimp faming has resulted in a significant reduction from 12,000 hectares in 1980 to 7,000 hectares in 2000 (Batagoda, 2005). The World Rainforest Movement (1999) disclosed that over the last ten years, many of the lagoons and estuaries in Sri Lanka have been subject to rapid destruction of its mangrove vegetation for tourism and commercial aquaculture (Liyanage, 1995). The inadequacy and lack of implementation of governing mechanisms to regulate the use of the coastal and marine resources exacerbated the conditions of mangroves particularly in the South if the country.

One of main reasons Sri Lanka has experienced this large scale conversion of mangroves to alternative land uses is the failure to recognise the ecological and economic benefits provided by these ecosystems, Many of the goods and services provided by mangroves are often not traded in a market and have characteristics of public goods. As a consequence mangrove goods and services are often interpreted as having little or no value. The importance of mangroves in supporting other ecosystems and economic activities has also not been fully understood and appreciated.

29 different mangrove species are found in Sri Lanka (GCEC, 1991; Pinto, 1986), with the most dominant ones being: *Rhizophora mucronata*, *Bruguiera gymnorhiza*, *Aegiceras corniculata R. apiculata*, *Cerebera manghas* and *Lumnitzera racemosa*. These species are primarily harvested for construction and domestic purposes by local communities. *Cerebera manghas*, for instance, is used for making paper, matchsticks, household utensils, agricultural implements, toys and masks for many traditional cultural activities (AIMS, 2005). Mangrove tannin is another important product derived from mangroves. Traditionally, Sri Lankans used tannin in curing fishnets. Twigs and branches of *Rhizophora mucronata*, *R. apiculata* and *Lumnitzera racemosa*, which are species found on the west coast, are used to form 'brush piles' or 'brush parks' in a specially devised fishing method (AIMS, 2005).

Being an island, the coastal land area in Sri Lanka represents 24 percent of the islands total size (62,705 sq km) excluding inland waters. 6.12 million people live in the coastal area, which represents 34 per cent of the entire population, leaving a population density of 446 people per sq km. With such a high population density a large number of human -based activities occur, such as coral mining, harvesting of coastal vegetation, salt extraction, tourism development, sand mining, prawn farming as well as a number of unauthorized development activities (Daily News, 2005).

Aim, hypotheses and objectives

In recent years the ecological, environmental and socio-economic importance of mangroves have been emphasised by international agencies, governments, local authorities, non-governmental organisations (NGOs), coastal communities and scientists. After the 2004 Indian Ocean Tsunami, many organisations (e.g. IUCN, UNEP, CARE and IWMI) involved in the reconstruction process have emphasised the importance of including the rehabilitation of damaged coastal ecosystems into conventional reconstruction activities in order to secure sustainable livelihoods. Some of the non-governmental, inter-governmental organisations and individuals engaged in environmental related project activities have allocated millions of dollars for coastal zone rehabilitation and sustainable management. Although mangrove ecosystems have the capacity to naturally regenerate and recover from external impacts this might be prevented by the increased pressure put on these systems by local communities. Mangroves are being exploited for their goods and in certain instances being cut down to provide land for new human settlements, hotels and infrastructure. The consequences and impact on local livelihoods associated with mangrove degradation is ill understood among policy and decision-makers. However, it is obvious that policy- and decision-makers often undervalue the goods and services provided by the mangrove ecosystems.

The overall aim of this study is to present the economic justification for including mangrove rehabilitation and restoration efforts in current tsunami reconstruction projects in Sri Lanka. The results provide a solid platform for the decision makers to select the best development strategies for the tsunami-affected communities by comparing the results provided by this study with the value of alternative uses of mangroves in these areas.

The following research hypotheses where defined for this project and will form the basis for data analysis and result presentation.

• The value of mangrove goods for subsistence use is higher in absolute terms for poor households compared to richer households.

• Healthy and intact mangroves provide valuable services in the form of support to near-shore fisheries and shoreline protection.

The main objective of this study is to improve awareness on the economic values of mangroves in order to justify mangrove rehabilitation and conservation as well as minimise ecosystem damage in the tsunami reconstruction process. Sub objectives include:

• To estimate the direct values of mangroves in tsunami-affected areas

• To estimate the indirect values of mangroves in tsunami-affected areas

• To draw conclusions that illustrate the importance of mangroves to local livelihoods and justify their rehabilitation in economic terms

Report structure

The report is structured as follows. *Section one* describes the study background and defines its overall aim and objective. *Section two* presents the study area. *Section three* outlines the methodology and key principles adopted by the study, including a short description of Total Economic Value (TEV), focus group discussions, household interviews and Participatory Environmental Valuation (PEV). *Section four* presents the results of the mangrove valuation study and *section five* draws conclusions. Finally, *section six* lists the references cited in the text.

2. Study Area

The study area is located in Tangalle District Secretariat (DS) Division of Hambantota district in Sri Lanka – between latitude (6.02) / longitude (80.78) and latitude (6.06) / longitude (80.89). Hambantota is one of the districts that was severely affected by the tsunami in 2004. Tangalle DS division is located next to the Matara district, which is 195 km south of Colombo and is one of the most dynamic coastal areas in the country. The area belongs to the intermediate climatic zone; with an annual rainfall of about 2,000 mm. Tangalle DS Division is subject to strong winds, especially along the coast from June to September, when the average wind speed is 23 km/hr. During the rest of the year, the average wind speed is around 18 km/hr (Ekaratne et al., 2000).

The area has been recognised as an area with unique biodiversity and harbours a variety of natural and man made vegetation/habitat types, including both terrestrial and wetland systems (IUCN, 2003). The area contains 287 plant species belonging to 65 families and the fauna documented in the area includes a total of 328 species of vertebrates out of which 14 species (4%) are endemic, while 27 species (8%) are nationally threatened (IUCN, 2003). The beaches in this area are also important nesting sites for all five species of globally threatened marine turtles[1] . Rekawa has also been identified as one of the most environmentally sensitive sites in Hambantota District, and is categorised as one of the 29 biodiversity areas in the district (HICZMP, 2000b).

Mangroves are found along the canals and the main basin of the Rekawa Lagoon (study area). Out of the 29 species of mangroves found in Sri Lanka 17 species[2] are found on the study area (Ranasinghe, 2003). Rekawa lagoon is the main source of inland fisheries in the study area and fish, crustaceans and shrimp make up most of the catch. Fish are generally caught throughout the year, although May to October represents the peak fishing season. Furthermore, there are nine species of crustaceans found in the lagoon and four species[3] of commercially important shrimp are caught between December and April (Ganewatte et al., 1995; HICZMP, 2000a).

Marine fishery (near-shore, offshore and deep-sea) is also a very important source of livelihood in the study area and two main fishing seasons are observed. The first running from August to April and the second from May to August. Even though there are peak fishing seasons, most of the fishermen are active throughout the year. According to an IUCN biodiversity assessment the sub-tidal zone of the study area includes 185 fish species in 119 genera and 62 families (IUCN, 2003).

The total population in Hambantota District is 525,370 people out of which 62,804 reside in Tangalle DS Division. There are 17,607 households located within the Division (DCS, 2001) and average monthly household income is recorded as Rs, 9,392, which is the third lowest in the country.

[1]Namely; *Chelonia mydas* Green turtle*, Caretta caretta* Loggerhead*, Dermochelys coriacea* Leatherback turtle*, Eretmochelys imbricata* Hawksbill turtle*, Lepidochelys olivacea* Olive Ridley turtle.

[2]*Acanthus ilicifolius, Acrostichum aureum, Aegiceras corniculatum, Avicennia marina, Avicennia officinalis, Bruguiera gymnorhiza, Bruguiera sexangula, Ceriops tagal, Clerodendrum inerme, Dolichandrone spathacea, Excoccaria aggalocha, Heritiera littoralis, Lumnitzera racemosa, Rhizophora mucronata, Sonneratia acidia, Sonneratia caseolaris* and *Typhe angustifolia* (Ganewatte et al, 1995).

[3]*Penaeus monodon, Penaeus semisulcatus,* and *Parapenaeopsis uncta*

Medagama

160 households reside in Medagama village accounting for 530 people (244 males and 286 females). Two thirds of the households receive Samurdhi [4], which is the highest percentage among all four surveyed villages.

Agriculture is the predominant source of livelihood and 41 households are engaged in this activity. Off-site employment comes in second place with 30 households holding jobs, and fisheries in third place with 24 households.

Mixed mangrove and scrub vegetation is found in Medagama including some coconut plantations. The mangrove area selected for valuation and makes up around 20 hectares surrounding inland brackish water bodies. There are very few constructions near the beach compared to the other three study sites.

Medilla

Medilla is a small village located next to Tangalle town, which is a very popular tourist destination because of its beautiful beaches. 326 households live in Medilla comprising of 1,002 people (437 males and 565 females).

According to the income categorisation of the GN (village head) 135 households are classified as poor and are recipients of Samurdhi. Fishing is the predominant source of livelihood and 73 households are engaged in this activity out of which 21 households are directly dependent on lagoon fisheries. In addition, there are 45 households holding jobs most of which are in the public sector.

Most of the Medilla's coastline has been developed for tourism purposes and as a result the mangroves in the area have been severely affected. At present there are about 48 hectares of mangroves left, which will be valued by the valuation exercise. The mangroves have been more or less disturbed and impacted by the tsunami.

Netolpitiya-south

Netolpitiya-south is located between Medagama and Rekawa-west. Out of the four villages in the sample the highest population is found here – 412 households including 1,195 people (542 males and 653 females). 250 households receive Samurdhi.

Agriculture represents the most important source of livelihood and engages 190 households. 132 households are employed in the public sector and 30 households depend on fisheries.

There are 20 hectares of mangroves in Netolpitiya-south, which are partly degraded. Most of the degradation took place prior to the tsunami.

Rekawa-west

Rekawa-west is a small village on the South coast of Sri Lanka, approximately 10 kilometres east of Tangalle. Rekawa borders a large saline lagoon (250 hectares), which is surrounded by good mangrove forests. There are 303 households and 958 people (514 males and 444 females) living in Rekawa-west. 135 households are classified as poor according to the number receiving Samurdhi.

The major income generating activities for the people of Rekawa-west are: lagoon fishery (144 households); agriculture (66 households); and tourism (20 households).

The beach in Rekawa-west is 50 meters wide with a gentle slope, and approximately half of the pandanus stands were damaged by the tsunami. 70 hectares of mangrove is found surrounding the lagoon and will be subject to valuation.

Rekawa Sri Lanka © Thushara Ranasinghe

[4]Sri Lankan social welfare

Courtesy : Google Maps

Figure 1: Aerial photos of the study area

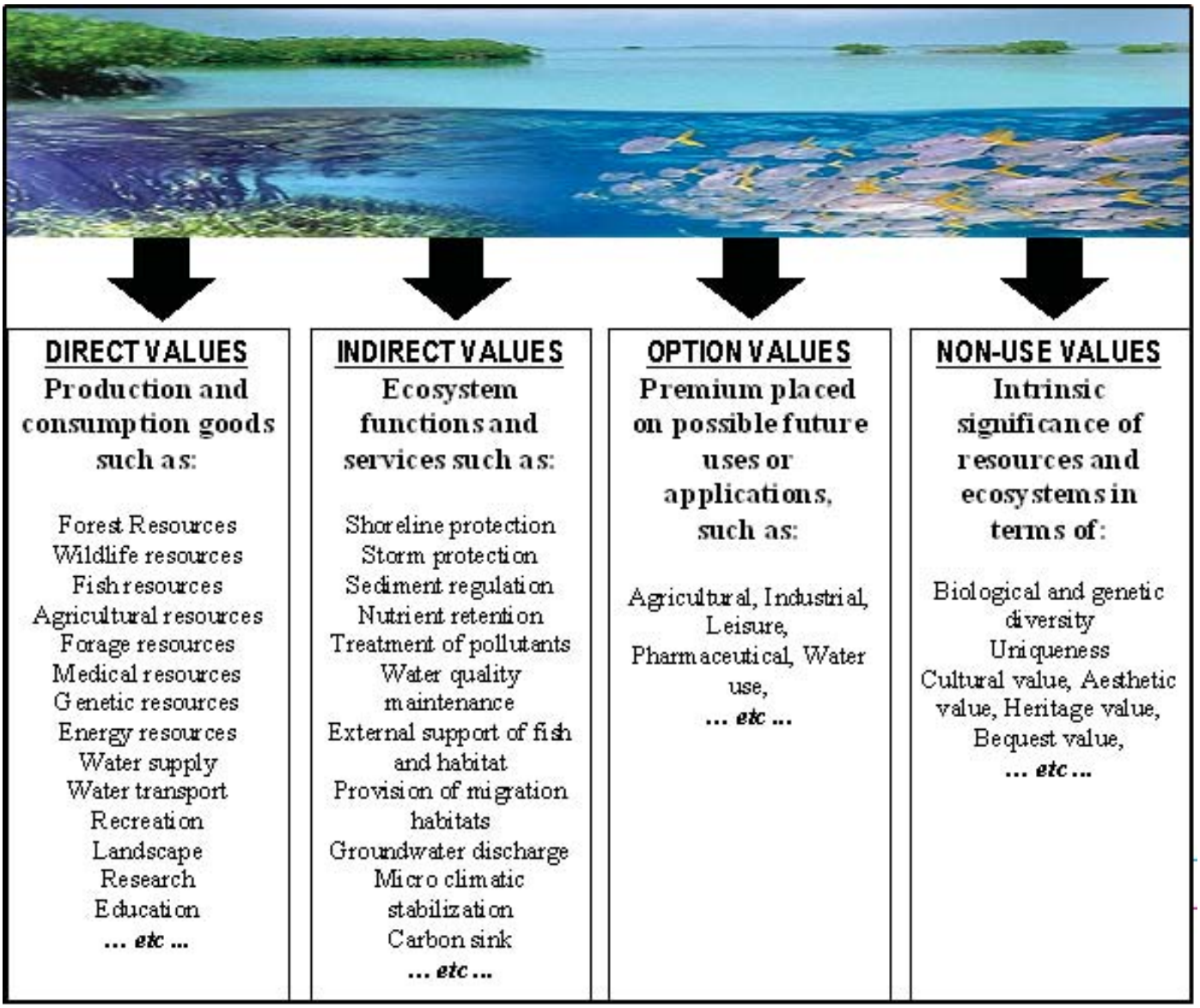
3. Study framework and metodology

Total Economic Value (TEV) and economic valuation

The most appropriate framework to assess the overall economic value of an ecosystem is the Total Economic Value (TEV) and represents the monetary measure of the change in an individual's well being due to a change in environmental quality. It is not environmental quality that is being measured per see, but people's preferences for changes in quality and quantity. Economic valuation of ecosystems tries to assess the preferences held by people, and the value determined 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 TEV framework shown below highlights the full range of economic values provided by mangroves.

Figure 2: TEV framework



Direct use values refer to values derived from actual use of the good either for direct consumption or production of other commodities. In the case of mangroves, direct use values would include the value of fuelwood, timber, wild vegetables, herbs, shellfish and fish.

Indirect use values refer to values derived from ecosystem functions and services, such as the benefits provided by mangroves as shoreline protection, breeding grounds and habitats for fish and shellfish species, storing carbon and conserving biodiversity.

Option values are those that approximate an individual's willingness to pay (WTP) in order to ensure that the goods and services can be utilised at a later date. Option values can be seen as an insurance premium for securing future use. Mangroves for example represent an option value in the form of protecting against future extreme weather events and natural disasters.

Non-use values refer to the benefits derived from the mere existence of mangrove ecosystems, above and beyond any direct or indirect use value that people may enjoy. Non-use values include both “existence” value and “bequest” value. Bequest values arise when people place a value on the conservation of particular resources for future generations or use and non-use values for offspring.

In this study attempts are only made to value the direct use and indirect use values of mangrove ecosystems.

Environmental valuation techniques and data collection approaches

Economic valuation methods can be tailored towards better reflecting local use values of an ecosystem. Many of these methods are survey based and require an element of local participation in order to generate vital information on seasonal variation and social differentiation and also qualitative information on the importance of indirect and non-use values (e.g. environmental functions and cultural values).

In the valuation study of this project, focus group discussions and household interviews were conducted to collect data, and the Market Price Method (MP) along with Participatory Environmental Valuation (PEV) were used to calculate the direct use values. Estimating the indirect use values, in the form of supporting near-shoe fisheries and shoreline protection, was based on the Effect on Production Method and Damage Cost Avoided Method.

Market Price Method

When a market price exists for ecosystem goods, the simplest, most straightforward method for valuing these goods is to use their market prices: how much it costs to buy, or what it is worth to sell. In a well-operating and competitive market these prices are determined by the relative demand for and supply of the product and should hence reflect its true scarcity, and equate to its marginal value.

The Market Price Method (MP) follows three steps:

1. Gathering data on mangrove products collected by the households from their mangrove ecosystems;

2. Collecting data on the market prices of mangrove ecosystem goods;

3. Multiplying price by quantity of each good to determine its actual market value.

In this study, households were requested to provide information on harvest levels throughout the year in order to ensure adequate coverage of seasonal variations.

The valuation of mangrove goods was done by multiplying local market prices with the quantities collected thereby generating the gross benefits. In order to calculate the real (net) benefits provided by mangrove goods to the households, the cost of extraction was deducted. Costs included expenses for buying and maintaining fishing gear and the opportunity cost of time spent (costed at the going wage rate for unskilled labor).

Participatory Environmental Valuation Method

As many environmental goods (particularly those utilised for subsistence) are rarely traded, are often undervalued by market prices and have characteristics of public goods, Participatory Environmental Valuation (PEV) was applied as an additional method to calculate the true value of fuelwood, timber and poles, and herbs and vegetables (the goods used exclusively for subsistence in the study). By comparing the valuation results of these goods from the market price method and the PEV method it becomes possible to identify the value-range within which the utility derived from fuelwood, timber and poles, and herbs and vegetables by households is represented.

In the PEV local villagers express the value of different mangrove products within the context of their own perceptions, needs and priorities rather than through conventional cash-based techniques. PEV has been developed to deal with economic valuation of the use of mangrove and other ecosystem goods by rural communities in developing countries. PEV acknowledges the fact that much local mangrove use went unaccounted for as it was consumed within the household and hence not valued by the market. PEV combines PRA techniques with more conventional economic valuation methods (contingent valuation and contingent ranking).

PEV follows a number of steps (Emerton, 1996):

1. Recording the main mangrove goods collected by the household on cards – one card for each good

2. Deciding on a numeraire. Should be something that: indicates a value, which can be translated easily into a cash amount; has local and individual value; and has a defined lifespan

3. Ranking the cards depicting the different mangrove goods according to their economic importance

4. Distributing a specified number of counters between the cards (including the numeraire) according to their perceived economic importance to the household

In this study, one-year sufficiency of rice was used as a numeraire, given that it is the staple food of Sri Lanka and can relatively easy be translated into a cash amount. Information on the rice consumption of each interviewed households was recorded as were the number of counters (beans) placed on each card. The value of each good was then expressed relative to the ranking of the numeraire.

Effect on Production Method

Even when ecosystem services do not themselves have a market price, other marketed products often rely on them as basic inputs. For example, near-shore fisheries depend on the services provided by mangroves in the form of nurseries and breeding grounds. In such a situation it becomes possible to assess the value of a specific ecosystem services by looking at its contribution to other sources of production, and to assess the effects of a change in the quality or quantity of that service.

There are three main steps to collect and analyse the data required for the effect on production method to value ecosystem services:

1. Determine the contribution of ecosystem services to the related source of production, and specify the relationship between changes in the quality or quantity of a particular ecosystem service and output;

2. Relate a specified change in the provision of the ecosystem service to a physical change in the output or availability of the related product;

3. Estimate the market value of the change in production.

The effect on production method relies on a simple logic, and it is relatively easy to collect and analyse the market information that is required to value changes in production of ecosystem-dependent products (see above, market price techniques).

Damage Cost Avoided Method

As is the case with mangroves, coastal ecosystems are frequently cited their ability to protect other economically valuable assets. In this study the shoreline protection value of mangroves is assessed by following the below steps:

1. Obtain information on the physical damage and livelihood loss caused by the tsunami at the study sites as well as at the control site;

2. Cost these damages, and ascribe the difference between the recorded damages at the study sites with the recorded damages at the control site – Medilla has been chosen as the control site as the village at this site was not sheltered directly by the mangrove.

Data collection is for the most part straightforward, usually relying on a combination of analysis of historical records, direct observation, interviews and professional estimates. The damage cost avoided method is often used for valuating ecosystem services.

Focus Group Discussions

A total of four focus group discussions were conducted (one per villages). The main objective of these discussions was to understand the different kinds of benefits obtained from mangroves in the study areas and the different kinds of mangrove goods extracted by its local users. In addition the status of the market and its prices were also discussed. FGDs can provide clarity on a number of issues that are important to the preparation of the actual survey, the development of questionnaires and the design of data recording templates. Furthermore, these discussions provide an opportunity for gathering ideas and perceptions of the local villagers on the use and management of mangrove resources in their area.

Household Interviews

200 [5] household interviews were conducted to assess the direct use values of mangrove goods as well as the indirect values of mangrove services. The sample represents 19% of the households in Medagama, 19% in Medilla, 19% in Rekawa-west and 13% in Netolpitiya-south. Within each village the households were divided into two main categories 1) mangrove good collectors (fuelwood, timber, vegetables, medicinal plants, and fish and shellfish) and 2) near-shore fishermen. In addition to that households were subdivided into different income categories to analyse for variation in mangrove dependence according to poverty level.

A questionnaire was prepared to define what specific goods were collected, when and how much. In addition the questionnaire included specific questions about the level of subsistence use of each collected good.

Households engaged in near-shore fisheries were also interviewed regarding the species of fish they caught, and information was gathered on fish catch quantities, market prices, the costs of operation (e.g. fuel), maintaining fishing gears and boats and the time spent on fishing. Based on this information the net annual value of near-shore fisheries was calculated.

Information on damage costs, caused by the Indian Ocean Tsunami, was also collected at a household level and included loss of property, livestock and livelihood. The loss of property included information on the costs of damage to houses and fishing equipment. Livestock losses where recorded as number of dead animals and livelihood losses as damage to agricultural crops. In addition, data on the cost of human injuries, caused by the tsunami, were also gathered in the form of expenses associated with purchasing medicine and travelling to the hospital as well as loss of income during the period of disability.

Data analysis

The data collected was analysed in order to derive average net per household values and average net per hectare values. In addition household values were disaggregated across different income categories to test the hypothesis that the value of mangrove goods for subsistence use is higher in absolute terms for poor households compared to richer households. Due to time and resource constraints the study does not perform any statistical analysis to test for result significance.

As mentioned, market prices were multiplied with the collected quantities of goods to arrive at the direct value of mangroves. As for the value of the mangrove services benefiting near-shore fisheries, the calculation is based on household survey data and the assumption that 30% to 80% of near-shore fish catch can be attributed to the mangrove services of fish nurseries and breeding grounds as recommended by (Rönnbäck, 1999). The net annual value of near-shore fisheries is calculated based on data obtained through the household interviews and a value range is calculated with 30% and 80% of the total value of near-shore fisheries representing the boundaries. It is important to note that the value of near-shore fisheries is not included in the direct value of fish caught inside the mangrove, but refers to fish caught of-site and hence does not lead to double counting.

Estimating the shoreline protection value is done by comparing actual damages between sites thereby expressing the damage cost avoided at the sites sheltered by mangroves. In this study the village of Medilla has been chosen as the control site as Medilla experienced severe property and livelihood damage since the village is not located behind a mangrove as is the case with the other three study sites. The mangroves in Medilla are located to the side of the village. Damages assessed include: loss of agricultural crops, human injuries, and loss of income during the period of disability.

As mentioned above this study only assessed the economic value of mangrove goods and services and does not capture option and non-use values. As a consequence the findings reported in the next section should hence be interpreted as minimum values and not as the total economic value of the surveyed mangroves.

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[5]30 in Medagama, 62 in Medilla, 52 in Netolpitiya-south and 56 in Rekawa-west.

4. Study results

In the following sections the results of the valuation study are presented. The results will be disaggregated according to village and household income level, and the number of households interviewed in each village will be mentioned as well as the income group to which they belong.

The direct use values that were assessed are grouped into six categories: shellfish; fish; timber & poles; herbs and vegetables; fuel-wood; and others while the indirect use values are represented by support to near-shore fisheries and shoreline protection.

Socio-economics characteristics of the sample villages

The four tsunami affected villages: Medilla; Medagama; Netolpitiya-south; and Rekawa-west were selected for this study as the data gathering locations.

The tables below show the distribution of households according to income categories and the factors determining this categorisation.

Table 1: Income distribution of household in the villages

Village	Number of People	Average Household Size	Number of Households	Income Category		
				Poor	Medium	Rich
Medilla	1,002	3.07	326	135	151	40
Medagama	530	3.31	160	110	36	14
Netolpitiya-south	1,421	3.45	412	250	72	90
Rekawa-west	958	3.16	303	135	125	43

The income categories and the corresponding criteria were defined by the GNs (village heads) for each village. The main factor applied for distinguishing between income categories was that of receiving Samurdhi, the Sri Lankan form of social service payment, which is commonly applied as an indication of poverty throughout Hambantota District. The households eligible for Samurdhi have a monthly income of less than Rs. 3,000. Other factors used to distinguish between medium and rich households are shown in the table below.

Table 2: Factors determining household income category

Village	Income categories		
	Poor	Medium	Rich
Medilla	Recipients of “Samurdhi” (Income < Rs. 3,000)	Owning agricultural land (Income Rs. 3,000-10,000)	Government job, multi-day boats, vehicles, other income sources (Income > Rs. 10,000)
Medagama	Recipients of “Samurdhi” (Income < Rs. 3,000)	Owning agricultural land (Income Rs. 3,000-10,000)	Government job, multi-day boats, vehicles, other income sources (Income > Rs. 10,000)
Netolpitiya-south	Recipients of “Samurdhi” (Income < Rs. 3,000)	Owning agricultural land (Income Rs. 3,000-10,000)	Government job, multi-day boats, vehicles, other income sources (Income > Rs. 10,000)
Rekawa-west	Recipients of “Samurdhi” (Income < Rs. 3,000)	Owning agricultural land (Income Rs. 3,000-10,000)	Government job, multi-day boats, vehicles, other income sources (Income > Rs. 10,000)

In order to get the largest relevant sample and the best basis for calculating values only the households collecting mangrove goods were interviewed. In the table below the numbers of collecting households in each surveyed village are shown along with the sample sizes. Also the total number of households is presented, as this will be used to calibrate per average household values at the village level.

Table 3: Number of households collecting mangrove goods in each village

Village	Total number of households	Number households collecting mangrove goods	Sample size of collecting households
Medilla	326	110 (34%)	28 (25%)
Medagama	160	93 (58%)	16 (17%)
Netolpitiya-south	412	36 (9%)	34 (94%)
Rekawa-west	303	146 (48%)	26 (18%)

The number of collecting households that were sampled in each village was to a large extent determined by household availability during the data collection period, which explains the large variation in the percentage of total number collecting households that were interviewed.

The six groups of goods that were identified as representing the direct use values of the surveyed mangroves are presented in Table 4 below.

Table 4: Groups of mangrove goods

Shellfish:	Fish:	Timber & Poles:	Herbs and Vegetables:	Fuelwood:	Other:
Shrimp (Kiri-issa) Shrimp (Gal-issa) Crabs	Aguluwa Bataya Carp China Godaya Japan Korali Lagga Marando Nailoti Penno Thatilla Waharali Other	Timber Wooden poles	Kerenkoku Kothalahimbutu Lunuvila		Coconut leaves industry Fodder

Fuelwood is the main source of energy used for cooking and heating purposes in the study area. The majority of the households collect fuelwood from the nearby mangrove forests. Fuelwood along with timber and poles, and herbs and vegetables are collected only for own consumption and not for commercial purposes.

In the study area local communities mainly use timber from mangrove species for construction purposes, as it is a durable building material. Especially the straight stems of *Ceriops tagal* (Punkanda), *Rhiziphora* (Kadol) and *Bruguiera* (Mal Kadol) are preferred for constructing wooden frames for roofs, doors and windows. Furthermore, a number of the larger constructions found in the area (hotels) have made wide use of timber from mangrove species. The timber from coconut trees is widely used as rafters (Amarasinghe, 1988).

Commonly fish and shellfish species caught in the study area include: *Penaeus indicus* (Kiriisa), *Mugil cephalus* (Godaya), *Etroplus suratensis* (Korali), *Lutjanus spp* (Panno.), *Cyprinus carpio* (Carp), *Tilapia nilotica* (Niloti), *Scylla serrata* (crab). In general shrimp and other shellfish species are in high demand and can be sold with a good profit.

A variety of herbs and medicinal plants are collected from the mangroves household consumption – in particular: *Aervalanata* (Polpala), *Gymnema sylvestre* (Masbedda), *Sarcostemma brunonianum* (Muwakeriya), *Vernonia cinerea* (Monarakudumbiya), *Eclipta prostrate* (Kikirindiya), *Ipomoea aquatica* (Kankun), *Cyperus rotundus* (Kalanduru) and *Sida veronicifolia* (Bavila). Vegetables are also harvested for subsistence purposes. For example the fiddlehead of *Acrostichum aureum* (Kernkoku) and the kernel of the fruit of *Terminallia catapa* (Bulu) are edible. Furthermore, bark tannin is used for curing leather and fishnets (Bandaranayke 1998).

In the following, the findings for the valuation study are shown for each village. The direct values are presented as an average per collecting household based on market prices. The values generated by the market price method are grouped into the six groups shown in Table 4 and disaggregated according to household income level. Finally, the indirect values, represented by the services provided by mangroves in supporting near-shore fisheries and protecting the shoreline, are presented.

Medagama

Direct use values

Table 5 below presents the average values of mangrove goods per collecting household and for all households in Medagama as well as the per hectare value. The values calculated are based on the data collected from 16 household interviews, which covers 10% of total households and 17% of the collecting households and includes 9 poor, 6 medium and 1 rich household.

Table 5: Values of mangrove goods collected by households in Medagama

Collected mangrove goods	Average quantity collected per HH	Unit	Average unit price (Rs)	Average gross value per collecting HH (Rs)	Average cost per collecting HH (Rs)	Average net value per collecting HH (Rs)
Shellfish						
Crabs	113.00	Kg	250	28,250	7,1179	20,533
Shrimp (Kiri-issa)	297.07	Kg	350	103,975	28,404	75,571
Shrimp (Gal-issa)	53.44	Kg	250	13,359	3,660	9,710
Fish						
Aguluwa	33.33	Kg	60	2,000	546	1,454
Godaya	396.38	Kg	50	19,819	5,414	14,405
Japan Korali	349.40	Kg	60	20,964	2,727	15,237
Nailoti	555.31	Kg	60	33,319	9,102	24,217
Penno	24.00	Kg	50	1,200	328	872
Thatilla	49.17	Kg	30	1,475	403	1,072
Waharali	7.50	Kg	50	375	102	273
Timber and poles						
Timber	3.28	Rafter	250	819	0	819
Herbs and vegetables						
Kerenkoku	8.25	Bundle	10	83	0	83
Fuelwood	28.67	Bundle	100	2,867	0	2,867
Value Per HH/year (Rs)				**228,504**	**61,395**	**167,109**
Value Per HH/year (US$)				**2,240**	**602**	**1,638**
Net Value per hectare/year (US$)						**7,618**

According to the table above the collecting households catch seven different fish species out of the thirteen species listed in the “fish-group” (see Table 4). On average the total fish catch per household is recorded as 1,415 kg per year equal to an average net income per fishing household of Rs 57,530 (US$ 564). The group of mangrove goods that adds most to household income is the “shellfish group” with an average value of Rs 105,814 (US$ 1,037) per year represented by average catches of 133 kg of crab and 351 kg of shrimp. Collection of fuelwood is estimated at 29 bundles per year per household, which is valued at Rs. 2,867 (US$ 28). The collection of herbs and vegetables is minor in Medagama.

Based on the results from the market price method the yearly net average value of mangrove goods per collecting household in Medagama is estimated at Rs 167,109 (US$ 1,638). The calculated value represents both goods that are collected for sale as well as for subsistence use.

Based on the PEV survey conducted in 30 households in Medagama the value of fuelwood was calculated as Rs 10,418 (US$ 102) per household per year. This is substantially higher than the value derived from market prices Rs 2,867 (US$ 28) and indicates that market prices severely undervalue the importance of fuelwood from a household perspective. The same seems to be the case with timber and poles, and herbs and vegetables. The PEV valued timber and poles at Rs 2,175 (US$ 21) while the market price method arrived at only Rs 819 (US$ 8). For herbs and vegetables PEV estimated Rs 4,190 (US$ 41) compared to Rs 83 (less than US$ 1) from the market price method.

Table 6 below disaggregates the gross values of mangrove goods for collecting households under different income categories based on the market price method. The table summaries the benefits for each income group, and further subdivide the values into non-cash income (consumed) and cash income (sold).

Table 6: The gross value of mangrove goods according to income category

Collected mangrove goods	Poor		Medium		Rich	
	Non-cash income (Rs)	Cash income (Rs)	Non-cash income (Rs)	Cash income (Rs)	Non-cash income (Rs)	Cash income (Rs)
Shellfish	2,829	103,487	14,154	166,388	17,355	271,895
Fish	3,744	63,802	1,176	38,541	9,478	410,722
Timber and poles	1,456	0	0	0	0	0
Herbs and Vegetables	80	0	100	0	0	0
Fuelwood	3,927	0	1,755	0	0	0
Other	0	0	80	0	0	0
Value per HH/year (Rs)	**12,036**	**167,289**	**17,265**	**204,929**	**26,833**	**682,617**
Value per HH/year (US$)	**118**	**1,640**	**169**	**2,009**	**263**	**6,692**

Fuelwood, timber and poles, and herbs and vegetables are the only goods collected exclusively for own consumption regardless of household wealth. In relative term shellfish and fish are however still the goods contributing the most to non-cash income. Selling fish and shellfish is the main source of cash income for all income categories, but as can be seen from the table above the absolute value increases the wealthier the household.

Overall Table 6 shows that non-cash income for poor households is estimated at Rs 12,036 (US$ 118) per household per year while cash income is Rs 167,289 (US$ 1,640) per household per year. For the medium category the values are non-cash Rs 17,265 and cash Rs 204,929 (US$ 2009), and for the rich households non-cash Rs 26,833 (US$ 263) and cash Rs 682,617 (US$ 6,692). While it is very clear that the overall value derived from mangrove goods for subsistence and cash increases across the income categories it is important to note that whilst the poor and medium households apparently benefit the least from mangroves in absolute terms that in relative terms the non-cash contribution to these income categories is double [6] compared to the rich households.

Indirect use values

Support to near-shore fisheries:

One of the main ecological services of mangroves is their support given to near-shore fisheries by serving as nursery and breeding grounds.

There has been considerable work and debate on the link between mangroves and fishery catches. In a recent comprehensive review by Rönnbäck in 1999, various studies are highlighted where 30% to 80% of fish catch and up to 100% of shrimp catch is attributed in some way or the other to mangroves. In this study, it is assumed that the dependence of near-shore fisheries is similar to the studies presented by Rönnbäck in 1999 and hence the assumption is made that 30% to 80% of the value of near-shoe fisheries can be ascribed to mangrove services.

[6] Poor: 7%, medium: 8%, and rich: 4%

In Medagama 14 households (9% of total households and 58% of households engaged in near-shore fisheries) were interviewed to collect information on annual fish catch and operational and maintenance costs. According to the collected data the total net value of near-shore fisheries has been estimated at Rs 8,676,591 (US$ 85,065) per year. There are 20 hectares of mangroves in the area, and based on the sea area supported by these mangroves and the recorded fish catch there, the average net yearly value per hectare mangrove is estimated to be in the range of Rs 130,149 (US$ 1,276) to Rs 347,064 (US$ 3,403), which translates into a net yearly value range per households, that engages in near-shore fisheries, equal to Rs 108,426 (US$ 1,063) to Rs 289,170 (US$ 2,835).

Shoreline protection:

Previous studies, which valued the shoreline protection function of mangroves, have estimated values based either on predicted property and livelihood losses or on costs from mitigating against potential harmful event. This study, however, makes use of actual damage assessments and estimated costs caused by the tsunami to properties and livelihoods as well as humans.

As mentioned Medilla is applied as a control site to illustrate the difference in damage between villages located behind mangroves, and hence sheltered from the tsunami waves, and Medilla which is located almost directly on the beach. As can be seem from Table 7 below the damage costs avoided in Medagama are calculated as Rs 12,631,000 (US$ 123,833) for property; Rs 5,706,000 (US$ 55,941) for livelihood; and Rs 45,650 (US$ 448) for other [7]. The protective value per hectare mangrove is Rs 919,133 (US$ 9,011), which translates into Rs 114,892 (US$ 1,126) per household.

Table 7: Damage cost avoided in Medagama

Actual damages	Medilla		Medagama		Damage cost avoided	
	Rs	US$	Rs	US$	Rs	US$
Property	12,666,000	124,176	35,000	343	12,631,000	121,833
Livelihood	9,034,500	88,574	3,328,500	32,632	5,706,000	55,941
Other	109,650	1,075	64,000	627	45,650	448
Total	21,810,150	213,825	3,427,500	33,603	18,382,650	180,222
Per HH (US$)						**1,126**
Per Ha (US$)						**9,011**

Summary

Table 8 summarises the use values (direct and indirect) provided by mangroves in Medagama. The values are presented as per household and per hectare figures. It should be noted that the values of resource extraction and support to near-shore fisheries are yearly values whereas the protective value is estimated as the damage cost avoided linked to a particular event – the Indian Ocean Tsunami.

Table 8: Total use value of mangroves in Medagama

	Value/Benefit (US$/HH)	Value/Benefit (US$/ha)
a) Direct use value		
Shell fish, Fish, Fuelwood, Timber and poles, Herbs & vegetables and other	1,638/year	7,618/year
b) Indirect use value		
Near-shore fisheries	1,063 – 2,835/year	1,276 – 3,403/year
Shoreline protection	1,126	9,011

[7]Other includes the medical costs of treating injuries sustained and loss of income due to inability to work during recovery.

Direct use values

The table below presents the results of the valuation study in Medilla with regard to the direct use values. The values calculated are based on the data gathered from 28 collecting households (8.5% of total households, 26% of collecting households, 12 poor, 13 medium and 3 rich households).

Table 9: Values of mangrove goods collected by households in Medilla

Collected mangrove goods	Average quantity collected per HH	Unit	Average unit price (Rs)	Average gross value per collecting HH (Rs)	Average cost per collecting HH (Rs)	Average net value per collecting HH (Rs)
Shellfish						
Crabs	74.32	Kg	250	18,580	5,341	13,239
Shrimp (Kiri-issa)	216.18	Kg	350	75,663	21,750	53,912
Shrimp (Gal-issa)	61.77	Kg	250	15,443	4,439	11,004
Fish						
Aguluwa	31.67	Kg	60	1,900	546	1,354
Bataya	13.29	Kg	50	664	190	473
Godaya	569.93	Kg	50	28,496	8,191	20,305
Japan Korali	456.01	Kg	60	27,361	7,865	19,496
Lagga	4.21	Kg	50	211	61	150.
Marando	16.67	Kg	60	1,000	287	713
Nailoti	53.82	Kg	60	3,229	928	2,301
Penno	154.29	Kg	50	7,714	2,218	5,497
Thatilla	250.82	Kg	30	7,525	2,163	53,62
Waharali	38.57	Kg	50	1,929	544	1,374
Other	33.63	Kg	60	2,018	580	1,438
Timber and poles						
Timber	2.90	Rafter	250	725	0	725
Wooden Poles	11.61	Poles	20	232	0	232
Herbs and vegetables						
Kerenkoku	13.43	Bundle	10	134	0	134
Kothalahimbutu	3.19	Kg	50	159	0	159
Lunuvila	0.96	Bundle	10	10	0	10
Fuelwood	36.46	Bundle	100	3,646	0	3,646
Other						
Coconut leaves	15.00	Leave	10	150	0	150
Total Value Per HH/year (Rs)				**196,789**	**55,116**	**141,673**
Total Value Per HH/year (US$)				**1,929**	**540**	**1,389**
Net Value per hectare/year (US$)						**3,183**

The households in the sample collects more than 20 different mangrove goods including 11 species of fish, 3 species of shellfish, fuelwood, a several herbs and vegetables. On average 1,623 kg of fish are caught per household per year. The mangrove goods contributing the most to overall income are the different shellfish species – in particular shrimp. On average each household catches 74 kg of crabs and 278 kg of shrimp per year. The quantity of fuelwood collected is recorded as 36 bundles per household per year.

According to the results in Table 9 the collected mangrove goods represent an average net value of Rs 141,673 (US$ 1,389) per year for the collecting households. These values represent both goods that are collected for sale as well as for subsistence use.

62 households in Medilla participated in the PEV survey. Once again data was collected on fuelwood, timber and poles and herbs and vegetables. Based on the PEV survey the value of fuelwood was calculated as Rs 12,038 (US$ 118) per household per year, which is way above the calculated marked value of Rs 3,646 (US$ 36). Similar findings were made for timber and poles and herbs and vegetables. In terms of numbers, timber and poles where through the PEV valued at Rs 5,237 (US$ 51) compared to 957 (US$ 9) using the market price method, whereas herbs and vegetables were valued at Rs 4,109 (US$ 40) and Rs 303 (US$ 3) under the PEV and market price method respectively. These results clearly indicate that market prices often severely undervalue environmental goods especially when these are used exclusively for subsistence purposes.

Table 10 below analyses the direct use values of mangrove goods for collecting households across income categories.

Table 10: The gross value of mangrove goods according to income category

Mangrove Products	Poor		Medium		Rich	
	Non-cash Income	Cash Income	Non-cash Income	Cash Income	Non-cash Income	Cash Income
Shell fish	5,466	116,280	3,429	109,937	910	44,590
Fish	7,369	94,867	2,697	71,801	780	33,220
Timber and poles	1,608	0	346	0	1,000	0
Herbs and Vegetables	527	0	158	0	40	0
Fuelwood	3,407	0	3,323	0	6,000	0
Other	20	900	28	323	0	0
Value per HH/year (Rs)	18,397	212,047	9,981	182,061	8,730	77,810
Value per HH/year (US$)	**180**	**2,079**	**98**	**1,785**	**86**	**763**

As can be seen from Table 10 all income categories gain substantial cash income from selling mangrove goods. However, it is interesting to note that in Medilla the level of non-cash income declines as the households become better off.

Indirect use values

Support to near-shore fisheries:

34 households (11% of total households and 47% of households engaged in near-shore fisheries) were interviewed in Medilla. With 48 hectares of mangroves in Medagama and total near-shore fisheries valued at Rs 125,854,639 (US$ 1,233,869) per year, the average net value per hectare of mangrove in supporting near-shore fisheries is estimated to be in the range of Rs 786,591 (US$ 7,712) to Rs 2,097,577 (US$ 20,564) per year. Per fishing household this translates into a value range of Rs 517,242 (US$ 5,071) – Rs 1,379,244 (US$ 13,522) per year.

Shoreline protection:

Out of the four sites selected for this study, Medilla records the highest level of damage. The main reason for this is that most of the infrastructure in Medilla is not sheltered from the sea by any natural vegetation, including mangroves. Hence it is not possible to calculate the value of damage cost avoided. However, as mentioned Medilla has been chosen to act as the control site for the other three study locations, and is in effect the reference point illustrating what damage might have been incurred in Medagama, Rekawa-west and Netolpitiya-south had these villages not been protected by mangroves.

The total cost of damage caused by tsunami in Medilla is recorded as Rs 21,810,150 (US$ 213,825).

Summary

Table 11 summarises the total use values of mangroves in Medilla as well as the indirect value of supporting near-shoe fisheries.

Table 11: Total Use Value Attached to the Tsunami Affected Mangrove Ecosystem

	Value/Benefit (US$/HH)	Value/Benefit (US$/ha)
a) Direct Use		
Shell fish, Fish, Fuelwood, Timber and poles, Herbs & vegetables and other	1,389/year	3,183/year
b) Indirect Use		
Near-shore fisheries	5,071 – 13,522/year	7,712 – 20,564/year
Shoreline protection	0	0

Rekawa-west

Direct use values

The direct use values, presented in Table 12 below, are based on data collected from 26 household interviews and include 12 poor, 14 medium households. Unfortunately, no households belonging to the rich category where able to participate in the study, and hence information is only available for the poor and medium income categories.

Table 12: Values of mangrove goods collected by households in Rekawa-west

Collected mangrove goods	Average quantity collected per HH	Unit	Average unit price (Rs)	Average gross value per collecting HH (Rs)	Average cost per collecting HH (Rs)	Average net value per collecting HH (Rs)
Shellfish						
Crabs	153.31	Kg	250	38,327	13,451	24,876
Shrimp (Kiri-issa)	238.78	Kg	350	83,573	29,329	54,244
Shrimp (Gal-issa)	40.85	Kg	250	10,212	3,584	6,628
Fish						
Aguluwa	26.03	Kg	60	1,562	548	1,014
Bataya	21.59	Kg	50	1,080	379	701
Godaya	467.65	Kg	50	23,383	8,206	15,177
Japan Korali	526.79	Kg	60	31,608	11,092	20,515
Marando	77.92	Kg	60	4,675	1,641	3,034
Nailoti	38.08	Kg	60	2,285	802	1,483
Waharali	67.57	Kg	50	3,378	1,186	2,193
Other	78.75	Kg	60	4,725	1,658	3,067
Timber and poles						
Timber	1.23	Rafter	250	308	0	308
Wooden Poles	2.50	Poles	20	50	0	50
Herbs and vegetables						
Kerenkoku	27.46	Bundle	10	275	0	275
Kothalahimbutu	0.19	Kg	50	10	0	10
Fuelwood	51.46	Bundle	100	5,146	0	5,146
Value per HH/year (Rs)				**210,594**	**71,875**	**138,719**
Value per HH/year (US$)				**2,065**	**704.66**	**1,360**
Net Value per hectare/year (US$)						**2,837**

Households in Rekawa-west harvest more than seven species of fish with an average catch of 1,304 kg per year representing an average net income of Rs 47,184 (US$ 463) per household per year. Shellfish species are the main income-generators accounting for household income equal to Rs 85,748 (US$ 841) a year. A number of other goods are also collected, including fuelwood and various species of herbs and vegetables. This is however mainly for own consumption.

On average, mangrove goods represent a yearly value of Rs 138,719 (US$ 1,360) for the collecting household in Rekawa-west.

Examining if the values attached to goods collected for subsistence purposes and presented in Table 12 above, do in fact reflect the utility derived from these goods, the PEV survey was carried out among 56 households. Under the PEV, the value of fuelwood was calculated as Rs 11,343 (US$ 111) per household per year, which is substantially more than Rs 5,146 (US$ 51) – the value derived from market prices.

A similar conclusion can be drawn regarding the values of timber and poles and herbs and vegetables. Timber and poles are under the PEV estimated at Rs 4,009 (US$ 39) per household per year and herbs and vegetables at Rs 4,063 (US$ 40) per household per year, whereas the values based on market prices are estimated at Rs 358 (US$ 4) for timber and poles and Rs 285 (US$ 3) for herbs and vegetables.

In Rekawa-west there does, according to Table 13 below, not seem to be a major difference in the importance of mangrove goods as a source of non-cash income across different income categories.

Table 13: The gross value of mangrove goods according to income category

Mangrove Products	Poor		Medium		Rich	
	Non-cash Income	Cash Income	Non-cash Income	Cash Income	Non-cash Income	Cash Income
Shell fish	2,224	116,793	3,350	139,985	0	0
Fish	5,975	42,435	3,030	90,484	0	0
Timber and poles	58	0	614	0	0	0
Herbs and Vegetables	205	0	352	0	0	0
Fuelwood	3,350	2,700	4,371	0	0	0
Other	50	0	26	0	0	0
Value per HH/year (Rs)	**11,862**	**161,928**	**11,743**	**230,469**	**0**	**0**
Value per HH/year (US$)	**116**	**1,588**	**115**	**2,260**	**0**	**0**

Non-cash income for all poor and medium households in Rekawa-west consists mainly of shellfish, fish and fuelwood. The contribution of timber and poles, herbs and vegetables and other mangrove goods for non-cash income is minor. The main source of cash income is made up of fish and shellfish. Table 13 furthermore shows that non-cash income for poor households in Rekawa-west is estimated at Rs 11,862 (US$ 116) per household per year while cash income is calculated as Rs 161,928 (US$ 1,588) per household per year. For the medium income category the values are for non-cash income Rs 11,743 (US$ 115) and for cash income Rs 230,469 (US$ 2,260) per household per year.

Indirect use values

Support to near-shore fisheries:

The 70 hectares mangroves found in Rekawa-west are together with the lagoon there of ecological importance, and are viewed as supporting the near-shore fisheries.

In Rekawa-west 31 households (10% of total households and 22% of households engaged in near-shore fisheries) were interviewed and revealed information that was used to calculate the value of near-shoe fisheries equal to Rs 115,703,001 (US$ 1,134,343) per year. Again assuming that between 30% and 80% of this value is sustained by mangrove services, the annual indirect value of mangroves in supporting near-shore fisheries can be calculates as between Rs 495,870 (US$ 4,861) and Rs 1,322,320 (US$ 12,964) per hectare per year.

The value per fishing household is estimated to fall in the range of Rs 241,026 (US$ 2,363) – Rs 642,804 (US$ 6,302) per year.

Shoreline protection:

In Rekawa-west the damage costs reported after the Indian Ocean Tsunami are shown in Table 14 and the damage costs avoided are calculated with reference to Medilla as the control site.

Table 14: Damage cost avoided in Rekawa-west

Actual damages	Medilla		Rekawa-west		Damage cost avoided	
	Rs	US$	Rs	US$	Rs	US$
Property	12,666,000	124,176	3,325,000	32,598	9,341,000	91,578
Livelihood	9,034,500	88,574	2,798,600	27,437	6,235,900	61,136
Other	109,650	1,075	6,000	59	103,650	1,016
Total	21,810,150	213,825	6,129,600	60,094	15,680,550	153,631
Per HH (US$)						**507**
Per Ha (US$)						**2,196**

The damage costs avoided are estimated at Rs 9,341,000 (US$ 91,578) for property, Rs 6,235,900 (US$ 61,136) for livelihood and Rs 103,650 (US$ 1,016) for other. On a per hectare basis this translates into Rs 224,008 (US$ 2,196) and on a per household basis into Rs 51,751 (US$ 507).

Summary

Table 15 summarises the average direct and indirect use values of mangroves in Rekawa-west. The values are presented per household and per hectare.

Table 15: Total Use Value Attached to the Tsunami Affected Mangrove Ecosystem

	Value/Benefit (US$/HH)	Value/Benefit (US$/ha)
a). Direct Use		
Shell fish, Fish, Fuelwood, Timber and poles, Herbs & vegetables and other	1,360/year	2,837/year
b). Indirect Use		
Near-shore fisheries	2,363 – 6,302/year	4,861 – 12,964/year
Shoreline protection	507	2,196

Rekawa Sri Lanka © Channa Bambaradeniya

Direct use values

Table 16 presents the annual average direct use values calculated for mangrove goods collected in Netolpitiya-south. The calculations are based on data collected from 34 households (14 poor, 16 medium and 4 rich households).

Table 16: Values of mangrove goods collected by households in Netolpitiya-south

Collected mangrove goods	Average quantity collected per HH	Unit	Average unit price (Rs)	Average gross value per collecting HH (Rs)	Average cost per collecting HH (Rs)	Average net value per collecting HH (Rs)
Shellfish						
Crabs	6.96	Kg	250	1,739	1,090	649
Shrimp (Kiri-issa)	57.74	Kg	350	20,207	12,661	7,546
Shrimp (Gal-issa)	2.47	Kg	250	618	387	231
Fish						
Bataya	4.94	Kg	50	247	155	92
Godaya	39.17	Kg	50	1,960	1,227	731
Japan Korali	26.94	Kg	60	1,616	1,013	604
Marando	1.76	Kg	60	106	66	40
Nailoti	20.65	Kg	60	1,239	776	463
Waharali	45.18	Kg	50	2,259	1,415	844
Other	6.18	Kg	60	371	232	138
Timber and poles						
Timber	0.71	Rafter	250	176	0	176
Wooden Poles	3.47	Poles	20	69	0	69
Herbs and vegetables						
Kerenkoku	18.71	Bundle	10	187	0	187
Kothalahimbutu	0.06	Kg	50	3	0	3
Lunuvila	0.06	Bundle	10	0.6	0	0.6
Fuelwood	20.69	Bundle	100	2,069	0	2,069
Value per HH/year (Rs)				**32,865**	**19,022**	**13,843**
Value per HH/year (US$)				**322**	**186**	**136**
Net Value per hectare/year (US$)						**244**

The households in Netolpitiya-south collect more than 20 mangrove goods, including six different species of fish. On average, mangrove related fish and shellfish catch per household per year is recorded as 145 kg of fish, 7 kg of crab and 60 kg of shrimp. The average net household income (non-cash and cash) generated by these goods is estimated as Rs 2,912 (US$ 29) per year for fish and Rs 8,426 (US$ 83) per year for crab and shellfish. Collection of fuelwood is estimated at 21 bundles per year per household, which is valued at Rs 2,069 (US$ 20) whereas the value of timber and poles, and herbs and vegetable is minor.

According to the results of the market price method, the total net value of mangrove goods per collecting household is Rs 13,843 (US$ 136) per year. This value represents both goods that are collected for sale as well as for subsistence use.

In Netolpitiya-south the PEV survey was conducted in 52 households. Under the market price method the value of fuelwood was calculated as Rs 2,069 (less than US$ 20) per household per year, but under the PEV the value was estimated to be Rs 8,100 (US$ 79) per household per year. Once again the PEV generated values much higher values then when making use of market prices. Timber and poles and herbs and vegetables also show significantly higher values under the PEV.

The results of analysing the values according to income category are shown in Table 17 below.

Table 17: The gross value of mangrove goods according to income category

Mangrove Products	Poor		Medium		Rich	
	Non-cash Income	Cash Income	Non-cash Income	Cash Income	Non-cash Income	Cash Income
Shell fish	575	35,750	183	15,982	0	0
Fish	2,103	4,661	1,929	8,719	0	0
Timber and poles	440	0	125	0	50	0
Herbs and Vegetables	180	0	248	0	0	0
Fuelwood	3,225	0	1,125	0	1,800	0
Other	0	0	0	0	0	0
Value per HH/year (Rs)	**6,523**	**40,411**	**3,610**	**24,701**	**1,850**	**0**
Value per HH/year (US$)	**64**	**396**	**35**	**242**	**18**	**0**

As can be seen from the table above fuelwood, timber and poles, and herbs and vegetables are the only mangrove goods collected exclusively for own consumption regardless of household wealth. The highest contribution for non-cash income comes from shellfish and fish. Cash income of poor and medium income households consists of mangrove associate shellfish and fish species only. It is also apparent that the absolute values decreases the wealthier the household.

Annual non-cash income from mangrove goods for poor households is estimated at Rs 6,523 (US$ 64), Rs 3,610 (US$ 35) for medium household, and Rs 1,850 (US$ 18) for rich households. Also in Netolpitiya-south it is quite clear that the poorest households depend the most on mangrove goods for subsistence purposes, and even that the overall value, both in absolute and relative terms, is highest for the poor category.

Indirect use values

Support to near-shore fisheries:

In the case of Netolpitiya-south 21 households (5% of total households and 70% households engaged in near-shore fisheries) were interviewed to collect data on the annual fish catch as well as the costs involved with fishing. There are 20 hectares of mangroves in Netolpitiya-south and the total yearly value of near-shore fisheries in the area has been estimated at Rs 9,957,921 (US$ 97,627). Once again assuming that 30%-80% of the value of near-shore fisheries can be ascribed to functioning mangroves, a per-hectare value is calculated to range between Rs 149,369 (US$ 1,464) and Rs 398,317 (US$ 3,905) per year.

On a per household level the values are calculated as Rs 99,552 (US$ 976) – Rs 265,506 (US$ 2,603) for fishing households.

Shoreline protection:

The observations carried out in Netolpitiya-south on the damage in economic and human terms are used to calculate the value of the role of mangroves as a barrier for tsunami waves. Using the data on the damage caused to the economic activities like fisheries and agriculture, values of damages for houses, other buildings, equipment and properties and cost of treatments for the injuries and disabilities made by the tsunami disaster, calculated the value of shoreline protection function of mangroves of Netolpitiya-south. Table 18 presents the damage cost avoided in Netolpitiya-south and as in other cases Medilla is applied as a control site to illustrate difference in damage.

Table 18: Damage cost avoided in Netolpitiya-south

Actual damages	Medilla		Netolpitiya-south		Damage cost avoided	
	Rs	US$	Rs	US$	Rs	US$
Property	12,666,000	124,176	0	0	12,666,000	124,176
Livelihood	9,034,500	88,574	1,632,600	16,006	7,401,900	72,568
Other	109,650	1,075	14,000	137	95,650	938
Total	21,810,150	213,825	1,646,600	16,143	20,163,550	197,682
Per HH (US$)						**480**
Per Ha (US$)						**9,884**

According to Table 18 above the damage cost avoided in Netolpitiya-south are Rs 12,666,000 (US$ 124,176) for property, Rs 7,401,900 (US$ 72,568) for livelihood, and Rs 95,650 (US$ 938) for other. The shoreline protection value per hectare of mangroves in Netolpitiya-south can hence be calculated as Rs 1,008,178 (US$ 9,884) and Rs 48,941 (US$ 480) per household.

Summary

Table 19 below summarises the use values derived for mangroves in Netolpitiya-south. The values include the direct use values of mangrove goods and the indirect use values of mangrove services, including supporting near-shore fisheries and providing shoreline protection.

Table 19: Total Use Value Attached to the Tsunami Affected Mangrove Ecosystem

	Value/Benefit (US$/HH)	Value/Benefit (US$/ha)
a). Direct Use		
Shell fish, Fish, Fuelwood, Timber and poles, Herbs & vegetables and other	136/year	244/year
b). Indirect Use		
Near-shore fisheries	976 – 2,603/year	1,464 – 3,905/year
Shoreline protection	480	9,884

Rekawa Sri Lanka © SEEDO Sri Lanka

Overall summary

In the sections above the results from each study site have been presented. However, seeking to influence and better inform decision-making and natural resource management, in the coastal areas of Sri Lanka, will require knowledge about environmental values at a larger spatial scale. For that purpose the section below has been devoted to provide information on the values of mangroves in Hambantota district. The four study sites will form the basis for this assessment and be viewed as representative examples of mangroves in the district. Furthermore, it is also seen as useful to carry out further analysis on the importance of mangroves to different income groups.

The values presented in the figures below are average values calculated based on results from the four study sites and illustrate the contribution of specific mangrove goods towards cash and non-cash income of poor, medium and rich households. The figures present the gross values of mangrove goods per collecting household per year.

Relative importance of mangrove goods as non-cash income for poor, medium and rich households

Figure 3: Relative importance of mangrove goods as non-cash income for poor households

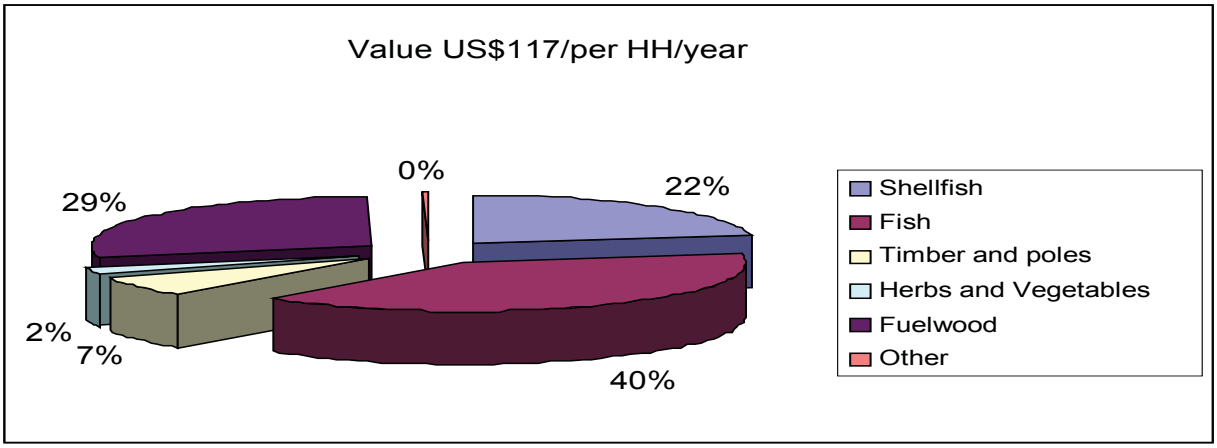
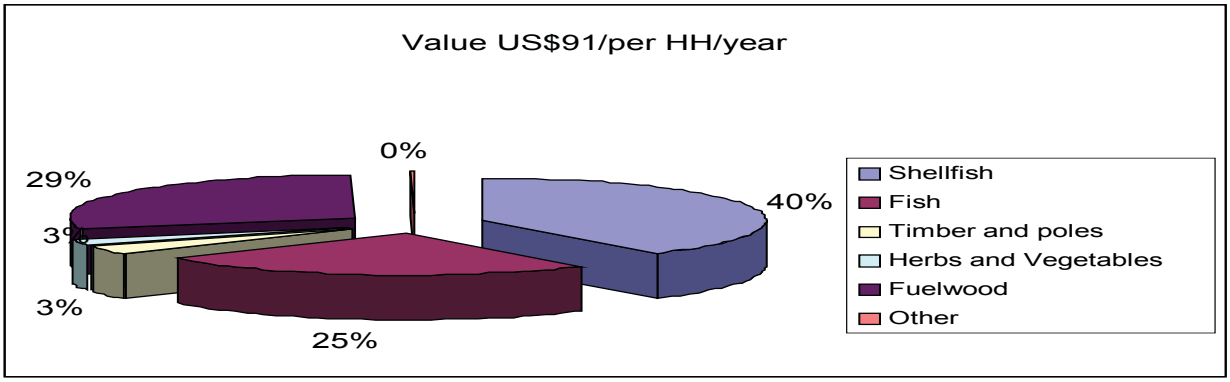


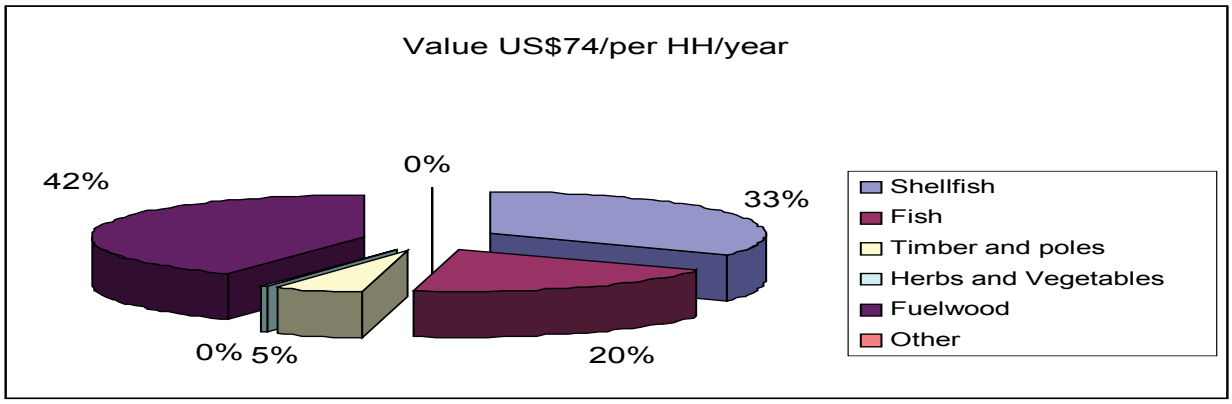
Figure 3 above illustrates the average contribution of the six groups of mangrove goods identified in Table 4 as sources of non-cash income for all poor households in the sample villages. As can be seen mangrove dependent fish species contribute up to 40% of the non-cash income generated by mangrove goods and fuelwood 29%, shellfish 22%, timber & poles 7%, and herbs and vegetables 2%. On average poor households collecting mangrove goods derive yearly benefits worth Rs 11,934 (US$ 117).

Figure 4: Relative importance of mangrove goods as non-cash income for medium households



For the households belonging to the medium income category, mangrove goods are valued at Rs 9,282 (US$ 91) per year, and shellfish make up the largest proportions of this. Furthermore, Figure 4 illustrates that fuelwood contributes with 29% and fish with 25%. Compared to the results above for the poor households, the better off household in the medium category depend less on mangrove goods for subsistence purposes.

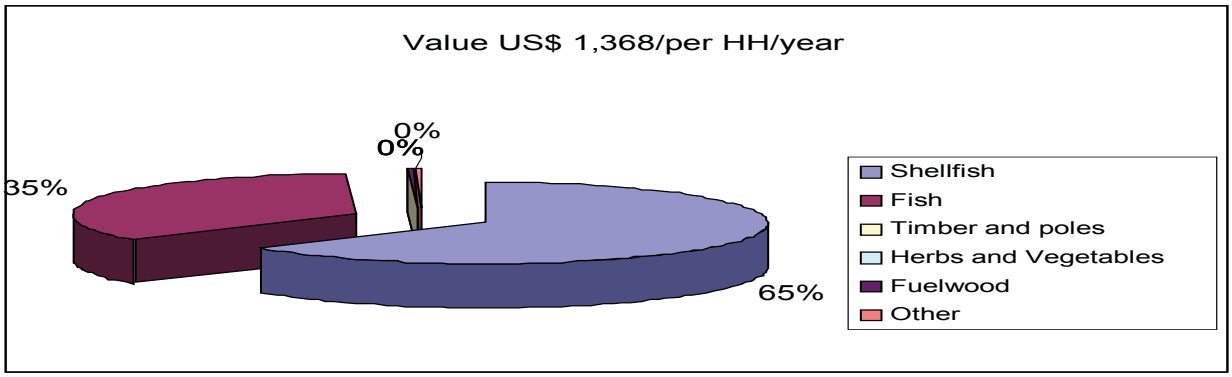
Figure 5: Relative importance of mangrove goods as non-cash income for rich households



Looking at the results for the rich households, as shown in Figure 5, it becomes apparent that the wealthier the household the less valuable mangrove goods appear to be in non-cash terms. For the rich households mangrove goods on average only represent a non-cash value of Rs 7,548 (US$ 74) per year, which is primarily made up of fish (42%), shellfish (33%) and fuelwood (20%).

Relative importance of mangrove goods as cash income for poor, medium and rich households

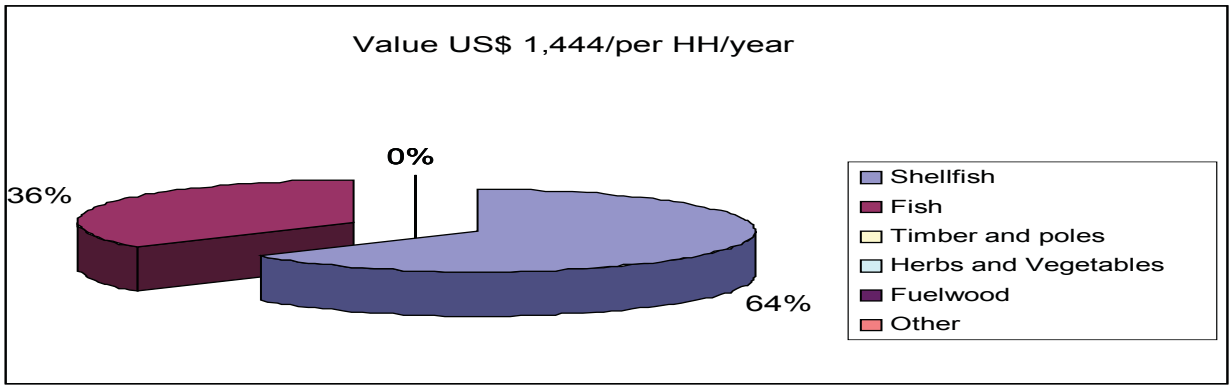
Figure 6: Relative importance of mangrove goods as cash income for poor households



In addition to the importance of mangrove goods for subsistence purposes, as illustrated above, a number of the collected goods also generate significant cash income for the households thereby contributing to their overall livelihood.

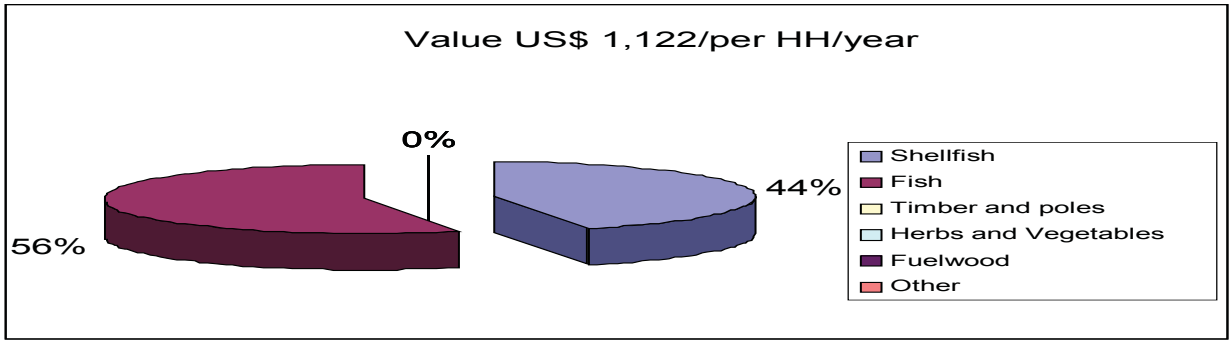
According to Figure 6 the average annual cash income from mangrove goods is estimated at Rs 139,536 (US$ 1,368) per poor household and is composed of income coming from selling shellfish (65%) and fish (35%).

Figure 7: Relative importance of mangrove goods as cash income for medium households



For the medium households shellfish and fish are also the two only mangrove goods collected for sale. Figure 7 shows that 64% of cash income from mangrove goods is generated from selling shellfish and 36% from selling fish. The gross annual value represented by these sales is estimated at Rs 147,288 (US$ 1,444) per household per year.

Figure 8: Relative importance of mangrove goods as cash income for rich households



For the rich households shellfish and fish still make up the source of cash income from mangrove goods. Fish are for the rich households the dominant contributor with 56% whereas shellfish account for the remaining 44%.

Overall all households in the study appear to benefit more than US$ 1,000 per year from selling mangrove goods, which is significant when compared to the average per capita income of US$ 252 and average per household income of US$ 1,104 in Hambantota district.

5. Conclusions

The present study can, based on the estimated direct and indirect values of mangroves in Hambantota district, draw the overall conclusion that mangroves are very important for local livelihoods both in terms of providing goods for consumption, but also as a main source of cash income.

Furthermore, the study has proven the hypothesis that the value of mangrove goods for subsistence use is higher in absolute terms for poor households compared to richer households, and that market prices tend to undervalue environmental goods that are used exclusively for subsistence purposes. In the case of fuelwood market prices at best managed to capture 45% of the true value of fuelwood as expressed by the collecting households. Also it is apparent that healthy and intact mangroves provide valuable services in the form of support to near-shore fisheries and shoreline protection.

For the resource dependent households participating in this study mangrove goods generate gross economic benefits that are over and above the average household income recording in Hambantota district. The annual net direct use values per household collecting mangrove goods have been estimated at US$ 1,638 for Medagama, US$ 1,389 for Medilla, US$ 1,360 for Rekawa-west and US$ 136 for Netolpitiya-south, which is considerable lower than the three other sites. There are two main reasons for this, which are: 1) households in Netolpitiya-south have more restricted access to the mangrove compared to the other sites; and 2) households in Netolpitiya-south have other major income sources and livelihood options as the village is located near a large road and a number of government jobs are available near by.

In addition, the indirect values of mangroves in supporting near-shore fisheries have been calculated as: US$ 1,276-US$ 3,403 for Medagama; US$ 7,712-US$ 20,564 for Medilla; US$ 4,861-US$ 12,964 for Rekawa-west; and US$ 1,464-US$ 3,905 for Netolpitiya-south – these numbers represent annual per hectare values. In terms of shoreline protection the per hectare values have been calculated as: US$ 9,011 for Medagama; US$ 2,196 for Rekawa-west; and US$ 9,884 for Netolpitiya-south. These values underline the valuable role, which intact and healthy mangroves provide in buffering against extreme weather events such as a tsunami.

It is believed that the present study provides useful information on the economic values of mangroves in Hambantota district, and that the information should be used to better inform decisions pertaining to managing mangrove ecosystems as well as planning reconstruction activities in the aftermath of the Indian Ocean Tsunami.

The fact that the study has proved that mangroves play a vital part in local livelihoods and that well managed mangroves contribute significantly to near-shore fisheries and shoreline protection should be used to facilitate the discussion on promoting sustainable managed natural ecosystems as an integral part of achieving development and alleviating poverty.

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