



**ECONOMIC ANALYSIS AND IMPLEMENTATION STRATEGY OF SELECTED  
MANGROVE SUPPORTIVE LIVELIHOOD OPTIONS FOR THE TARGETED COASTAL  
COMMUNITY OF TIMOR-LESTE**

**Project Title: Building Shoreline Resilience of Timor-Leste to Protect Local  
Communities and Their Livelihood**

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## **Abbreviation and Acronyms**

CBA	Cost Benefit Analysis
CE	Choice experiment
CVM	Contingent Valuation Method
FAO	Food and Agricultural Organisation
GEF	Global environment facility
GoTL	Government of Timor-Leste
JICA	Japan International Cooperation Agency
LDCF	Least developed countries fund
MAF	Ministry of Agriculture and Fisheries
MOF	Ministry of Forestry
SBEPB	Sustainable Bio-energy Production from Biomass
TEEB	The Economics of Ecosystems and Biodiversity
TEV	Total economic value
TOR	Terms of Reference
UNFPA	United Nations Family Planning Association
WTP	Willingness to Pay

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# **1. INCEPTION REPORT**

## **I. Introduction**

### **A. Background and Context**

The objective of this study is to undertake an economic valuation of mangrove supportive livelihoods. It is assessing the existing livelihood / economic activities and recommend the most feasible activities to the respective target mangrove restoration sites. This can be new or existing economic activity supporting livelihood options for coastal community which would enhance biodiversity conservation in the long-run and to enhance resilience through adopting ecosystem-based approaches. The approach of the study will involve the development of mechanisms whereby protection of mangroves can effectively undertake and sustain physical and economic assets against climate change induced hazards and non-climate related anthropogenic impacts. At the same time this project will deliver social and economic benefits to support activities that will bring about transformational change in the management and utilisation of mangrove resources and habitats which help to reconcile economic growth and needs for food security with ecosystem conservation and sustainable use coastal community in project areas. The study will be designed to investigate four key topics: local-level knowledge of mangrove uses and benefits, ecosystem service values, joint natural resource management experiences, and the need for community-based incentives. The timeframe of the assignment is 60 days.

### **B. Purpose and Scope of Evaluation**

Mangrove trees are used for multiple purposes such as firewood, timber wood, wood chip and pulp production, charcoal production and animal fodder. However, in some parts of the world it is no longer sustainable, threatening the future of the forests although harvesting has taken place for centuries. Mangrove forests have often been seen as muddy, smelly, unproductive and so cleared to make room for agricultural land, human settlements, infrastructure, and industrial areas. More recently in Timor-Leste clearing mangroves were reported for tourism, shrimp aquaculture, and salt farms (Gef, 2015). This clearing is a major factor behind mangrove loss in Timor-Leste and around the world.

Pressure from communities for development is a key driver for mangrove loss in Timor-Leste like anywhere else in the world. It has been the practice of traditional coastal livelihood to

depend on salt production using mangrove for fuel. In order to control this, there are ongoing efforts such as Sustainable Bio-energy Production from Biomass (SBEPB) to reduce the demand for wood by communities in Timor-Leste. The SBEPB was to promote sustainable production and utilization of bio-mass resources to support local people which will reduce the demand for fuel wood. However, it is good to inquire whether the SBEPB activities have significant contribution to relieve the pressure from communities on mangroves for fuelwood? Evidence shows that human always seek available next best option if current livelihood practice is not sufficient to cover livelihood expenditure. According to an economic analysis, researchers found that farmers in Timor-Leste were able to generate more salt with the introduction of salt evaporation ponds with reduced physical effort. However, during the rainy season farmers tend to go back to cut mangroves to cook salt to prevent disruption to livelihood income as the value of mangroves is worth nothing to them. Demonstrating the real value (also known as Total Value) may change human attitude before destroying the mangroves for other immediate benefits which are not sustainable. Scope of this evaluation is to demonstrate the total value of mangroves.

## **II. Methodology**

### **A. The Methodology of the Study**

Primary objective of this consultancy is to conduct robust economic analyses to identify most viable mangrove-supportive livelihoods in the target municipalities. Critical ecosystem services sustained by mangrove forests in this area include: supporting (nutrient cycling, soil formation); provisioning (food, fresh water, wood, fuel); regulating (climate & flood regulation), and cultural (aesthetic, educational, recreational) values. In an ideal situation, the total economic value (TEV) of the ecosystem services should be used in comparing mangrove ecosystem conservation value against other development activities (Wattage & Mardle, 2005). This economic study follows the Millennium Ecosystem Assessment approach in characterizing the benefits that people obtain from ecosystems as provisioning, regulating, supporting and cultural services. This reflects recognition that mangroves do not just generate physical products, but also provide the primary productivity and life support services that underpin human wellbeing and livelihoods in project areas. This would emphasise that the final output of the economic model should be viable livelihood options to be introduced to the target community for its multiple benefits (i.e., enhanced livelihoods through ecosystem-based mangroves restoration activities).

In this analysis three types of assessments will be used for *provisioning and cultural* value estimation. A three-tiered approach to ecosystem valuation will be adopted, based on the proposal of the global initiative “The Economics of Ecosystems and Bio-diversity (TEEB)” (TEEB, 2010). **First**, the direct value of mangrove products (ecosystem products) will be calculated, followed by the effect of a change in the area of the mangroves on production to assess the value of habitat provision (ecosystem service). This is an assessment of direct livelihood benefits using current market prices. The household (HH) survey will yield significant data on the use of mangrove products, and will show that the household income on fish and non-fish mangrove products such as for fuel-wood, medicine, fodder honey collection, etc. In addition to that the Agricultural and General Census of 2015 in Timor-Leste would be ideal sources for relevant data collection. A simple spreadsheet analysis will be used to estimate direct value of mangrove products. The **second** stage will be the effect on production or the value of the habitat provisioning service provided by mangroves. This will be the value derived from the benefits of offshore fisheries. Three scenarios will be developed using the per hectare value as current year value using the market price. The first scenario will be the baseline, which states no change in area and derives net present value of the site level value per hectare over a period of 5 years. Two alternative scenarios will be developed that will be used to analyse how a 25 percent decrease/increase of mangrove area would impact on offshore fish productivity. Finally, a modified cost-benefit analysis will be undertaken to support the argument for investing in mangrove conservation (Wattage and Soussan, 2003). These provisioning services or mangrove products support food security and livelihoods in number of ways. They may be consumed directly (for example fish, honey and plant-based medicines), used as an input into other production processes (such as boats and traps for fishing, fodder for livestock production, or fuelwood for cooking), or sold to generate cash that can then be used to purchase food supplies and other items. Mangrove based tourism is also serves as an important source of income and employment for coastal communities, however, initial study indicates that there is no mangrove-based tourism. As such this study would suggest developing eco-tourism which would bring additional income to local people as a payment for conserving the resources.

In addition to provisioning and cultural services values, list of regulating services is also making a major contribution to the total value provided by mangrove ecosystem. Mangrove forests act as a protection against tsunami and regulate flooding in many parts of the world. Mangrove products tend to be especially important for poorer and more vulnerable sectors

of the coastal population, and typically serve as fall back or safety nets in times of emergency or stress, when other sources of income and subsistence fail. Similarly, supporting services provide fundamental processes such as nutrient cycling and water exchange that support the other three categories. These values are difficult to estimate as they are not selling in a market place. A choice experiments (CE) approach will be used to assess community perceptions of the value of key regulating and supporting services, including fisheries nursery and breeding, shoreline protection, flood control and biodiversity services (Wattage, 2011). Willingness to Pay (WTP) value can be deduced from the results of a CE study. There are other available methods such as Contingent Valuation Method (CVM), Hedonic Pricing (HP) and Travel Cost method (TCM) for valuing environmental commodities, however, CE is more preferable as it reveals stakeholder preferences for management attributes in addition to the WTP value. Hence, CE has been selected for this study.

Design an integrated implementation strategy:

Design of an integrated implementation strategy for each livelihood option will be based on the investigations made, field visits to the field sites and other data analyses of secondary and survey data (primary). Using this information, it is easy to identify combination of Community Based Ecological Mangrove Rehabilitation and potential livelihood options appropriate for selected sites to present to communities. Finally, a preliminary cost-effectiveness analysis will be carried out of the proposed livelihood options/social businesses or interventions (which will be validated during different consultations), if necessary.

Stakeholder involvement plan for the implementation of the selected best livelihood options integrated with mangrove rehabilitation, coastal management and adaptation interventions will be carried out. Methodology use for this will be either CBA or the cost-effective analysis. The interlink with all stakeholders is vital for the success of an integration scheme of this nature. Setting up the conservation policy / livelihood options and implementing it appropriately requires the collaboration of many disparate stakeholders at provincial levels.

## **B. Indicators**

All indicators develop in this study will match the SMART criteria (specific, measurable, achievable, relevant, time bound).



### **C. Methods of Data Collection and Data Analysis**

Data will be collected via questionnaire surveys of local households, community focus group discussions, stakeholder consultations, expert interviews and a desk-based literature review. Collected data (both primary and secondary) will be analysed using appropriate statistical or econometric models such as linear or non-linear regression approaches. Employ critical gender consideration in the economic analysis. Secondary data were collected from the MAF and the General Directorate of Statistics (UNFPA) which are helping to create the bigger picture of the analysis, however, the final economic analysis will be based on the primary data collection at the field sites (seven districts) of the project. FAO statistics are also collected and are very useful in filling the gap of data.

### **D. Sampling**

The study focused on the project area, adjacent villages and towns. All people living in this stretch of land are likely to be affected as a consequence of either conservation or conversion of mangrove lands for development. This is the section that is immediately threatened from development activities and with the most to gain from any improvement in conservation. Although those who are living relatively close to the project area would be affected immediately by any improvements, the impact of total benefits may be more widespread. However, given time and resource constraints, the study is limited to the project adjacent areas in which the most significant impact of conservation related benefits might be expected. A random sample will be selected from the area for the data collection.

### **E. Preliminary Findings**

Public secondary data suitable for an economic analysis is hard to find, however, contacts have been made with relevant state officials. MAF is the key ministerial organisation approached and they have overwhelmingly agreed to participate and provide relevant information. In addition to that the help of JICA to find out relevant data sources was very useful. Secondary data will be collected from the ministry, Department of Statistics and the Department of Forestry to find our viability of their operations in mangrove areas. In addition to that the information on National Census of 2015 and the Agricultural Census of 2015 will be very useful.

## F. Limitations

Sample selection and conducting a field survey in remote and rural part of the country is having a minor risk, however, all precautionary activity will be taken before the survey. Obviously, the selection of a good sample and a survey instrument is a key to achieving reliable results in any survey. However, the consultant's prior experience on the subject area will not lead to any risk on the applied methodology. Nevertheless, there are always a component of risk in conducting a field survey and getting right answers to questions from uneducated rural people and this is something inherent in any field data collection.

## III. Work Plan

Evaluation Phases	Deliverables	Responsible Person	Location	Timeline / Unit Days
1	Inception report including detail plan and methodology	Consultant	Timor-Leste	5
2	Draft economic analysis of mangrove supportive livelihoods options in the target municipalities	Consultant	Timor-Leste	20
3	Draft implementation strategy of selected mangrove supportive livelihood options for the targeted coastal community of Timor-Leste/ financial modelling and RCT methods	Consultant	Home based and Timor-Leste	25
4	Final economic analysis of mangrove supportive livelihoods options and detail implementation strategy of selected livelihood options for each targeted coastal community of Timor-Leste and RCT methodology	Consultant	Timor-Leste	10

#### **IV. Logistic Support**

During the mandate of the consultant he will rely on infrastructure and expertise of UNDP. This applies to consultant's work in the field and UNDP is providing as much assistance as possible to facilitate the study.

Consultant will use a vehicle (rental) during the field survey as prescribed in the original ToR.

## 2. FINAL REPORT

### I. Introduction

#### A. Background and Context

In the past few decades, mangroves in Timor-Leste have been subject to a wide variety of threats. Mangrove area loss was around 85 percent from 1940 to today which reduced the area of 9000 ha to 1300 ha (UNDP 2015). In many places, these threats can be attributed to anthropogenic pressures. Mangrove trees are used for multiple purposes in Timor-Leste such as firewood, timber wood, wood chip, pulp production and animal fodder. The threats also come from agriculture, shrimp farming, salt cooking, grazing by domestic animals, harvesting non-wood forest products, sewage discharge, and garbage disposal. Besides anthropogenic threats climate change looms in the background as a potential threat to the mangrove ecosystem in many parts of the country. More particularly, the sea level rise is anticipated to accelerate in the coming decades.



Figure 1. Impact of sea level rise in Aubean, Manatuto area (Photo by author).

Many fishermen and their families live within the mangrove areas in Timor-Leste. Like in some parts of the world mangroves in Timor-Leste is no longer sustainable and threatening the future of the forests although harvesting has taken place for centuries. Mangrove forests have often been seen as unproductive and so cleared to make room for agricultural land, human settlements, infrastructure, and industrial areas. More recently in Timor-Leste clearing mangroves were reported for industry, tourism, shrimp aquaculture, and salt farms

(UNDP 2015). This clearing is a major factor behind mangrove loss in Timor-Leste and around the world.



Figure 2. Mangrove clearance for industrial activities in Hera, Dili (Photo by author).

Pressure from governments and communities for development is a key driver for mangrove loss in Timor-Leste like anywhere else in the world. In addition to that it has been the practice of traditional coastal livelihood to depend on mangrove as an energy source. In order to control this, there are ongoing efforts to develop additional livelihood activities such as eco-tourism to reduce the threat to mangroves as well as to provide additional source of income to communities.

### **B. Objective of the study**

The overexploitation of mangrove resources and their destruction for alternate livelihood activities is unsustainable, moreover, it is continuing to increase. Additionally, mangroves and the communities' dependent on them are threatened by climate change as shown in Figure one. If this trend continuous, the potential to lead to a loss of livelihoods and income will rise. The outcome will be the increased vulnerability of mangrove dependent communities and families to climate change induced hazards such as sea level rise, inundation, coastal erosion, loss of biodiversity etc. Hence, this project focused on two crucial interventions to address the sustainable management of mangroves in Timor-Leste.

*The objectives of this project are:*

1. To increase awareness and capacities of local communities including school leavers and community-based institutions for the sustainable use of mangrove resources. The project will also be reducing the dependence of communities on mangrove resources through alternative livelihood opportunities. The implementation strategy will also mainstream the potential and felt impacts of climate change. The alternative strategies will guarantee that livelihoods and empowered institutions move towards making communities and the mangroves they depend on more resilient in the face of climate change.

2. Estimation of total value of mangroves will allow comparing the multiple benefits of mangrove with other development interventions for effective conservation and management of mangroves. The analysis would help to make recommendations for the most feasible activities to the respective target mangrove restoration sites. This would encourage biodiversity conservation to enhance resilience through adopting ecosystem-based approaches.

## **II. Project sites identified for mangrove conservation in Timor-Leste**

### **A. Identified project sites**

A preliminary assessment of potential sites for mangrove rehabilitation was carried out during the project preparation stage. The identified sucos and relevant project sites are given in table 1.

<b>District</b>	<b>Project sites</b>
Bobonaro	Biacou
Liquiça	Lake Maubara, Ulmera and Tibar
Dili	Hera and Metinaro
Covalima	Suai-Loro and Tafara
Manuhafi	Lake Modo Mahut
Manatuto	Aubeon
Viqueque	Irabin de Baixo

Table 1. Mangrove project sites

Source: UNDP (2015)

The total population of these districts are around 688482<sup>1</sup>, however, these project sites represent approximately 5,300 households and a population of 25,000 (UNDP, 2015). Through mangrove rehabilitation, and by incorporating mangrove maintenance, mangrove-supportive livelihoods including eco-tourism activities into suco development plans, the project will reach more than 25,000 coastal residents or to the total district population as direct and indirect beneficiaries of various project interventions.

The identification of exact mangrove areas is not available at the time of this report; however it is intended to make a rough sketch of sites during the field visits in March 2017. Preliminary investigation of google earth maps of the area has helped to make rough sketches of mangrove sites in suco maps given below.



Figure 1. Project area - Bobonaro district: Source: wikipedia.org

Only Biacou area shows some presence in mangroves. This was verified in field visits and updated the map. Population difference between urban and rural is wider (1:7) in the district.

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<sup>1</sup> According to the population census 2015.



Figure 2. Project area - Liquiça district. Source: wikipedia.org

Lake Maubara and Tibar are the project sites in Liquiça district and have significant influence of salt mining on the growth of mangroves. The awareness of the true value of mangroves against the salt mining is essential to control the damage to the growth of mangroves. The district population is primarily rural with 1 to 13 proportion of urban rural disparity.



Figure 3. Project area – Dili district. Source: wikipedia.org



The threat to mangrove is extensive in Dili as it is the capital city of the country and heavy concentration of population in a smaller area. Usually development is cantered towards the capital city causing poor air/water quality, insufficient water availability, waste-disposal problems, and high energy consumption. These factors are exacerbated by the increasing population density and high demands of urban environments. Strong city planning will be essential in managing these and other difficulties as the Dili's urban areas swell. The urban rural population proportion is 7.5 to 1.



Figure 4. Project area – Cova Lima district. Source: wikipedia.org

Predominantly rural Cova Lima district has two mangroves project sites, Suai-Loro and Tafara. Population disparity between rural and urban is 6 to 1.



Figure 5. Project area – Manufahi district. Source: wikipedia.org

Lake Modo Mahut is the key project site of the district which is consists of extensive mangrove growth alongside the river basin and the coastal belt. Population concentration is rural and it is about 6 to 1 compared with the urban.



Figure 6. Project area – Manatuto district. Source: wikipedia.org

Manatuto district spread from north to south of the country, however, project site is located in the south side of the district. The total mangrove area is unknown. The population concentration is rural which is about the proportion of 12 to 1 with urban.



Figure 7. Project area – Viqueque district. Source: wikipedia.org

Irabin de Baixo is the only project site of the district which is located in the east side of the district. Mangrove area is unknown yet any development to the mangrove cover will have significant influence on fishing industry. The population disparity between the rural and urban is 11 to 1.

Primary objective of this consultancy is to conduct robust economic analyses to identify most viable mangrove-supportive livelihoods in the target municipalities.

## **B. Literature review of mangrove supportive livelihood options**

Ecosystem services sustained by mangrove forests in the project area support livelihood by providing numerous services, i.e., supporting (nutrient cycling, soil formation); provisioning (food, fresh water, wood, fuel); regulating (climate & flood regulation), and cultural (aesthetic, educational, recreational) values. This reflects recognition that mangroves do not just generate physical products, but also provide the primary productivity and life support services that underpin human wellbeing and livelihoods in project area. However, communities of project areas are currently not guided or provided with sufficient incentives to become stewards of mangrove resources, ecosystems or the essential services that grant coastal protection and livelihood sustainability. It is also noted that rarely mangrove rehabilitation and livelihood development linked to achieve sustainable results. Employment and income generation potential associated with mangrove rehabilitation, protection and sustainable management has not been exploited as part of the local level development plans, investments or public and private partnership initiatives in Timor-Leste until this project.

Mangrove supported livelihood options are widely practised in other countries and derive benefits for the wellbeing of poor communities. Bangladesh for example uses the “Triple F model” (Forest, Fruit & Fish) for mangrove conservation and poverty reduction which provides a new way to make barren coastal land productive again (UNDP, 2011). The process is very simple and involve only small investment. Community themselves can organise and practice the method without additional technical support. By building mounds and ditches, fruit and timber trees can be grown, and in the water fish can be cultivated. Interspersed with the fruit and timber trees are high yielding vegetables which brings additional income to families, which can also be grown on top of the mounds and along the banks of the ditches. The model can be implemented in many areas of Timor-Leste that can

be modified to fit in local conditions. When completed the entire model is raised as such it is protected from tidal surges and storms.

In West Java, Indonesia mangrove has been used in support of coastal fisheries in Indramayu Regency (Yulianto, et.al., 2016). Fishing is treated in this project as a system consisting of three interacting components such as aquatic biota, aquatic habitat and humans. Humans as users of those resources is important to care mangroves which is a habitat for fish. Fish are a resource that is hunted, so that the activity somewhere will affect the presence of fish in another area. The effects of an activity on mangrove will affect fishing activities offshore and the destruction of mangroves will have an impact on the decline of the marine fisheries. Therefore, understanding the interaction between the mangroves to fisheries is essential to determine the mangrove management policies and fisheries management. The aim of this study is to compare the performance of the fishing activity (effort, harvest and rent) on the condition of the waters with the presence or influence of mangrove and without their influence. The performance of the coastal or nearshore fisheries will present in equilibrium of open access, maximum sustainable yield and of maximum economic yield. Results of this study are expected to provide early information on the fish resources management policy and management of mangroves policy as a habitat for fish in Indonesia.

This study provides an overview of experience supporting the restoration of fishing livelihoods in the Philippines following Typhoon Haiyan (Potier, 2014). The response included the directly supporting those livelihoods and promoting recovery of the mangroves and coral reefs on which those fishing livelihoods depend. Three ecosystems play a critical role in the maintenance of fisheries resources in tropical regions: mangroves, coral reefs and seagrass beds. They are interconnected and need to be considered as a whole when engaging in coastal resource management. These activities are essential to achieve sustainable use and management of economically and ecologically valuable resources in the coastal areas. Most importantly it has to consider interaction among and within resource systems as well as those of humans and their environment. In this connection, effective management of coastal resources is essential for protecting fishing communities from further risk and decline. The activities of the Concern project began after the Typhoon in November 2013, with integrated livelihood activities in 2014. The project included three components: a) designing and building more eco-friendly boats for small-scale fishers b) rehabilitating essential mangroves and coral reefs and c) strengthening local capacity for coastal resource

management. Small-scale fishing communities are some of the most vulnerable in the world and face particular risks to their lives and livelihoods in the face of climate change. To the degree possible, emergency response and recovery projects following natural disasters such as Typhoon Haiyan should be designed to support rehabilitation of coastal ecosystems. The project offers key recommendations and decision trees to support the design of similar projects in the future.

The Coastal Ecosystem Services in East Africa (CESEA) project is a collaboration between scientists and researchers in Tanzania, Kenya and the UK to find new ways to help local people maintain their coastal resources whilst beating poverty, in particular those that rely on mangroves and seagrasses which are vital for fish, coastal protection and the capture and storage of carbon. The project helped with the local and national management of these ecosystems through three different approaches. First, they were working with the forestry departments in Kenya and Zanzibar to open up new channels of engagement with local communities on livelihood activities. This followed by carrying out research on how to emulate the success of mangrove payments for ecosystem services for seagrasses which provide similar carbon capture benefits. Finally, they explored why some communities in East Africa have a good record of managing their mangroves and seagrasses, whilst others have degraded ecosystems. The project was for three years from 2013 to 2016.

Findings of these studies and field survey data analysis were used for the selection of mangrove supportive livelihood options for the target municipalities in Timor-Leste.

### **III. Possible mangrove supportive livelihood options for the targeted coastal community**

#### **A. Selected mangrove supportive livelihood options for each targeted area**

Mangrove forests were cleared for daily requirement of household or employment for many years by people living in mangrove areas of Timor-Leste.

##### ***a) Ecotourism***

Most tourism in natural areas of the world today is not ecotourism and is not, therefore, sustainable. Ecotourism is distinguished from the tourism by its emphasis on conservation, education, active participation of community and responsibility of the traveller. The World

Conservation Union (IUCN) definition of ecotourism is "environmentally responsible travel to natural areas, in order to enjoy and appreciate nature and accompanying cultural features that promote conservation with low visitor impact to provide beneficially active socio-economic involvement of local peoples". Specifically, ecotourism possesses conscientious, low-impact visitor behaviour which is something ideally match with the condition of rural Timor-Leste. It attempts to maintain sensitivity towards, and appreciation of, local cultures and biodiversity which is essential in rural areas. Fishermen and farmers of mangrove areas in Timor-Leste understand the value of mangroves and support for local conservation efforts which makes ecotourism fits well with the local conditions. The survey carried out in project areas has revealed that the majority of people expect sustainable benefits to local communities which is an important characteristic of ecotourism. Moreover, local people participation in decision-making is a key aspect of ecotourism and the survey results revealed that as majority are willing to participate in decision making process. Ecotourism provides educational components for both the traveller and local communities which is an important aspect of this project.

Project Site	Eco-Tourism	Inter/multi Cropping Similar to FFF Model)	Value added Products	Small Scale Aquaculture	Total Number of Livelihood Options
Boacou	√	√			2
Lake Maubara	√	√			2
Ulmera				√	1
Tibar	√	√		√	3
Hera	√				1
Metinaro		√			1
Suai-Loro	√	√	√	√	4
Tafara		√			1
Lk Modomahut	√	√	√		3
Aubeon	√	√		√	3
Irabin de Baixo	√	√			2

Table 2. Identified mangrove supportive livelihood options in project sites

As shown in table 2, Eco-tourism has been suggested by stakeholders of 8 out of 11 project sites. It is important to develop eco-tourism as it is an ideal supplementary source of income for local people while maintaining the integrity of the mangrove based coastal eco-system.

This win-win situation undoubtedly brings additional livelihood support for those who are depending on mangroves in Timor-Leste. Preliminary bio-physics report of the project has recommended eco-tourism as an additional income source for 10 out of 11 project sites (Ilman, 2017).

Eco-tourism can be developed in the site of *Biacou* in Bobonaro district, however, the concept of tourism is new to the area. The community need technical support if they want to start eco-tourism in the area. The support from the local community is very high for the development of eco-tourism. *Lake Maubara* in Liquica district has already plans for the development of eco-tourism in the lake area. Government is planning to build a hotel in the lake site, but construction has not yet started. There are some plans by private companies to develop eco-tourism in the lake area. However, stakeholders believe that the company will make profit on this business and may hire few local peoples but it is not going to help the region. The best solution is for the project is to join the private consortium and to provide technical support to set up the eco-tourism using stakeholders. This way stakeholders could provide their labour in eco-tourism activities. Mangrove eco-system is the key to the success of eco-tourism; hence project stakeholders can engage in mangrove conservation activities while working on eco-tourism. Lake Maubara is also an ideal site for the development of sport fishing. The area around the lake is available for some infrastructure development. Out of the other two project sites in Liquica district *Tibar* site has been selected for eco-tourism. *Tibar* site has been selected by stakeholders for eco-tourism as this is a good idea to increase the income of local people. People visiting the area for tourism buy local products which will increase income of local people. This is also supporting small businesses of the area and may also be develop associated new businesses. This is also make awareness of the mangrove as people go to see the type of benefits mangrove provides to the people. Out of the two project sites in the district of Dili, *Hera* site has been selected for eco-tourism activities. This site has more potential to develop eco-tourism as it is closer to Dili. The airport is closer for even international travellers. The main harbour of the country is very close which is very useful for arranging cruise liners to bring foreign travellers. Out of the two sites in Covalima district, only *Suai-Loro* has been identified as suitable for eco-tourism development. Eco-tourism, work with local people which brings supplementary income to poor people of the area. Stakeholders have suggested a viewing point to see nature and birds which can attract foreign tourists. With the new road development of the area this is going to be a more viable activity which is operated by local people to earn foreign

exchanges for the country. The project in *Lake Modamahut* is an ideal site for eco-tourism development. In stakeholder discussion, it has been identified that the diversification of mangrove activities into eco-tourism is essential for people to get additional income. *Aubean* project site has also been selected for eco-tourism development. This is one of the livelihood activity that brings some additional income for the local people. The suco leader and all stakeholders have suggested that the area is suitable, and it is better to develop a pilot project in eco-tourism. Suco leader has attended a seminar on eco-tourism and he discussed about it with the community on what he learned and advantages. He personally believes there are potentials for the development of eco-tourism. *Irabin-di-Baixo* is the mangrove project in Viqueque district which should implement eco-tourism this year as this is very important to people. Eco-tourism for local and foreign travellers can bring additional income in mangroves areas, however, condition of roads in the area may cause some problems for travellers. In this project, we have to work with the community. After careful consideration of these sites and studying possible impacts of selected activities on natural environment followed by a feasibility study, eco-tourism can be established in identified project sites.

#### ***b) Inter/multi Cropping in Agricultural Lands***

The agricultural activities practiced in project areas are not well organised, diverse as well as prone to various kind of risks. Paddy monoculture dominates in some landscape along with small pockets of seasonal vegetables, fruits and cassava. Growing of salt tolerant varieties of rice is the only option left in some of the areas. The wide spread destructions of embankments and consequent inflow of saline water into the agricultural fields in some project area makes the lands more unproductive by accumulating salt on the top soil. Hence, traditional agriculture is not conducive in some areas. The income from agriculture or fisheries alone is not sufficient for poor people to maintain a sustainable living conditions. Poor people in Asian region have tried various solutions in a similar situation and some are proven successful practices to bring additional family income. Alternate farming systems or inter/multi cropping systems have to be introduced in accordance with the required environmental conditions. The Sundarban Development Board of West Bengal, India had introduced the paddy cum fish culture with rainwater harvesting facilities in which 2/3 land is devoted to agriculture and 1/3 to aquaculture or water storage. Similarly, orientation towards salinity tolerant rice varieties and vegetables should be given priority in some areas. This type of fodder cultivation along with selective animal husbandry can achieve sustainable



agriculture with the financial assistance from micro-finance institutions. The Triple F model in Bangladesh can produce enough fruit, vegetables and fish to supplement nutrition in the family diet and also to generate regular extra income from the sale of excess produce (UNDP, 2011). For family fuel needs, people rely on the protective mangrove forests, fruit and timber trees. Timber trees also provide a good additional earning in the longer term when trees are matured. The model offers a great opportunity to improve family food and income security for poor coastal population. This method can be introduced into Timor-Leste with modification to fit in the local conditions and responsive to local needs.

Inter/multi cropping is another source of income for farmers and fisherman of project areas at times their main source of income fails to support livelihood activities. There are many formats of mixed/inter cropping in available lands, however, careful consideration of most suitable activities would be able to support local poor. Modification of existing formats such as Triple F model in Bangladesh are well suitable for the condition in Timor-Leste. It is important that a team comprising relevant disciplines such as agriculture, biology and socio economics to draw up a suitable plan for a model fit into condition of Timor-Leste. EU funded Global Climate Change Adaptation (GCCA – TL) in Dili provides supports for many crops as inter or minor crops with other major crops. As shown in table 2, there are eight sites that have potentials and also made a request to develop inter/multi cropping in agricultural lands.

In *Biacou* site It was agreed that multi/inter cropping can be used in the area to get an additional income. Crops such as Banana, Coconut and other fruits can be tried with mangroves. It was decided in *Lake Maubara* site in Liquica district that mangrove mix with other crops would help people to get additional income. The concept similar to triple F model could implement in the lake site. *Tibar* project site of the same district is also suitable for multi/inter cropping activities. *Metinaro* project site at the Dili district has been identified for inter/multi cropping in mangrove and agricultural areas which may adopt the scheme similar to triple F model. Both projects in the district of Cova-lima is in favour of inter/multi cropping, however, the project site *Suai-Loro* is more suitable for such intervention. They do intercropping in some areas with the help of Horticulture department, but they were not properly organised and was not successful. *Tafara* site is more like a jungle with mangroves which makes it is unsuitable for inter/multi cropping activities. Stakeholders of the *lake Modamahut* are willing to engage in inter/multi cropping in mangrove and agricultural areas. Fishing alone cannot be sustainable for the people and they believe that inter/multi cropping is the best alternative livelihood activities suitable for the lake area. Inter/multi crops is

suitable for getting an additional income in *Aubean* project site, however, there are many trees in the beach areas causing some problems. Stakeholders suggested a scheme similar to Bangladesh's FFF model which is suitable in this area. Suco leader who organised the stakeholder discussion has visited Bangladesh to study the FFF model. He suggested a model similar to FFF model but with some variations to fit into local conditions. Out of the key points discussed in *Irabin de Baixo* project site, one of the salient point is that the diversification of mangrove related fishing activities is important and the concept similar to FFF model could be adopted.

### ***c) Small-scale Aquaculture.***

Small-scale aquaculture can make an important contribution to nutrition, food security, sustainable livelihoods and poverty alleviation in rural Timor-Leste. The issues constraining the sustainable development of small-scale fisheries remain poorly understood although the majority people are depending on fisheries in project areas. Project activities will have a plan to look after small-scale fishers, fish workers and their livelihood. State and regional governments should have a plan to develop fishing operations at suco levels without making fishermen and their operations marginalised. Project activities should recognise the importance of small-scale fisheries to national economies. Project activities should recognise the contribution of small scale aquaculture on food security and it should be valued and enhanced. Those who are dependent on the small-scale fisheries sector should be empowered to participate in decision-making with dignity and respect through integrated management of the social, economic and ecological systems underpinning the sector.

Small-scale aquaculture is an additional livelihood activity that could improve livelihood in project areas. If funds are available, project should provide assistance for fishermen to improve sustainable fisheries development. Furthermore, it is important to help poor fishermen to market excess fish production after household consumption. Community management or co-management of fisheries are highly successful in small scale fishery management in many Asian countries and such experience can be used in project areas. Both *Ulmera* and *Tibar* sites are in favour of developing small scale aquaculture in their project sites. Aquaculture on small scale would be appropriate for salmon, crabs, tilapia, and milk fish involving local people in *Ulmera* site. Both these sites can be easily adopted for the development of small scale aquaculture which will not destroy the coastal natural environment and also provide additional source of support for the poor. Crabs and shrimps

in small scale aquaculture were suggested in *Suai-Loro* site. For crabs, there were small scale aquaculture during 1990's in the same area. *Aubean* project sites is also one of the suitable site for small scale aquaculture project. Tiger shrimps are catching in the lake area in *Aubean* which is a good future for fishermen. Community should involve in shrimp aquaculture in small scale. Moreover, the view of stakeholders of the area is that the large scale private sector shrimp aquaculture is always aiming for profit maximization but not for the welfare of the local people.

**d) Value-added mangrove products.**

Most common value-added fish products are shrimp paste, fried fish, fish balls and fishcakes. Similarly, other value-added non-timber forest products such as baskets can supplement the incomes of small-scale producers and coastal communities.

Value added products are the best strategies farmers can employ to improve net profitability. These products can open new markets, enhance the public's appreciation for the new product and extend the marketing season. Value-added processing simply offers fishermen/farmers the potential to capture a larger share of the food value. This share otherwise goes to intermediary person. Small scale farmers are mostly poor because this bigger share of the profit enjoys by the wealthy middle man. Consumer choice is the key, hence, consumers buy more "ready-to-eat" or "ready-to-cook" food while farmers generally produce and market raw agricultural commodities at a price closer to the cost or sometimes below the cost. For example, selling fried fish instead of raw fish, fetching a higher price. A change in the physical state or form of the product closer to the end of the value chain helps improve livelihood of poor farmers/fishermen. This is a new concept, hence, only 2 out of 11 are favoured for this as indicated in table 2. The production of a product in a manner that enhances its value also comes under the value-added products, such as eco-labelled for sustainably caught fish products. During this project period the promotion of value added product could be added as a project activity at any point. This will not require additional investments but only expenditure for few demonstrations.

Value-added final products instead of raw produces always fetches a higher price. *Suai-Loro* and *Lake Modamahut* project sites are particularly keen in implementing value added products under project activities. Value added fish products were tried in *Suai-Loro*, for

example, fried fish with some added ingredients with a higher price margin. Project activities can incorporate some training for local people to produce value added fish products for sale.

## **B. Implementation of mangrove rehabilitation and restoration activities**

Mangrove rehabilitation and restoration activities are providing strong support for mangrove supportive livelihood options for the target municipalities in project areas. As shown in table 3, four mangrove rehabilitation and restoration activities were identified under each project sites.

Project site	Protection by traditional law (Tara-Bandu)	Awareness programs for school leavers & adults	Reduce pollution	Re-planting and/or ecological restoration of mangroves	TOTAL MANGROVE REHABILITATION AND RESTORATION ACTIVITIES
Biacou	√			√	2
Lake Maubara	√			√	2
Ulmera		√		√	2
Tibar	√	√	√	√	4
Hera			√	√	2
Metinaro			√		1
Suai-Loro	√	√	√	√	4
Tafara	√		√	√	3
Lake Modamahut			√		1
Aubean		√	√	√	3
Irabin de Baixo			√		1
<b>TOTAL PROJECT SITES</b>	<b>5</b>	<b>4</b>	<b>8</b>	<b>8</b>	

Table 3. Identified mangrove rehabilitation and restoration activities in project sites

### **a) The assignment of property rights (Tara-Bandu Law).**

Land and property rights create incentives for sustainable management and governance of natural resources such as mangroves, agricultural lands, forest resources, coastal resources and wild species of plants or animals. These fundamental property rights questions become even more critical where natural resource markets are concerned, such as markets for timber or non-timber forest products, wildlife, ecotourism, agricultural

products, payment for environmental services and other revenue-generating activities (USAID, 2006). Households with secure land rights are typically better-off than those with insecure, limited or no land rights (FAO, 2002). Strengthening local institutions on natural resource governance is one way of protecting natural resources. This ensure high levels of equity and sustainability of resource management. One such method is introducing “Tara-Bandu” traditional law to protect mangrove destruction in Timor-Leste. The effectiveness of this law is influenced under certain social and institutional settings, and by specific attributes of the resources and members involved. Institutional arrangements should be strengthened by making them more transparent, accountable and inclusive for better results. Two mangrove project sites of this project are already practicing this law in managing mangroves and the knowledge and experience of these two sites can be an inspirational source for another project site/s.

Traditional law Tara-Bandu is one way of providing property rights to people who are living in mangrove areas. Through the law, suco leaders are vested with some powers to punish perpetrators of mangrove destructions. This traditional law has been used in the past, however, with the changes in modern societies, young peoples are especially difficult to control by suco leaders those who have no police powers. However, 5 out of 11 project sites are in favour of the traditional law as a suitable method of protecting mangroves as shown in table 3. There are two project sites are practicing Tara-Bandu traditional law with some success in controlling mangrove destruction. Ilman (2017) has also indicated that 9 out of 11 project sites are suitable to implement traditional law Tara-Bandu. No traditional law to control the damage to mangroves, hence, communities in *Suai-Loro* and *Tafara* project sites make agreement to protect forests using the law. They are strongly in favour of using Tara-Bandu law. *Biacou* is one project site currently practicing the law “Tara Bandu” in Timor-Leste. This practice was started in 2012 as such no felling of mangrove trees in the area. This is how the law is practicing in this area. If someone cuts a mangrove tree the fine is \$100 per tree. Also, he/she will have to give one animal, 50 Kg. of rice, 1 packet of cigarette, 1 packet of chewing leaves. This will be implemented by the suco leader and all respectable people of the suco will attend for the occasion. Other project sites could follow this procedure in implementing the law. Tara Bandu law has been used in the past but it was stopped from 2012 in *Lake Maubara* site. If community study the weaknesses of implementing the program, this can be re-introduced soon to control the destruction of mangroves. The lessons they learned may be useful for other sucos to implement the traditional law with

success in their community. No traditional law to control the damage to mangroves in the *Taffara* project site, however, there were suggestions to introduce traditional law “Tarabandu” in this community by the Government and the institutional level Law of Forestry. This is going to approve during this year and the project could support this initiative.

***b) Mangrove Awareness Programs.***

It is important to design awareness programs on aspects of the biology, ecology and the value of mangroves and the associated fisheries. As revealed in the field survey many people are not aware of basic functions of mangroves and uses. With the introduction of public awareness programs that are designed to educate and sensitize the local community, project can generate a significant positive interest in participatory management of the mangrove resources. Awareness on the functions of mangroves, ecological links between mangrove ecosystems and resources such as fish is the key to winning management support. The introduction of sense of ownership of the resources by the local population and their legal empowerment are key requirements for them to execute control measures on their mangrove resources. This is an essential component in the process aimed at achieving full community support for the sustainable utilisation and management of coastal resources. Local communities through this process are beginning to protect and to plan better ways of exploiting their mangrove resources. Based on knowledge (biology, ecology, and socio-economic) gleaned through awareness campaigns, they become stewards of mangrove restoration programs with positive results. The same program should run with final year high school children and educating younger generation which will have profound impact on mangrove conservation.

Awareness program on mangroves for school leavers and adults would help fishermen/farmers to improve their knowledge on functions of mangroves as well as fishing and sustainable farming practices. One urgent need is on the knowledge of replanting/regeneration of mangroves. This came out in several discussions as one of the key help in conserving and wise use of mangroves. The need for awareness programs on mangroves were highlighted in 4 out of 11 projects, however, this should be a key component in project activities if possible annually in all project sites. Similarly, it is absolutely necessary to teach these aspects for school leavers as they are the next group of leaders who take over fishing and farming activities. Four project sites identified for

awareness programs are *Ulmera*, *Tibar*, *Suai-Loro* and *Aubean*, however, this practice should be introduced in all project sites.

**c) Reduce Pollution Levels.**

The best method to improve livelihood of people living in the area is improving the cover of mangroves in all project sites. This is as important as re-planting and re-generation of mangroves in the area. The major threat to mangrove destruction is pollution levels in mangrove sites and cleaning the area from pollution is a best provision for mangrove re-generation. Although the mangrove stands showed themselves capable of recovering from an oil spill, the recovery time was very long, more than seven years, and the recovered stands presented reduced structural development and different species composition. (Maia-Santos, et. al., 2012). Project activities during the project period will allocate resources for cleaning pollution level which ultimately support for mangrove regeneration along with replanting of lost areas of mangroves.

Reduction of pollution levels in mangrove areas are a key component in sustainable management of mangrove ecosystem in Timor-Leste. It has been noted in field visits that pollution has destroyed mangrove coverage in many road sides. The threat of pollution is very high in all project sites, hence, 8 out of 11 project sites have indicated the necessity of controlling pollution as an urgent task. This may require some investments, however, there are provisions under the project for similar task. The need for pollution control was highlighted and identified as a control mechanism in Ilman (2017). It is essential in clearing the existing pollution and also maintaining pollution free mangrove environment. Project activities can monitor dumping domestic waste into wetlands. Although project sites identified for reduction of pollution levels are *Tibar*, *Hera*, *Metinaro*, *Suai-Loro*, *Taffar*, *Lake Modamahut*, *Aubean* and *Irabin de Baixo*, it is essential to extend it to all project sites.

**d) Replanting and Ecological Restoration of Mangroves in Project Areas.**

This is one of the requirement identified in many project areas. Timor-Leste is confronted with various issues and challenges at both policy and operational fronts which act as major impediments in the successful restoration and conservation of mangroves. One very crucial challenge is on the fact that shrimp farming, salt farming and other industrial activities (for

example, oil and gas storage) require clearing of mangroves. In addition to that pollution has already contributed towards destroying mangrove plants adjacent to main roads and other economic activity centres. Serious policy flaws and lack of coordination among government agencies has negatively contributed towards the restoration and conservation of the mangroves. Ecological Mangrove Restoration are very different from restoration by planting only and should be part of a coordinated programme involving multidiscipline i.e., ecology, coastal dynamics and sociology. The involvement of multiple stakeholders of the project areas is a key to the success of the program.

Replanting and/or ecological restoration of mangroves is the best solution to problem of lost areas of mangroves in Timor-Leste. Regeneration of a healthy mangrove forest ensues if the enabling biophysical conditions or mangrove growth are put back in place. This can be hard, but this is the only way forward. Stakeholders in project areas, 8 out of 11 are in favour of ecological restoration of mangroves including replanting where necessary. Although project sites identified for this purpose are *Biacou, Lake Maubara, Ulmera, Tibar, Hera, Suai-Loro, Taffara, and Aubean*, these activities should be undertaken in each and all project sites during the project period. Suitable mangrove protection and restoration activities were also suggested at project sites by Ilman (2017).

#### **IV. Economic Analysis of Mangrove Supportive Livelihood Options**

There are several livelihood activities for people living in coastal Timor-Leste which brings additional income in addition to fishing and agriculture. The objective of this study is to estimate full economic analysis of mangrove supportive coastal livelihood options.

One of the key output of the project is to achieve a coverage of at least 1000 ha of coastal mangroves under the outcome 2. Assuming that the project will reach this target within the time scale of four years, the benefits side of the cost-benefit analysis used only that activity. Any other benefits project will achieve from outcomes 1 and 3, can be considered as extra benefits. Total cost for the work plan (outcome 1-3) was given in pages 61-63 of the project report (UNDP, 2015). This has been used as the total cost over 4 years in the economic analysis. Project output will be at least 1000 ha of coastal mangroves which will achieve over the period of 4 years. It was assumed that the output will be 0 ha in year one, up to 400 ha in year two, up to 800 ha in year 3 and up to 1000 ha in year four. To find out the total (use and non-use) values, planted area in each year was multiplied by the value



estimated in Economic Analysis (Appendix), which was US \$ 55538 per hectare per annum. As shown in table 4, the Internal rate of return is 1746% which is highly profitable. The net present value is very high, and the project is highly profitable. In the cost side of the project all outcomes 1-3 were included, however, in benefits only the outcome 2 was considered. This demonstrate the total viability of the project confirming the worth of project activities.



## V. Recommendations for mangrove supportive livelihood options

From the discussion and meetings conducted with stakeholders, community leaders and government officials regarding the mangrove characteristics, economic valuation and livelihood options, a series of conclusions were drawn that were formulated into recommendations. These are listed below with actions to implement the recommendations shown as bullet points.

1. Implement traditional law “Tara-Bandu” at suco level to protect existing mangrove areas.
  - Collate information on two project sites implementing traditional law (Biacou & Lake Maubara) and understand the effectiveness of traditional law.
  - Ensure that indigenous knowledge is incorporated into the implementing process.
2. Ministry/ies responsible for environmental issues to finalise the National policy for mangrove protected areas. These sites were identified by the mangrove specialist of the project (Ilman, 2017)
  - Make a formal request to the Ministry/ies to revive the National Steering Committee.
  - Co-ordinate policy development with the National Planning Council.
3. Encourage development of local initiatives in mangrove wetlands to generate income through ecotourism.
  - Establish community-based ecotourism enterprises.
4. Improve communication between mangrove and agricultural researchers to implement mixed cropping and livestock in mangrove areas.
  - Establish a network of researchers, policy-makers and stakeholders.
5. Reduce pollution levels in mangrove areas and encourage replanting and/or regeneration of mangroves in recognised areas.
  - Establish fences to protect mangrove plants from domestic animals.
6. Use the value of wetlands (wherever possible) in cost benefit analysis when cost and benefits of development activities are being carried out in wetland areas.
  - Test the reliability of using wetland value in policy decisions.
  - Prepare rules and guidelines to use such values in extended cost-benefit analysis.

General Recommendation: These points to be circulated to all participants for comment and in order to seek volunteers to lead or assist with actions.

## **APPENDIX: Detailed Economic Analysis**

### **I. Introduction**

#### **A. Background and Context**

Mangrove trees are used for multiple purposes such as firewood, timber wood, wood chip, pulp production, charcoal production and animal fodder. However, in some parts of the world it is no longer sustainable and threatening the future of the forests although harvesting has taken place for centuries. Mangrove forests have often been seen as muddy, smelly, unproductive and so cleared to make room for agricultural land, human settlements, infrastructure, and industrial areas. More recently in Timor-Leste clearing mangroves were reported for tourism, shrimp aquaculture, and salt farms (UNDP, 2015). This clearing is a major factor behind mangrove loss in Timor-Leste and around the world.

Pressure from communities for development is a key driver for mangrove loss in Timor-Leste like anywhere else in the world. It has been the practice of traditional coastal livelihood to depend on salt production using mangrove for fuel. In order to control this, there are ongoing efforts such as Sustainable Bio-energy Production from Biomass (SBEPB) to reduce the demand for wood by communities in Timor-Leste. The SBEPB was to promote sustainable production and utilization of bio-mass resources to support local people which will reduce the demand for fuel wood. However, it is good to inquire whether the SBEPB activities have significant contribution to relieve the pressure from communities on mangroves for fuelwood? Evidence shows that human always seek available next best option if current livelihood practice is not sufficient to cover livelihood expenditure. According to an economic analysis, researchers found that farmers in Timor-Leste were able to generate more salt with the introduction of salt evaporation ponds with reduced physical effort. However, during the rainy season farmers tend to go back to cut mangroves to cook salt to prevent disruption to livelihood income as the value of mangroves is worth nothing to them. Demonstrating the real value (also known as Total Value) may change human attitude before destroying the mangroves for other immediate benefits which are not sustainable. Scope of this economic evaluation is to demonstrate the total value of mangroves.

## **B. Objective of the study**

The objective of this study is to undertake an economic valuation of mangrove supportive livelihoods assessing the existing livelihood / economic activities. The analysis would help to make recommendations for the most feasible activities to the respective target mangrove restoration sites. This process involved several steps. First step was to identify all suitable sites using Google map data to recognise the location of respective project sites. The identification of new or existing mangrove supportive economic activities for coastal community were carried out during the second field visit. The primary data collection was also carried out using a sample survey of households of selected project sites. Data collection and analysis helped to determine the total value of mangrove conservation with selected livelihood activities. This would encourage biodiversity conservation to enhance resilience through adopting ecosystem-based approaches. The approach of the study was involved the development of mechanisms whereby protection of mangroves can effectively undertake and sustain physical and economic assets against climate change induced hazards and non-climate related anthropogenic impacts. This study was designed to investigate local-level knowledge of mangrove uses and benefits, ecosystem service values, joint natural resource management experiences, and the need for community-based incentives.

## **II. Economic Analysis**

### **A. Methods of Data Collection and Economic Analysis**

As there were no factual data on selected project sites on mangrove related activities, it was difficult to design a proper economic analysis. However, secondary data were collected from the General Directorate of Statistics and UNFPA, which were used to generate estimations for respective project districts. FAO statistics were also collected and used in the analysis.

Final economic analyse was based on the primary data collected at ten field sites (seven districts) of the project. Data were collected via questionnaire surveys of local households, community focus group discussions, stakeholder consultations, expert interviews and a desk-based literature review. Collected data (both primary and secondary) were analysed

using appropriate statistical and econometric models. Employ critical gender consideration in the economic analysis.

There are strong theoretical grounds for using surveys to measure benefits of mangroves if truthful revelation of preferences can be obtained. In order to carry out the economic valuation study, a sample survey was designed and pre-tested in Metinaro project areas. Initial investigation indicated that the questionnaire was not difficult to understand but it was taking a little bit longer time than anticipated. There are few recreational areas in project areas that are suitable for water-based recreation. Similarly, there are several areas that are suitable for nature appreciation and eco-tourism. Both the recreation and the nature appreciation areas are dependent upon the conservation of mangroves and the benefits accrued to the conservation is therefore possible to capture using survey methods. Choice experiment method has been selected for the analysis which will introduce later.

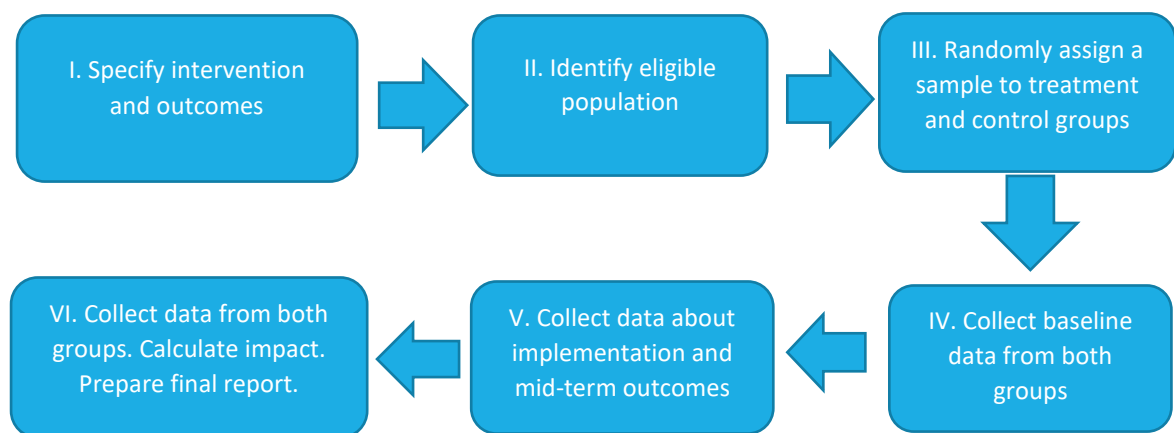
A copy of the survey questionnaire and the choice selection in the choice experiment study is given in the appendix I. The survey was focused on project areas, adjacent villages and towns. All people living in this stretch of land are likely to be affected as a consequence of either mangrove conservation or conversion of the land for development. This is the plot of land that is immediately threatened from development activities and with the most to gain from any improvement in conservation. Although those who are living relatively close to the project areas would be affected immediately by any improvements, the impact of total benefits may be more widespread. However, given time and resource constraints, the study was limited to the adjacent areas to projects in which the most significant impact of conservation related benefits might be expected. This obviously places constraints on how the results are interpreted for the whole region but was necessary in practical terms.

## **B. Sample Selection and RCT Methodology**

It was originally anticipated that we will use randomized controlled trial (RCT) methodology for sample selection in the economic analysis. RCT is widely used for impact evaluation in which the population receiving the program or policy intervention is chosen at random from the eligible population. Similarly, a control group is also chosen at random from the same eligible population. It tests the extent to which specific, planned impacts are being achieved against the control group. An RCT is usually measures the effect of a program or policy intervention on a particular outcome. The key feature of an RCT is that it uses random

assignment of an intervention. This design is called an experimental design. RCT is only useful for measuring impact in certain conditions. The intended impacts of the program or policy intervention can be readily agreed and measured and also requires a relatively large sample. RCT is usually planned before an intervention begins.

Usually in a RCT design the following approach will follow.



Source: Adapted from (UNICEF, 2014)

Figure 1. Overview of conducting an RCT

RCT can be used when the project work begins after identification of population and project boundaries including the extent of mangroves in project sites.

At the stage of economic analysis, only possible sampling method was the simple random sample. Due to the short time availability and limited resources, a convenient random sample was selected by choosing every fifth house or a fifth person met on the way in project areas.

### C. Viability of Economic Activities

The study recently carried out was focused on the project area, adjacent villages and towns. All people living in project areas are likely to be affected as a consequence of either conservation or conversion of mangrove lands for development. This is the section that is immediately threatened from development activities and with the most to gain from any improvement in conservation. Although those who are living relatively close to the project areas would be affected immediately by any improvements, the impact of total benefits may be more widespread. Given time and resource constraints, the study completed was limited

to the project adjacent areas in which the most significant impact of conservation related benefits might be expected.

Cost Benefits Analysis (CBA) tries to identify and value the costs and benefits that will arise with the proposed Least Developed Countries Fund (LDCF) project and to compare them with the situation as it would be without the project. The difference is the incremental net benefit arising from the investment made in the project. The objective of the LDCF project is to improve livelihood activities by promoting conservation.

Project on building shoreline resilience of Timor-Leste to protect local communities and their livelihoods has identified “use values” aspects of total economic value (TEV) (UNDP, 2015). Using aspects of direct and indirect uses this study reported total use values which are summarised in table 1-2.

<b>Direct values of mangroves</b>	<b>Value US\$ Million</b>
Timber energy	2.38
Forage (using surrogate market price of hay as a substitute)	25.0
Timber carbon	2.38
Total direct value	29.76

Table 1. Direct use values of mangroves

The report also estimated indirect value of mangroves which is shown in table 2.

<b>Indirect values of mangroves</b>	<b>Value US\$ Million</b>
Habitat for fish	19.6
Off-shore fishing	1.8
Source of carbon store	4.24
Total indirect value	25.64

Table 2. Indirect use values of mangroves

The total use value which constitutes of direct and indirect uses of the mangroves is estimated at approximately US\$ 55.4 million per year. The non-use value of the total value is also essential in the total economic value and the estimation of which will describe in the next section.



### **III. Total Economic Value including Non-use Value**

#### **A. Estimation of non-use values**

In addition to revealing other livelihood activities, this study has estimated non-use values using WTP method. From the choice of the two main approaches of stated preference techniques, the contingent valuation method (CVM) and choice experiments, the latter has been identified in respect of valuing the conservation values. Although CVM is widely used for eliciting respondent's preferences for un-priced benefits associated with marine environmental quality, the specific nature of the resource to be valued makes it difficult to use in this study. Flawed estimates are likely to be produced where the resource is difficult to imagine, such that the respondents' preferences for the good in economic terms cannot be well-defined. Choice Experiments, in contrast, are not so constrained. Choice experiment approach to be particularly useful for evaluating mangrove livelihood alternatives and levels in addition to estimation of single WTP value.

The aim of choice experiment mechanism is to estimate the structure of an individual's preferences by establishing the relative importance of the different attributes as incorporated within a set of alternatives (pre-specified in terms of levels of attributes) presented in questionnaire format. The design aims to estimate in so doing (a) the relative importance of the individual attributes; (b) the trade-offs or marginal rates of substitution that individuals are willing to make between these attributes; and (c) the total satisfaction or utility scores for different combinations of attributes. The total utility that an individual derives from that alternative is determined by the utility to the individual of each of the attributes. Choice-experiments consider the number of alternatives while either holding the attribute levels associated with each alternative constant, or by varying them, thereby producing choice sets. The respondents' express their opinion by making a choice between the different combinations presented. Fixed choice set design is used in this study and is particularly widely used. In the implementation of a study, there are several steps and considerations that have to be completed, forming the basic framework of evaluation. Firstly, a set of attributes ( $p=1\dots, t$ ) are chosen and the alternatives defined. This involves 3 key elements: understanding the decision problem and environment, identifying determinant attributes, and establishing attribute positioning measures. These elements involve the disaggregation of the management process into key attributes with different potential levels. Attribute positioning measures, such as the level of accomplishment of attributes, are developed that

satisfy the research objectives and are meaningful to the individuals targeted for survey (See Appendix I).

In the field of coastal resources management, choice experiment has not been applied to any great extent. Aas et al, (2000) used a choice modelling approach for evaluating various fisheries management alternatives and programs for harvest regulation in a recreational fishery in Eastern Norway. With an environmental dimension within the area of private goods, choice experiments have been applied to inter alia eco-labelling in fisheries by several authors (Wessels et.al., 1999; Beckett et.al, 1999; and Teisl et. al., 1999). In the area of public environmental goods, notable works have been in respect of pollution and coastal values: visibility changes (Rae, 1983 & 1984), water pollution (Wattage, 2015), air pollution (Lareau and Rae, 1989), hunting trips (Mackenzie, 1990, 1992 and 1993), water-based recreational resources (Smith et, al. 1986)), sustainably and quality labelled fish products (Jeffrey et.al, 2004), fisheries management objectives (Wattage et.al, 2005) and conservation of deep sea corals under marine protected areas (Wattage, et. al, 2011). For a detailed list of applications of choice experiments see (Adamowicz, 2001). These studies reveal that there is a growing appreciation of choice experiments in the area of environmental valuation in coastal resources.

## B. Choice experiment study

Attributes	Level I	Level II	Level III
<b>Conserve mangroves ecosystem</b>	Further damage to mangroves for economic activities ( <i>manenfd</i> )	Some damage to mangrove (Status quo) ( <i>manensq</i> )	No damage to mangrove environment ( <i>manennd</i> )
<b>Improve rural livelihood</b>	Contribute to low income and poor standard of living ( <i>livhdl</i> )	Some income (Status quo) ( <i>livhdsq</i> )	Contribute to higher income and standard of living ( <i>livhdh</i> )
<b>Your contribution for an institution that could support these activities</b>	USD 0/Month (Status quo) ( <i>WTP0</i> )	USD 10/Month ( <i>WTP10</i> )	USD 50/Month ( <i>WTP50</i> )

Table 3. Attributes and levels used in the study

The application of choice experiments in mangrove project areas within the context of conservation is targeted at measuring the preferences of the general public for the protection of mangroves and associated values. Thus, public perception and their preferences were sought for conservation of mangroves and improvement to rural livelihood with their willingness to pay (WTP).

The Cox Regression Procedure (proportional hazard analysis) of SPSS software was used to fit the choice model to the data set and to determine the importance of each attribute and level given in table 3.

The attributes and levels used in the survey are described in the questionnaire given in Appendix I. Method of partial likelihood estimated utility values using Cox regression analysis.

The proportional hazards model of Cox regression used continuous-time survival data. The choice experiment was analysed using the Conditional Logit procedure. Generalised and conditional logit models (CLM) are usually used to model consumer choices, while the cumulative logit model is used in situations where the response of an individual unit is restricted to one of a finite number of ordinal values. The IBM SPSS software does not have a procedure that is specially designed to fit the conditional logit models. However, the CLM procedure can be used to fit these models with some modification to the data entry procedure. The use of multinomial logit (MNL) for the job has some limitations and it differs in two respects. The explanatory variables can include characteristics of the choice options as well as variables describing the relationship between the chooser and the option. Second, the set of available options can vary across individuals in the analysis. Preference elicitation for choices using the Cox regression procedure has been well documented in the coastal applications. Choice modelling approach using PHREG procedure in SAS was used to evaluate three overriding fisheries management objectives within English Channel fisheries (Wattage et al., 2005) and also to evaluate objectives of marine protected areas in Irish Waters (Wattage et al., 2011).

The most conclusive use of model results given in the appendix II is the generation of measures for welfare change associated with the conservation of mangroves. This has direct implications for the sustainability of coastal ecosystems. From an economic perspective, the program to conserve mangrove is the change in the economic welfare of

those affected by the change. The change in economic welfare generally increases as a result of increased mangrove area. Implicit prices (part-worth) for welfare changes can be estimated using the results of regression model reported in appendix II. The implicit price is the negative of the ratio of any two of the attributes and provides the measure of trade-offs that individuals in the sample would be willing to make between attributes that is implied by the data (Hanley et.al, 2006, Stewart & Kahn, 2006). In economic sense, the implicit price is the marginal rate of substitution between the two attributes or the slope of an indifference curve. Implicit price of any attribute with the price (or cost) provides WTP<sup>2</sup> value. More detailed analysis is given in appendix II. The final non-use value for mangrove conservation is shown in table 4.

<b>Marginal Product</b>	<b>No Damage</b>	<b>Further Damage</b>	<b>Low income</b>	<b>Higher income</b>	<b>Total Value \$</b>
Mangrove environment	0.136010	0.677461	-	-	0.813471
Livelihood improvement	-	-	0.755181	0.467617	1.222798
Total WTP	0.136010	0.677461	0.755181	0.467617	2.036269
Total WTP/Month					1401935 <sup>3</sup>
Total WTP/Year					16823218

<sup>2</sup>  $MP_i = -(\beta_i/\beta_2)$

$\beta_2 = wtp_{10}$ ;

<sup>3</sup> Population in project districts (2015) is 688482.

Table 4. Non-use value estimation.

The total value of mangroves (use and non-use) is given in table 5.

<b>Mangrove values per annum</b>	<b>US\$ Millions</b>
Total use	55.4
Total non-use	16.8
<b>TOTAL</b>	<b>72.2</b>

Table 5. Total (use and non-use) value of mangroves

When comparing mangrove areas with other development activities, this total economic value should be used in comparing costs and benefits.

#### IV. Recommendations

From the discussion and meetings conducted with stakeholders, community leaders and government officials regarding the mangrove characteristics, economic valuation and livelihood options, a series of conclusions were drawn that were formulated into recommendations. These are listed below with actions to implement the recommendations shown as bullet points.

1. Develop a system to collect mangrove field statistics at least on the project sites comes under this project. There are no data collection at village or suco levels. Project and planning information should maintain at least project level and collection of data at ministry level is not effective.

- Recommendation to be brought to a meeting of the competent authorities.

2. People live in mangrove area should have awareness of mangrove replanting, conservation and maintaining in existing plantations.

- Competent authorities to be advised of relevant findings.

3. Information about issues relating to wetland conservation is included in school and university curriculum

- Strengthen content by dissemination of research findings and by involvement of schools in monitoring activities.
- Seek to establish a source of funding to support school and university activities.
- Seek out and disseminate indigenous knowledge about wetland utilisation.

4. Use the value of wetland (wherever possible) in cost benefit analysis when cost and benefits of development activities are being carried out in wetland areas.

- Test the reliability of using wetland value in policy decisions.
- Prepare rules and guidelines to use such values in extended cost-benefit analysis.

<b>Attributes</b>	<b>Level I</b>	<b>Level II</b>	<b>Level III</b>
<b>Conserve mangroves ecosystem</b>	Further damage to mangroves for economic activities	Some damage to mangrove (Status quo)	No damage to mangrove environment
<b>Improve rural livelihood</b>	Contribute to low income and poor standard of living	Some income (Status quo)	Contribute to higher income and standard of living
<b>Your contribution for an institution that could support these activities</b>	USD 0/Month (Status quo)	USD 10/Month	USD 50/Month

General Recommendation: These points to be circulated to all participants for comment and in order to seek volunteers to lead or assist with actions.

### **Appendix I: Design of Choice Experiment Study**

Attributes and levels used in the study

#### **Orthogonal Design**

\*Generate Orthogonal Design.

SET SEED 2000000.

ORTHOPLAN

/FACTORS=Mangrove 'Mangrove Design' (1 'Further damage' 2 'Some damage CS' 3 'No damage') Improve 'Improve livelihood' (1 'Low income' 2 'Some income' 3 'Higher income')

Contribution 'Contribution WTP' (1 'USD 0 month' 2 'USD 10 month' 3 'USD 50 month')

/REPLACE.

## Orthogonal Plan

### Warnings

A plan is successfully generated with 9 cards.

### Card List

Mangrove	Improve	Contribution	STATUS	CARD
3	3	1	0	1
1	2	3	0	2
3	1	3	0	3
1	3	2	0	4
2	3	3	0	5
3	2	2	0	6
2	2	1	0	7
2	1	2	0	8
1	1	1	0	9

Mangrove	Livelihood	Contribution	STATUS	CARD
No damage	Higher income	USD 0/month	0	1
Further damage	Some income	USD 50/month	0	2
No damage	Low income	USD 50/month	0	3
Further damage	Higher income	USD 10/month	0	4
Some damage	Higher income	USD 50/month	0	5
No damage	Some income	USD 10/month	0	6
Some damage	Some income	USD 0/month	0	7
Some damage	Low income	USD 10/month	0	8
Further damage	Low income	USD 0/month	0	9

### Some damage to mangrove environment (Status Quo):

There is some damage to the mangrove environment with the economic activities of the area. This situation is familiar to the residents as this is part of their current livelihood activities. We are assuming some disturbance to the natural environment due to other economic activities.

**Further damage to mangrove environment:**

If there is no intervention from a governmental or non-governmental organisation, the damage to the mangrove environment will continue to grow bigger and bigger. The result will be a catastrophic and will not be able to reverse the negative impact on mangrove ecosystem which support fishing and other ecosystem functions. The mangrove ecosystem also supports humans with firewood, fish, and act as a natural barrier against coastal disasters which are essential to human wellbeing. Further damage to this ecosystem through other economic activities will danger the life of poor people living in the area as they are primarily depended on the rural agriculture. Depending on management practices, agriculture can also be the source of numerous disservices, including loss of wildlife habitat, nutrient runoff, sedimentation of waterways, greenhouse gas emissions, and pesticide poisoning of humans and non-target species. Farming systems of the area rely on ecosystem services provided by natural ecosystems, including pollination, biological pest control, maintenance of soil structure and fertility, nutrient cycling and hydrological services. The damage to the natural ecosystem is also damaging poor livelihood farming activities.

**No damage to mangrove environment:**

We assume that there is some intervention from governmental or non-governmental organisation which could help to control the damage inflicted in mangrove environment through other economic activities. Through the conservation of mangrove environment, eco-tourism will be developed as an alternative income sources which will provide tourists to enjoy the natural coastal environment without damaging it.

**Some income (Status Quo):**

Mangrove is not well manged in the area as such the income from these activities are very minimal. Mangrove is considered as just a way of getting firewood but not appreciate its full economic potentials. Hence, conservation of mangroves is not considered as important.

**Low income and poor living:**

If current condition prevails and there are no benefits from mangroves, the damage to natural environment will continue. Thus, current income levels of poor people will further go down causing worst living conditions of the area.

**Higher income and better living:**



Through the conservation activities, we aim to maximise the benefits of mangroves in project areas. In practise, this means we bring people together to find practical solutions for mangrove conservation and better livelihood options. We plan to develop better mangrove planting methods, eco-tourism, and other improved livelihood condition in the project areas through mangroves. Mangrove resources of the area depending on the rural people and the benefits of these services should proportionately give to the people of the area. This income be a part of their services for looking after the resources.

**US\$ 0 for eco-tourism institution (Status Quo):**

In current situation, we do not have a proper institution to regulate mangrove activities of the area. For that you don't have to contribute anything for the improvement of mangroves.

This is a PURELY HYPOTHETICAL SITUATION in which we assume that an organisation will be created to improve mangrove in project areas. The institution will:

- Produce direct financial benefits for conservation.
- Generate financial benefits for both local people and private industry.
- Deliver memorable interpretative experiences to eco-tourists that help raise sensitivity to host countries' political, environmental, and social climates.
- Design, construct and operate low-impact facilities.
- Recognize the rights and spiritual beliefs of the Indigenous People in your community and work in partnership with them to create empowerment.
- Minimize physical, social, behavioural, and psychological impacts.
- Build environmental and cultural awareness, and respect.

Preliminary assessments indicate that the value of these mangrove ecosystem services to fisheries and agriculture is enormous and often underappreciated. Mangrove ecosystems also produce a variety of ecosystem services, such as regulation of soil and water quality, carbon sequestration, support for biodiversity and cultural services.

**US\$ 10 for an institution:**

Would you be willing to contribute US\$ 10 for the maintenance of this institution?

**US\$ 50 for an institution:**

Would you be willing to contribute US\$ 50 for the maintenance of this institution?

**Survey Questionnaire**



1. Tourism
2. Aquaculture
3. farming
4. Building boats
- 5 Fishing activities
6. Salt farming by cooking
7. \_\_\_\_\_
8. \_\_\_\_\_
9. \_\_\_\_\_

**c. What kind of mangrove-based livelihood activities are more suitable for the project areas? (Please circle)**

1. Eco-tourism
2. Small-scale aquaculture
3. Nature-based farming
5. Building boats
5. Co-management of fishery
6. Recreational
7. \_\_\_\_\_
8. \_\_\_\_\_
9. \_\_\_\_\_

### SECTION III

**Question 1. In the following questions, please CIRCLE the number that best describes your level of agreement.**

<b>Question 1.</b>	<b>Strongly disagree</b>	<b>Disagree</b>	<b>Neutral</b>	<b>Agree</b>	<b>Strongly agree</b>
<b>a)</b> Before filling in this survey I was unaware of the mangroves of this area	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
<b>b)</b> I have never come across any type of mangrove destruction	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
<b>c)</b> I have an interest in recreational activities in the project area	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
<b>d)</b> I have little or no interest in the marine environment	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
<b>e)</b> I think that the local community has a responsibility for the protection of the mangrove environment in project area	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
<b>f)</b> The Government should do more to improve mangrove of this area	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
<b>g)</b> The salt producers should do more to improve mangroves of the area	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
<b>h)</b> The Government should do more to protect coastal environment	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
<b>i)</b> Sucos are responsible in looking after mangroves	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>



**(Information on mangrove related livelihood activities)**

**Question 8. What kind of mangrove related livelihood activity? (Please circle)**

1. Fishing    2. Farming    3. Hovey collecting    4. Firewood

**Livelihood Activities**

Do you, or anyone in your household do any of the following activities in the wetland or lagoon area? D= Daily    W= Weekly    M=Monthly

Activity	Level of labour input (days per week)		Type of raw material used (e.g. fish, mangrove wood, palm)	Place raw material obtained (e.g. marsh, canal, lagoon)	Quantity harvested (in kgs)		
	own	hired			D	W	M
Fishing (in lagoon, marsh or canal)							
Fishing (in coastal waters at sea)							
Firewood collection							
Tanin production for fishing nets and sails							
Collection of timber for housing, craftwork							
Brush-park collection for fishing							
Collection of palm for roofing, weaving, fencing etc.							

Crab collection							
Fruit collection							
Production of Charcoal							
Other (please specify)							

**SECTION V.** (Information you provide in this section will remain strictly CONFIDENTIAL)

**Question 8. What is your age?**

\_\_\_\_\_ years

**Question 9. Are you? (Please circle)**

1. FEMALE                      2. MALE

**Question 10. Do you have children? (Please circle)**

1. YES                                      2. NO. If YES, how many? \_\_\_\_\_

**Question 11. Which of the following best describes your education to date? (Please circle)**

1. University degree
2. Professional (i.e. CIMA)
3. Secondary level
4. Primary level
5. No formal education
6. Other (\_\_\_\_\_)

**Question 12. Which of the following best describes your occupation? (Please circle)**

1. Professional
2. Teacher/Lecturer
3. Self-employed
4. Housewife/Homemaker
5. Farmer
6. Retired

7. Unemployed

8. Other (Please specify) \_\_\_\_\_

**Question 13. What is your approximate annual household income?**

\$ \_\_\_\_\_

***A summary of the results of this survey will be provided at <http://www>.***

***Thank you for completing this survey. Your time is greatly appreciated!***

## **Appendix II: Choice Experiment Analysis.**

### **A. Model estimation using IBM SPSS Statistics 22.**

The purpose of this analysis is to reveal the preference of the general public of Timor-Leste on building shoreline resilience in mangrove ecosystem to protect local communities and their livelihoods. A field survey was conducted as part of a Gef/UNDP funded project to collect observations for scenarios presented in table 1. It also incorporated the key features regarded as the most important in the implementation and improving mangrove conservation and improving livelihood condition. It also tried to estimate people's willingness to pay (WTP) for mangrove conservation and improving livelihood condition. This gives us the total economic value.

In defining the model structure, care was taken to ensure completeness of the system, such that all major issues related to the mangrove conservation and improving livelihood condition were incorporated and identifiable in some level. Considerable time was given to clarifying the terms used in the attributes and their underlying implications so that the decision attributes developed were clear and concise. The three main attributes and the associated levels considered in the analysis are shown in table 1. The overriding objective grouping them all was to ensure protection of mangroves while improving livelihood condition. While in this case study, only three attribute groups are employed, choice experiment models can generally consider even more attributes and associated levels. For more details of the analytical procedure was given in the appendix II.

#### **A1. Results of the Cox Regression procedure**

The Cox regression (CR) procedure of SPSS software was used to fit the choice model to the data set and to determine the importance of each attribute. Using the method of partial likelihood, this procedure was modelled to do Cox regression analysis of continuous-time survival data to estimate the proportional hazards model. This section details the results of the choice experiment, which was analysed using the Conditional Logit procedure. Generalised and conditional logit models (CLM) are usually used to model consumer choices, while the cumulative logit model is used in situations where the response of an individual unit is restricted to one of a finite number of ordinal values.



The estimated chi-squared values for likelihood ratio indicate that the model is very highly significant (table 1). At a significance level of  $\alpha = 0.01$ , one would reject the null hypothesis of no relationship between choice and the attributes. The model test indicates a high level of significance with probability  $<0.0001$ , suggesting that there is a strong relationship between choice and the attributes.

**Table 1: Tests of Model Coefficients <sup>a</sup>**

-2 Log Likelihood	Overall (score)			Change from Previous Step			Change from Previous Block		
	Chi-square	df	Sig.	Chi-square	df	Sig.	Chi-square	df	Sig.
1799.877	31.409	6	.000	30.195	6	.000	30.195	6	.000

a. Beginning Block Number 1. Method = Enter

The significance of the model was carried out using  $\chi^2$  likelihood ratio tests. The method used was the *likelihood ratio chi-square* obtained by comparing the log-likelihood for the fitted model with the log-likelihood for a model with no explanatory variables. The ratio was calculated by taking twice the positive difference in the two log-likelihoods. Taking the logistic values this produces  $-2 \times \log$ -likelihood for each of the models. The chi-square is the difference between those two numbers. However, for smaller samples such as in this study and samples with extreme data patterns, the likelihood ratio chi-square test is superior over the other tests (Jennings, 1986).

Most significant part of modelling is the estimation of parameter values of the maximum likelihood model and their related statistics which are presented in table 2. As shown in the table, parameter values for the *MANENND* (*mangrove environment no damage*) and *WTP50* are not significant even at the  $\alpha = 0.10$  level. Descriptive labels for all variables are presented along with the zero coefficients for the reference levels (i.e. status quo). The other estimated coefficients of the model have values relative to the reference level. Under the attribute of *Conserve Mangrove Ecosystem*, the part-worth utility (i.e. the estimated coefficient) for the variable status quo (current situation) is a structural zero, while the part-worth utility for “*further damage*” is -0.523 and “*no damage*” is - 0.105. Hence, the “no damage” is preferred

over both the “status quo” and “further damage”. The magnitude of the estimated coefficient indicates which objective is more preferred by the sample respondents. The success of mangrove conservation generally depends upon the control of human activities of the area. The survey finding confirms that out of the potential control options, the people of mangrove areas prefers the control of damaging mangroves. One parameter (*manenfd*) tested under this first attribute proved significant at  $\alpha = 0.01$  level.

**Table 2. Variables in the Equation <sup>b</sup>**

	<b>B</b>	<b>SE</b>	<b>Wald</b>	<b>df</b>	<b>Sig.</b>	<b>Exp(B)</b>
Manennd	-0.105	0.199	0.277	1	0.599	0.901
Manenfd	-0.523	0.319	2.695	1	0.1	0.593
Manensq			.	0 <sup>a</sup>	.	
Livhdhi	-0.583	0.258	5.111	1	0.024	0.558
Livhdli	-0.361	0.211	2.912	1	0.088	0.697
Livhdsq			.	0 <sup>a</sup>	.	
wtp50	0.141	0.257	0.3	1	0.584	1.151
wtp10	0.772	0.23	11.226	1	0.001	2.163
wtp0sq			.	0 <sup>a</sup>	.	

a. Degree of freedom reduced because of constant or linearly dependent covariates

b. Constant or Linearly Dependent Covariates  $manensq = 1 - manennd - manenfd$  ;

$livhdsq = 1 - livhdhi - livhdli$  ;  $wtp0sq = 1 - wtp50 - wtp10$  ;

The second management attribute tested in the model was the “*improve rural livelihood*”. When compared to the *status quo* (current practices), *livhdli* and *livhdhi* were preferred. The magnitude of the estimated parameter indicating that the (-0.583) was preferred over *livhdli* (-0.361). Moreover, both parameters proved highly significant at  $\alpha=0.05$  and level  $\alpha=0.10$  level (table 2), with the part-worth utility for the status quo.

The third management attribute tested in the model was “*WTP*” which is the management and monitoring cost. This willingness to pay (WTP) value was designed as a payment which would be an additional monthly contribution per person. The status quo was set as \$0 (no additional cost) and compared to a \$10 or \$50 additional monthly contribution to mangrove conservation. The results reveal that \$10 (+0.772) was more favourable over the status quo (pay nothing) and highly significant at  $\alpha=0.01$  level. As such this value has been used to

calculate total WTP. The other WTP of \$50 contribution (+0.141) is less favourable to the status quo and also not significant ( $\alpha=0.584$ ).

## A2. Probability associated with each choice

The parameter estimates of table 2 has been used to estimate the probability of each of the 9 choices presented to survey respondents. As indicated in table 3, the most preferred combination of attribute and the level is WTP10 contribution for mangrove conservation with a probability of 0.16716. This indicates that the significant improvement to mangrove conservation work is the most preferred option according to the general public of Timor-Leste. The preference for this level is clear as it is the most profound action that will lead to the save mangroves. The second highest choice indicated by the probability is 0.14781 for some livelihood improvement through mangrove protection.

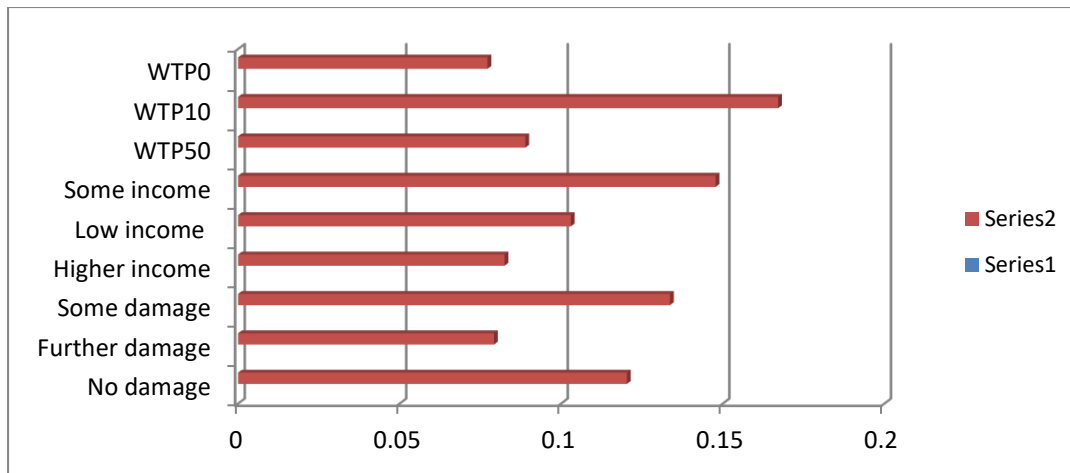
Table 3: Probability of choice

ATTRIBUTES	LEVELS	PROBABILITY
Mangrove environment	No damage	0.12038
	Further damage	0.07925
	Some damage (status quo)	0.13369
Livelihood condition	Higher income	0.08251
	Low income	0.10302
	Some income (status quo)	0.14781
WTP per month	\$50	0.08894
	\$10	0.16716
	\$0 (status quo)	0.07724

The third preference represented by the probability value of 0.13369 to some damage to mangrove environment. This is mainly because most of the people living in this area would expect some consumption of mangroves in their livelihood. The fourth level of probability 0.12038 is assigned to no damage to mangroves. Looking to the consensus of opinion using the choice probabilities, it is possible to get a crude indication of the importance/preference attached to each of the individual objectives arising out of consensus. One way of doing this

is to take a simple average of probabilities for each attribute, the results of which are shown in figure 4.

Figure 4: Estimation of the degree of importance attached to each attribute (derived from the full set of 27 alternatives).



As shown in the figure 4, the ranking of attributes and levels suggests that the top 2 preferences are for WTP10 and improvement of some income levels. These results are largely as expected given the results of the maximum likelihood model and confirm the level of importance attached by the mangrove conservation. These probability values are also gives an indication on what mangrove supportive livelihood options they would prefer in the target municipalities. More details of mangrove supportive livelihood options will be discussed in deliverable 3 and 4.

### **B. Total non-use value of mangrove conservation**

Understanding non-use value of mangroves has direct implications for the sustainability of mangrove ecosystems in Timor-Leste. Mangrove is a public good, hence the implicit price or the WTP can multiply with the closest population. Using the population of the district we could estimate the total non-use value for mangrove conservation.

Table 5: Estimation of total non-use values.

Parameter variable	Estimate	Std Error	Chi-Square	Pr > ChiSq
Manennd	-0.105	0.199	0.277	0.599
Manenfd	-0.523	0.319	2.695	0.101
Manensq	0			
Livhdhi	-0.583	0.258	5.111	0.244
Livhdli	-0.361	0.211	2.912	0.088
Livhdsq	0			
wtp50	0.141	0.257	0.3	0.584
wtp10	0.772	0.23	11.226	0.001

$$MP_i = -(\beta_i / \beta_2)$$

$$\beta_2 = wtp10$$

MP	nd/hi	fd/li		Population in project districts (2015)
Manen	0.13601	0.677461	0.813472	688482
Livhd	0.755181	0.467617	1.222798	
Total	0.891192	1.145078	2.036269	
Total WTP/Month \$	613569.5	788365.4	1401935	
Total WTP/Year \$	7362833	9460385	16823218	

According to the annual census of 2015, total population in project districts is 688482. Thus, the total non-use value for mangrove conservation using the field data collected in mangrove areas is US\$16.8 million.

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