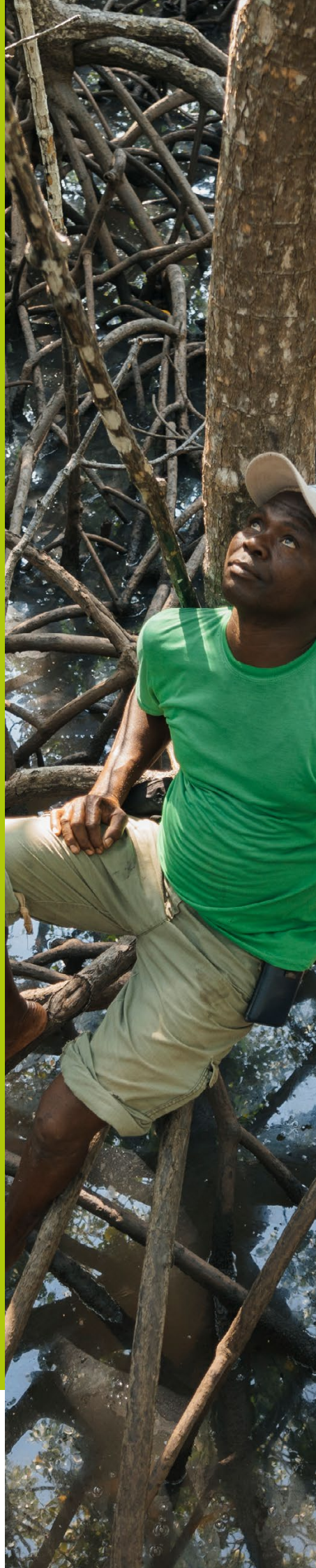
MANGROVE SOCIOECONOMIC EVALUATION AND CONSERVATION FRAMEWORK IN MOZAMBIQUE

Prepared by: Macamo C., Mahanzule R., Bandeira S., Balidy H., Machava V



SAVE OUR MANGROVES NOW!

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SAVE OUR MANGROVES NOW!

Bringing together governments, conservation specialists and coastal communities, Save Our Mangroves Now! (SOMN) aims to reverse the decline of mangroves to restore biodiversity, protect livelihoods and mitigate against the impacts of the climate crisis. It is a joint initiative by the German Federal Ministry for Economic Cooperation and Development (BMZ), World Wildlife Fund (WWF), the International Union for Conservation of Nature (IUCN) and Wetlands International. SOMN envisions a world with thriving mangrove habitats that work in harmony with local communities. Its mission is to mobilize action by facilitating policymaking, programmes and investments that regenerate mangrove ecosystems, tackle climate change and provide livelihoods, with an ambition to ensure that mangrove ecosystems are conserved, restored and sustainably used to the benefit of people and nature, locally and globally.

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Abbreviations

ANAC	Admnistração Nacional de áreas de Conservação (National Administration for Conservation Areas)
CBD	Convention of Biological Diversity
CBOs	Community-Based Organizations
CCP	Conselho Comunitário de Pesca (Community Fishing Council)
CGRN	Comité de Gestão de Recursos Naturais (Natural Resources Management Comitee)
CSO	Civil Society Organizations
CVM	Contingent Value Method
DNAF	Direcção Nacional de Florestas (Forest National Directorate)
DUAT	Direito de Uso e Aproveitamento de Terra Right of Use of Land
DW	Dry weight
EAME	East African Marine Ecosystem
FAO	Food and Agriculture Organization
FGD	Focal Group Discussions
GDP	Gross Domestic Production
ICZM	Integrated Coastal Zone Management
INE	Instituto Nacional de Estatística (National Statistics Institution)
IUCN	International Union for the Conservation of Nature
TEV	Total Economic Value
MIMAIP	Ministério do Mar, Águas Interiores e Pesca (Ministry os Sea, Inland Waters and Fisheries)
MTA	Ministério da Terra e Ambiente (Ministry of Land and Environment)
NDCs	National Determined Contribution
NGO	Non-Governmental Organization
PDD	Plano de Desenvolvimento do Distrito (District Development Plan)
PNDT	Plano Nacional de Desenvolvimento Territorial (National Plan for Territorial Development)
POEM	Plano de Ordenamento do Espaço Marítimo (Marine Spatial Planning)
POLMAR	Politica do Mar (Sea Policy)
REDD+	Reducing Emissions from Deforestation and Degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries
REPMAR	General Regulation of Marine Fisheries
SADC	Southern African Development Community
SDAE	Serviços Distritais de Actividades Económicas (District Services of Economic Activities)
SDGs	Sustainable Development Goals
SDO	Sustainable Development Objectives
SDPI	Serviços Distritais de Planeamento e Infraestruturas (District Services of Planning and Infrastructure)
UNEP	United Nations Environmental Program
USD	United States Dollars
WIO	Western Indian Ocean
WTP	Willingness to Pay
WWF	World Wide Fund for Nature

Acknowledgements

This work is part of the Save Our Mangroves Now! (SOMN!) initiative, an effort by the cosortium of WWF Germany, WWF US, IUCN and BMZ. The goal of the initiative is to promote mangroves conservation, restoration and sustainable use and produce benefits at local, regional and global scales. The initiative contributes to the Agenda 2030, the Paris Agreement, the Aichi Biodiversity targets and the Global Biodiversity Framework. In Mozambique the initiative is also aligned with the Mangrove Management Strategy. The Ministry of and and Environment kindly made available part of the data collected during the "Mangroves mapping, inventory and carbon assessment in the provinces of Maputo, Inhambane and Nampula provinces, Mozambique" project. Our gratitude extends to AQUA (Agency of Environmental Quality) (Xai-xai delegation) for the support during data collection at the Limpopo Estuary, and to the National Resources Management Comitee of Nhangau, for helping with the community meetings and data collection.

Célia Macamo
Salomão Bandeira
Henriques Balidy
Rosalina Mahanzule
Vilma Machava
Sádia Chitará-Nhandimo
2021

Executive summary

Mangroves are coastal ecosystems of paramount importance. Wood, poles, charcoal, fish, coastal protection, climate and recreation are among the most significant goods and services they provide to coastal communities. Mangroves also contribute to the equilibrium of coastal and marine habitats in general and participate in the regulation of chemical and biological processes at regional and global scale. However, there are threatened, mostly by human activities, but also natural phenomena and climate change. Mangrove protection and conservation is therefore a priority, particularly in communities where the dependence over natural resources is high. Knowing the value of the ecosystems and the services it provides is important to develop conservation strategies. However, this is a little exploited field. This study aimed at identifying and quantifying mangroves goods and analysing how Mozambique's policy and strategic development plans address socio-economic aspects of mangroves.

The study methods combined secondary (bibliographic search) and primary (field collected) data to (1) identify and map the main uses, goods and services provided by mangroves to coastal communities in Mozambique; (2) assess direct and indirect contributions of mangroves for national economy (including monetary and non-monetary values); (3) identify the main pressures and threats to mangroves, and sustainable use models of mangrove resources; (4) assess relevant national development plans, such as the National Plan for Territorial Development (PNDT), the Marine Spatial Plan (POEM), the District Development Plans (PDD) as mangrove conservation tools; and (5) assess the strategic, political and legal framework and how it addresses the socio-economic relevance of mangroves in Mozambique. Field data were collected in Matutine (Maputo province), Limpopo Estuary (Gaza), Nhangau (Sofala) and Mecúfi (Cabo Delgado), representing southern, central and northern Mozambique, respectively. Individual interviews with key informants and focal group discussions with community members were conducted in the 4 sites, to collect information on mangrove uses, contribution to domestic income and willingness of the community to contribute to mangrove conservation. The literature review was conducted to support the findings, but also to understand how the legal, political and strategic framework of Mozambique addresses the relevance of mangroves and their resources.

Mozambique has 3054 km^2 of mangrove forests distributed along the coast, but almost 50% of this extension is concentrated in central Mozambique (Sofala and Zambezia provinces). All 9 true mangrove species that occur in the WIO region can also be found in Mozambique, and the fauna is also very diverse. The goods and services derived by mozambique's coastal communities include wood materials, food, medicine, tannins and others. Mangroves are also site for the development of economic activities, such as fishing, and honey and salt production. Traditional ceremonies and recreation also take place in mangrove forests in Mozambique. Mangroves also provide ecological services, such as coastal protection, biodiversity site, biolfiltering, water quality control and climate regulation.

National estimates indicate that mangroves are decreasing near densely populated areas and stable or increasing in remote areas. In some other areas mangroves are being lost to natural extreme events, such as cyclones and hail storms. It is expected that these forests can recover given some time.

Estimating the value of mangrove ecosystems and the goods and services they provide is very difficult, as the existent methods probably under valuate them. Studies at the Zambezi delta and Limpopo river estuary estimated that mangroves are worth between USD 1 068 060 560 per year and USD 12 715.98 per year, respectively.

Mangroves management is under the Ministry of Sea, Inland Waters and Fisheries, which works in coordination with several other institutions under the Ministry of Environment (e.g.: National Directorate of Forests, National Directorate of Conservation areas) and state representatives a district level (e.g.: District Services of Economic Activities). At local level, communities

are invited to put in place local sustainable management practices, provided that wood resources are not commercially exploited. These systems have been observed at the Limpopo estuary, and Nhangau, the last one with a smaller degree of success given the influence of external factors.

There are several developing instruments in Mozambique and many of them address and promote mangrove conservation, while also highlighting its socio-economic importance in a way or other. Some examples include the Maritme Spacial Planning (POEM), the Policy and Strategy of the Sea (POEM), the Tourism Strategy, the Mangrove Strategy and Management Plan, etc. However, many of these instruments, as well and the national legislation, need to be harmonized and mainstreamed, as many of the instruments are disconnected.

The communities of our four study sites exhibit rural characteristics, their main economic activities being fishing-related, agriculture and informal employment. Average monthly income ranges between USD 55 and USD 133. Mangroves are an important source of income for these communities, and the most valuable products are fish (and invertebrates), firewood, building material and medicines. About 97% of interviewed community members claimed to feel responsible for mangrove management, and that they were willing to contribute to mangrove conservation, mostly working 5.2 hours a week. In general, these communities feel that they are somehow part of the management process, however only 37% of the interviewed claimed to be aware of mangrove legislation. This study shows that socio-economic uses of mangroves are still mainly limited to livelihood models, and that there is still room for other uses that can provide added benefits to the communities. This may imply adapting strategies that are appealing to other stakeholders otherwise not included, such as the private sector. The study also shows that the communities have a strong understanding of the importance of mangroves, reflected in their interest in contributing to conservation. Such interest must be capitalized, and it starts with more in-depth studies that look at other potential resources, exploring Payment for Ecosystem Services Models and other innovative business models.

Photo: © James Morgan / WWF-US

1. Background

Mangrove ecosystems are critical in the provision of goods, and ecological and socio-economic services to coastal communities across the globe (Costanza & Folke, 1997; Daily *et al.*, 1997; Vo *et al.*, 2014). These are categorized as use values: mostly extractable goods such as wood, fish, use of the ecosystem for the development of economic activities, recreational and cultural use (direct uses). Indirect uses that come in the form of ecological services that they provide, and the optional value, which refers to the future direct or indirect use, are also use values. The non-use values include existence value; and bequest value or the value of satisfaction from preserving a natural or historic environment (Natural heritage or cultural heritage) for future generations (Vo *et al.*, 2012; Oleson *et al.*, 2015; Rizal *et al.*, 2018). The sum of all use and non-use values of mangroves makes the Total Economic Value (TEV).

The TEV of a mangrove forest is very difficult to assess, in part because no single method can accurately put a price tag to every service provided, but also because the value of some of such services may be relative. Also the fact that mangroves have a complex functionality that is not fully understood, and that they are linked to other coastal and marine ecosystems makes this assessment rather more difficult. Globally there are relatively few studies that try the assess the economic value of mangroves, and many of which recognise that the ecological values are probably highly underestimated. Most of the studies only evaluate one or a few resources or services, usually the direct use values. Kairo *et al.* (2009) estimated the net value of US$379.17/ha/yr for mangrove woody resources only of a 12-year-old replanted forest in Gazi Bay (Kenya). When adding carbon sequestration and coastal protection the total value of the forest spiked to US$2902.87/ha/yr. In other study, the value of mangroves in Kenya has been estimated in 1 166 USD/ha (including provisioning, regulating and cultural services) (Huxham *et al.*, 2015). In a management perspective however, it is increasingly clearer that estimating these systems economic value is crucial to promote better and more effective management practices, while at the same time exploring better options to improve the life quality of coastal communities.

The importance of mangrove to coastal communities, climate adaptation and mitigation is currently widely recognised in Mozambique. This has been reflected in a number of governance instruments and actions that in the recent years highlight the need for conservation sustainable management and restoration of mangroves. However, many of these instruments fail to showcase the socio-economic contribution of the mangroves and do not explore the numerous opportunities to combine conservation and income generating, only considering, in most of the cases, subsistence activities.

This study aims at identifying and quantifying mangroves goods and analysing how Mozambique's policy and strategic development plans address socio-economic aspects of mangroves.

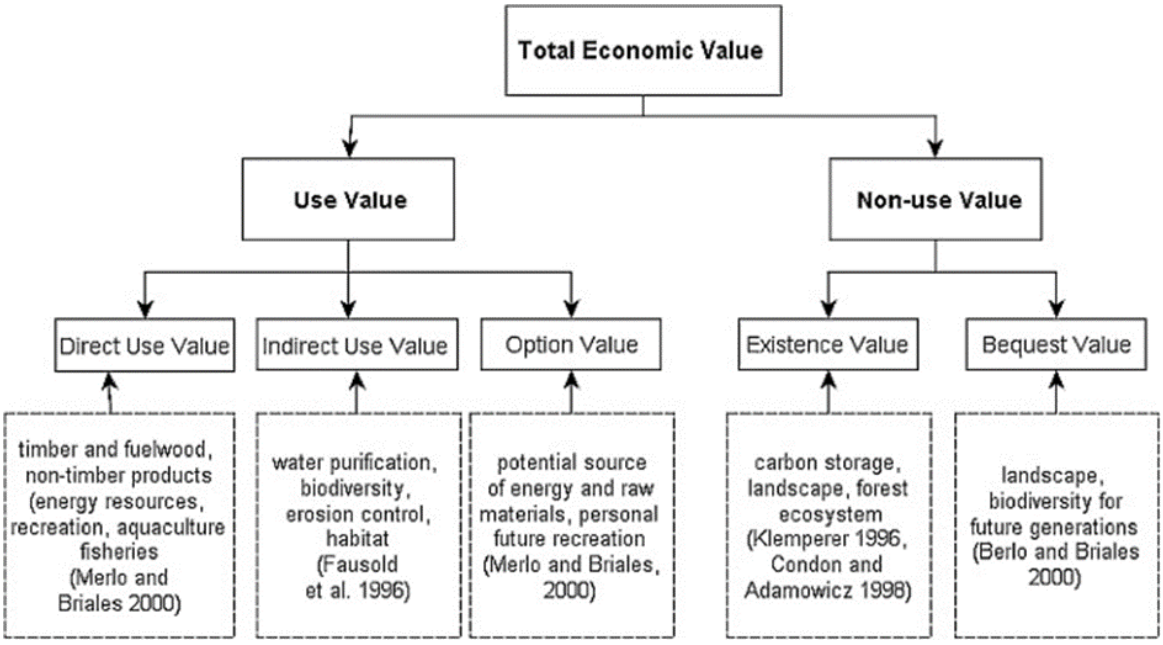


Figure 1. Mangrove goods and ecosystem services to be valued for a total economic valuation of mangrove forests. The total economic value is obtained by summing all use values and non-use values.

2. Study objectives

This study aims to respond the following objectives:

- To identify and map the main uses, goods and services provided by mangroves to coastal communities in Mozambique;
- To assess direct and indirect contributions of mangroves for national economy (including monetary and non-monetary values);
- To identify the main pressures and threats to mangroves, and sustainable use models of mangrove resources;
- To assess relevant national development plans, such as the National Plan for Territorial Development (PNDT), the Marine Spatial Plan (POEM), the District Development Plans (PDD) as mangrove conservation tools;
- To assess the strategic, political and legal framework and how it addresses the socio-economic relevance of mangroves in Mozambique

3. Methodology

3.1. DESCRIPTION OF STUDY AREA

Mozambique is situated in the south-east coast of Africa. The country is bordered in the north by Tanzania, northwest by Malawi and Zambia, Zimbabwe on the west, and on the east by the Mozambique channel and Indian Ocean, in the south and south-west by South Africa and Swaziland (Figure x).

According to the Mozambique National Census (2017) the total population in Mozambique is estimated at around 27.7 million people, a 35% increase of the population size when compared to the 2007 Census. The overall population density in the country is 33.5 people/km^2. This data suggests that the human pressure on natural resources, including mangrove forests and their resources, might increase over time as the population grows. The country is divided into 11 provinces (Niassa, Cabo Delgado, Nampula, Zambézia, Tete, Manica, Sofala, Inhambane, Gaza and Maputo) and capital (Maputo) with provincial status.

In the present study, in order to have representation from all regions of the country, four provinces were considered for data collection at community level, namely: Maputo, Gaza, Sofala and Cabo Delgado.

3.2 DATA SOURCE

Primary and secondary data were used for this study. The secondary data was based on the review of available literature, documents and reports found in institutions at central and provincial levels. The literature review was used to collect data on mapping the forms of use of mangrove resources, goods and services throughout the country. Information on mangrove related economic activities, such as fisheries (at national and local level) were obtained from relevant sources such as the National Institute of Statistics (Instituto Nacional de Estatística – INE) and the Ministry of Sea, Inland Waters and Fisheries (Ministério do Mar, Águas Interiores e Pescas – MIMAIP). These included figures such as number of people involved in these activities, contribution to the country GDP, and other relevant aspects.

The primary data were collected through focus group discussion at community level and individual interviews with key informants to provide missing information. Key informants included: mangrove experts, policy makers, practitioners, local authorities, community leaders, private sector, NGOs, civil society and other stakeholders.

A detailed methodology on the assessment of direct and indirect contribution of mangroves to the national economy and human well-being (including monetary and non-monetary values) is provided below.

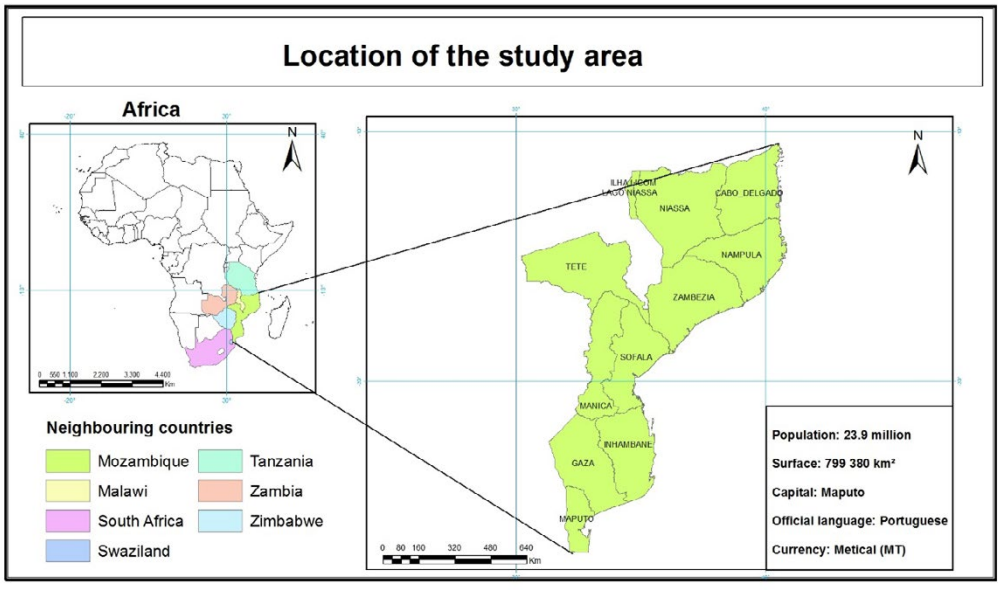


Figure 2. Mozambique geographical location

3.3 DATA COLLECTION

3.3.1. INDIVIDUAL INTERVIEWS AND FOCAL GROUP DISCUSSIONS

The data collection followed standard methods adopted in social sciences studies, which consisted in a combination of quantitative and qualitative approaches. In order to achieve the study goals within the time frame of the project, individual interviews with key informants and focal group discussions were conducted.

A buffer of 12 Km was drawn around each mangrove formation to reflect the stipulated target population, i.e. communities living within 10 km of the mangrove forest formation. This also allowed a better understanding of the communities' livelihood and their relationship with mangrove ecosystems.

A total of five (5) districts were visited. At the community level, 24 FGD were conducted, composed of 6 to 15 people per group disaggregated in gender (male or female) and age (youth = younger than 30; or adult = more than 30 years old). In some sites, due to limitations of number of participants, those were not separated according to age groups, however individual responses during the group discussions were recorded as respondents being younger or older than 30 years.

There were a total of 266 participants, of which 40.2% were women and 59.8% men. See Table 1 for more details on Districts and gender groups covered by the FGDs.

Table 1. Sites of the study and total number of Focal Group Discussions (FGD) participants by social group.

Province	District	Number of FGDs	Number of participants by social group (age and gender)				
			Young		Adult		Total
			Men	Women	Men	Women	
Cabo Delgado	Mecufi	6	43	13	4	7	67
	Metuge	5	55	9	8	5	77
Gaza	Xai-Xai	6	12	0	0	0	57
Sofala	Beira	5	7	0	22	22	51
Maputo	Matutuíne	2	0	2	8	4	14
Total		**24**	**117**	**24**	**42**	**38**	**266**

Eleven (11) interviews with key informants were also conducted. These included local government personnel in the District Service of Economic Activities (Serviços Distritais das Actividades Economicas - SDAE), School Directors and community leaders.

Both individual interviews and focal groups discussions addressed: main uses of mangroves and their resources, income from mangrove associated activities, cultural valuation, valuing non-extractable goods and services, mangroves management, food security, legal framework and mangrove policies.

3.3.2. FIELD OBSERVATION

Field observation is a data collection method that provides complementary information, as it helps the researcher to identify and obtain evidence on several aspects about which the interviewees might not be aware of. Therefore, this method was used for all research purposes, with the aim of exploring explanations for different behaviours of the interviewees, which they do not feel comfortable to approach or for which they simply have no justification.

3.3.3. MANGROVE PRODUCTS MARKET PRICE ASSESSMENT

This assessment covered mangrove extractable goods such as firewood, charcoal, poles and non-woody forest products such as leaves used as animal fodder, honey and medicine. The market price method was used to access the monetary value that each product has, which is established through the exchange of goods and services in the market, and the interaction between the production value (supply) and the consuming value (demand) (Spaninks and van Beukering, 1997).

The market price method estimates the economic value of ecosystem products or services that are bought and sold in commercial markets. This method can be used to access value changes in quantity or quality of a good or service (Borinelli and Rocha, 2006; Adeyemi et al., 2012). Through the data from the interviews and the market price assessment, monetary values of mangrove ecosystems services in the study area were accessed and valued based on the Ecosystem Service Valuation Database (TEEB; Van der Ploeg and de Groot, 2010; Rosales et al., 2017; Tuan, 2013).

The income generated from the mangroves were deducted from the profit that is obtained in the marketing process, which were calculated using the following formula:

Profit=Net margin/Total cost

Where:

*The Net margin is the difference between the production value (received price * quantity) and the Total cost (includes all the necessary expenses), this includes the taxes that are paid.*

Other formulas used in the process of income calculation are described below:

Production value = Received price*Quantity

Net margin = Production Value-Total cost

Cost/Benefit Ratio = Total cost/ Production Value

The quantity units used to calculate the production value were: unit for poles and small poles; kg for fishing products; and bags for charcoal.

3.3.4. ECONOMIC VALUATION OF ECOSYSTEM SERVICES

For economic valuation of ecosystem services, the Contingent Valuation Method (CVM) was adopted, which is a questionnaire-based economic valuation method often used to assign monetary values to non-marketable ecosystem goods and services.

Based on this method, a hypothetical scenario was simulated in relation to which the research participants expressed their willingness to pay for the mangrove ecosystem conservation. The knowledge of the resource to be valued by the participants was used as an assumption, so the scenario presented included a brief description of the socio-economic and ecological functions of the mangrove, revealing the importance of its conservation.

The average Willingness to Pay (WTP) per person can be determined as the average of the provisions to be paid in cash and the provisions to be paid in labour for all participants that decide to contribute to the ecosystem maintenance. For participants who decided to pay in labour their WTP (per year) was deducted as the opportunity cost of labour estimated from the number of hours of work that each participant decided to work per week in the mangrove conservation,

To evaluate the WTP in cash, 10 values in Meticais (13, 27, 40, 53, 66, 80, 93, 106, 119 and 133) indicated randomly were made available and in an open-ended question format, respondents expressed the amount they wanted.

3.3.5. DATA ANALYSIS

Although the information collected is oriented to achieve the same objectives, the fact that it was obtained from different techniques and procedures suggests different treatment. A data base was created using Excel program, and afterwards analysed qualitative and quantitatively.

The analysis of qualitative information (from focus groups and interviews) was carried out based on

triangulation techniques, where, several sources of information are considered for each aspect. The additional sources included, but were not restricted to, bibliographic review and direct observation. This method allows to assess the coherence of trends in responses or pronouncements made during the interview process. The triangulation technique helps to filter the personal opinions of the interviewed (Carter *et al.,* 2014).

Quantitative analysis was performed with the statistic package STATA, which allowed mathematical analysis of parameters such as mean, median, comparison of means, regression and correlation between variables under study. This analysis also allowed a better representation of the study results in the form of graphs, tables and others.

3.2. MAPPING MANGROVES USES, GOODS AND SERVICES IN MOZAMBIQUE

Two approaches were followed to map mangroves uses, goods and services in Mozambique: (1) an extensive literature review which was carried out to assess the amount and quality of mangrove socio-economic information readily available for Mozambique; and (2) interviews with key informants to complete whatever knowledge gaps that remain.

The literature review was carried out covering relevant publications on mangrove uses in Mozambique. This included scientific papers, technical and scientific reports and other studies. Some of the studies that were explored with more detail, as they were conducted recently and provide an interesting picture of sites with different settings were:

a. A study conducted by the Eduardo Mondlane University in Mozambique, which looks at mangroves socio-economics and value chain analysis. This study was conducted in the provinces of Maputo, Inhambane and Nampula and targeted the following sites: in Maputo the sampled areas included Montanhana, Chiango, Bairro dos Pescadores, Costa do Sol, Matola, Katembe and Matutuíne; in Inhambane the sampled areas were Inhambane Bay, Morrumbene, Vilankulos and Inhassoro; in Nampula de sampled sites were Mongicual, Mossoril, Mozambique Island and Nacala. Data collection took place between November 2019 and September 2020. complementary information was also obtained from other studies, such as Inácio, 2018.
a. Socio-economic studies by WWF conducted in the Zambezi delta in 2016. This study looked at the main forms of use of mangrove resources and their value chain.
b. A socio-ecological study conducted between 2016 - 2017 that looked at the Value Chain Analysis of Mangroves in Central Mozambique (Zambezi delta, Nhangau and Chiveve river).
c. A socio-economic study conducted at the Limpopo estuary in 2014. This study aimed at valuing the forest of the Limpopo Estuary, considering both direct and indirect value. The final objective was to develop guidelines for the forest sustainable management and financial sustainability of restoration activities;

The interviews with key informants considered a broad range of stakeholders, including different mangrove users (e.g.: fishermen, pole cutters, firewood and invertebrate collectors, charcoal producers, etc.), managers, local authorities, mangrove researchers, and others. Semi-structured interviews will be conducted with the key informants in order to assess how mangrove resources are used in different locations in Mozambique.

The information provided was compiled and systematized in order to show differences between the regions of the country (eg. south, center and north), urban, peri-urban and rural areas or other important categories.

3.3. PRESSURES AND THREATS TO MANGROVES, AND SUSTAINABLE USE MODELS OF MANGROVE RESOURCES

The main pressures and threats to mangroves in Mozambique have already been identified in several studies (e.g.: Macamo et al., 2016). However, it is important to further understand the main drivers of mangrove loss in the country and document models of sustainable use. A mixed approach that combines literature review, field visits and interviews with key informants was used. Visited sites included the Limpopo Estuary Community, the Nhangau Community and Macúfi.

3.4. NATIONAL INSTRUMENTS (DEVELOPMENT PLANS, POLITICAL AND LEGAL FRAMEWORK) AND THE SOCIO-ECONOMIC ROLE OF MANGROVES

In this section, a number of national development and natural resources management tools were analysed to understand in which ways mangroves conservation is addressed and the socio-economic role of mangroves is depicted in these instruments. The development plans analysed included the National Plan for Territorial Development (PNDT), the Marine Spatial Plan (POEM) and the District Development Plans (PDD). Similarly, national strategies and the legal framework was analysed (e.g.: Mangrove Strategy and Action Plan, the REDD+ Strategy and international protocols that Mozambique has signed). Such analysis included: (1) identifying the instruments; (2) interpret its relevance to mangrove conservation and socio-economic relevance; (3) a gap analysis of every instrument and (4) opportunities for improvement.

4. Mangroves of Mozambique: short summary

4.1. EXTENSION AND DISTRIBUTION

Mozambique is listed as one of the top 15 countries in the world with the largest mangrove extent, ranked 13rd in global estimates, second in the African continent and first in the Western Indian Ocean Region (Spalding *et al.* 2010; Giri *et al.* 2011; Fatoyinbo and Simard 2013). Mangroves occur sparingly in the southern Mozambican coast, while dominating the central coast from the Save River up to Angoche. In the northern coast they are more common in embayments and protected coasts. All the nine species that occur in the Western Indian Ocean region can also be found in Mozambique. *Avicennia marina* is among the most common occurring in the marine and terrestrial margins of the forest. However, from Inhambane to the north, seaward *A. marina* may be replaced by *Sonneratia alba*. *Ceriops tagal* and *Rhizophora mucronata* are also present in most of the sites and grow in the inner parts of the forest. *Bruguiera gymnorrhiza*, *Xylocarpus granatum*, *Heritiera littoralis* and *Lumnitzera racemosa* prefer areas where salinity is more stable, sometimes with freshwater seepage. *Xylocarpus moluccensis* has only been recorded at the Zambezi delta and northern Nampula province (Memba), but it is likely to occur in other sites as well (Barbosa et al., 2001; Macamo et al., 2016; Bandeira, personal observation).

The country mangrove extension is estimated at 3 054 km^2 (Fatoyinbo and Simard 2013). However, such figure may change according to the methodology used for the estimate (Table 1). It is important to mention though that most studies were conducted with limited data collected from the field. Localized studies are more frequent and cover several areas, such as Maputo Bay, the Incomáti Estuary, the Save Delta, the Zambezi Delta and Pemba Bay. In general, such mappings indicate a trend of decreasing or degradation of mangrove extension near urban areas or major human settlements, while in remote areas the extension tends to be stable or increase.

Table 2. Different estimates of mangrove area in Mozambique

Reference	Year	Estimated area (km^2)	Method
FAO 1994	1990	3 968	Remote sensing
Spalding *et al.* 1997	1980	3 459	Map analysis
FAO 2007	1997	3 927	Combined information from different sources (Tropical Forest Resources Assessment 1980 (FAO and UNEP, 1981a,b,c); Global Forest Resources Assessment 2000 (FAO, 2001) and FRA 2005 (FAO, 2006)
Fatoyinbo *et al.* 2008	1999-2002	2 909	Remote sensing
Giri *et al.* 2011	2000	3 188.51	Remote sensing
Fatoyinbo and Simard 2013	1999-2002	3 054	Remote sensing

4.2. FLORA AND FAUNA DIVERSITY

Mangroves are sites of high plant and animal diversity. On what regards to vegetation, apart from the 9 true mangrove species, there are a number of other associated species that have some tolerance to this particular type of environment, although lacking specific adaptations. These are *Pemphis acidula*, *Phoenix reclinata*, *Brexia madagascariensis*, *Foetida oblique*, *Hibiscus tiliaceus*, *Terminalia catappa*, *Thespesia pupulnea, Arthrocnemum*, *Salicornia*, *Suaeda* and *Sesuvium portulacastrum*. The mangrove fern *Acrostichum aureum* has been recorded in several places such as the Zambezi delta, Maputo Bay, Bons sinais estuary and Nampula province. Herbaceous species include *Sporobolus virginicus*, *Dactyloctenium sp.*, *Juncus kraussii*, *Phragmites australis* and *P. mauritianus*.

Table 3. Recent trends in mangrove area coverage at selected sites in Mozambique

Region in Mozambique	Site	Period of study	Area (km^2)		% of change	Major impacts	Source
			T_0	T			
North	Cabo Delgado	1995-2005	325	369	+13.5	Local use for firewood, building material	Ferreira *et al.* 2009b
	Olumbi	1991-2013	7.24	5.56	-25.4	Harvesting, pathways, invertebrate harvesting	Macamo et al., 2018
	Pemba Bay	1991-2013	21.43	31.30	+23.1	Aquaculture, saltpans, logging	Macamo et al., 2018
	Quirimbas National Park	1991-2013	112.44	123.48	+9.8	Local harvesting, natural sedimentation and erosion	Nicolau *et al.* 2017
	Nacala Bay, new port area	2013-2016	0.365	0.276	-24.9	Port development	Macamo et al., 2019
Central	Zambezi Delta	1994-2013	333.1	370.34	+10.1	Erosion, natural causes	Shapiro *et al.* 2015
	Chiveve River (Beira city)	2016-2017	0.23	0.1	-43.5	Urban encroachment	Uacane and Ombe 2016; Salomão Bandeira, pers. Obs.
South	Save River	1999-2014	147.44	84.02	-56.9	Cyclone impact in 2000	Macamo et al., 2016
	Limpopo Estuary	1999-2001	9.28	3.82	-58.8	Floods in 2000	Bandeira and Balidy 2016
	Incomáti Estuary	1991-2003	42.31	44.51	+5.1	Deforestation	Macamo *et al.* 2015

The mangrove fauna in its turn is very rich, the diversity decreasing from sea to land, and from lower latitudes to higher latitudes (Guerreiro *et al.* 1996; de Abreu *et al.* 2008). The main taxonomic groups inhabiting mangroves include (but are not restricted to) crustaceans, molluscs, polychaetes, sipunculid worms, fish, insects and birds. Among the reptiles, crocodiles a common within the Zambezi delta and rare in other parts, but occasional sightings may occur after severa floods in the mainland (ref). There are anecdotic reports of occurrence of marine turtles at the Espírito Santo estuary (Zacarias Nhantumbo, personal communication). Marine turtles are frequent visitors to mangroves as reported in other parts of the world. Buffalos also occur in the wetlands near the Zambezi delta, and hippos occur both in Save and Zambezi Delta. Crustacean are represented by crabs, shrimps and barnacles (e.g.: *Balanus amphitrite* and *Chthamalus dentatus*). Crabs are the most conspicuous group and include species such as *Cardisoma carnifex*, *Parasesarma catenatum*, P. guttatum, *Neosarmatium meinerti*, N smithi, *Coenobita cavipes*, *Cranuca inversa*, Austruca *annulipes*, *Paraleptuca chlorophthalmus*, Tubuca *urvillei*, *Gelasimus vocans* and *Scylla serrata*. Other mangrove crab species are *Mareotis depressus, Dotilla fenestrata*, *Chiromantes ortmanni*, *C. eulimene*, *P. leptosoma, Metopograpsus thukuhar*, *Ilyograpsus paludicola*, *Eurycarcinus natalensis* and *Epixanthus frontalis*. Shrimps also occupy different niches within the mangrove habitat. Some of them have economic importance, such as Penaeus indicus, P. japonicus, P. monodon, P. semisulcatus, *Metapenaeus Monoceros* and *M. stebbingi*. Molluscs are represented by the gastropods *Littoraria scabra*, *L. intermedia*, *L. subvittata* and *L. pallescens*; *Cerithidea decollata*, *Terebralia palustris*, *Melampus semiaratus* and *Cassidula labrella*. Bivalvia molluscs are well represented by *Sacrostea cuculata* and *Isognomon* sp. Among the vertebrates, fish species are also common and very diverse. Some examples include the mud skipper *Periophthalmus spp.*, *Yongeichthyes nebulosus*, *Priolepis inhaca*, *Ambassis natalensis, Siganus sutor, Gerres oyena* and *Sillago sihama.* Mangroves are also home to several species of birds, some of which are migrants and/or protected species. Some of the common species documented in Mozambican mangroves are *Egretta ardesaica*, *E. garzetta*, *E. gularis*, *Ardea goliath*, *A. melanocephala*, *Ciconia ciconia*, *C. nigra*, *Threskiornis aethiopicus*, *Halcyon senegaloides*, *H. albiventris*, *Haliaeetus vocifer*, *Phoenicopterus minor* and *P. ruber* (Impacto 2013) and the little Greenbacked heron *Butoroides striatus* (Kalk 1995; Bento 2014).

4.3. GOODS AND ECOLOGICAL SERVICES

Mangroves are important for the communities in Mozambique as their goods and services are used in different ways. The direct uses comprise mostly extractable goods, such as wood, poles, firewood, bivalves, crabs, honey, leaves, and many other. Such products are used for domestic consumption and trade, although mangrove wood commercial exploitation is not permitted by law. Mangroves are also site for the development of economic activities. Fishing, aquaculture, salt extraction, honey production and ecotourism are some of the activities that can be developed in the mangroves. Additionally, mangroves have a significant socio-cultural value for the communities (e.g.: for traditional ceremonies) and provide traditional medicine.

The indirect use values are essentially non-extractable and comprise ecological services, such as coastal protection against erosion and climatic events, nursery for fauna, feeding ground and habitat for many vertebrate and invertebrate species, biofiltering, water quality control and carbon sequestration (Walters *et al.* 2008). Many mangrove fauna species are temporary visitors, and will live in mangroves at a certain stage of their life cycle or visit during the flooding tide and leave on the ebb tide, seeking food and protection against visual predators. The migration might also be related to feeding behaviour. Mangroves contribute to the equilibrium and productivity of adjacent ecosystems, a role that is also achieved through export of organic matter. On sandy flats of Inhaca Island for example, mangroves contribute to the total organic matter input with more that 700t/year (DW) of litter (de Boer 2002). *Avicennia marina* is one of the species with higher contribution to litter fall in Maputo Bay (Fernando and Bandeira 2009), and part of this litter is trapped within the forest as a carbon reservoir. The role of Mozambican mangroves as carbon sinks has been demonstrated at the Zambezi Delta (Stringer *et al.* 2015; Fatoyinbo *et al.* 2018). The contribution of soil carbon in the first meter of depth was estimated at 45% to 73% (Stringer *et al.* 2015), but larger contributions are expected in estimates up to 2 m (Gress *et al.* 2017).

4.4. THREATS TO MANGROVES IN MOZAMBIQUE

Local estimates indicate a decreasing trend in mangrove area close to major human settlements while those away from human settlement or in remote areas remain intact or are experiencing growth. For example, de Boer (2002) reported an overall decrease in mangrove area in Maputo Bay (that is close to the capital city of the country), while another location far away from the city in the same bay showed accumulation and formation of new mangrove forests. Similar findings were reported by LeMarie *et al.* (2006) for the Incomáti Estuary in the same bay whereas Ferreira *et al.* (2009a) observed increased mangroves areas in Rovuma Estuary and Quiterajo, two remote sites in the northern province of Cabo Delgado. Threats to mangroves are either human (anthropogenic) induced such as deforestation for wood products, to create land for establishment of saltpans and urban settlement or natural causes in the form of cyclones, floods and strong waves.

The extraction of mangrove wood resources is the main threat to mangroves in Mozambique. Mangroves logging as a main form of forest degradation was reported in several parts of the country, such as the Incomáti estuary near Maputo city (LeMarie *et al.* 2006; Macamo *et al.* 2015), Nhangau (around Beira city) and Quelimane. Charcoal production is also a major cause of deforestation of mangroves in Mozambique, urban and highly populated areas being more vulnerable (Saket and Matusse 1994; Barbosa *et al.* 2001; Macamo *et al.* 2015). Other threats to mangroves are solar salt production, since it changes the hydrologic regimes and causes saltwater intrusion (Monteiro and Marchand 2009). Salt works led to conversion and loss of mangrove areas at places such as Maputo Bay, Mossuril, Pemba Bay and Mecúfi (Barbosa *et al.* 2001). They were mostly concentrated close to populated areas or peri-urban centres.

The most documented natural causes of mangrove degradation in Mozambique are cyclones and floods. Cyclones Eline (2000), Japhet (2003) and Favio (2007) impacted on the forests of the Save delta and caused losses of about 50% of the whole area ((Massuanganhe *et al.* 2016; Macamo et al., 2018). Other forests in the region, such as the mangroves of the Pomene Reserve were also impacted (Balidy *et al.* 2005). Studies indicate a steady recovery in both sites (Balidy *et al.* 2005). More recently, cyclones Idai and Kenneth also impacted significantly on mangroves in central and northern Mozambique, with about 2500 ha being lost or severely impacted (IUCN, 2020). At the Limpopo estuary, the 2000 floods cleared more 5.46 km^2 (half of the area) after the forest was submerged for more than 45 days (Bandeira and Balidy 2016). Natural sedimentation has been recorded in parts of the Zambezi delta (Shapiro et al., 2015) and the Querimbas Natural Park (Nicolau et al., 2017). In southern Mozambique massive mangrove die back was reported at the Maputo river mouth and Maputo Species Reserve, due to unclear reasons. A hail storm was indicated as a possible reason. Sea level rise and other climate change impacts are also potential trheats to the mangroves all across the country, emphasis to the central and northern regions, where sea level rise and increased frequency and severety of storms are expected to be more damaging (Cabral *et al.* 2017).

5. Study results and discussion

5.1. MANGROVE MAIN USES AND SERVICES IN MOZAMBIQUE

5.1.1. NON EXTRACTABLE USES AND ECOSYSTEM SERVICES

Mangrove services can be classified in use values and non-use values. The use values are direct uses (extractable goods, development of economic activities, recreational and cultural use, etc.), indirect uses and option use value. The non-use values are existence value and bequest value. This section explores direct and indirect use value. The non-extractable uses comprise essentially ecosystem services which are ecological and socio-economic.

There is enough scientific evidence that demonstrates that mangroves protect the coast line against wind and wave erosion (Marois et al., 2015; Guannel et al., 2016). This role is also acknowledged by several communities across the country: at the Save delta, mangroves protected the coastal village of Nova Mambone during cyclone Eline, one of the most severe cyclones that hit the area (Massuanganhe et al., 2015). The mangroves were severely impacted, and currently are partially recovered, but the local communities acknowledge that damages to infrastructure and human lives in the village were reduced due to the protection role of the dense barrier that mangroves formed. This fact was confirmed by the pattern of the impact of the cyclone on the mangroves: ocean, river and channel stands were much damaged than those in the inner parts and terrestrial margin (Macamo et al., 2016). Another example of such role being acknowledged by the communities was found at Beira city and Nhangau community. The Chiveve is an urban small river that runs across Beira and was recently dredged and rehabilitated as a measure to assist in flood control in the city. Beira citizens also recognise that the channel and the now healthier forest provide landscape beauty, protect the infrastructure in this part of the town, improve air quality and promote business (Machava-António et al., 2020). The Nhangau community further north experienced the negative impacts of mangrove loss when mangroves were chopped down and their houses became increasingly more vulnerable to erosion and destruction by strong winds (Macamo, 2018). Currently this community is engaged in a replantation program and local regulations forbid the extraction of wood along the protective marine margin of the forest (Bandeira et al., 2016; Macamo, 2018).

Fauna nursery is another ecological service frequently mentioned by the communities (Machava-António et al., 2020; Machava-António et al., in prep.). At the Limpopo Estuary and Nhangau, the communities reported a significant increase in fish and crab captures years after part of the mangroves were restored (Bandeira and Balidy, 2016; Macamo, 2018). According to key informants at the Limpopo estuary, fish captures have increased to such a level that fish from the Limpopo estuary is being transported to as far as the Nampula province, further north (Henriques Balidy, personal communication). The role of fauna nursery is also directly related to supporting fisheries. Penaeid shrimp fishery is an important source of income for the country (industrial and semi-industrial fisheries) and for local communities (artisanal fishermen). Shrimp was the 9th to 10th most important product of export in Mozambique between 2016 and 2019 (worth USD 29 452 000 in 2016, USD 37 030 000 in 2018 and USD 33 490 in 2019) (INE 2017, 2019, 2020). The most important fishing grounds in Mozambique are surrounded by mangroves which have important role in the life cycle of these invertebrates. Additionally, shrimp aquaculture has great potential in the country, although currently only one of the four aquaculture farms are operational (Chevallier, 2013). Other mangrove-related economic activities with great potential in the country include bee keeping (experimental artisanal production at the Limpopo estuary) and eco-tourism.

Mangroves sequester and store huge amounts of carbon, being therefore contemplated as key for climate change mitigation (Tailladart et al., 2018). In Mozambique carbon assessments have been conducted at Sofala Bay (Sitoi et al., 2014), the Zambezi delta (Stringer et al., 2015), and Maputo Bay (Magalhães, 2018). All estimates indicate that Mozambican mangroves store amounts of carbon that are similar to other parts of the globe, such as the Sundarbans in Southern Asia (Rahman, 2015). Even though this function is not commonly mentioned by the communities, it provides an opportunity for the development of REDD+ programs that can help provide financial sustainability to mangrove conservation programs.

Table 4. Main uses, goods and services extracted from mangroves by communities in Mozambique. Sources: Barbosa et al., 2001; Taylor et al., 2003; Bandeira et al., 2016; Hoguane et al., 2017; Macamo, 2018; Macamo et al., 2018; Machava-António et al., 2020.

Uses	Services	Sites were observed/ acknowledged by communities	Obs
Non-extractable	Coastal protection	Maputo Bay, Inhambane, Nhangau, Nampula	Communities aknowledge the protection role of the mangroves of Save river mouth during cyclone Eline (2000) at Nova Mambone village (northern Inhambane)
	Tide flood control	Beira, Chiveve channel	The Chiveve channel and their mangroves constitute a combined green and grey insfratctructure recently restored to provide flood control in the city of Beira. It was crucial for flood control during cyclone Idai which made landfall near Beira in March 2019. Its efficacy was proved again during subsequent urban floods, tropical storm Chalane (2020) and cyclone Eloise (2021)
	Water purification	Across the country	
	Landscape beauty	Beira, Chiveve Channel, Inhambane city, Mongicual	Beira Municipal Green Park was built along the Chiveve river channel, and mangroves are integrated in the landscape
	Culture and recreation	Across the country	In Maputo (Costa do Sol) and Cabo Delgado (Palma) traditional religious ceremonies are conducted in the mangroves
	Fauna nursery	Across the country	Communites of the Limpopo estuary and Nhangau reported increase in fish captures years after mangroves were restored in the region
	Reference point	Lalane (Cabo Delgado province)	A small patch of mangroves is used as reference point to indicate the proximity of the village by fisherman
	Development of economic activities	Inhambane Bay, Mecúfi (eco-tourism) Quelimane, Mieze	Eco-tourism Aquaculture farms were implanted in Maputo (experimental), Sofala, Zambezia and Cabo Delgado. Currently all, nut the Zambezia farm, are non-operational

Extractable	Firewood	Across the country	
	Charcoal	Across the country	At Inhambane, near the Mutamba river, mangrove charcoal is used in bricks furnaces
	Wood	Across the country	
	Food source (non-animal)	Maputo Bay, Beira, Mozambique Island	Succulents and mangrove fruits are collected and used in local dishes
	Fishing ground	Across the country	The Sofala Bank and Maputo Bay are the most important fishing grounds of the country, both supported by extensive mangrove formations. Mangroves and their surroundings are also important sites for invertebrate collection (crabs, fish, shrimp, gastropods, bivalves)
	Salt (production)	Across the country	Salt pans proliferate at Mossuril district (Nampula province) and are possible threat at Mecúfi (Cabo Delgado province)
	Honey production	Across the country	Experimental community-based commercial production is being initiated in some parts of the country (eg.: Limpopo estuary)
	Medicinal use	Beira	*X. granatum* fruit used to treat stomach ailments

5.1.2. EXTRACTABLE GOODS

The communities of Mozambique make several uses of mangrove goods and services in different ways. Wood, poles, *lacalacas* (thinner poles) and firewood are one of the most exploited extractable good from mangroves in Mozambique. Different species produce distinct quality wood; therefore, each species is used for specific purposes (Table 5). Another factor that influences the choice of the species is their availability. For instance, at Costa do Sol (Maputo Bay, souther Mozambique), *Avicennia marina* is the dominant species and largely exploited. Further south at the Maputo River estuary, *Ceriops tagal* and *Rhizophora mucronata*, which are much more available, are also largely used. Similar trends were observed at the Querimbas National Park, Pemba Bay and Olumbi (Nicolau et al., 2017; Macamo et al., 2018). Mangrove wood is used for house and boat construction, production of domestic utensils, furniture, fishing gear and beehives (de Boer, 2002; Barbosa et al., 2001, Taylor et al., 2003; Machava-António et al., 2020). Firewood is collected by women and children and used essentially as a primary source of domestic fuel. Mangrove wood is also used to produce mangrove charcoal, which has a distinct quality from that of terrestrial species. At Inhambane Bay (around Mutamba river) mangrove charcoal and wood is used to produce artisanal bricks, which are sold in the region (Machava-António et al., in prep.). Mangrove charcoal is also largely produced in Nhangau (where the production and commercialization poses a threat to mangroves conservation), and other parts of the country (Hoguane et al., 2017). The bark of Rhizophoraceae species (particularly *Rhizophora mucronata*) is used to extract tannins, which are used as local dye in fishing gear.

In some regions cattle grazing in the mangroves is very common (Minchinton et al., 2019). At the Limpopo estuary for instance, were there are extensive mangrove restoration programs and cattle grazing is an important economic activity, there have been conflicts between those groups engaged in mangrove restoration and cattle breeders, as the animals invaded recently restored areas and caused damages (Henriques Balidy, personal communication). Cattle grazing in the mangroves was also observed in Maputo Bay, but it is likely to occur in other parts of the country.

Mangroves also provide natural remedies for several ailments, some of which are used in cultural ceremonies by traditional healers. The *Xylocarpus granatum* fruit for instance, is reportedly used to cure stomach ache in central Mozambique (Macamo, 2018). The medicinal properties and distinct taste of mangrove honey is also acknowledged in communities in Maputo Bay, Inhambane, Sofala and Cabo Delgado provinces, and in other parts of the world (Yap et al., 2014). Communities at Mozambique Island and Mussoril consume the fruit of *Sonneratia alba*. The ripe fruit is usually collected by women and children, and the preparation involves grating, mixing with peanut and cooking in water. The resulting sauce is eaten with boiled rice or maize porridge.

Mangrove associated tree species are also used by coastal community. The succulent *S. portulacastrum* is used to produce a traditional cultural dish known as *mpfixiri* (Beira) or *sirisiri* (Nampula). This dish is served in some famous restaurants at Mozambique Island, one of the best known cultural tourism sites of Mozambique. In southern Mozambique, *S. portulacastrum* and *Salicornia sp.* are consumed in salads and soups. *Salicornia* has raised a lot of interest from the gastronomic, pharmacological and cosmetic industry around the globe (Isca et al., 2014). The barks of *T. polpunea* and *H. tiliaceus* are used to produce ropes, belts and straps, while the edible fruits and sap of *P. reclinata* are used to produce a traditional alcoholic beverage (Barbosa et al., 2001). The reed *P. australis* is a multi-purpose species (used to build fences, walls and roofs) and *J. kraussi* is used to make handmade bags and floor mats, commonly sold in local markets to tourist and locals (Barbosa et al., 2001; Taylor et al., 2003). At the Espiruto Santo Estuary a community is using propagules of *R. mucronata* in experimental aquaculture tanks, where tilapia and shrimp is being produced. Community members also referred that *R. mucronata* propagules were also successfully used in poultry breeding (Zacarias Nhantumbo, personal communication). However, there is need to better understand the nutritional potential of mangrove propagules as animal feed and potential benefits and safety for both humans and animals.

Table 5. Main uses of mangrove resources in Mozambique.

Species	Common names	Main uses
True mangrove species		
Avicennia marina	White mangrove; mangal branco; musso, n'tsowozi, txomahati, inveda, mpedge	Charcoal, boat construction, domestic utensils, medicinal uses, beehives, animal fodder
Bruguiera gymnorrhiza	Orange mangrove; Ikapa, nkandala, m'piria, mfumansi, setaka, xitaka, m'finse	Building material, firewood, charcoal, boat construction, domestic utensils, medicinal uses
Ceriops tagal	Indian mangrove; mangal indiano; Ikapa, nsangi, mucandala, hlohlodjani	Building material, boat accessories, charcoal, dyes, fishing traps
Heritiera littoralis	Mozambique mangrove; mangal moçambique; mucolongo, necolongo,	Charcoal, firewood, building material and boat accessories
Lumnitzera racemosa	Black mangrove; mangal preto; piripito, mpiripito	Medium quality building wood, firewood and charcoal
Rhizophora mucronata	Red mangrove; mangal vermelho; nhantamzira, mtanganda, sinkaha, ikapa	High quality building material, charcoal, firewood, tanning, medicinal uses, fishing traps and weapons
Sonneratia alba	Apple mangrove; mangal maçã; mpiria, tjindiri	Wood for boat construction and other fishing related utensils; edible fruit
Xylocarpus granatum	Cannonball mangrove; mangal bola de canhão; Murrubo, marrubo, nseti, shukuliha, mutumbutumbo	Canoes, charcoal, firewood, furniture and medicinal uses
Xylocarpus moluccensis	Cedar mangrove	Tannins, wood for canoes and furniture; medicinal uses
Associated mangrove species		
Thespesia pupulnea	Portia tree; mulola	Bark used to produce rope
Hibiscus tiliaceus	Beach hibiscus, nolo, swombe,	Used to make belts and straps
Phoenix reclinata	Date palm; kindzu, tchindo, muchindo	Edible fruits (alcoholic beverages)
Sesuvium portulacastrum	Shoreline purslane; secilii, serisiri, mpfixiri	Salads, soups, traditional meal (mpfixiri, sirisiri mathapa)
Phragmites australis	Reed; caniço, gondze, hlanga,	Fences, hut roof and walls
Juncus kraussii	Salt marsh rush	Bags and mats
Salicornia sp		Salads, soups, potential medicinal properties

Many fauna species are collected and consumed by local communities, or sold in the local markets. The gastropods *C. decollata* and *T. palustris* are local delicacies from southern to northern Mozambique. At Olumbi (Cabo Delgado province in northern Mozambique) *T. palustris* exploitation was so extensive that parts of the landward margin of the mangrove forest are filled with empty shells of the mollusc (personal observation, October 2013). Collected by women and children (but sometimes by men to), they provide an important source of animal protein when others are not available, similarly to bivalve *S. cuculata*, whose exploitation requires expertise. Women from Nampula (Mongicual, Mozambique Island, etc) described the process of extracting *S. cuculata* as laborious and delicate, but rewarding, referring to the need of being careful not to get hurt in the process, collecting the right amount of food for the family while ensuring the sustainability of the exploitation and the possibility of feeding their family without spending money to buy food.

The mangrove crab *S. serrata* is a delicacy in many parts of the country. The species is exploited by both men and women, and consumed or sold in local and regional markets. Other mangrove associated species are located in the surrounding mud banks: the clam *Meretix meretix*, *Donax faba*, *Eumarica paupercula*, and *Solen cf. cylindraceus* are some examples of the several species that can be found in this habitat. These species are collected for domestic consumption and sold in local markets and restaurants. Many of them are part of the traditional gastronomy of the country.

5.2. MANGROVES VALUATION IN MOZAMBIQUE

The economic value of mangrove forests, including their resources and services provided, have been assessed in a few locations in Mozambique, following distinct methodologies. All studies were however unanimous in the finding that mangroves are essential to the living of local communities, and many of the services (especially those related to non-use values) are difficult to assess.

The Zambezi delta is one of the most important mangrove formations of the country, being part of a Ramsar site. Apart from well-established stands that can grow up to 50 km inland and trees that grow as high as 35m, the delta has a high diversity of fauna and flora and support the fisheries in the most important fishing ground of the country (Macamo et al., 2016), while storing large amounts of carbon comparable to other highly productive systems (Stringer et al., 2015). At the global level, the delta has been recognised by the Convention of Biological Diversity as an EBSA site (Ecologically and Biologically Significant Area) – the Quelimane to Zuni River (https://chm.cbd.int/database/record?documentID=203995). The population of the delta is estimated in 188 206 people, distributed in the districts of Marromeu (Sofala province) and Chinde (Zambézia province) (Hoguane et al., 2017). The total area of the delta was estimated in 37 034 ha in 2014 (Shapiro et al., 2015). Hoguane et al. (2017) estimated the mangroves of the Zambezi delta were worth USD 44 440 800 per year in charcoal (USD 236 per capita per year) or USD 38 315 560 in poles (USD 204,64 per capita per year). The protective function was estimated at USD 740 680 000 per year (or USD 20 000 per ha per year), based on the value of the infrastructure that the mangroves protect; while fishery and carbon sequestration functions were estimated at USD 22 220 400 (or USD 600 per ha per year) and USD 222 204 000 per year (or USD 6000 per ha per year), respectively. The overall value of the mangroves was estimated at USD 1 068 060 560 per year, 98% of which derived from indirect use values.

Similar assessments were made for the Limpopo estuary. The Limpopo estuary mangroves historically occupied about 928 ha, now reduced to about half of the initial extension. The 2000 floods are the main cause of loss and degradation of these forests, but human interference are also indicated as a past threat (Bandeira and Balidy, 2017). Nevertheless, the forests still contribute significantly to the community livelihood and well-being (Masike, 2014). The mangroves of the Limpopo estuary grow in the districts of Limpopo and Xai-xai and directly benefit the communities of Zongoene, Voz de Frelimo and Chilaulene. It was estimated that the 3 localities bear 9227 families (Masike, 2014). Based on the average size of the families in this two districts (according to the 2017 National Census) (http://www.ine.gov.mz/operacoes-estatisticas/censos/censo-2007/censo-2017/divulgacao-os-resultados-preliminares-iv-rgph-2017), it was estimated that this corresponds to 41 383 people. Charcoal and poles production, for instance, were estimated at USD 5 990 and USD 738 088.2 per year, respectively at the Limpopo estuary, while the carbon sequestration function was assessed at USD 635 337.2 for the whole estuary. The whole use values of the Limpopo forest were assessed at USD 7 066 667.

Like other assessments of ecological services, both studies had a few limitations, which included:

- Underestimation of the value of ecological services and goods, due to the methods limitations. For instance, wood, poles and charcoal value was calculated based on conservative sustainable rates of extraction;
- The value of protective function (assessed in the Zambezi delta) varies significantly according to a number of factors, including species composition, infrastructures at risk, country economy, etc. Therefore, in specific areas of the delta the value could be higher or lower;
- The non-use values were not estimated and are difficult to estimate, as there are largely based on community perception.

Table 6. Mangrove ecosystem valuation in the Zambezi delta and Limpopo estuary

Good or ecological service	Estimated value (USD) per year	
	Zambezi delta	Limpopo estuary
Charcoal	44 440 800	5 990
Poles	38 315 560	738 088,2
Coastal protection	740 680 000	Not assessed
Habitat and nursery	22 220 400	5 198 172
Carbon sequestration	222 204 000	635 337,2
Natural and traditional medicine	Not assessed	12 715,98
Honey production	Not assessed	833,3

5.3 MANGROVES MAIN PRESSURES AND THREATS (SUSTAINABLE USE MODELS OF MANGROVE RESOURCES)

The main threats to mangroves in Mozambique are related to human interference. The general trend is that remote areas are usually preserved in near pristine or healthy condition, while those near major human settlements are in different levels of degradation. That is the case of the capital cities of Maputo, Matola, Beira and Quelimane.

In Maputo, mangroves are threatened mostly by excessive logging, urban expansion and pollution. Studies at Costa do Sol show changes in structural parameters, where stands tend to be mono-specific (dominated by *A. marina*, a resilient species) with dwarf or very crooked trees (Bandeira et al., 2009; Amade et al., 2019; Macamo et al., in prep.). Mangrove trees usually grow crooked and dwarf in response to environmental stresses such as high salinity, lack of soil nutrients, shallow soils, low temperatures, pollution and other human induced stress (Kairo et al., 2002; Bandeira et al., 2009). At Costa do Sol, Mapulene and Espírito Santo estuary, mangroves are being trapped and the hydrological regimes altered due to urban expansion and land reclamation. As a result, the tidal inundation regimes are altered causing mangrove die back and/or growth limitations. Quelimane peri-urban neighbourhoods are also encroaching into the mangroves, where the deposition of solid waste and posterior built of precarious houses is a common practice. On the other side, salt pans expansion is an issue in some regions, such as Mussoril (Nampula province) and Mecúfi. At Quelimane, mangrove restoration initiatives were conducted in a few abandoned saltpans, an initiative that could be replicated in other sites.

Mangrove ecosystems are within 7 protected areas in Mozambique, and it is estimated that on total 888.06 km^2 of mangrove forest are protected in the national network of protected areas (Macamo, 2018). This number corresponds to 27% of the total mangrove extension of the country, and its more than 3 times the global percentage of 7.7% and above the 10% target by the Convention of Biological Diversity (giri et al., 2011; https://www.cbd.int/sp/targets/). However, not all mangroves within protected areas are effectively protected. For instance, a study conducted at the Querimbas National Park found that wood extraction affected the forest regeneration potential to stocking ranges below the ideal, even though it remained at a sustainable level (Nicolau et al., 2017). Later on it was referred that these forests were extensively targeted for wood during the post-cyclone Kenneth reconstruction efforts and to respond to the huge demands for natural resources by the feeling communities from the armed conflict in northern Cabo Delgado (reference OIKOS).

Mangroves are naturally dynamic systems, where expansion and reduction of the area can occur naturally. For example, an increase of 3 723 ha was reported for the Zambezi delta between 1994 and 2013 (Shapiro et al., 2015). Increase in area and losses due to this

natural dynamic were also reported in the Maputo Bay (de Boer, 2002), QNP (Nicolau et al., 2017), Pemba Bay (Ferreira et al., 2009; Macamo et al., 2018) and in other parts of the country. As part of this natural dynamic, mangrove loss was also observed in several sites, such as the Govuro river and Zambezi delta (Shapiro et al., 2015). On the other hand, extreme weather events such as cyclones and floods were responsible for the loss of several hectares in the Save river mouth (cyclone Eline 2000), Buzi and Pungue estuaries (cylone Idai 2019) and Ibo (cyclone Kenneth, 2019) (Table 7). In the Maputo river mouth mangroves are dying due to an unknown reason, although it is speculated locally that such mortality may be due to changes in sedimentation patterns in the area and/or a hail storm.

Table 7. Impact of natural extreme events on mangrove forests in Mozambique

	Landfall site	Known impact of mangroves
cyclone Eline (2000)	Vilankulos	Damaged 6 342 ha of mangrove at the Save river delta and about 546 ha at the Limpopo estuary
cyclone Idai	Near Beira (central Mozambique)	Impacted on 2 400 ha of mangroves at Beira, Búzi and Púngue districts. Post-cyclone reconstruction efforts put additional pressure on mangrove resources. Later on, the same areas were impacted by cyclone Eloise (2021)
cyclone Kenneth	Near Ibo Island (northern Mozambique)	Impacted non-quantified area, but damages were severe at Ibo.

5.3.1. SUSTAINABLE USE MODELS

The Mozambican institutional framework determines that mangroves are managed by different entities at different levels and involving different stakeholders, as provided for in the national legislation. At the national level mangroves are managed by the Ministry of Sea, Inland Waters and Fisheries (MIMAIP) with the contribution of the National Directorate of Forests (DNAF) which is under the Ministry of Land and Environment (MTA). Both institutions have provincial representations, who also assist the District Services of Planning and Infrastructure (SDPI) and District Services of Economic Activities (SDAE) at the district level. SDPI and SDAE, together with the Provincial Services of Economic Activities are responsible for capacity building in mangrove related issues, mangrove restoration and supporting the local community. Within municipalities, mangrove management is under the respective municipal authorities, while in protected areas the National Administration of Conservation Areas (ANAC, under MTA) works with MIMAIP for that matter. In rural areas the local communities are incentivized to engage in mangrove management through community-based associations, natural resources management committees (CGRN) and community fishing councils (CCPs).

According to Agrawal (2003), natural resources sustainable management models are dependent on the existence of 4 essential conditions: (a) the size of the community (small communities with clear limits, shared norms, appropriate leadership, homogeneity of interests and low levels of poverty); (b) resources characteristics (small size, will low levels of mobility and high predictability in well-defined boundaries); (c) the institutional arrangement for the resource management (simple easy rules, designed locally, with easy enforcement and graduated sanctions, high community participation, and were the benefits outweight the costs); and (d) the external environment (low influence of external markets, recognition of local authorities, governance, compensation for conservation efforts and low-cost exclusion technology). In Mozambique, although community participation is incentivized by the legislation and by the National Mangrove Management Strategy, few community-based management models have been documented and assessed for its efficacy. However, many communities follow locally designed rules that are implemented within specific contexts. For example,

at the Limpopo estuary communities do have access to mangrove wood resources, but mangrove users are urged to engage in replanting and other management activities (Bandera et al., 2016). People from outside the community are not allowed to cut mangroves, and if caught locally designed sanctions are applied. A similar model was found at Nhangau, however with much lower levels of implementation, since the Nhangau community is much bigger and exposed to external influences (Bandeira et al., 2016; Macamo, 2018). An analysis of several mangrove management models around the globe found a number of factors that contributed to the success or failure of the models (Table x). These can guide the elaboration of local instruments in Mozambique and assist in the assessment of their efficacy.

While there is a need to better understand and document the management models being implemented in the communities in Mozambique, there is also a need to consider alternatives to traditional models. For instance, at Ecuador, concession models were communities were granted rights of use of mangrove forests for capture of seashells and crabs produced positive results in mangrove conservation, despite anthropogenic pressure from shrimp industry (Rodriguez, 2018).

5.4. ADDRESSING THE SOCIO-ECONOMIC IMPORTANCE OF MANGROVES: THE CONTRIBUTION OF THE NATIONAL DEVELOPMENT PLANS, THE NATIONAL STRATEGIES, AND THE POLITICAL AND LEGAL FRAMEWORK IN MOZAMBIQUE

5.4.1 NATIONAL DEVELOPMENT PLANS

The Maritime Spatial Planning Plan (POEM)

The Government's Five-Year Program 2015-2019, in its Priority 5 "Sustainable and transparent management of natural resources and the environment" frames the need to promote the organization of the national maritime space, namely in view of the strategic objectives of: (i) improving planning and territorial ordering and strengthening monitoring, inspection and accountability in the preparation and implementation of plans; (ii) ensure the integration of the Green-Blue Economy and the green growth agenda in national development priorities, ensuring the conservation of ecosystems, biodiversity and the sustainable use of natural resources; (iii) strengthen the capacity for assessing and monitoring environmental quality, especially in the areas of implementation of development projects; (iv) promoting studies and research aimed at reducing the risk of disasters and adapting to climate change; (v) reduce the vulnerability of communities, the economy and infrastructure to climatic risks and natural and man-made disasters.

POEM is a relevant instrument for the management of mangrove in conjunction with other regulatory instruments in force.

The general objectives of the POEM aim to: (1) Establish a maritime spatial planning, respecting the principles of integrated management and sustainable development; (2) Promote the sustainable, rational and efficient economic exploitation of the sea and marine resources and ecosystem services, ensuring the compatibility and sustainability of the different uses and activities developed therein, taking into account inter and intra-generational responsibility in the use of the maritime space national and aiming at job creation; (3) Ensure the preservation, protection and recovery of natural values, biodiversity and coastal and marine ecosystems and the maintenance of the good environmental status of the marine environment, as well as the prevention of risks and the minimization of the effects resulting from natural disasters and climate change or human action; (4) To guarantee legal certainty and transparency in the procedures for granting titles for the private use of maritime space, and to allow the exercise of information and participation rights.

POEM anticipates the trends and forecasts of growth or development of sectors that occur in the maritime space, in order to avoid the generation of conflicts and environmental degradation. It also promotes economic, social, cultural and scientific development, promoting synergies and optimizing the use of natural resources, minimizing or avoiding environmental degradation and improving the status of ecosystems and marine species. POEM will allow the resolution of conflicts that may exist between the development of different uses, activities and functions, such as, for example, tourism, fishing and the establishment of conservation areas. In addition, the generation of information and knowledge within coastal areas and the maritime space as an indirect result of the POEM will be a benefit for technological and scientific development. It is also expected to increase knowledge and enhance the underwater archaeological heritage and marine biological resources, among many other benefits that will be achieved through the implementation of the plan.

With the POEM it intends to develop in harmony and integration with the National Plan for Territorial Development (PNDT), under the responsibility of MTA, which aims to order the uses and activities in the continental territory and in the islands of Mozambique. As long as the uses, activities and functions that occur in coastal areas interact both with the marine environment (effluents, contamination, construction of infrastructure, etc.) and with the uses and activities developed at sea (transport, aquaculture, tourism, etc.), POEM and PNDT must be mutually permeable instruments. Thus, it is crucial that the methods and techniques used are compatible with each other. In addition, the POEM will take into account the spatial planning defined in the PNDT for coastal and island areas, in order to promote the integration of uses and activities developed at sea with those carried out on the coast.

5.4.2. POLICIES AND STRATEGIES

a. a. National Environment Policy (Resolution 5/95)

It lays the foundation for Mozambique's sustainable development through a compromise between socio-economic development and environmental protection.

b. Policy and Strategy for the Sea (POLMAR) (Resolution No. 39/2017)

It mentions mangroves especially in relation to their value to communities and summarizes the causes of deforestation by providing a guideline for their management. Within the marine and coastal environment, the Government of the Republic of Mozambique prioritizes the conservation of resources and ecosystems for the well-being of society and guarantees the general right to enjoy a healthy environment. It protects marine and coastal ecosystems, their functionality and productivity, the services associated with them, and prevents the negative impacts of environmental changes on marine and coastal spaces. In relation to territorial development, the Government of the Republic of Mozambique looks at mangrove ecosystems, coral reefs, seagrasses, coastal dunes, beaches, cliffs, seabed and subsoil of the sea, as a natural heritage of the State that require planning programs, zoning, conservation, recovery, management and management. Pillars C and E focus on mangroves and associated resources, with:

THE PILAR C. Marine and coastal environment. The Government of the Republic of Mozambique prioritizes the conservation of resources and ecosystems for the well-being of society and guarantees the general right to enjoy a healthy environment. It protects marine and coastal ecosystems, their functionality and productivity, the services associated with them and prevents environmental changes from negative impacts on marine and coastal spaces.

THE PILAR E. Territorial development. The Government of the Republic of Mozambique looks at mangrove ecosystems, coral reefs, seagrasses, coastal dunes,

beaches, cliffs, sea bed and subsoil as being state assets that require planning, zoning, conservation, recovery, management and management.

c. Tourism Policy and Strategy for its Implementation (Resolution No. 14/2003)

This document encourages the development of sustainable tourism in harmony with the conservation and protection of biodiversity. The preservation and sustainability of biodiversity are priorities of this strategy.

Policy and Strategy for the Development of Forests and Wildlife (Resolution No. 8/97)

It establishes good management of forest resources and ecological sustainability in the use of natural resources. Management of fragile ecosystems including mangroves and biodiversity conservation are relevant aspects of this policy.

d. Mangrove Management Strategy (Mangrove Strategy) 2020 - 2024

This is the main document that identifies the goals to be achieved in relation to mangrove management in Mozambique and highlights the need for effective management involving all parts of the mangrove ecosystem.

The document presents a vision, mission, values, objectives and pillars for the management of mangroves in Mozambique. The pillars of the strategy are: 1) Management, Protection and Sustainable Use of the Mangal Ecosystem; 2) Reinforcement of legislation and supervision; 3) Institutional capacity building and coordination; 4) Environmental education and awareness; 5) Research and knowledge management. The strategy includes the baseline knowledge on mangroves in the country, its overall and national value, causes of degradation and presents various aspects of planning, management, restoration and enforcement measures, in an ecosystem approach to the mangrove in Mozambique.

e. National Strategy for Adaptation and Mitigation of Climate Change (2013-2025)

This strategy highlights the importance of mangroves in increasing fisheries resilience through the regeneration and implementation of coastal protection measures through mangrove forests.

f. National Development Strategy (2015-2035)

This instrument recognizes that climate change can significantly affect development. In this regard, the strategy emphasizes the need to invest in resilience to climate change in order to reduce losses and damages. This result can be achieved through, for example, healthy mangrove forests.

g. Environmental Strategy for Sustainable Development of Mozambique (2007-2017)

The strategy prioritizes the integrated management of natural resources recognizing the poor planning and poor control of the different activities that have caused problems of erosion, mangrove destruction and species reduction.

h. Strategy and Plan of Action for the Conservation of Biological Diversity in Mozambique (2015-2035)

It outlines guidelines and defines priority actions for the conservation of biological diversity to be implemented by the various sectors of activity, with a view to ensuring sustainable development. The strategy also aims to (i) reduce the direct and indirect causes of biodiversity degradation and loss; (ii) improve the conservation status of biodiversity, safeguarding the diversity of ecosystems, habitats, species and genetic conservation; (iii) improve the sharing of benefits from biodiversity and ecosystem services to all sectors of government and society; (iv) improve implementation through participatory planning, knowledge management and capacity building, and synergies between national and global targets for biodiversity conservation.

This strategy also establishes the logical framework for the preparation of the action plan for the 20-year time horizon up to 2035 containing the following main aspects for strategic actions:

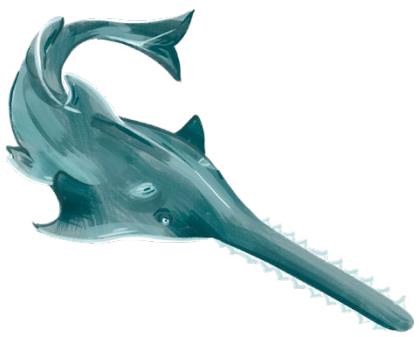
- Strengthening of the Legal and Institutional Framework on biodiversity;
- Improved knowledge about the functional relationships and processes inherent in ecosystems;
- Use of adaptive practices for rehabilitation and management of ecosystems;
- Promotion of benefit sharing;
- Implementation of management actions at the appropriate scale, taking due account of proper planning and decentralization;
- Guarantee inter-sectoral cooperation and national and international partnerships.

i. National Strategy and Action Plan for Integrated Coastal Zone Management (2015-2020)

It promotes the management and preservation of marine and coastal resources through decisions based on technical and scientific knowledge as well as strengthening the resilience of marine and coastal ecosystems to the impacts of climate change.

j. National Strategy for Reforestation (2009)

The overall objective of this strategy is to establish forest plantations to rehabilitate degraded ecosystems and conserve biodiversity. These plantations could be used to recover environmentally degraded areas, restore and sustain biodiversity, mangroves, wetlands, mountainous areas, agriculture and human development as well as protect river basins and carbon sequestration. In these plantations the priority goes to native, endemic, endangered or endangered species.



k. National Strategy for the Reduction of Emissions from Deforestation and Forest Degradation, Forest Conservation and the Increase of Carbon Reserves through Forests (REDD +) (2016-2030)

This strategy promotes mechanisms for restoration and rehabilitation of degraded or deforested forests through natural or assisted regeneration. Recognizing the ecological functions of mangroves, the strategy promotes the reduction of causes of deforestation and forest degradation to increase carbon stocks, as well as to establish forms of control and sustainable use.

REDD + actions in Mozambique and with mangrove linkage include (i) reducing greenhouse gas emissions by reducing the rate of deforestation or increasing the rate of carbon sequestration; ii) increased income and quality of life of rural populations living in areas near the mangrove; iii) reduction of production costs and risks to the community and producers in coastal districts with mangrove; iv) creation of synergies with other productive and environmentally friendly activities.

l. Mozambique Voluntary Commitment for Implementation of SDG 14 e 13

The Government of Mozambique, as a contribution to the Sustainable Development Goals, committed itself to the United Nations, through the Ministry of the Sea, Inland Waters and Fisheries, to reforest 5,000ha of degraded mangrove by the year 2024.

5.4.3. REGIONAL AND INTERNATIONAL CONVENTIONS

The main international instruments ratified by Mozambique and relevant to mangroves are the “Ramsar Convention” for the protection of wetlands, the “Nairobi Convention”, linked to marine and coastal systems and the interface between land and sea in the western region of the Indian Ocean and the “Convention on Biological Diversity” (CBD) on biodiversity management measures in Mozambique.

The international conventions on environmental protection, signed or ratified by the country below, shall apply to the Strategy.

a. Convention on Wetlands of International Importance, especially those that serve as habitats for water birds (Ramsar Convention, 1971)

Mozambique acceded to the Ramsar Convention through Resolution 45/2003 of 5 November 2003. It is an international, intergovernmental treaty that provides mechanisms and structures for national action and international cooperation for the conservation and consistent use of wetlands, with a view to development of the planet. This convention deals specifically with wetland ecosystems, including mangroves.

b. United Nations Convention on Biological Diversity (1992)

This convention ratified by Mozambique by Resolution No. 02/94 of 24 August, encourages governments to commit to the conservation and sustainable use of biological resources, as well as the creation of protected areas to enhance the protection of biological diversity.

It was conceived as a practical tool for applying the principles of Agenda 21 especially Articles 12 and 15, related to the management of fragile ecosystems including mangroves and biodiversity conservation.

c. Convention for the Protection, Management and Development of the Marine and Coastal Environment for the East African Region (Nairobi Convention, 1996)

The Nairobi Convention, ratified by Mozambique in 1996 (Resolution 17/96 of 26 November), aims at marine and coastal management, which includes mangroves as one of the representative ecosystems in the region. This agreement has two protocols, one regarding Protected Areas and Wildlife and the other the Cooperation among States Parties in Combating Marine Pollution.

The convention develops the concept of transboundary problems but also includes local issues of global concern such as mangrove degradation, the transformation and conversion of its areas and the need to create comparable and similar management patterns in the countries covered by this convention East Indian Ocean).

d. d. The Convention on Climate Change (1992)

Ratified by Mozambique by Resolution No. 01/94 of 24 of 1994, it encourages measures to control the degradation of the marine and coastal environment and of precaution to prevent or minimize the causes of climate change as well as to mitigate its adverse effects.

e. African Convention on the Conservation of Nature and Natural Resources (1968)

Ratified in 1981 by resolution 18/81 of 30 December. The purpose of this convention is to ensure the conservation, use and development of the soil, water, flora and fauna resources of its member states in accordance with the scientific principles and interest of its peoples. Article 5 (iv) obliges Contracting Parties to prevent and control water pollution. This Convention makes it possible to take future actions addressed to the signatory States as a means of improving conservation and promoting sustainable development by raising revenue for related issues and increasing the level of cooperation between States.

f. Convention on Migratory Species (CMS, 1983)

Ratified by Mozambique as a member state was made in 2008 (Resolution 9/2008, of 19 September). The Parties to this Convention shall endeavor to protect migratory species, to preserve or restore their places of origin, including beaches and mangroves, to mitigate obstacles to migration and to control other factors that may endanger them.

g. United Nations Convention on the Law of the Sea (UNCLOS, 1982)

Ratified by Mozambique in 1996 through Resolution 21/96 of 28 November, it establishes the delimitation of the various maritime zones, their respective legal regimes and, in general, the powers of States in these zones. Section XII on the protection and preservation of the marine environment establishes States' obligation to protect and preserve the marine environment, to prevent, reduce and control pollution, including measures necessary to protect fragile ecosystems and endangered, endangered or threatened species.

h. Sustainable Development Objective (SDO, 2015)

The Sustainable Development Objectives, especially (SDO) 14 related to the protection of marine life, emphasize that the country must "sustainably manage and protect marine and coastal ecosystems by 2020 to avoid significant adverse impacts, including through capacity for resilience, and take steps to restore them in order to ensure healthy and productive oceans. "

Other important aspects are fisheries in that most of the fishery resources depend on mangrove as a nursery, as well as the issue of combating pollution, with a view to improving the management and sustainable use of marine resources.

i. Strategic Framework for Biodiversity Conservation in the East African Marine Ecosystem (EAME, 2005-2025)

EAME's strategy is to ensure that all priority habitats in the region are effectively conserved and ensure benefits for present and future generations. In the long run, it promotes the productivity, stability and diversity of mangrove and associated biota. As an objective, it aims to reduce the decline in quality and in the mangrove area, with an indicator of less than 400,000 ha of healthy, viable and representative mangrove in the Eco-region.

j. The UN Decade on Ecosystem Restoration 2021-2030. "Prevent, halt and reverse the degradation of ecosystems worldwide"

There has never been a more urgent need to restore damaged ecosystems than now. Restoration of ecosystem is fundamental to achieving the Sustainable Development Goals, mainly those on climate change, poverty eradication, food security, water and biodiversity conservation. The UN Decade on Ecosystem Restoration (hereafter the Decade) is a global effort aimed at restoring the planet and ensuring One Health for people and nature. The Decade unites the world behind a common goal: preventing, halting and reversing the degradation of ecosystems worldwide. Forests, grasslands, croplands, wetlands, savannahs, and other terrestrial to inland water ecosystems, marine and coastal ecosystems and urban environments—all of them are in dire need of some level of protection and restoration. This incredible challenge can only be met if everyone—including Member States, local governments, partners from the private sector, academia and civil society—come together to find viable, lasting solutions. Restoring damaged ecosystems is an efficient and cost-effective way people can work with nature to address the most pressing challenges humanity is facing today.

Led by El Salvador and together with over 70 countries, the United Nations General Assembly (UNGA) proclaimed 2021–2030 as the Decade on Ecosystem Restoration on March 1, 2019. In its resolution, the UNGA recalls the United Nations Environment Assembly's resolution calling for the conservation and restoration of all ecosystems. The UN Environment Programme (UNEP) and Food and Agriculture Organization (FAO) are tasked to lead the implementation. The UN Decade on Ecosystem Restoration also aligns with the Decade of Action for the Sustainable Development Goals.

Political momentum for action, as demonstrated by the call for this Decade, is growing and it is not happening in a vacuum. Awareness of climate change and other environmental challenges has reached new heights in many countries. Scientific studies that highlight the potential of restoration in fighting global warming have mobilized journalists and their audiences alike.

k. Nairobi Convention and its new products (Mangroves restoration handbook): Guidelines on Mangrove Ecosystem Restoration for the Western Indian Ocean Region

The UNEP Nairobi Convention developed Guidelines on Mangrove Ecosystem Restoration for the Western Indian Ocean region targets communities, civil society, national agencies, and practitioners involved in mangrove conservation activities. The Guidelines provides background information on the mangrove forests and their attributes, as well as the threats they face – both human and natural. Using experiences in mangrove restoration projects from Kenya, United Republic of Tanzania, Mozambique, Madagascar, Mauritius and Seychelles, the Guidelines analyses challenges facing community-based mangrove restoration projects; and provide possible solutions to the identified problems.

Many mangrove restorations projects have been implemented with specific objectives, such as production forestry, coastal protection, ecosystem preservation, and fisheries support, among others. Lessons from around the world have demonstrated that mangrove restoration is feasible as long as the questions of why, where, when, how and by whom are appropriately addressed. The Guidelines demonstrate the value of goal setting in restoration projects and illustrate how they can be achieved. There are many ongoing mangrove restoration activities in the WIO region, involving different stakeholders, including local communities, government agencies, non-governmental organizations (NGOs), private sectors, and funding agencies. However, these initiatives are faced with a number of operational challenges that have led to multiple failures. The Guidelines comprehensively analyse prevailing circumstances, sharing local lessons for best institutional arrangements and stakeholders' engagement mechanisms that enable efficient implementation of restoration projects.

Interaction between local communities and mangroves is often not well appreciated when formulating mangrove restoration projects. Over-exploitation of mangrove resources and conversion of the area into other land uses are socio-ecologically complex issues that require deep understanding of the root causes to identify possible intervention measures. Multiple dimensions of mangrove restoration and management have been addressed in the Guidelines.

Many mangrove restoration initiatives in the region are small scale, largely involving one to several local communities and only a few mangrove tree species. Implementation of mangrove restoration projects at larger scale involves more species and consequently requires adaptive approaches (learning by doing) to be effective. Adaptive pathways include the use of multiple scenarios of future socio-economic and physical changes (e.g. population growth, climate change, or land-use).

l. Southern African Development Community (SADC)

The Southern African Development Community has existed since 1992, following the transformation of the Southern African Development Co-ordination Conference or SADCC, created in 1980 by nine of the member states. This transformation, which took place on August 17, 1992 in Windhoek, Namibia, was motivated by the end of the apartheid regime in South Africa.

The region faces a series of problems, from natural difficulties such as prolonged droughts, the high prevalence of AIDS and poverty. The eradication of these problems includes among the main goals:

Promote sustainable development through the collective interdependence of member states and self-confidence;

Achieve sustainable use of natural resources and protection of the environment.

5.4.4. LEGAL FRAMEWORK FOR MANGROVE MANAGEMENT

The legal framework for the environmental sector in Mozambique is the National Environment Policy, (Resolution No. 5/1995 of August 3rd) which outlines the goal of achieving ecosystem protection and maintenance. The Policy and Strategy for the Development of Forests and Wildlife states that management and conservation plans are the main means to attain ecological sustainability and promotes the participation of the local communities. Human intervention for mangroves rehabilitation and restoration is supported by the National Strategy for Climate Change Adaptation and Mitigation as a means to increase fisheries

resilience and protection of threatened coastal ecosystems associated with mangroves. The National Strategy and Action Plan for Mangrove Management approved in 2020 is a guiding instrument aiming to at promoting comprehensive approaches that allow social development while protecting the ecosystem, and upholding scientific research to support decision making including mangrove restoration.

The use and conservation of mangroves in Mozambique is regulated by a series of legal instruments that basically bans any form of commercial exploitation of mangrove wood and discourage pollution, degradation and transformation of mangrove forests, while at the same time promoting sustainable use and community participation in management actions. Mangroves are regarded as areas of partial protection, and therefore the use of its resources is restricted. The law forbids infrastructure development in mangrove forest, exception given to basic infrastructure (such as those for water supply, electricity and telephone lines) or others with national interest (like ports). Mangrove destruction for oil and gas industry is also discouraged, but if inevitable, compensation schemes are envisages and mandatory as per the law. The legislation also regulates the chemical composition of effluents and wastewater discharge in bays, estuaries and ocean and forbids trawling and purse seine in bays and estuaries. Acknowledging the potential contribution of REDD+ programs to forest conservation, the legislation created a regulation for the approval of such projects (Macamo and Sitoe 2017). The table below details these instruments and their implications for mangrove management.

Table 8. Main national legal instruments relevant to mangroves

Legal instrument	Incidence on mangroves
The Constitution of the Republic (22 December 2004, BR I Series, No. 51)	*Article 37 reads: "The State promotes initiatives to ensure the ecological balance and conservation and protection of the environment with a view to improving the quality of life for citizens. "Article 45 can read" every citizen has the duty to ... f) defend and conserve the environment; ... g) defend and preserve the public and community good. " can challenge acts that violate their rights established in the Constitution and other laws. " Article 90 establishes that "Every citizen has the right to live in a balanced environment and the duty to defend it." In this way, constitutional conditions are created and the State is charged with responsibility for leading environmental conservation actions, as well as responsibility of the citizen to defend and conserve the environment.*
Law 20/97 of 1 October, the Law on the Environment	*In article 9, it refers to the prohibition of pollution and it can be read in paragraph 1 that "in the national territory production, deposit in the ground and subsoil, discharge into water or into the atmosphere , of any toxic and polluting substances, as well as the practice of activities that accelerate erosion, desertification, deforestation or any other form of degradation of the environment, outside the legally established limits and in paragraph 2, it is expressly prohibited to import into the territory waste or hazardous waste, except as provided in specific legislation. " Clearly there is a window of opportunity here to protect mangroves from dumping and deforestation.* *However, in this provision, the Government is held liable "to ensure that adequate measures are taken to: maintain and regenerate animal species, restore damaged habitats, and in particular monitor activities or use substances faunal species and their habitats. "(Article 12, paragraph 2).*

Decree No. 45/2006 of 30 November, Regulation for the Prevention of Pollution and Protection of the Marine and Coastal Environment	*This is the main tool with direct incidence for beach pollution, which operates Law 20/97 of 1 October in the context of prohibition of pollution of the coastal and marine environment in the national territory regardless of source. In the context of the regulation, the discharge, in waters under national jurisdiction, of hazardous or noxious substances which, in accordance with international standards and current waste management regulations, pose a high risk to both human health and aquatic ecosystems, including those provisionally classified as such, in addition to ballast water, tank washing residues or other mixtures containing such substances (Article 15).* *This decree prohibits the pollution of the environment by chemicals or solid waste, especially fragile ecosystems. It also prohibits open fecalism, and the installation of scrap, dumps and nitriding, landfills, construction materials and toxic or hazardous products along the coast, especially in fragile ecosystems (covering mangroves). Specifically, it addresses wetlands, prohibiting the discharge of untreated effluents, introduction of exotic species, uncontrolled fires and forest activities that lead to the loss of more than 15% of the area under exploitation. Also prohibited are all activities that change their hydrological regime (Article 65). This law again defines the partial protection areas, allowing only the construction of basic infrastructure and small constructions in precarious material. Public works of recognized interest for national development are also allowed.* *Through Article 62 (native coastal flora), it prohibits logging in areas covered by this Regulation.* *Paragraph 3 of this article provides that local communities have the right to exploit existing species of native flora in areas that are the subject of this regulation, provided that it is carried out as permitted by Decree 12/2002 of June 6 and these areas are not degraded. Article 65 (on wetlands) covers mangroves as important wetlands, mainly in flood management and water quality maintenance.*
Decree no. 18/2004 of 2 of June Regulation on Environmental Quality Standards and Effluent Discharge	*Annex III establishes standards of emission of liquid effluents and Annex V establishes maximum values of several chemicals in the effluents that have like receiving body the sea or the ocean. Article 16, paragraph 4, provides that values can be adjusted to lower numbers depending on the sensitivity and use of the receiving environment, particularly when it is composed of lakes, reservoirs or bays with poor water renewal or their tributaries.*
The Tourism Law - Law no. 4/2004, of 17 October	*Under Article 16 (1), it is the duty of suppliers of tourism products and services to "(a) conserve the environment and comply with the rules relating to their protection; e) to preserve and, in cases of damage, to repair public and private assets that have a relationship with tourism ".*
Decree No. 70/2013 of 20 December Regulation of Procedures for the Approval of Projects to Reduce Emissions from Deforestation and Forest Degradation	*Regulation under review and mentions the REDD +*
Law n ° 19/97 of October 1, Land Law	*Article 8 (c) considers mangroves as a partial protection zone (the strip of the sea-shore and in the outline of islands, bays and estuaries, measured from the line of maximum highs up to 100 meters inland). Partial protection zones do not acquire rights to use and use land, and special licenses may be issued by municipalities or provincial governments. It also establishes the participation of communities in the management of natural resources, especially in rural areas. The customary forms of use of resources by communities are protected by this provision (Article 24).*
Law 10/99 of 7 July Forestry and Wildlife Law	*Article 13 ensures the customary use of resources by communities and promotes the recovery of degraded areas through forest plantations, including degraded fragile ecosystems. It also prohibits the transformation of degraded fragile ecosystems, establishing that their previous condition must be restored. This law also promotes participatory management through the creation of local councils with local community representation. The law also establishes fines to be charged to violators for unauthorized exploitation of forest resources, and is aggravated if the infraction is in a protection zone, such as mangroves.*
Decree No. 12/2002 of 6 June Regulation of the Law of Forests and Wildlife	*This decree categorizes some mangrove species as 3rd class wood producers, namely Heritiera littoralis, Ceriops tagal, Bruguiera gymnorrhiza, Avicennia marina and Rhizophora mucronata.*
Decree n ° 89/2020 of 8 October Regulation on Maritime Fisheries (revoke the previous General Regulation on Maritime Fisheries, 43/2003 of 10 Dec.)	*Article 21 limits the sizes of fishing net meshes (thus prohibits fishing with mosquito nets) and establishes minimum sizes of the harvested animals. Article 40 prohibits trawling and purse-seine fishing in bays and estuaries.*

Decree 35/2001 of 13 November, General Regulation of Aquaculture	*Article 26, paragraph 1 is prohibited the transformation of areas with mangrove in aquaculture facility. Paragraph 2, the use of mangrove areas is permitted only for the construction of the water pumping station, anchorage and water inlet channel of fixed ground installations, which shall be provided for in technical and environmental impact studies with observance of the provisions of paragraph 1 and paragraphs 6) and 6) of paragraph 2 of article 12 of this Regulation. Paragraph 3 If the construction of the installations provided for in the preceding number requires the removal of the mangrove, due compensation must be made with the planting of an area corresponding to the cleared area.*
Law no. 21/2014 of August 18, Petroleum Law	*Article 6, ... The State always ensures respect for national interests in relation to ... research and conservation of marine ecosystems and other natural resources ...*
Law No. 3/93 of June 24, Investment Law	*Obligation to conduct an environmental impact study and pollution problems that may arise as a result of activities, waste and / or waste on forest resources. It also assigns responsibility to companies to prevent and minimize such impacts. It also recommends compliance with emission limits for pollutants and pollutants that have a negative impact on the environment.*
Law no. 8/2003. Law of the Local Organs of the State (LOLE)	*It stimulates the promotion of activity of protection and restoration of the environment at the local level.* *In their actions (Article 9), local government bodies respect the autonomy, the powers and competencies of local authorities. Local government bodies coordinate their plans, programs, projects and actions with the local authority bodies within their territory, with a view to the smooth achievement of their duties and responsibilities.* *In the performance of their administrative functions (Article 10), local State bodies articulate with other authorities and with the community authorities, strictly observing the Constitution of the Republic, other laws and regulations on the subject.* *Article 18, empowers the Provincial Government as an organ responsible for ensuring the implementation, at the provincial level, of centrally defined government policy. It also confers administrative autonomy in the context of the devolution of the central administration.* *Article 36 confers the district, as the local organ of the State in charge of carrying out the Government's program and the Economic and Social Plan, with powers of decision, execution and control of the activities envisaged.* *Article 43 makes the district departments responsible to ensure, under the direction of their respective directors, for the execution of programs and plans defined by the organs of the State of higher echelon and guidance and support to the economic and social units of their respective sectors of activity.* *This structure is replicated to the level of the Administrative Post (article 47), from this to the level of the localities represented by the communities, constituting the administrative structure at the base level.* *It is responsible for localities, promoting economic, social and cultural development of the locality, in accordance with the Government's Economic and Social Plan and mobilizing and organizing the participation of the local community in solving the social problems of the respective locality (article 50).*
Decree no. 54/2015 of 31 December, Regulation on the Environmental Impact Assessment Process	*Pursuant to Articles 2 and 3, this Regulation applies to all public or private activities which may directly or indirectly affect environmental components. Any development initiative that may affect endangered species or sensitive ecosystems (eg beaches, coastal dunes and other relevant dunes) requires an environmental impact study ", as these activities fall under category A as described in Annex I to the above Regulation.*
Law No. 5/2017 of May 11, Law on Protection, Conservation and Sustainable Use of Biological Diversity	*The purpose of this Law is to establish basic principles and standards for the protection, conservation, restoration and sustainable use of biological diversity throughout the national territory, especially in conservation areas, as well as the framework of an integrated administration for development the country.* *Article 62, provides for imprisonment over twelve to sixteen years and a corresponding fine, to violators according to the paragraphs of this article.*
Law no. 16/2014 of 20 June, Law on the Protection, Conservation and Sustainable Use of Biological Diversity.	*Article 20, provides for the creation of environmental protection areas, which are a protected area of conservation, of public domain of the State, delimited, managed in an integrated way, where the interaction between human activity and nature model the landscape with aesthetic qualities, specific and exceptional ecological or cultural, producing important ecological services for its residents and neighbors.*
Law No. 22/2013 of 1 November - Fisheries Law	*The Fisheries Law mentions the zoning of fishing areas, aspects related to the prohibition and adequacy of the fleet in relation to resources (Article 12 (1)) not touching the habitat in particular. In its article 17 of this mentions a prohibition of the use of dangerous substances to the resources and the biodiversity, and is silent on the habitat or mangrove ecosystem.*

Law of the Sea, Resolution No. 21/96 of 26 November, ratifies the United Nations Convention on the Law of the Sea and the Agreement concerning the implementation of Part XI of the Convention.	*Article 145 Protection of the marine environment (... prevent, control and reduce pollution and other hazards to the marine environment including the coast ...) "... (...) establish, with due regard to the sovereignty of all States, a legal order to the seas and oceans to facilitate international communications and to promote the peaceful uses of the seas and oceans, the equitable and efficient use of their resources, the conservation of living resources, and the study, protection and preservation of the marine environment "(Preamble). Part XII - "Protection and Preservation of the Marine Environment" ... "States have an obligation to protect and preserve the marine environment" (Article 192) ... "Prevention, reduction and control of pollution, including measures necessary to protect fragile ecosystems and endangered, threatened or endangered ".*
Decree no. 63/2020: Regulates Law no. 7/2019, of 31 May, which establishes the legal framework for the organization and functioning of State Representative Bodies in the Province and repeals Decrees no. 5 / 2020, of 10 February and 16/2020, of 30 April.	This Decree aims to regulate the organization and functioning of the State's representative bodies in the province. Article 1, number 2 foresees how the Secretary of State in the Province is still competent: f) promoting community participation in the planning of economic, social and cultural development in the province; g) to issue an opinion on the planning of maritime, lake and river spaces, under the terms of the law; h) issue an opinion on requests for private use of lake and river maritime spaces, under the terms of the Law; Article 17 (Provincial Environment Service) The Provincial Environment Service has the following functions: 1. Within the scope of the Environment: a) participate in the licensing and inspection of sector activities, under the terms of the law; b) promote the integrated and sustainable management of the rural, urban and marine environment; c) implement centrally assumed bilateral and multilateral agreements; d) guarantee the implementation of centrally assumed climate change projects; e) disseminate legislation on the environment; f) establish measures to prevent degradation and control environmental quality; g) promote initiatives for the management of solid waste and effluents; h) promote initiatives for the prevention, control and recovery of degraded soils. 2. Within the scope of the Land: a) participate in the inspection of the activities of the land sector, under the terms of the law; b) propose the declaration of areas for the State's reserve; c) participate in the elaboration of spatial planning instruments; d) authorize requests to issue special licenses in partial protection zones; e) to issue opinions on DUAT requests over 1,000 hectares; f) issue opinions on DUAT requests for competence at the central level; g) coordinate the resettlement of populations resulting from the implementation of economic projects of interest to the State. 3. Within the scope of Forests and Agro-Forestry Plantations: a) participate in the licensing and supervision of activities in the sector, under the terms of the law; b) guarantee the sustainable use of woody biomass in the province; c) guarantee the sustainable use of forest resources; d) develop actions to combat the illegal exploitation and commercialization of forest resources; *e) channel the percentage of the approved rate of forest exploitation to local communities;* *f) systematize information on forest resources;* *g) ensure the reduction of gas emissions from deforestation and forest degradation;* *h) establish measures to prevent and control uncontrolled fires;* *i) ensure the development of agroforestry plantations;* *j) to promote forest research programs;* *k) promote the internal processing of resources from agro-forestry plantations;* *l) participate in the forest inventory;* *m) processing requests for concession of areas with more than 20,000 hectares.*

Decree no. 64/2020: Regulates Law no. 4/2019, of 31 May, which establishes the legal framework of the principles, organization rules, powers and functioning of the Provincial Decentralized Governance Executive Bodies and repeals Decrees No. 2/2020, of 8 January and 15/2020, of 13 April.	*Article 1 of this Decree is intended to regulate the rules of organization, competences and functioning of Organs executive bodies of provincial decentralized governance.* *Article 21 (Provincial Directorate for Territorial Development and Environment) The Provincial Directorate for Territorial Development and Environment has the following functions:* *1. Within the scope of the Environment:* *a) implement the environmental and ecological zoning plan;* *b) develop programs for reforestation, planting and tree conservation;* *c) carry out civic and environmental education programs;* *d) implement standards for the management, protection, conservation, inspection and monitoring of the use of natural resources;* *e) implement policies to integrate the green economy, biodiversity and climate change into sectoral programs;* *f) implement measures to prevent degradation and control environmental quality;* *g) implement initiatives for the prevention, control and recovery of degraded soils;* *h) ensure the participation of local communities in the management of natural resources and ecosystems;* *i) implement measures to combat pollution of the aquatic environment;* *j) implement programs to combat the degradation of mangroves and aquatic and coastal ecosystems.* *Paragraph 2 of this article provides:* *a) to implement agro-forestry projects and programs;* *e) ensure the implementation of measures to prevent and control uncontrolled fires;* *f) ensure the implementation of community programs for the management of forest and wildlife resources, including 20%;* *h) ensure forest restocking.* *3. Within the scope of land:* *a) participate in the process of processing DUAT requests;* *b) issue opinions on requests for areas up to 1,000 hectares;* *c) guarantee the State's reserves;* *d) to propose administrative policies and measures aimed at improving land management and administration;* *e) ensure the implementation of measures taken within the scope of inspection.* *4. Within the scope of Territorial Planning:* *a) participate and coordinate in the elaboration of spatial planning instruments;* *b) elaborate ecological zoning;* *c) coordinate resettlement resulting from natural disasters;* *d) participate in the elaboration of housing programs.*

The legislation provides in general aspects protection to the mangrove forests, but in reality its enforcement is poor. Most of the instruments do not mention "mangroves" in particular, but rather refer to "wetlands", "fragile ecosystems", or "areas of partial protection". This can be a weakness, because general protection does not account for particular issues which might be neglected. For instance, the fishery law and its regulation never forbid or regulate fishing within mangrove areas, but restricts instead using of drag nets into a land. Mosquito net usage is banned, never been allowed but need to be enforced. Such enforcements may require tackling poverty issues that will enable community over other options fr sustainable fisheries and mangrove protection and sustainable use. The new REPMAR (of 2020) regulates mesh sizes and minimum size of catch fisheries include main crab species caught in mangrove forests. This is a new instrument and needs to be disseminated and its implementation has to be tied with enabling environment for society uplifting and buy-in. It is also important to acknowledge that there are other mangrove products (besides, mud crab, fish and shrimp) whose exploitation needs further regulation. Such is the case of the mangrove snails T. palustris and C. decollata, which are consumed in many places. The rather recently approved mangrove management strategy can be an avenue to moderate mangrove resources harvested by communities.

The customary use of mangrove resources by the local communities is quite widespread in the countryside and in some peri-urban areas though selling mangrove wood in discouraged and often appended. However, given the strengthening of mangrove policies (namely the mangrove strategy and voluntary commitment for mangrove restoration of 5000 ha) the "customary use" appears increasingly not allowed

to selling mangrove products (including wood and charcoal) that has been tolerated and quite a tradition in their community. Mangrove woody products are frequently apprehended by the authorities when sold in informal markets and are not allowed in markets. There is also a need to regulate infrastructure building and land use upstream, given their potential impact in estuaries and other areas where mangroves occur. For example, the operation of dams is regulated by the Decree 47/2009 from October 7th, which says little about minimum ecological flows.

Above in Table 8 we highlighted mainly the main instruments, top-down avenues that mangrove forests and resources can be management and reinforced. Of top relevance we have the following:

- The Environmental Impact Assessment Law as it regulates any impact on mangroves and other critical habitats prompted by approved economic/developments activities. This instruments also regulation compensation schemes
- Regulation on Pollution, Prevention and protection of the Marine and coastal environment. Prohibits forest exploitation in mangroves safeguarded the right of local communities to appeal for their livelihood
- The new approved REPMAR (regulation of Marine Fisheries) that bans use of dragging net into land. Very powerful and regulated for implementation from 2023. Sensitization and sckemes for community development and poverty alleviation is needed to a successful application of this new instrument.

Following the above mentioned instruments are The Land law, The Environmental Law, The Fisheries law and the Sea law.

Important to mentions policies instruments or platforms that play a role more a cross-cutting approach. These includes the Mangrove Management Strategy (2020-2024); the National voluntary commitment of planting 5000 hectares of 2017. Added to this are the POLMAR (Maritime Policy), POEM (Marine Spatial Planning) yet to be finalized and disseminated and other important such as general strategy for reforestation, REDD+ strategy for Mozambique, ICZM (Integrated Coastal Zone Management) of Mozambique. National Determined Contributions (NDCs) as emanated covers also mangroves forests and this need to be followed as Mozambique embark on activities to reduce carbon emission; such approach can be linked with mangrove voluntary commitments and mangrove strategy including the REDD+ strategy. Population centres such as municipalities need to have management plants for their green parks, green belts including their mangrove forests as aligned with these cross-cutting policies platforms.

Mangrove management is a dynamic process. Mozambique having quite a largest mangrove forests and multiple issues need to strengthening its assessment and approach, getting additional support to new global platforms such as the UN vision of the decade of restoration 2020-2030 as tied with the SDGs and the detailed assessment of interventions on mangroves that put at the centre the communities, yet the most advantaged and depended on direct use of mangroves.

The following best practices need to be tackled by all stakeholders: governments at various levels, NGOs, communities and CBOs and other groups such as the private sector and research centres and students and general public. Such best practices cover the following application of mangrove management strategy including restoration mangrove compensation, community issues, private sector participation, finance skims, buy-in communities into mangrove management, best practices in mangrove law/policies, sensitization practices. Of special relevant is role of mangrove in tackling extreme weather events such as floods and cyclones coupled with mangrove direct and indirect values as a buffering storm water, floods and protecting infrastructures and peoples' lives.

The main gap for a faster and continue updated of mangrove management in Mozambique could be the inter-institutional discussion forum and decentralization of mangrove management as well as existence of few funds for implementation and community sensitization and buy-in. Creative initiatives such as nature based solutions, addressing not just habitat but also community's vulnerabilities and private and corporate engagement in mangrove management agenda is needed. Furthermore, mangrove expertise in the country is there and continue to growth but is still not enough to support extensive activities such as extensive mangrove discussion furum in all coastal districts. Dedicated CBOs and NGOs capacitation is also needed. Science community response to calls for NDCs, payments for ecosystems initiatives such as REDD+ and mangrove restoration initiatives is

needed and, the link and mentorship with other advanced initiatives in Africa and world is important for continuing uplifting and visibility of mangrove agenda in Mozambique.

5.5. MANGROVES SOCIO-ECONOMIC PROFILES IN MOZAMBIQUE

5.5.1. COMMUNITY ECONOMIC PROFILE

Table 9 shows that agriculture and fishing are the main economic activities in the study sites, as more than 90% of FGD participants are involved in these activities, while only 19% of participant have been engaged on self-employment in the informal market. Disaggregated data shows that all FDG participants are involved in fishing, excepting in Mecufi where fishers are about 88%. Similarly, all FDG participants are involved in agriculture in all districts, excepting for Metuge, where this number goes down to 73%. Self-employment was only found among FGD participants in the Limpopo estuary. These communities live nearby a major urban center (the city of Xai-Xai, which is the capital of the province), which may provide alternative livelihood opportunities, other than mangrove related activities only.

Both men and women are full engaged on income activities in the agriculture sector, while in the fishing sector there are more men offering their labor (77%) (Table x). Women in the fishing sector were only found in the districts of Metuge and Xai-Xai, being 36% and 42% of the respondents, respectively. Self-employment, mainly in informal sector is an alternative income activity performed by FGD participants in Xai-Xai, although Nhangau and Metuge are also close to urban centers, only respondents in the FGD in Xai-Xai referred to alternative livelihoods activities, and this result suggest that in urban areas (Xai-Xai) with potential for mangrove grow, besides agriculture and fishing there are other job opportunities in informal sector for both men and women.

Table 9. Main income activities in the study sites.

Income Activity	Mecufi (n=67)		Metuge (n=77)		Limpopo estuary (n=57)		Nhangau (n=51)		Matutuíne (n=14)		All (n=266)	
	n	%	n	%	n	%	n	%	n	%	n	n
Agriculture	67	100	56	72.7	57	100	51	100.0	14	100	245	92.1
Fishing	59	88	77	100	57	100	51	100.0	14	100	258	97.0
Hunting	0	-	0	-	0	-	0	-	0	-	0	0
Formal Employment	0	-	0	-	0	-	0	-	0	-	0	0
Self-Employment	0	-	0	-	51	89.5	0	-	0	-	51	19.2
Other	0	-	0	-	0	-	0	-	0	-	0	0

Table 10. Gender distribution in income activities in the study site

Income Activity	Gender	Mecufi (n=67)		Metuge (n=77)		Limpopo Estuary (n=57)		Nhangau (n=51)		Matutuíne (n=14)		All (n=266)	
		n	%	n	%	n	%	n	%	n	%	n	%
Agriculture	Men	0	-	0	-	0	-	0	-	0	-	0	-
	Women	30	44.8	0	-	0	-	0	-	14	100	44	16.5
	Both	37	55.2	56	72.7	57	100	51	100	0	-	201	75.6
Fishing	Men	59	88.1	49	63.6	33	57.9	51	100	14	100	206	77.4
	Women	0	-	0	-	0	-	0	-	0	-	0	-
	Both	0	-	28	36.4	24	42.1	0	-	0	-	52	19.5
Self-Employment	Men	0	-	0	-	0	-	0	-	0	-	0	-
	Women	0	-	0	-	0	-	0	-	0	-	0	-
	Both	0	-	0	-	51	89.5	0	-	0	-	51	19.2

Table x summarizes the income by FGD participants from the livelihood activities in the study sites. From the table it is observed that on average about 3300,00 MZN and 4300,00 MZN are monthly earned from agriculture and fishing activities, respectively. This indicates that, in the study sites, fishing is a more profitable than agriculture. The global trend on amount earned is also observed in all districts excepting in Mecufi where agriculture appears as a more profitable activity. This result is not surprising, as in Mecufi many FGD participants are employed in the agriculture compared to fishing, meaning that this sector is more attractive in the district.

Table 11. Average income from livelihood activities in the study sites (in MZN per month)

Income Activity	Mecufi (n=67)	Metuge (n=77)	Limpopo estuary (n=57)	Nhangau (n=51)	Matutuíne (n=14)	All (n=266)
Agriculture	3133,33	3750,00	4191,67	3360,00	2500,00	3293,48
Fishing	3080,00	5770,00	5733,33	4380,00	4235,00	4373,04
Self-Employment	-	-	8000,00	-	-	8000,00

5.5.2. USE OF MANGROVE RESOURCES IN THE STUDY SITES

In the study areas all the FGD participants are using mangrove products (Table ...). In addition, the results show that there are many mangrove products and derivatives used by community members, that include fish, firewood, building material, furniture and traditional medicines. From these products, fish (94%), traditional medicines (84%) and firewood (71%) are the three most important mangrove products or derivatives used by majority of FGD's participants, whilst honey and furniture are used by about 20% of FGD participants in the study area. There is also a significant number of FGD participants (31%) who are using a succulent (*Sesuvium portulacastrum*) in the district of Beira.

Table 12. Use of mangrove products in the study sites.

Parameters n		Mecufi (n=67)		Metuge (n=77)		Xai-Xai (n=57)		Beira (n=51)		Matutuíne (n=14)		All (n=266)	
		%	n	%	n	%	n	%	n	%	n	%	
Use of mangrove		67	100	77	100	57	100	51	100	14	100	266	100
Mangrove products	Fish	67	100	77	100	57	100	35	68.6	14	100	250	94.0
	Succulent	0	-	0	-	0	-	16	31.4	0	-	16	6.0
	Firewood	9	13	77	100	57	100	45	88.2	0	-	188	70.7
	Construction material	9	13	53	69	45	78.9	51	100	0	-	158	59.4
	Furniture	0	-	53	69	0	-	0	-	0	-	53	19.9
	Traditional Medicines	51	76	77	100	54	94.7	41	80.4	0	-	223	83.8
	Honey	0	-	0	-	57	100	0	-	0	-	57	21.4
	Eco-tourism	0	-	0	-	3	5.3	0	-	0	-	3	1.1
	Plants based food	0	-	0	-	0	-	15	29.4	0	-	15	5.6

5.5.3. VOLUME OF MANGROVE PRODUCTS

Table x summarizes the average quantity of mangrove products collected or produced in the study sites. From the table it is observed that fish is the mangrove product collected in all districts and in average about 27 Kg are collected per day (adding to 10 tons per year). According to the results, in the district of Matutuíne in the season of high catch the fisherman can catch up to 50 Kg/day. This site is located within the Maputo Bay area, which is an important fishing ground surrounded by mangroves. Firewood is also an important product collected in three districts (Metuge, Xai-Xai and Beira). On average 23 Kg are collected per week (adding to 1.2 tons per year).

Building material is other mangrove products collected solely in Mecufi and Metuge, and there is large evidence that building material is collected at Beira (Nhangau) at an alarming scale, with markets established for mangrove poles commercialization, while Xai-Xai is the one location where honey is produced. The average quantity collected or produced of these two mangrove products is 17 Littre/6 months (honey) and 43 units/week (building material). These results suggest that study areas are high potential mangrove zones in the country and good management practices will guarantee sustainability of mangrove ecosystem.

Table 13. Average quantity of mangrove products collected or produced in the study area.

Product	Unit	Mecufi (n=67)	Metuge (n=77)	Xai-Xai (n=57)	Beira (n=51)	Matutuíne (n=14)	All (n=266)
Fish/invertebrates	(Kg/day)	26.7	30.0	25.8	13.8	50.0	27.0
Marine algae	(Kg/week)	-	-	-	40.0	-	40.0
Firewood	(Kg/week)	-	13.0	41.7	12.8	-	22.9
Construction material	(Unit/week)	38.0	41.0	50.0	43.0	-	43.0
Furniture	(Unit/week)	-	66.0	-	-	-	66.7
Traditional medicines	(Kg/day)	0,3	0.6	0.6	0.4	-	0.5
Honey	(Littre/6 months)	-	-	16.7	-	-	16.7
Plant based foods	(Kg/month)	-	-	-	200	-	200

In this study the production and cost were estimated only for fish, as this product is the only one collected or produced in all districts and sold by community members. Thus, table 14 shows that the average price of fish in the study is 81, 00 MZN/Kg, with high price collected in Xai-Xai district (169, 20 MZN/Kg) while the low price was collected in Matutuíne (15, 00 MZN/Kg). The only transaction costs mentioned by the communities were those related to related to transport. These are charged by a third party and refer to the transport of the products from the fish landing site up to the market. On average 218, 80 MZN per trip are spent on transport of fish from the landing site to market. Disaggregated data shows that costs charged by transporters are higher at the Limpopo estuary (725, 00 MZN per trip) and lower in Matutuíne (50, 00 MZN). The cost of transport varies according to the means (car, bicycle, motorcycle) and distance. The cost at the Limpopo estuary is particularly high since the products are transported to distant markets in central and northern Mozambique.

In other hand, the average gross margin in the study areas is 1.968,20 MZN per day and the high gross margin was obtained in Xai-Xai (3.640,36 MZN/day) whilst Beira and Matutuíne registered the lowest price, around 700,00 MZN/day. These results suggest that fish collection is more profitable in the study areas where community members earn in average 718.393,00 MZN per year.

Table 14. Costs and margins for fish collection in the study sites.

District	Quantity (Kg)	Price (MZN/Kg)	Production value (MZN)	Total Cost (MZN)	Gross Margin (MZN/day)
Mecufi	26.7	46.70	1,246.89	66.70	1,180.19
Metuge	30	48.30	1,449.00	80.00	1,369.00
Xai-Xai	25.8	169.20	4,365.36	725.00	3,640.36
Beira	13.8	50.00	690.00	-	690.00
Matutuíne	50	15.00	750.00	50.00	700.00
All	27	81.00	2,187.00	218.80	1,968.20

Quantity – refers to the amount of product (fishing product) acquired in a day
Price – is the amount (money) received for the product

The **Net margin** is the difference between the production value (received price * quantity) and the **Total cost** (includes all the necessary expenses), this includes the taxes that are paid.

Other formulas used in the process of income calculation are described below:

- The quantity unit for fishing products is kg
- Production value = Received price*Quantity
- Gross margin=Production value-Total cost

5.5.4. MANGROVE MANAGEMENT

Based on the data collected from FGDs, a total of 258 participants, feel responsible for the management of the mangrove ecosystem (Table 15). Asked about what would be the best measures taken to ensure the conservation of mangrove forests, the interviewed groups mentioned mostly inspection and community sensitization.

Table 15. Community sense of responsibility for mangrove conservation.

Province	Location	Feels responsible for Mangrove conservation	
		n	%
Cabo Delgado	Mecufi (n=67)	59	88.06
	Metuge (n=77)	77	100.00
Gaza	Xai-Xai (n=57)	57	100.00
Sofala	Beira (n=51)	51	100.00
Maputo	Matutuíne (n=14)	14	100.00
Total (N=266)		**258**	**96.99**

The key informants interviewed, District governments (SDAE: Serviços Distritais das Actividades Económicas) as well as community leaders were unanimous in stating that they feel obliged to protect the mangrove resources, because of their position, and they have done so through mobilization and awareness campaigns on controlled use of resources. Mangrove reforestation was also observed at the Limpopo Estuary, Nhangau and Mecúfi, highlighting the communities of Nhangau and Limpopo, which have successful history of mangrove restoration (Figure ...). Management and law enforcement however is an issue, particularly at Nhangau.

It is important to note that one of the ways found by the government to guarantee the conservation

Figure 3. Mangrove restoration at Nhangau (© Celia Macamo)

of mangroves was the establishment of the no-take period (from 1st December to 31st March), which prohibits the exploitation of marine and forest resources. According to the key informants, the main stakeholders and decision makers on mangrove management and conservation are the Municipal Government, Maritime Administration, Fisheries Directorate, the community fisheries councils and the local community. Regarding the challenges faced in the conservation of the mangrove ecosystem, the key informants pointed out the following:

1. Poor collaboration between government institutions responsible for mangrove conservation and the local community;
2. Low enforcement of laws by users;
3. Weak dissemination of mangrove use laws;
4. Poor awareness of the local community about the importance of rational use of mangrove resources;
5. Lack of alternative sources to mangroves to support family's needs;

According to the key informants, the groups involved in mangroves management include the community police, local government structure, natural resources management committee, community fisheries councils and local community.

Table 16. Groups involved in the management of mangrove ecosystems per site, their rules and responsibilities.

Site	Group	Rules	Responsibilities
Limpopo estuary	Community police	Mobilization and Regular Patrolling	Establishment groups of Mobilization and Inspection
	Local government structure	Laws Implementation	Sensitization and control of mangrove resources
			Ensure sustainable extraction of mangrove products
	Natural Resources Management Committee		Mitigate conflicts related to the management of mangrove ecosystems
Nhangau	Mangrove Management committee	Do not use mangrove fishing resources during the prohibition period (no-take period established by law)	Regular Patrolling
			Mangrove restoration
Metuge Mecúfi	Community Fisheries Councils		Regular Patrolling
			Mangrove Management and Fishery Resources
Matutuíne	Community Fisheries Councils	Guaranty the use of the adequate fishing gear	Regular Patrolling
		Do not use mangrove fishing resources during the prohibition period (no-take period established by law)	Mangrove Management and Fishery Resources

5.5.5. ECONOMIC VALUATION OF ECOSYSTEM SERVICES

The FGD participants were asked if they would be willing to contribute to the implementation of a plan to stop mangrove degradation and improve the conservation of the ecosystem. A vast majority of the respondents (259 respondents, corresponding to 97.37% of the interviewed) agreed to contribute to such plan, against 7 (2.63%) who did not agree. This result demonstrates that there is a very high level of community awareness on trends of mangrove degradation, and that communities are also aware of the importance of this ecosystems and the need to maintain the ecological services that they provide. This is also possibly related with the level of dependence that these communities have for their livelihood and income generation. All the seven participants that declared that were not willing to contribute to the mangrove conservation plan were from Beira.

Table 17. Number of participants willing to contribute to a mangrove conservation plan.

Province	Location	Number of respondents able to support	
		n	%
Cabo Delgado	Mecufi (n=67)	67	100.00
	Metuge (n=77)	77	100.00
Gaza	Limpopo estuary (n=57)	57	100.00
Sofala	Nhangau (n=51)	44	86.27
Maputo	Matutuíne (n=14)	14	100.00
	Total (N=266)	**259**	**97.37**

The implementation of the conservation plan would require community commitment, so the proposal is that families would be required to contribute a certain amount of money per month, or through their labour. Asked to the participants about the form of contribution, 252 (94.74%) responded that they were willing to contribute through their labour, while 14 (5.26%) were willing to contribute in cash (Table x). The fact that the majority of FGD interviewed opted for payment in labour is consistent with the high level of scarcity of formal employment in rural areas of Mozambique, a situation that also occurs in the communities around the study areas.

Table 18. Type voluntary of contribution of the communities to the hypothetic mangrove conservation plan in the study sites.

Province	District	Providing labor		Providing cash		Total
		n	%	n	%	
Cabo Delgado	Mecufi (n=67)	67	100	0	-	67
	Metuge (n=77)	77	100	0	-	77
Gaza	Limpopo estuary (n=57)	57	100	0	-	57
Sofala	Nhangau (n=51)	51	100	0	-	51
Maputo	Matutuíne (n=14)	0	0	14	100.00	14
	Total (N=266)	**252**	**94.74**	**14**	**5.26**	**266**

The average of WTP with labor was estimated at 5.2 hours per week (that is equivalent to 129.7 MZN per week, 518.8 MZN per month). Sofala province, presented the high average WTP in labor (7.3 hours per week), against the rest of study sites, which can be associated with the fact that the communities specifically at Nhangau are very sensitive to conservation and involved in mangrove restoration initiatives (such as those at Praia Nova in Beira city). Cabo Delgado, specifically in Mecufi District, was the second site where participants declared much time to contribute on mangrove conservation (6.5 hours per week) against Metuge District (3.2 hours per week). Similarly to Nhangau, Mecúfi has mangrove restoration initiatives, benefiting from government and NGOs financing. Some parts of Mecúfi are also facing severe erosion, believed to be related to mangrove destruction for saltpans establishment, also as reported heavy rains some related to 2019 Kenneth Cyclone. Therefore, while this community has been largely sensitized on mangrove related issues, it is also facing some of the consequences of mangrove loss (e.g.: erosion, lack of mangrove wood resources). Additionally, to the presented facts, it is important to point out that Sofala and Cabo Delgado provinces were recently hit by severe tropical cyclones in the recent years (tropical cyclones Idai in 2019, Eloise in 2021 and tropical storm Chalane in 2020 made landfall at Beira; while tropical cyclone Kenneth made landfall at Cabo Delgado in 2019). During these events the protection role of mangroves and other coastline vegetation was evidenced, while at the same time the communities experienced the negative consequences of mangrove loss due to the cyclones and human action. These has increased community awareness and sensitivity on mangrove related issues, increasing their willingness to engage, which leads one to believe that participants may have underestimated the resource for fear that it will actually be charged.

Table 19. Average time to work on mangrove conservation actions

Province	District	Average time per week (in hours)
Cabo Delgado	Mecufi (n = 67)	6.5
	Metuge (n = 77)	3.2
Gaza	Limpopo estuary (n = 57)	4.2
Sofala	Nhangau (n = 51)	7.3
Maputo	Matutuíne (n = 14)	-
Total (N=266)		5.2

Matutuíne was the only district where FGD participants decided to contribute in cash, with an average amount of 7,000.00 MZN / year (that is 583.3 MZN per month, 145.8 MZN per week) (see Table 5 below). None of the interviewees resides in the site of study. According to them, they reside in nearby villages where they engage in other income activities, mangrove related activities being an additional source of food and/or income. According to them, the fact that they have alternative sources of income enables them to contribute in cash.

Table 20. Average monetary contribution that communities are willing to give for mangrove conservation

Province	District	Average amount for contribution (in MZN/year)
Cabo Delgado	Mecufi (n=67)	-
	Metuge (n=77)	-
Gaza	Limpopo estuary (n=57)	-
Sofala	Nhangau (n=51)	-
Maputo	Matutuíne (n=14)	7.000,00

5.5.6. AWARENESS LEVELS OF SUSTAINABLE MANGROVE ECOSYSTEM MANAGEMENT

In last 10 years the mangrove ecosystem has experiencing changes in the study areas. According to table 21, many community members indicated that in last 10 years the mangrove ecosystem is being severely degraded (49%), while about 38% mentioned that a slight degradation is being observed in the mangrove ecosystem. However, disaggregated data shows that in Xai-Xai and Matutuíne all community members mentioned that mangrove ecosystem is now severely degraded, suggesting that urgent intervention is needed in these district to restore the local mangrove ecosystem.

According to the interviewees, the main reasons for such degradation are over- exploitation for trading and building houses; and an increased number of harvesters due to the lack of alternative employment options and other alternatives for survival.

Table 21. Perceptions of changes in mangroves in the last years.

Change tend	Mecufi (n=67)		Metuge (n=77)		Xai-Xai (n=57)		Beira (n=51)		Matutuíne (n=14)		All (n=266)	
	n	%	n	%	n	%	n	%	n	%	n	%
Slightly degraded	8	12.0	66	86.0	0	-	28	55.0	0	-	102	38.3
Unchanged	22	33.0	11	14.0	0	-	0	-	0	-	33	12.4
Severely degraded	37	55.0	0	-	57	100	23	45.0	14	100	131	49.2

5.5.4. STAKEHOLDERS INVOLVED IN MANGROVE MANAGEMENT, CONSERVATION AND RESTORATION

In the study areas there are many entities working alone or in collaboration with community members on mangrove management, conservation and restoration. From Table 22 it is observed that community members themselves are the main group involved on mangrove management, conservation and restoration, either individually or groups. Also, there are in the study areas a total of 47 Community Based Organizations (CBO's) and 17 Civil Society Organization (CSO) working together with community members on mangrove management, conservation and restoration.

Table 22. Stakeholders involved in mangrove management and conservation in the study sites.

Partners	Mecufi (n=67)	Metuge (n=77)	Xai-Xai (n=57)	Beira (n=51)	Matutuíne (n=14)	All (n=266)
Local leaders	10	6	38	3	6	63
Mangrove Conservation Groups	31	26	6	67	2	132
CBO's	7	3	5	30	2	47
Other Institutions	7	4	6	3	0	20
CSO	4	0	5	10	0	19
NGO's	4	2	9	0	2	17
Community Members	5	4	7	106	20	142
Others	0	0	1	0	0	1

5.5.5. KNOWLEDGE ABOUT MANGROVE POLICIES AND RULES

Although all respondents have access to mangrove resources, there is a little knowledge about mangrove polices and rules in the study sites, as only 37% of all FGD participants indicated that they know about this matter. In Metuge the situation is alarming as all FGD participants mentioned that they do not know about mangrove polices and rules. This result suggest that efforts should be made to make sure that mangrove users in the study site are well informed about mangrove polices and rules, as way to reduce overexploitation on mangrove products and derivatives.

In terms of access, 100% of community members mentioned that they can entry and use (exploit) mangrove products, - but being mangroves a protected area by the government community members are not permitted to extract mangrove wooden resources for income generation, only 25% and 0%, respectively indicated the exploitation of mangrove wooden resources for this purpose. These results suggest that community members are only allowed to use the mangrove products, but management of these resources is done by higher authorities not at the community level.

Table 23. Knowledge on mangroves policies and use rules.

Parameters n		Mecufi (n=67)		Metuge (n=77)		Xai-Xai (n=57)		Beira (n=51)		Matutuíne (n=14)		All (n=266)	
		%	n	%	n	%	n	%	n	%	n	%	
Knowledge about Mangrove Policies and Rules		31	46.3	0	-	39	68.4	15	29.4	14	100	99	37.2
Have access to Mangrove resources		67	100	77	100	57	100	51	100	14	100	266	100
Type of access	Entry	67	100	77	100	57	100	51	100	14	100	266	100
	Remove	67	100	77	100	57	100	51	100	14	100	266	100
	Management	16	23.9	0	-	0	-	37	72.5	14	100	67	25.2
	Exclusion	0	-	0	-	0	-	0	-	0	-	0	0

Entry - Right to enter or access the resource
Remove – Right to obtain products from resource, example: timber harvesting
Management – Right to regulate internal standards and transform the resource by making improvements
Exclusion – Right to determine who will or will not have access to the mangrove

5.5.6. FOOD SECURITY PROFILE

According to FGD interviews, 98% of community members experienced periods of lack of food during the year. Disaggregated data highlight Xai-Xai as the only site were no community member reporter periods of food unavailability (10%) throughout the year. The majority of community members experienced unavailability of food more than 3 months (79%), while 21% of community members experienced food unavailability between 1-3 months. This situation is more critical in Matutuíne and Beira districts were all community members experienced more than 3 months and exactly these districts experienced in average 4 and 6 months, respectively with food unavailable.

Table 24. Food unavailability and number of months with limited access to food in the study areas.

Parameters n		Mecufi (n=67)		Metuge (n=77)		Xai-Xai (n=57)		Beira (n=51)		Matutuíne (n=14)		All (n=266)	
		%	n	%	n	%	n	%	n	%	n	%	
HH with food unavailability		67	100	77	100	51	89.5	51	100	14	100	260	97.7
Nr. Of Month with food unavailable	1	0	-	0	-	0	-	0	-	0	-	0	-
	1 – 3	28	41.8	15	19.5	15	26.3	0	-	0	-	58	21.4
	> 3	39	58.2	63	81.8	42	73.7	51	100	14	100	209	78.6
	Average	3		4		3		6		4		4	
Nr. Days with food unavailability per month	1	67	100	77	100	51	89.5	51	100	14	100	260	97.7
	1 – 3	0	-	0	-	0	-	0	-	0	-	0	-
	> 3	0	-	0	-	0	-	0	-	0	-	0	-

In contrast, Table 25 show that more than 70% of community members have food available between 7-9 months and only 20% have food available during 10-12 months. However, in the study area community members have food available on average during 8 months and this period is extended to 9 months in Mecufi and Xai-Xai, suggesting that these districts are not food insecure compared to Beira.

Table 25. Number of months with food availability.

Parameters n		Mecufi (n=67)		Metuge (n=77)		Xai-Xai (n=57)		Beira (n=51)		Matutuíne (n=14)		All (n=266)	
		%	n	%	n	%	n	%	n	%	n	%	
Nr. Of Month with food availability	1 - 3	0	-		-		-	6	12	0	-	6	2.3
	4 - 6	0	-		-		-	16	31	0	-	16	6.0
	7 - 9	51	76.1	62	80.5	36	63.2	29	57	14	100	192	72.2
	10 - 12	16	23.9	15	19.5	21	36.8	0	-	0	-	52	19.5
	Average	**9**		**8**		**9**		**6**		**8**		**8**	

In the Table 26 it is observed that many community members are feeding themselves by a combination of vegetables and carbohydrates (32%), while a combination of Vegetables, Carbohydrates and proteins is made by 24% of community members. These results suggest that though community members are experiencing food insecure periods across the year, they nutrition status is somehow balanced through the combination of the main staple foods on diet.

Table 26. Composition of the diet in the study sites.

Parameters n		Mecufi (n=67)		Metuge (n=77)		Xai-Xai (n=57)		Beira (n=51)		Matutuíne (n=14)		All (n=266)	
		%	n	%	n	%	n	%	n	%	n	%	
Type of food consumed	Vegetables	16	23.9	0	-	51	89.5	0	-	0	-	67	25.2
	Carbohydrates	12	17.9	32	41.6		-	7	13.7	0	-	51	19.2
	Veg & Carbo	39	58.2	45	58.4	0	-	0	-	0	-	84	31.6
	Veg & Carbo & Proteins	0	-	0	-	6	10.5	44	86.3	14	100	64	24.1

The majority of community members (58%) is consuming less quantity of food and exchange the food products as combined strategy to fight against food unavailability in the study areas. However, there are other 34% of community members who solely exchange food products consumed as way to mitigate hungry. Xai-Xai and Beira are the districts where more than 80% of community members adopt these two strategies against food unavailability (Table 27).

Table 27. Changes made on food consumption habits in the study areas.

Parameters n		Mecufi (n=67)		Metuge (n=77)		Xai-Xai (n=57)		Beira (n=51)		Matutuíne (n=14)		All (n=266)	
		%	n	%	n	%	n	%	n	%	n	%	
Change on food consumption	Less quantity	8	11.9	17	22.1	0	-	0	-	14	100.00	39	14.7
	Change on kind of food	8	11.9	32	41.6	51	89.5	0	-	0	-	91	34.2
	Less quantity & Change on kind of food	51	76.1	51	66.2	0	-	51	100	0	-	153	57.5

5.5.7. LIMITATIONS OF THE RESEARCH

Although the terms of reference and expected outputs are clearly articulated, there were several limitations that were identified during the field work. These are:

- Limited access to the study sites due to several factors. At the Limpopo estuary data collection took place in the eminence of seasonal floods due to heavy rains. The then declared flood alert state impacted on the availability of people for the interviews, while the heavy rains interrupted many access ways. On the other side, data collection in Beira was postponed due to cyclone Eloise which made landfall in the area during the proposed week for data collection;
- The COVID-19 pandemic limited the mobility of the researches to the study sites. Therefore, the samplers were trained remotely (via phone, Whatsapp, etc.), which resulted, in some cases, in poor application of the methodological approach and lack of physical supervision during the collection process. This limitation affected particularly the data collected at Beira and Limpopo estuary.
- The COVID-19 pandemic and subsequent limited mobility of researchers also limited the access to some key informants. Therefore, some interviews were conducted on the phone, which, again, limited the access to information. Could face to face interviews have been made, some aspects would surely be exploited in more depth;
- The pandemic also limited the number of FGD that could be conducted and the number of participants in each group, thus the amount of data that was obtained;
- At Beira there was a complex bureaucratic process to access the communities for the interviews. It is also possible that the lack of incentives for government technicians hindered collaboration in the data collection process.
- In Maputo province there was a limited number of participants for Focus Group Discussion, which forced not to separate according to age groups or sex.

6. Conclusions and recommendations

This study assessed the value of mangroves and their resources in Mozambique, considering mostly the use values of 4 representative sites in southern, centre and northern Mozambique. It also analysed strategy, policy and legal frameworks that regulate the use of mangroves and the guide the country's development to understand how mangrove socio-economic components are covered in such instrument. In general, mangroves and their importance to population well-being is increasingly mentioned in several management and development guiding instruments. However, there are mostly referred to for subsistence source of livelihood, which hinders their potential to provide robust income to communities, and to attract investment from the private sector. The study also showed that different communities explore different mangrove resources and in different ways. These means that more studies are need to identify such forms of use, and explore their potential for sustainable use at a larger scale. For instance, gastropods *T. palustris* and *C. decollata* are part of national gatsronomy, but this is rarely explored by the tourism industry. There is also need to conduct more studies on mangroves valuation – as this study showed, in each forest different resources are used, and based on the local traditions and availability of other resources, mangroves value and importance can vary. Knowing the local value of a forest is an important tool for decision making and for offsetting. The concept of PES (payment for ecosystem services) is also rarely mentioned, and when it is, carbon sequestration is the most referred ecological service. However, many others can be considered, such as nursery value (important for fishing industry), landscape beauty (for tourism industry) and food (for gastronomy in the tourism industry). There is need to design development policies that are attractive to the private sector, and turn mangrove conservation into a financially sustainable, but also profitable activity. Future studies should cover more people and ensure that different stakeholders are involved. Data should also be collected in urban areas (ex.: Maputo city, Quelimane, Matola), where protective rules might be more significant considering the urban infrastructure.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Impacts of Cattle on the Vegetation Structure of Mangroves

Todd E. Minchinton1 & Hannah T. Shuttleworth1 & Justin A. Lathlean1 & Russell A. McWilliam1 & Trevor J. Daly2

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Annexes

ANNEX I: DRAFT QUESTIONNAIRES FOR STAKEHOLDERS

QUESTIONNAIRE I

Community Focus group discussion

My name is _____ and I am coming to invite you to participate in this survey, whose purpose is to collect information that will help the government and researchers to better understand the problems related to mangrove socioeconomic aspects and conservation framework in Mozambique in order to adopt the necessary measures to resolve. In this way, I intend to ask questions related to mangrove use, market, management in your community. However, I must inform you that your participation in the interview is entirely voluntary, and any information you provide will be treated with secrecy and confidentiality and, under no circumstances will your community be associated with your responses. In the hope that you agree to participate, feel free not to answer any questions or all of them if they are not comfortable for you. Thanks!!!!!

SECTION 1: LOCATION DETAILS

1.1 Province..... 1.2 District .....

1.3 Administrative Post .....1.4 Community/Village.....

1.5 GPS Lat..... .....Long.....Alt..... Meters

1.6 Total number of participants [ ] Young Male [ ] Old Male [ ] Young Female [ ]Old Female

1.7 Date of interview ...../...../2020 1.8 Duration: Start -Time ...../..... End Time...../.....

1.9. Which are the main income generating activities in this village? Please rank them.

1. Agriculture.....
2. Fishing.....
3. Hunting.....
4. Formal employment (specify).....
5. Informal Employment.....
6. Other Specify.....

SECTION 2.0: MANGROVE USE

2.1. Do your community extract resources/ products from the mangrove ecosystem?

[1] Yes [2] No

2.2. Which products do you harvest from the mangroves?

Products	**2.2a. Does the community exploit this product? 1.Yes 2.No**	**How many people in the community exploit this products? (Man/ woman)**	**2.2b. How often have you collected these products? 1.Daily 2.Weekly 3. Monthly**	**2.2.b What quantities of these products have you collected at a time?**	**2.2.d Who is responsible for collecting these products? 1.Man 2.Woman 3.Both**	**2.2.e What is the main purpose of this products 1.Consumption 2.Sale**
Fish/ invertebrates						
Seaweed						
Firewood						
Building materials						
Furniture materials						
Traditional medicine						
Honey						
Eco-tourism activities						
Tannins						
Plant-based food						
Others.....						

2.3 Rank the most important resource from mangroves, give reason and how much time is spent in the activities.

Product	2.3.a Rank at a scale of (0-5) 0 is least important while 5 is the most important	2.3.b What are the reason of your choice?	2.3.c How much time is spent in the activities
Fish/ invertebrates			
Seaweed			
Firewood			
Building materials			
Furniture materials			
Traditional medicine			
Eco-tourism activities			

Cultural/religious activities			
Honey production			
Tannins			
Plant-based food			
Others			

2.4. Has the community in this area been exploring products in the mangrove from other areas?

1. Yes 2. No .....

2.4.a. If so, what products do you explore most? And in which areas (important to identify potential problem areas)

1.....

2.....

3.....

2.4 State the importance of mangroves to the following:

1. Fish population.....
2. Climate change .....
3. Livelihood of the people.....
4. Others.....

SECTION 3: TRANSPORT OF MANGROVES ECOSYSTEM PRODUCTS

3.1 Which products do you transport mostly?

.....
.....
.....

3.2 What are the means of transport commonly used to transport the products explored in the mangrove ecosystem?

Products	**3.2.a How the transportation of these products is done?** **1. By foot** **2.Bicycle** **3.Motorized** **4. Face / lorry** **5.Other .....**	**3.2.b What is the main target market for products?**	**3.2.c What is the distance to the place of sale (km)**	**3.2.d What quantities do you usually carry?**	**3.2.e How much do they pay for shipping? (per unit of measure)?**
Fish/ invertebrates					
Seaweed					
Firewood					
Building materials					
Furniture materials					
Traditional medicine					
Honey					
Eco-tourism activities					
Tannins					
Plant-based food					
Others.....					

3.3 What are the constraints faced in transporting products from the mangrove ecosystem?

.....
.....
.....

SECTION 4: MARKETING OF MANGROVE PRODUCTS

4.1 Which products from the mangrove ecosystem are most commercialized in this region?

.....
.....
.....

Products	4.1.a Does the community sell these products? 1.Yes 2.No	4.1.b Number od people responsible for selling this product 1. Man 2. Woman 3.Young man 4. Young woman	4.1.c What has been the volume of sales per month?	4.1.d What is the sales value per unit? (Price per unit of measure)	4.1.e How many traders are there per product in this village?	4.1.f Who are the main buyers? 1.Consumers 2. Wholesalers / retailers 3.Processors 4. Other esp_____
Fish/ invertebrates						
Seaweed						
Firewood						
Building materials						
Furniture materials						
Traditional medicine						
Honey						
Eco-tourism activities						
Tannins						
Plant-based food						
Others.....						

4.2. Would you like to sell more products than you are selling now? _____1. Yes 2. No

4.2 a. If so, in addition to those that already sell, are there any other products that you would like to sell? (for example, someone who explores firewood and wants to explore fish)

What products would you like? .....
.....
.....

4.2.b. If so, what are the main factors that prevent the expansion of the sale of products? 1. Very weak market, 2. Lack of labor, 3. Weak infrastructure system, 4. Low market price, 5. Climatic reasons, 6. Low demand, 7. Others

.....
.....
.....

SECTION 5.0: MANGROVE MANAGEMENT

Do you feel responsible for the conservation of the mangroves? [ ] 1. Yes [ ] 2. No

If yes, how?

.....
.....

If No why?

.....
.....

5.2 Are there a member of a mangrove conservation group?[ ] Yes [ ] No

5.3 Which people are in charge of managing the mangroves?

.....

.....

.....

.....

.....

5.4 Are there any compensatory measures give to the people participating in Mangrove conservation.

If yes, name them and describe how this is done.

.....
.....
.....
.....

5.5 Which key stakeholders are involved in the management, conservation and restoration of mangroves?

key stakeholders	5.5.a. Does the stakeholder are involved in the management, conservation and restoration of mangroves Yes No	Total	Man	Woman	Comments
Local leaders					
Local conservation groups					
Community-based organizations					
Other government institutions (specify)					
Sivil society					
NGOs (specify)					
Member of community					
Others (specify)					

What are the major threats to mangrove conservation?

Threat	Rank (0-5)	Reasons
Overexploitation		
Pollution		
Illegal harvesting		
Coastal development		
Sedimentation		
Eco-tourism activities		
Settlement		
Others (inadequate policy) or policy enforcement		

5.5 Would you be willing to contribute to mangrove conservation?

[1] Yes, give reason .....

[2] No, give reason .....

5.5.a If yes how much or how many hours

[1] Money .....

[2] Labor hours.....

5.5.b What are your recommendation for improvement of mangrove conservation?

.....
.....
.....
.....

.....
.....

.....

SECTION 6.0: FOOD SECUIRTY QUESTION

6.1 How many meals do you have in a day

a. 1 b. 2 c. 3

6.2 How has these changed for the last 5 years

- Less portion
- Changes in type of food.
- Changes in number of meals per day
- All the above

6.3 What type of meals do you have

a. vegetables b. carbohydrates (ugali , rice e.t.c) c. Proteins d . a&b e. b& c f. a, c and c

6.4 How often do you have meals?

Daily c. thrice a weekd. twice e. once a week

6.5 What is your view on the overall condition of the mangrove ecosystem in the past 10 years?

[1] Slightly degraded [2] Unchanged [3] Severely degraded

6.6 How do you view the condition of the mangrove resources for the past 10 years based on the following characteristics? [1] Decreased [2] No change [3] Increased

Resource	1	2	3	6.6 a. If there was a change, what are the main reasons?	6.6 b. What is the impact of this change?
Mangrove forest area size					
Quantity of timber					
Availability of fish/invertebrates					
Quantity of firewood					
Availability of herbs					
Ecosystem services (erosion control)					
Species diversity					

6.1.c. What important actions have been taken to minimize the impact of the change in resource availability in this region?

.....
.....
.....

6.1.d. What products are becoming more difficult to find in the mangrove ecosystem?

.....
.....
.....

SECTION 7.0: MANGROVES POLICY AND LEGAL FRAMEWORKS

7.1 Are you aware of any rules and regulations governing the management of Mangroves?

[1] Yes [2] No

7.2. If yes, which ones?

.....

.....

.....

.....

.....

7.3. Do you have access rights to the mangrove resources?

[ ] 1. Yes [ ] 2. No

7.4. If yes, outline the type and strength of rights associated with access to the mangrove resources.

Type of rights	Right present (Yes/ No)	Duration of rights	Strength of rights	
			Weak	Strong
Access - right to enter				
Withdrawal - right to obtain 'products' of a resource, e.g. harvest timber				
Management - right to regulate internal use patterns and transform the resource by making improvements				
Exclusion - right to determine who will have access to the forest and to exclude outsiders				

Mangrove cultural service

Probably use time to understand value of mangroves in culture services or non-use value (Time use Value)

QUESTIONAIRE II

Key informants

QUESTIONS FOR KEY INFORMANTS IN THE COMMUNITY

Are you aware of Mangrove Trees?

[ ] 1.Yes [ ] 2.No

If yes, briefly explain 73% Protects from what they are?

.....
.....
.....

Is growing Mangrove trees important?

[ ] 1.Yes [ ] 2.No

Rate the significance of Mangrove trees.

.....
.....

How do you view the condition of the Mangrove trees in coastal areas?

[ ] 1Decreased [ ] 2 No change [ ] Increased

If changed, list out the reasons for this.

.....
.....

The phenomenon of decreasing mangrove trees affects the People living in surrounding regions?
[ ] 1.Yes [ ] 2.No

Do you think this situation can be saved?

[ ] 1.Yes [ ] 2.No

If yes, what are the ways?

.....
.....

1. What according to you are the measures that can be taken in avoiding the destruction of Mangroves?

.....
.....
.....

2. Who do you think can manage Mangroves effectively?

[ ] 1.NGOs, [ ] 2.overnment, [ ] 3. Community groups, [ ] 4.Individuals

3. How is the mangrove used in the area?

.....
.....
.....

4. What do you use it for?

.....
.....
.....

5. Do you manage the mangroves in any way?

.....
.....
.....

CULTURAL SERVICES

What are the Cultural benefits obtained from mangroves?

- Ecotourism,
- Spiritual attachment,
- Indigenous knowledge,
- Recreation

QUESTIONAIRE II

Management

KEY STAKEHOLDERS DISCUSSION (Government Institutions, Organization, Community Key informants and other relevant stakeholders)

1. Do you feel responsible for the conservation of the mangroves?

[ ] 1.Yes [ ] 2.No

If yes , how?

.....
.....

If No why

.....
.....

2. How are the products from the mangrove ecosystem utilized in the community (Wood, Timber, Fish)?

.....
.....
.....

3. Are there alternative resources that can be used to supplement or substitute mangrove products and services that the community demands? [ ] 1.Yes [ ] 2.No

3.1 If yes, Are these alternatives affordable?

.....
.....
.....

4. Who are the main stakeholders and key decision are involved in the management, conservation and restoration of mangroves?

key stakeholders	5.5.a. Does the stakeholder are involved in the management, conservation and restoration of mangroves Yes No	Total	Man	Woman	Comments
Local leaders					
Local conservation groups					
Community-based organizations					

Other government institutions (specify)					
Sivil society					
NGOs (specify)					
Member of comunity					
Others (specify)					

5. Who do you think can manage Mangroves effectively?

[ ] 1.NGOs, [ ] 2.overnment, [ ] 3. Community groups, [ ] 4.Individuals

6. In your opinion, would you term the current local governance structure as effective in the conservation and management of the mangroves? [ ] 1.Yes [ ] 2.No

5.1 If yes , how?

.....

.....

5.2 If No why

.....

.....

7. What take place in the mangrove ecosystem? What actions have been taken to curb destructive practices on mangroves?

.....

.....

8. What challenges do you face in the management and conservation of the mangrove ecosystem?

.....

.....

9. What groups are involved in the governance of mangrove ecosystems? What are the roles and responsibilities of each group in governance?

.....

.....

10. How do you view the state and value of Mangroves comparing the current state with 10 years ago? Is it improving or deteriorating? Has the value [ ] 1. Increased or [ ] 2. Decreased?

11. What factors do you think have led to the current state in the mangrove ecosystem?

.....

.....

12. What cultural activities form part of mangrove everyday use? List them and rank them in the order of importance. Examples (1.Spiritual, 2. Religious –kaya shrines, 3.Aesthetic (leisure walks in the mangroves), 4. Self-importance)

1.....

2.....

3.....

4.....

1.1 For each of the example above, describe .....
a. Any cultural practices used in the conservation of mangroves

.....
.....
.....
.....

13. Rank in the order of importance mangrove uses?

.....
.....
.....

14. What is the community perception about mangrove?

b. Mangrove are there to be used
c. Mangroves are there to be conserved
d. Both

For each explain in details.

15. What are the social benefits of mangrove? List and rank them in the order of importance

.....
.....
.....
.....

16. What are the legislative and compemsatory tools that have helped in management of mangroves? Llist them and rank them in order of success, importance to the organization and importance to the community.

.....
.....
.....

17. Where does the community foresee itself in mangrove conservation?

.....
.....
.....

18. What do you will be the picture 20 years' times if the current status of mangrove uses and conservation continues?

.....
.....
.....

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