SOCIO-ECONOMIC ROLE OF MANGROVES

AND THEIR CONSERVATION FRAMEWORK IN TANZANIA

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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

BMZ	Germany Federal Ministry for Economic Cooperation and Development
CBFM	Community Based Forest Management
CBO	Community Based Organization
CoFMA	Community Forest Management Agreement/Area
DCCFF	Department of Commercial Crops, Fruits and Forests
DFC	District Forest Conservator (for TFS)
DFD	Department of Forrest Development
DfID	Department for International Development
DFNRNR	Department of Forest and Non-Renewable Natural Resources
DFO	District Forest Officer (for District Councils)
EUR	Euro
FAO	Food and Agriculture Organization of the United Nations
FGD	Focus Group Discussion
GIS	Global Information Systems
GMA	Global Mangrove Alliance
GMW	Global Mangrove Watch
ICM	Integrated Coastal Management
ICMU	Integrated Costal Management Unit
ICZM	Integrated Coastal Zone Management
IMS	Institute of Marine Sciences of the University of Dar es Salaam
IUCN	International Union for Conservation of Nature
JCBNP	Jozani-Chwaka Bay National Park
JFM	Joint Forest Management
KICAMP	Kinondoni Integrated Coastal Area Management Project
KII	Key Informant Interview
MACEMP	Marine and Coastal Environment Management Project
MBREMP	Mnazi Bay Ruvuma Estuary Marine Park
MIMP	Mafia Island Marine Park
MLF	Ministry of Livestock and Fisheries
MNRT	Ministry of Natural Resources and Tourism
MPA	Marine Protected Area
MPRU	Marine Parks and Reserves Unit
MSP	Marine Spatial Planning
NC	Nairobi Convention
NICEMS	National Integrated Coastal Environment Management Strategy
NORAD	Norwegian Agency for Development Cooperation.
PECCA	Pemba Channel Conservation Area
PFM	Participatory Forest Management
RCMRD	Regional Center for Mapping of Resources for Development
REMP	Rufiji Environmental Management Project
RUMAKI	Rufiji-Mafia-Kilwa seascape
SOMN	Save Our Mangroves Now
TACMP	Tanga Coelacanth Marine Park
TAFIRI	Tanzania Fisheries Research Institute
TANSEA	Tanzania Sensitivity Atlas

TASAF	Tanzania Social Action Fund
TCMP	Tanzania Coastal Management Partnership
TCZCDP	Tanga Coastal Zone Conservation and Development Programme
TFS	Tanzania Forest Services Agency
TZS	Tanzania Shilling
UNEP	United Nations Environment Programme
USAID	United States Agency for International Development
USD	United States Dollar
VPO	Vice President's Office
WI	Wetlands International
WIO	Western Indian Ocean
WIOMN	Western Indian Ocean Mangrove Network
WIOMSA	Western Indian Ocean Marine Science Association
WIOSAP	Strategic Action Programme for the Protection of the Western Indian Ocean from Land-based Sources and Activities
WWF	World Wide Fund for Nature

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Executive Summary

INTRODUCTION

Despite the growing recognition of the importance and value of mangroves to nature and society, given the multiple ecosystem services of ecological and economic relevance that they provide, they have continued to be abused, degraded and removed. Repeated calls for action to protect the remaining and restore the degraded and lost mangroves are made. In addition to appreciating the role of mangroves for job creation and food security, the need for their sustainable conservation is propelled as more knowledge is emerging on their high capacity to serve as carbon sink and so an important inclusion in the international policy agenda on climate change agreements. "Save Our Mangroves Now (SOMN)" is one of such initiatives which was conceived from realization and recognition of the inadequacies in knowledge of the socio-economic landscape of mangroves in the Western Indian Ocean (WIO) region and the complexities in their conservation frameworks at local and national levels, particularly in the four major mangrove countries of Kenya, Tanzania, Mozambique and Madagascar. One of the activities of SOMN is the profiling of mangroves' socio-economic role and their conservation frameworks in the four countries. This report is for Tanzania, underpinning the 'national case' and identifying the 'key entry points' for maximizing the socio-economic benefits and values and appraising the conservation framework.

Specifically, this appraisal aimed at availing:

(i) Socio-economic benefits and values that mangroves provide and valuation of their direct and indirect contribution to the local economies and livelihoods of dependent coastal communities;

(ii) Potential for business cases to enhance sustainable use and conservation values of mangroves to incentivize communities' participation;

(iii) State of governance of and practice in mangroves conservation, that can best contribute to national development planning and implementation.

METHODOLOGY

This profiling exercise included gathering information and evidence on the direct and indirect mangrove contribution to the national economy as well as examples of sustainable uses, supporting economic appreciation of the values of mangroves. This was done through a multistage approach in four overlapping phases:

(i) Defining the scope of the study, that involved selection of the site and stakeholder identification.

(ii) Review of literature to identify data gaps, formulate research questions, tools and result area, variables and indicators.

(iii) Field surveys, stakeholder consultations and observations

(iv) Feedback and reporting.

The ten designated mangrove blocks in the mangrove management plan for mainland Tanzania were grouped into four, that is Tanga, Bagamoyo-Dar es Salaam-Mkuranga, Rufiji-Mafia-Kilwa, and Lind-Mtwara blocks, whereas for Zanzibar, the ten management units were grouped int two, that is Unguja and Pamba blocks, representing similar local perceptions on the uses and values of mangrove ecosystems and are consistent with the interests of many conservation actors. A two-day stakeholders' workshop was convened to:

(i) Appraise the status and localized threats to mangrove ecosystems and potential best options/practices for sustainable use and development, and

(ii) Appreciate the multiplicity of stakeholders and associated opportunities and challenges in the conservation framework in converging for a common national mangrove agenda.

A review of literature was done to identify data gaps and develop variable and indicators of assessment. Field surveys and identification of business cases for mangroves involved consultations with stakeholders through focus group discussions, key informant interviews and physical observations. Remote sensing data and GIS as a tool were applied to map and analyse some features of socio-economic importance associated with mangroves. Valuation of mangrove ecosystem services for both direct use and indirect (non-use) values was conducted for selected goods and services through market price analysis for extractable mangrove products and avoided/replacement and travel costs for other non-use values. However, due to the imposed ban on harvesting of mangroves wood products, perceptions on community dependence and use of mangroves resources were not fully disclosed in some areas.

RESULTS AND DISCUSSION

STATUS AND EXTENT OF MANGROVE COVER

There is inconsistence in the estimated mangrove forest coverage often related to differences in methodological approaches used. For mainland Tanzania for example, the most recent – 2015 national estimate of 2015 indicates that there is about 158100 ha of mangroves, implying a significant increase from the earlier estimate of 115475 ha reported in the national management plan of 1991 but without explicit indication of the source of such increase, because degradation and loss have continued to be widespread. Such inconsistence is reflected on the inappropriateness of conservation and management planning including valuation of the forest stocks and resources therein. For Zanzibar, mangroves are the second largest forest formation but there is no reliable statistics on their extent in cover and health because the only would be officially accessible data is as old as 1950 and that of 1997 indicating a total of 18000 and 19748 ha respectively, again without an explicit indication of the source of increase in cover. It is due to the inconsistent estimates of the mangrove cover that planning for sustainable management and restoration is impaired, and this is therefore an urgent call for a national inventory.

SOCIO-ECONOMIC USES AND BENEFITS

Majority of the coastal rural population continue to rely on natural resources for their livelihood and where mangroves occur, they are not spared from the human pressures. However, there are often no clear boundaries between subsistence and commercial activities, which involve a combination of use of the land, sea and inter-tidal resources coupled with the remote nature of mangroves. For example, poles, timber, charcoal, fish and shellfish associated with mangroves have mixed values as products for domestic use (subsistence) and/or commodities of trade (commercial).

Traditional uses of mangroves that have persisted across generations albeit often dubbed illegal to support livelihoods and local economies in Tanzania include provision of wood and non-wood products such as fuel wood, poles, timber, honey and traditional medicines as commodities for both domestic and trade. During the colonial era and early post-independence times, mangrove poles, charcoal and barks have reportedly been one of the important export commodities particularly to Arabia from both the mainland Tanzania and Zanzibar. While Zanzibar is the main gateway, information on the business proceeds of the mangrove trade is not openly available as most of the products landed there are from illegal harvests. Mangrove forests support fisheries, serving as home to a variety of fish, crab, shrimp, and mollusk species. They are also reported, though to a limited extent to securing the coastline, sequestering carbon and control pollution. Some coastal communities also benefit from mangroves as they support eco-tourism, although again to a very limited extent, with one successful example of the Pete Community Boardwalk within Jozani-Chwaka Bay National Park

in Zanzibar. This potential calls for investment and technical support to operate the mangrove boardwalks. Nonetheless, at local area-specific level, it is understood that not all mangroves provide similar ecosystem services, nor perceived and appreciated in the same way in all areas where they occur partly due to local traditions and culture.

VALUATION OF MANGROVE ECOSYSTEM SERVICES

Valuation of mangrove ecosystem services is masked by regulatory complications, such that most of the extractable mangrove products are considered illegal commodities and therefore information on their market chain is not readily available. This largely explains why there is very limited information in literature about the value of mangrove ecosystems in Tanzania, and the little information available is characteristically exaggerated. There are also complexities in perceptions and definitions of the economic domain of mangroves associated to social wellbeing and local economies, which often limit the choice of ecosystems services for inclusion into economic valuation. Accordingly, the valuation of mangrove ecosystem services for this study was limited to the ecosystem services summarised below.

Goods and Services	Ecosystem service value	
	(TZS)	Equiv USD
Mangrove poles	14.6 billion yr^{-1}	6.4 million yr^{-1}
Mangrove timber	48.2 billion yr^{-1}	21 million yr^{-1}
Fuelwood	8.8 billion yr^{-1}	3.8 million yr^{-1}
Prawns	5.2 billion yr^{-1}	2.3 million yr^{-1}
Honey	41.4 million yr^{-1}	18000 yr^{-1}
Coastal protection	1.8 trillion yr^{-1}	795.6 million yr^{-1}
Carbon storage	2.6 trillion yr^{-1}	1.1 billion yr^{-1}
Biodiversity (restoration)	255 million yr^{-1}	111,400 yr^{-1}
Eco-tourism	382.5 billion yr^{-1}	165.9 million yr^{-1}
Total	**4.8 trillion yr^{-1}**	**2.1 billion yr^{-1}**

BUSINESS CASES IN MANGROVE AREAS

Evidence of business cases such as aquaculture (shrimp/prawn farming, mud crab fattening), eco-tourism (boardwalks, bird watching) was tracked as potential businesses that are being talked about and promoted, but less practiced. The same is construed with solar salt pans, which are characteristic in mangrove areas, and on which restoration of abandoned salt pans is often challenging. The gist for this is inadequacy or lack of consideration of the private business sectors into conservation landscape. Accordingly, the following are recommended for consideration for advancing the inclusion of the private sector into sustainable mangrove management and conservation, but which warrant further studies.

(i) Conservation practitioners can mediate policy dialogues between salt producers and policy/decision makers on the role that the industry can potentially play to support conservation of mangroves such as through restoration and community development to incentivize local communities around mangroves areas.

(ii) Salt pans use largely barren salt flats. Mangroves tend to come after abandonment of salt pans, conditions of which should be made favourable for afforestation.

(iii) Integrated salt-fish farming with mangrove planting offer opportunities to convert abandoned salt pans into productive fish ponds. This is already being done though in rudimentary way, but offers great potentials

for investment into medium and large-scale fish production if well planned, managed and technically supported.

(iv) Advocacy to salt pans operations to support socio-economic development of neighbouring communities as part of their corporate social responsibility.

(v) Beekeeping and mariculture are more spoken that practiced. Most of the attempts end up in trial phases, failing to meet community expectations. In mariculture for example, guidelines to facilitate establishment, management and development of the industry at different scales have been developed, but local investment has not yet received adequate force. Yet, field observations on the two activities revealed huge potential for local investments and it calls for their high advocacy.

(vi) Potential of mangrove forests for eco-tourism is well demonstrated by the one living example of Pete Community Mangrove Boardwalk describe above. Apparently, high establishment/investment costs that can seldomly be raised from local sources, are associated with the limited attempts to promote the activity.

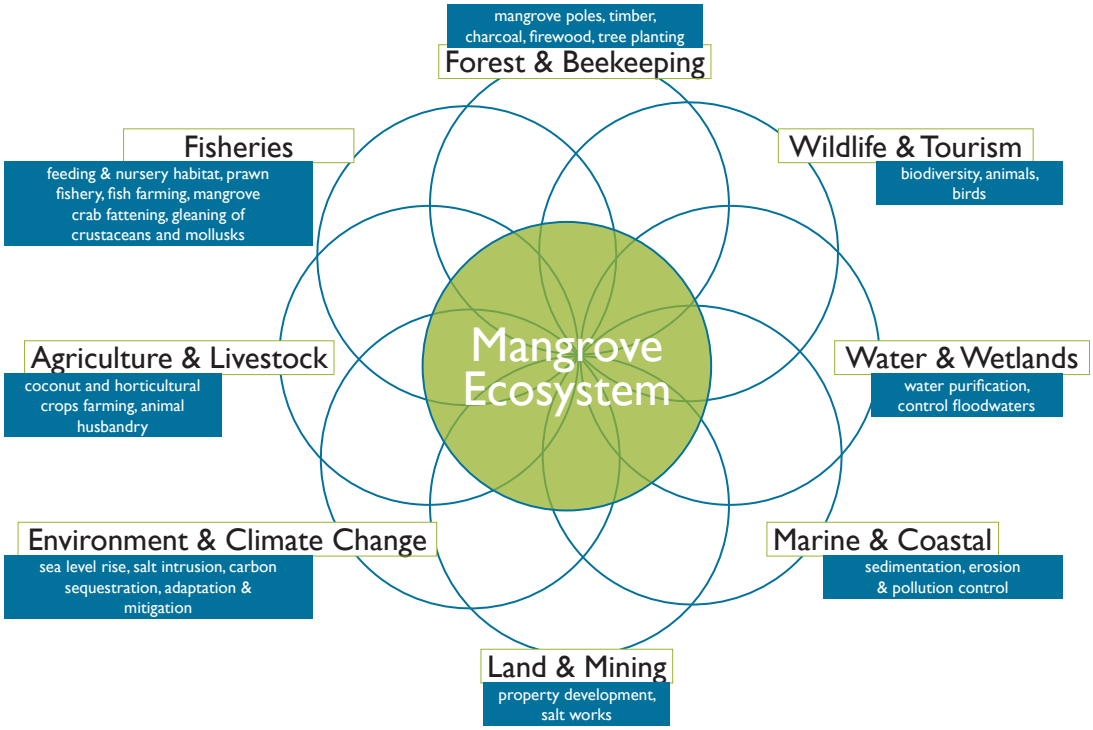
CONSERVATION FRAMEWORK FOR MANGROVES

Human pressures that are driven by poverty and the increasing population with increased demand from the natural capital for survival do not spare mangroves. Common human-induced threats to mangrove forest degradation and loss are related to uncontrolled utilization for wood products and controversial conversion to other land uses such as agriculture, aquaculture and salt pans. This calls for adequately government buy-in that is essential to ensure that mangroves are conserved and restored. It is important that government agencies at all levels recognise and appreciate mangroves for what they are worthy so that due implementation and enforcement of policies and legislations are put in place. This is amplified by the fact that although mangroves forests are designated as state forest reserves since the colonial era all through, the protectionist policies and regulatory mechanisms have generally achieved limited success, with prevalent frictions between people and the state, calling for particular reforms in the management strategies of mangrove forests. This is further supported by the fact that attempts to imposed state bans on mangrove harvest in the mainland Tanzania, for example, did not stop illegal harvesting as intended, instead, sparked community ressentiments that they are being deprived of their traditional access and use rights of mangroves to secure livelihoods. In Zanzibar for example, legal recognition of mangrove as state reserves is inconsistent, inexplicit and/or remains silent in situations where mangrove stands occur on unprotected land and therefore exposed to encroachment. It is pertinent that in order to obtain the necessary support for the governance of the mangrove forests, local communities must believe or perceive that there is a synergy between conservation and usage of the mangrove resources to support their livelihoods.

The institutional, policy and legal framework is characterized by disintegration that compounds to the socio-economic misperception on the critical role of mangroves and further expose them to irresponsible exploitation. The multidisciplinary nature of the mangrove ecosystems attracts several sectors that claim some role to play in the utilization, but often with little responsibility to protecting the mangroves. The complexity summarized by the following figure has attracted repeated calls for coordination that seems to remains wild, unclear and unappreciated.

The conflicting interests or rather overlapping mandates reported between TFS, the Marine Parks and Reserves Management Unit (MPRU) and Resident Mineral Authorities are unwelcome exemplary jurisdictional barriers for concerted efforts to secure the future of mangroves. This is because the establishment and use of Marine Protected Areas is considered as one of the would-be effective measures to secure the future of mangroves that occur in MPAs. Integrated coastal zone management has a strategy developed but infrequently referred to in practicing conservation measures implicitly due to the uncoordinated nature of the institutional framework as demonstrated by the summary figure above. Marine spatial planning has not yet been in its full practical terms, as it is still being conceptualized than applied on the ground.

In terms of practicing mangrove management and conservation, shortcomings are prevalent in the development and institutionalization of mangrove management plans, characterized by the inadequacies



in implementing participatory forest management strategies, which for mangroves demand a contractual joint forest management. It is recommended that it is high time the provisions of JFM are revisited to enable their full realization. Mangrove restoration to compensate for degraded and lost areas has also remained haphazard, with more failures than successes. Lack of and/or poorly defined objectives for mangrove restoration, coupled with inadequate knowledge and technical guidance on the proper steps to ensure success are characteristic limitations. Dependence on short termed donor funded project-based initiatives to drive mangrove restoration is also problematic as it was revealed during the study, that upon ceasing of donor support with project phase-out, the business-as-usual resumes.

CONCLUSIONS

This study aimed at appraising the socio-economic and conservation of mangroves and their resources in Tanzania based on the community, conservation practitioners and managers perceptions and empirical field observations. The current forest policy and legal frameworks have maintained the protectionist model that designate mangrove forest reserves as state owned, with restricted use by local communities. This has overall achieved limited success as mangrove degradation and loss continues, associated with human extractive use and conversion pressures. The inefficient top-down mangrove protection approaches, suggests that the expansion and strengthening of the tenure rights of local communities to mangroves should be a central to their sustainable management and conservation.

Accordingly, the following are recommended for consideration, that may nevertheless require further studies:

(i) Develop/adopt a dedicated mangrove policy

(ii) Promote state and non-state inter-agency and cross-sectoral coordination at different levels of governance

(iii) Sustain and strengthen awareness raising programmes and institutional capacity at all levels

(iv) Explore and engage private sector in mangrove ecosystem conservation and restoration

(v) Redefine the legal basis for community co-management arrangements for mangrove ecosystem,

(vi) Appraise feasibility of the promoted alternative livelihood sources for mangrove dependent communities.

Mangroves of Makoba Bay, Zanzibar

1. Introduction

1.1 BACKGROUND

Understanding the landscape of socio-economic and conservation framework for mangroves require a reliable knowledge of the state of the forest in terms of its extent and health. Unfortunately, our knowledge on these attributes is still inadequate, characterized by data inconsistencies. In the State of World's Forests 2020 report, mangroves are reported to cover 14.8 million ha (**FAO and UNEP, 2020**) while in the State of the World's Mangroves report released by the Global Mangrove Alliance (GMA) on 26th July 2021, mangrove forests that stride the tropical coastlines around the world, are reported to cover 13.6 million hectares as of 2016 (**Spalding and Leal, 2021**). The latter is drawn from the Global Mangrove Watch (GMW) maps that have been officially recommended by the UN Environment as the most reliable. Accordingly, countries that do not have their own local and national mangrove monitoring systems are encouraged to use these maps, especially when reporting on the applicable Sustainable Development Goals (**Spalding and Leal, 2021**). Such inconsistent global reporting of mangrove coverage is also reflected at national and local scales, with many countries lacking reliable estimates for appropriate conservation and management planning including valuation of the forest stocks and resources therein. Tanzania is not exceptional as presented in Chapter 3, **Table 3.1**, which summarizes the inconsistent estimates of mangrove coverage. This is important because mangroves provide multiple-benefits that are of environmental, ecological and economic relevance to human society with more than 100 million people living within 10 km of large mangroves forests and directly benefiting from the resources (**UNEP 2014**). Unfortunately, mangroves have been abused, degraded and removed. A recent opinion paper by a team of global mangrove experts shows that the negligent and irresponsible exploitation of mangrove resources has largely been attributed to the historical misperceptions of their values (**Dahdouh-Guebas et al. 2020**), often associated with their ecosystem disservices, such as being habitats for dangerous animals like crocodiles and snakes, and insects like mosquitoes, in addition to their remoteness, difficult accessibility and muddy locations. These negative views have branded mangroves as valueless wastelands that can be simply cleared, drained and converted to other land uses that are considered as more economically relevant such as aquaculture, agriculture or areas for infrastructure, settlement and urban development (**Friess et al. 2020**; **Goldberg et al. 2020**).

Even though there has been an improved understanding of the value of mangroves to nature and society in the recent past (**UNEP 2014**; **Spalding and Leal 2021**), the legacy of negative perceptions continues to derail influential users, actors, and decision-makers, consequently undermining future conservation efforts (**Dahdouh-Guebas et al. 2020**). These warrants repeated calls for action to protect the remaining and restore the degraded and lost mangroves (**Spalding and Leal 2021**). Degradation and loss of mangroves have undesirable effects on fisheries, shoreline stability and resource sustainability (**UNEP-Nairobi Convention/USAID/WIOMSA, 2020**). Many initiatives are now on the course that aims to support sustainable conservation of mangroves for job creation and food security around the globe (**Spalding and Leal 2021**). This is gaining more momentum as mangroves are high on the international policy agenda on climate change agreements (**Herr and Landis 2016**).

"Save Our Mangroves Now (SOMN)" (**www.mangrovealliance.org/save-our-mangroves-now/**) supported by the German Federal Ministry for Economic Cooperation and Development (BMZ) and implemented by World Wide Fund for Nature (WWF), the International Union for Conservation of Nature (IUCN) and Wetlands International (WI), is one of such initiatives which was conceived from realization and recognition of the inadequacies in the socio-economic landscape of mangroves in the Western Indian Ocean (WIO) region and the complexities in their conservation frameworks at local and national levels. This initiative focuses broadly on (i) Contributing to the setting up of the international policy agenda for mangroves, (ii) Promoting policy reforms at national and regional levels in the WIO region and (iii) Building stakeholders' and actors' partnerships. One of the activities of SOMN is profiling of mangroves' socio-economic role and conservation framework in four major mangrove countries in the WIO region, that include Kenya, Tanzania, Mozambique and Madagascar. The need for these mangrove socio-economic and conservation profiles underpinning the 'national case' and identifying the 'key entry points' for maximizing the socio-economic benefits from mangroves comes as a response to one of the observations from a global analysis of the legal frameworks for mangrove

governance, conservation and use in the four countries (**Slobodian and Badoz 2019**). Furthermore, profiling mangrove socio-economic and conservation aims to address the recognised knowledge gap of mangrove ecosystem services valuation studies in eastern Africa to provide estimates at regional and national level (**Vegh et al. 2014)**. This profiling exercise include, inter alia, gathering information and evidence on mangroves' direct and indirect contribution to the national economy, as well as examples of sustainable use schemes, supporting an economic appreciation of the values of mangroves. Findings reported here are expected to facilitate the discussion and advocate the representation of mangrove baselines and indicators in the national dialogue and reporting of contribution of sustainable natural ecosystems and resources for socio-economic development. Country level data will feed into regional level estimate of the overall value of mangroves that has been denoted at US$ 42.7 billion (**Obura et al. 2017)**.

1.2 OBJECTIVES

1.2.1 OVERALL OBJECTIVE

To compile a socio-economic and conservation profile as the basis for informing national coastal policy and development planning, including identification of investment priorities for mangrove conservation and restoration, and climate change mitigation and adaptation.

1.2.2 SPECIFIC OBJECTIVES

- Assessment of socio-economic benefits and values that mangroves provide (wood and non-wood goods and services) and valuation of their direct and indirect contribution to the local economies and livelihoods of coastal communities through enhanced income and food security, as well as strengthening their resilience to shocks;
- Examination of the potential for business cases to enhance sustainable use and conservation values of mangroves to incentivize communities for environmental and social safeguards through supported with locally relevant scientific and economic evidence;
- Assessment of the state and practice of the conservation framework for mangroves, that can best contribute to national development planning and implementation through such tools as National Mangrove Management Plan, participatory forest management (PFM), Integrated Coastal Zone Management (ICZM) and Marine Spatial Planning (MSP) that appreciate the multiplicity of stakeholders and actors with different interests and priorities.

Integrated fish farming and salt making at Pujini - Pemba, Tanzania

Field observation, Lindi. © Kelvin Kamnde

2. Methodology

2.1 STUDY DESIGN

The present assessment employed a multi-stage approach as summarized in **Fig. 2.1**. The four phases were however not in the strict chronological order, rather overlapping.

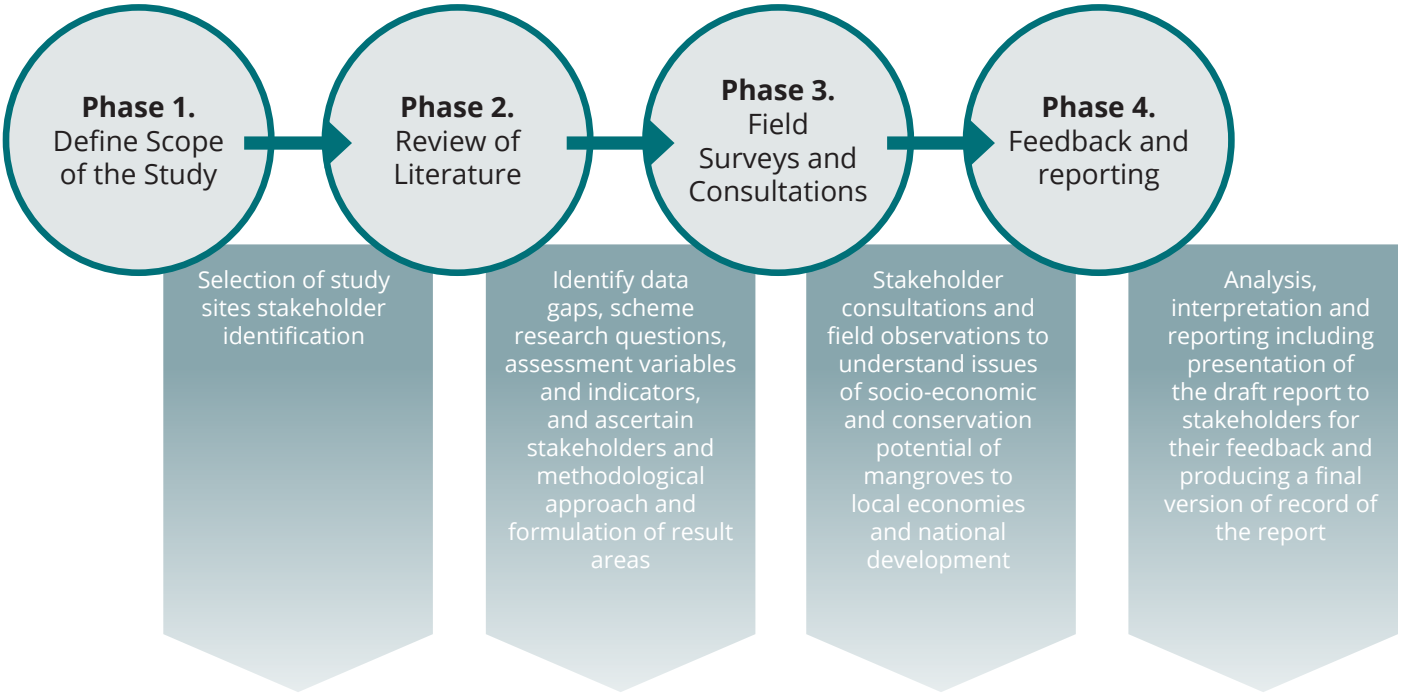


Figure 2.1. Summary of four methodological phases adopted in conducting this study.

2.2 SCOPE OF STUDY

2.2.1 STUDY SITES

For the purpose of this study, the ten mangrove blocks defined in the mangrove management plan for mainland Tanzania (**MNRT 1991**; **Semesi 1992**) and the ten management units for Zanzibar (**DCCFF 2009a**) were modified (**Fig. 2.2**). Accordingly, for mainland Tanzania, Mkinga and Tanga (initially Muheza and Tanga) and Pangani blocks were grouped into one Tanga Block; Bagamoyo, Dar es Salaam and Mkuranga (was Kisarawe) were grouped as Bagamoyo-Dar es Salaam-Mkurunga Block; Rufiji, Mafia and Kilwa were grouped as RUMAKI Block; Lindi and Mtwara were grouped as Lindi-Mtwara Block.

For Zanzibar, Chwaka Bay, Menai Bay, Makoba Bay, Kinazini-Maruhubi, and Mtowapwani-Kigunda-Tumbatu management units were grouped as one Unguja Block, whereas Pemba Channel Conservation Area (PECCA), Ngezi, Micheweni, Muwambe and Kisiwa Panza-Matumbini management units were grouped as one Pemba Block. The modified blocks represented similar local perceptions on the uses and values of mangrove ecosystems based on respective community traditions, culture and dependence

Figure 2.2. Map of the coastal area of Tanzania showing important mangrove areas and selected field sampling sites and conservation actors and initiatives.

pattern, and geographical affinities and orientation (local conditions). The modified management blocks ensure that appropriate management information is conveyed in accordance with local conditions and requirements and further that the geographical aggregation is consistent with the interests of many conservation actors, who often have followed the same order for interventions and investments. For example, WWF Tanzania has worked in the RUMAKI area as one block for various conservation programmes. The former TCZCDP worked in the entire of Tanga block, while Lindi-Mtwara has often been considered as the southern corridor for development programmes. Similarly, for Zanzibar, Unguja and Pemba islands are

considered as unified blocks rather than smaller site units by either regions or districts for conservation of natural resources.

2.2.2 STAKEHOLDERS IDENTIFICATION AND ENGAGEMENT

Stakeholders (communities, conservation actors and the past and present initiatives) were identified during a two-day stakeholders' meeting (**Plate 2.1**) to raise awareness on the mangrove conservation agenda for Tanzania, organized by WWF Tanzania Country Office and held on 26 – 27 November 2020 in Dar es Salaam. This meeting brought together participants from different interest groups and actors in mangrove conservation, including District Forest Officers (DFOs), District Forest Conservators (DFCs), community representatives, Marine Protected Areas (MPAs), and local NGOs and CBOs (**Annex 2.1**). The meeting served as a forum to:

- Appraise the status and localized threats to mangrove ecosystems and potential best options/ practices for sustainable use and development.
- Appreciate the multiplicity of stakeholders and associated opportunities and challenges of the conservation framework in converging for a common national mangrove agenda.

The draft report was presented at another stakeholders meeting held on 17th November 2021 in Zanzibar (**Annex 2.2**), for review and feedback. Comments were received and incorporated.

2.3 REVIEW OF LITERATURE

A comprehensive and systematic review of literature (retrievable and grey, both technical and scientific studies; government statements and records; and policy and legal instruments) was done to identify relevant socio-economic and conservation indicators (**Table 2.1**). The identified indicators were used to guide field surveys and populate the data matrices as appropriate. The literature review aimed to consolidate the debate, assumptions and hypotheses surrounding the role of mangroves in supporting human wellbeing and economic development. This review of literature gauged most of the relevant information that would have been collected through such other methods like household questionnaire surveys.

Plate 2.1. Participants of the mangrove stakeholders meeting held on 26-27 November 2020 at the Protea Courtyard Hotel in Dar es Salaam, Tanzania. © January Ndagala

Table 2.1: Selected indicators of socio-economic role of mangroves and their conservation framework.

Socio-economic Indicators	Conservation framework Indicators
Mangrove extent and cover	Community conflict on existing regulations
Extractive exploitation for mangrove wood products (timber, poles, firewood, charcoal)	Collaborative management arrangements
Conversion of mangrove areas to other uses (salt pans, aquaculture, agriculture, infrastructure and properties)	Effectiveness / Inadequacy of policies, strategies and regulations
Human settlements in and around mangroves	Institutional and technical capacity development
Loss of habitat and ecosystem services	Restoration

2.4 FIELD SURVEYS

Field surveys involved a mixture of methods including consultations with various individuals, groups, business enterprises, institutions, market surveys, physical observations and collection of geographical coordinates for mapping. Consultations were done in form of Focus Group Discussions (FGDs) and Key Informant Interviews (KIIs). A list of consulted individuals and affiliations is provided as **Annex 2.3**. Notes from these consultations are summarized as **Annex 2.4**.

2.4.1 FOCUS GROUP DISCUSSIONS

FGDs were conducted (**Plate 2.2**) with state and non-state officials on site specific issues for different sites, for example, salt pan operations in Tanga Block and Lindi-Mtwara Blocks, aquaculture and beekeeping in Lindi-Mtwara Block, designated conservation areas in Pemba Block, state and non-state institutional roles in RUMAKI Block, roles of collaborative forest management arrangements in Unguja Block etc.

2.4.2 KEY INFORMANT INTERVIEWS

This involved purposive identification and selection of individuals for key informant interviews (KIIs) including both from state and non-state institutions, private businesses and individual entrepreneurs for in-depth consultations on specific matters of interest to a particular site. For example, large scale salt pans producers in Tanga (**Plate 2.3**).

2.4.3 FIELD OBSERVATIONS

Physical observations of production and conservation activities at selected mangrove areas were done to prove concepts on the empirical role of mangrove related socio-economic activities (**Plate 2.4**) and effectiveness of conservation measures (**Plate 2.5**) as provided by different sources including policy and legal frameworks governing coastal and marine resources.

Plate 2.2. Focus group discussion held at Ngezi-Vumawimbi Nature Reserve in Pemba.

Plate 2.3. Interview with the Director General of Neelkanth Salt Limited (with hat), the largest operator of solar salt pans in mangrove areas in Tanzania.

Plate 2.4. Beekeeping in the mangroves in Mtwara.
© Kelvin Kamnde

2.4.4 VALUATION OF MANGROVE ECOSYSTEM SERVICES

Valuation of mangrove ecosystem services for both direct use and indirect (non-use) values was conducted for selected goods and services from each of the four ecosystem service categories (**Table 2.2**). Market prices for direct use values of extractable mangrove products such as firewood, charcoal, poles, timber and honey were enquired through targeted market visits (**Plate 2.6**) and consultations with individuals involved in the business loop. However, this was challenging since such individuals often tended to be reluctant to cooperate as most of the targeted products are illegally acquired, especially for commercial purposes, of which mostly are destined to Zanzibar from major mangrove formations in the mainland like the Rufiji Delta, Kilwa, Ruvu Estuary, Kipumbwi-Sange, Mkinga. Accordingly, while the market price quotations used may be right, the quantity of goods and services used to derive the values are not reliable, and often underestimated.

Avoided or replacement cost and travel costs were used for non-use values of mangroves including regulating services such as mitigation and adaptation to climate change impacts, e.g., coastal protection (**Plate 2.7**); supporting services such as biodiversity and cultural services such as eco-tourism (**Plate 3.10**).

2.4.5 IDENTIFICATION OF BUSINESS CASES

This was done through literature review, FGDs, KIIs and physical observations to identify business cases

Plate 2.5. Planted Rhizophora mucronata at Makangale, part of the Ngezi-Vumawimbi Nature Forest Reserve on Pemba Island looks good but it represents a restoration failure from poor site selection which has resulted in stunted growth after 4 years.

Plate 2.6. Mangrove timber from Rufiji Delta at a local market in Zanzibar, albeit harvesting mangroves for timber is prohibited.

associated with mangrove forests that have potential to transform the socio-economic landscape and contribute to sustainability of mangrove resources.

2.4.6 MAPPING OF SOCIO-ECONOMIC ACTIVITIES AND INDICATORS

Remote sensing data and GIS as a tool were applied to map and analyse some features of socio-economic importance associated with mangroves. For this, location and distribution of salt works and type of house roof tops in selected areas were considered as indicators of socio-economic change as compared to the state of mangrove conservation.

2.5 STUDY LIMITATIONS

Similar to the observation by **von Mitzlaff (1989),** who reported limitations in access to some information from communities due to fear following the state ban on mangrove harvesting that was imposed 2 years before in 1987, this study was also conducted in a similar situation as the state ban on harvesting of mangrove wood was in place since 2016. This made it difficult to see a true picture of community perceptions on the dependence and use patterns of mangrove resources. Individuals remained reluctant, claiming that the government has imposed a ban, and therefore they do not have access to mangroves for livelihood support any more and that they were perceptively afraid of speaking about those matters not to be implicated as standing against the government order. For example, production of mangrove products such as charcoal and timber is prohibited and therefore information on these products is clouded with misinformed exploitation and falsified values of their extraction and use.

Unavailability of data on mangrove harvests is chronic. No single credible dataset of even licenced cutting of mangrove poles could be retrieved from districts offices, both TFS and District Councils. This explains one of the major challenges in implementation of mangrove management plans and is coupled with loss of institutional memory, for some data being held by individuals either in their shelves or personal computers and upon retirement nothing can be easily retrieved.

Table 2.2. Valuation methods for selected mangrove ecosystem services. This should be cross referenced with Table 3.13.

Ecosystem Service Category	Goods and Services	Valuation Method	Remarks
Provisioning	Fuelwood (firewood and charcoal)	Market price	Consumer price of harvested wood products at local markets
	Poles		
	Timber		
	Food (fish,	Market price	Annual production value from recorded catches / harvests, prices at local markets
	Prawns		
	Mangrove crabs		
	Honey		
Regulating	Coastal protection	Avoided/ replacement cost	Construction of seawall, groynes to protect human properties and life
	Carbon storage	Market price	Voluntary market price per ton of carbon credits from forestry and land-use projects that reduce emissions or remove carbon from the atmosphere range from US$ 4.33 to US$ 5.60 per credit (www.ecosystemmarketplace.com). To convert to carbon dioxide, multiply by the ratio of the molecular weight of carbon dioxide to that of carbon (44/12) to yield a value of -361.44 metric tons CO2 ha-1 yr-1 in the year of conversion
Supporting	Biodiversity	Replacement cost	Costs of mangrove restoration for recovery from degradation and loss
Cultural	Eco-tourism	Travel cost	Willingness to pay park entry/usage fee and access mangrove boardwalk

Plate 2.7. Constructed seawall and planted mangroves to protect it at Pangani Town for protection of settlements and properties from coastal/river bank erosion. The seawall has added another value of being a recreation area.

Traditional boat building using mangrove wood in Rufiji Delta

3. Results and Discussion

3.1 OVERVIEW

Mangrove forests in Tanzania are gazetted as state forest reserves. In the mainland Tanzania, the national mangrove management plan (**MNRT 1991**; **Semesi 1992**) set the stage for mangrove conservation, proposing zoning (**Table 3.1)** as a management strategy to ensure sustainable utilization and conservation. A similar approach was adopted for mangroves of Zanzibar (**DCCFF, 2009c**). Development of the management plans were informed by socio-economic studies (**Table 3.2**) that this assessment adopted as key baseline reports for understanding how the socio-economic landscape of the mangrove ecosystems in the country has evolved and/or transformed in response to the implementation of management plans and changes in the socio-economic development over time. Results and discussion in this report is in accordance with the following three areas that reflect the three specific objectives stated above, starting by an overview of the state of the mangrove forests including the inconsistently reported coverage and threats to the sustainability of the mangrove resources.

- Socio-economic role and valuation of mangroves for enhancing human welfare and economic development.
- Business cases for development of local economies in mangrove areas.
- Complexity of conservation framework that is marred by a multitude of stakeholders' and actors' interests, and priorities and tools that do not converge as well as the lack a common ground to support best practices.

Table 3.1. Categorization of mangrove forests for their effective management. Source: MNRT (1991); Semesi (1992)

Management Category	Description of Purpose
Mangroves for total protection	To preserve the natural vegetation and associated fauna by restricting access to only non-destructive scientific uses and protective functions. Such mangrove areas include environmentally and genetically stressed and coastal fringing
Productive mangroves for controlled harvesting	Serves to maintain forest productivity while permitting controlled harvesting for poles, timber and fuelwood depending on species composition as that influence use preference. These are those that have stand density of over 50% and average stand heigh of over 10 m
Mangroves for recovery and rehabilitation	Restricted access to permit recovery from natural regeneration and/or assisted regeneration and where necessary by planting. Time monitor and ascertain recovery is envisaged to be 3 to 25 years depending on the desired outcome whether for production or protection.
Mangroves for development	Allocated for specified, carefully controlled production and development activities both at commercial and subsistence levels. Such activities include aquaculture, solar salt making, tourism, beekeeping etc.

Table 3.2. Baseline literature for socio-economic assessment of the role of mangroves and their conservation in Tanzania.

Report / Study Title	Year	Author/Publisher / Availability
Coastal Communities in Tanzania and their Mangrove Environment	1989	**von Mitzlaff (1989)** Division of Forest and Beekeeping, Ministry of Natural Resources
The Zanzibar Mangroves Socio-economic Final Report	2009	**DCCFF (2009b)** Department of Commercial Crops, Fruits and Forestry, The Revolutionary Government of Zanzibar

3.2 SOCIO-ECONOMIC ROLE AND VALUATION OF MANGROVES

3.2.1 MANGROVE COVER AND DISTRIBUTION

Mangrove forests in Tanzania occur in continuous but fragmented stands almost all along the coastline (**Mangora et al. 2016**; **Fig. 2.2**). However, as summarized in **Table 3.3** and **Table 3.4** there is inconsistence in the reports on the estimated mangrove forest cover in Tanzania. This inconsistence is related to a number of reasons including differences in methodological approaches used, and often the level of accuracy has neither been indicated nor verified and validated. For example, for the mainland Tanzania, the recent estimated coverage of 158,100 ha reported by NAFORMA (**MNRT 2015**) is debated due to the substantial disparity from the immediate past estimations of for example, 115,475 ha (**MNRT 1991**; **Semesi 1992**) and 108,138 ha (**Wang et al. 2003**), indicating a substantial increase without providing information on any possible source of the increase in cover. For Zanzibar, mangroves are the second largest forest formation after the coral rag forests. Old mangrove cover estimates of about 12,000 ha for Pemba and 6,000 ha for Unguja (**Griffith 1949**; **1950**) were officially recognised until 1997 when new estimates of 13,919 ha on Pemba and 5,829 ha on Unguja were provided as part of the national wood biomass survey initiative (**Leskinen et al. 1997**). The increase in cover for Pemba was not explicitly substantiated. These inconsistent statistics on mangrove cover explain the uncertain estimated rates of deforestation and loss of mangroves for the country. It is challenging to develop achievable plans to manage any resource if its current condition is not well established, as that may result into misleading perceptions. It is due to the inconsistent estimates of the mangrove cover that the existing regulatory frameworks for preservation, conservation, sustainable management, and restoration of mangroves often come with sweeping statements such as the loss of mangrove cover is over a certain percentage and/or simply that there is high deforestation rate. Now that the available statistics on mangrove cover do not show accuracy in deforestation rates on a national scale, and that there are economic and logistic constraints to develop national inventories, then updated district and local inventories (**Table 3.4**) should be supported for further integration of results at the national level.

Based on the typology by **Lugo and Snedaker (1974)**, four types of mangrove forests occur in Tanzania defined by local topography and hydrology (**Mangora et al. 2016)**: These are (i) riverine mangroves which are large continuous and structurally well-developed formations (**Plate 3.1**) occurring in the Rufiji Delta and the estuaries of Pangani, Wami, Ruvu and Ruvuma rivers (ii) lagoon mangroves formed in and around semi-enclosed bodies of water and receiving seasonal freshwater like many of those in Mkinga, Tanga, Kipumbwi-Sange, Bagamoyo-Dar es Salaam-Mkuranga, Kilwa-Lindi-Mtwara (**Plate 3.2**) (iii) coastal fringing mangroves which are, purely driven by the functions of tidal forcing in enclosed bays, creeks and lagoons around the islands of Mafia, Pemba and Unguja (iv) over-wash mangroves that characterize the numerous small islands mainly around Pemba. These different formations explain local differences in the traditionally acclaimed perceptions on the socio-ecological values placed on mangroves from place to place. Accordingly, not all mangroves that occur in Tanzania like in many other countries would offer same ecosystem services wherever they occur.

Table 3.3. Inconsistency in reported mangrove area coverage in Tanzania over the past seven decades.

Year	Area (ha)	Methodology/Comment	Coverage	Source
1949-1950	18,000	Unspecified field surveys	Zanzibar (Unguja and Pemba)	**Griffith (1949, 1950)**
1980	90,000	Analysis of the deforestation rate	Mainland Tanzania	**FAO & UNEP (1981)**
1989	245, 600	Analysis of aerial photography of 1988/1989 by Ministry of Lands		**Spalding et al. (1997)**
1989	115,467	Inventory and analysis of aerial photography of 1988/1989 (Ministry of Lands, 1990), Tanzania mainland	Mainland Tanzania	**Semesi (1992)**
1990	323,300	Unspecified	United Republic of Tanzania	**Earth Trends (2003)[1]**
1997	19,748	Field surveys	Zanzibar (Unguja and Pemba)	**Leskinen et al. (1997)**
2000	127,200	Map analysis for East African Coastal Database & Atlas Project: Tanzania, 2001	Unspecified	**Taylor et al. (2003)**
2003	108,138	Remote sensing	Mainland Tanzania	**Wang et al. (2003)**
2006	127,052	Digitization of topographic maps and aerial photographs 1980-1990 for mainland and aerial photos of 2006 for Zanzibar	United Republic of Tanzania	**TANSEA (2016)[2]**
2010	128,683	Expert reports and analysis of literature		**Spalding et al. (2010)**
2015	158,100	Remote sensing data analysed for NAFORMA report	Mainland Tanzania	**MNRT 2015**
2015	114,419	Landsat 8, created through a supervised digital image classification technique at 30-m spatial resolution	United Republic of Tanzania	**RCMRD[3]**
2016	111,404	Remote sensing data from JERS-1 SAR, ALOS PALSAR and ALOS-2 PALSAR-2.	United Republic of Tanzania	**GMW (2016)[4]**

[1]Earth Trends www.earthtrends.wri.org
[2]Tanzania Sensitivity Atlas (TANSEA) www.ims.udsm.ac.tz/tansea/
[3]Regional Center for Mapping of Resources for Development (RCMRD) SERVIR project http://gis1.servirglobal.net:8080/geonetwork/srv/api/records/74e6c47b-a6c9-49fa-bddb-46f091257022
[4]Global Mangrove Watch (GMW) https://data.unep-wcmc.org/datasets/45

Plate 3.1. An example of a well-developed stand of mixed species of R. mucronata and C. tagal in Rufiji Delta.

Plate 3.2. Semi enclosed mangroves of Kilwa Masoko Bay.

There are ten mangrove species that occur in Tanzania in mixed distributions. However, the most common species found in almost all stands include *Avicennia marina*, *Sonneratia alba*, *Ceriops tagal*, *Rhizophora mucronata* and *Bruguiera gymnorrhiza*. Other species with fair distribution among mangrove stands, albeit not extensive include *Xylocarpus granatum*, *Lumnitzera racemosa*, *Heritiera littoralis*, whereas rare species in Tanzania are particularly *X. moluccensis* and *Pemphis acidula*. The condition of these mangrove forests varies depending on exploitation pressures that are mostly associated with their perceived and empirical uses and values and enforcement of exploitation regulations and management measures (**Mangora 2011**; **Mangora et al. 2016**).

Table 3.4. Trend in mangrove cover (ha) for different management blocks from available literature.

Block	Sub Block	Source and Estimated Coverage (ha)							
		Griffith (1949; 1950) for Zanzibar	Semesi (1992) for Mainland	Leskinen et al. (1997) for Zanzibar	Wang et al. (2003) for Mainland	Mayunga and Uhinga (2018) for Mafia Island	Monga et al. (2018) for Rufiji Delta	TANSEA (2016)[1] for whole country	GMW (2016)[2] for whole country
Tanga	Mkinga		9,403.3		9,313			6,163.83	5,656.72
	Muheza							13.77	21.17
	Tanga							3,636.45	2,864.39
	Pangani		1,755.6		3,879			2,260.35	2,060.93
Bagamoyo-Dar-Mkuranga	Bagamoyo		5,635.8		5,051			4612.77	3424.67
	Dar es Salaam		2,168.2		2,516			1933.48	1426.59
	Mkuranga		3,858.3		4,092			4,877.19	5,107.25
RUMAKI	Rufiji Delta		53,254.8		48,030		45,519	48876.12	41227.65
	Mafia		3,472.9			3,187.25		3,773.61	2,575.58
	Kilwa		22,438.7		21,755			21,324.96	23,353.85
Lindi-Mtwara	Lindi		4,546.5		4,044			4901.85	4027.53
	Mtwara		8,941.5		9,458			9285.33	8652.51
Unguja	Unguja	6000		5929				4,872.96	3,389.49
Pemba	Pemba	12000		13919				10,520.37	7,615.93
TOTAL		18,000	115,475.6	19,548	108,138			127,053.04	111,404.26

[1]Tanzania Sensitivity Atlas (TANSEA) www.ims.udsm.ac.tz/tansea/
[2]Global Mangrove Watch (GMW) https://data.unep-wcmc.org/datasets/45

3.2.2 SOCIO-ECONOMIC USES AND BENEFITS OF MANGROVES

3.2.2.1 Socio-economic characteristics of coastal regions

Table 3.5 summarizes the general population trend indicating that the population has doubled and, in some regions, tripled since independence in 1961. **Table 3.6** summarize the socio-economic dependence of the population on natural resources, indicating that majority of the population continue to rely on natural resources to make their living with farming as their major source of livelihood and wood fuel (firewood and charcoal) for household energy, demonstrating the significant human pressure on the natural resources. With this pattern of dependence on natural resources for a living, mangrove forests are not spared from human pressures wherever they occur. Nonetheless, discussions on the socio-economic aspects of human dependence on mangrove ecosystems and their support to societies' wellbeing,

including local economies and how they facilitate sustainable development in Tanzania are complicated (**Mainoya et al. 1982**; **von Mitzlaff 1989**; **Semesi 1998**). This is often because mangrove forest ecosystems and the socio-economic systems of mangrove dependent rural communities are not congruent and information on the human component of the coupled human-nature systems in mangroves areas is sparse. It is more complicated because for the rural poor mangrove dependent communities, there are often no clear boundaries between subsistence and commercial activities, which involve a combination of use of land, sea and inter-tidal resources, coupled with the remote nature of mangroves. For example, poles, timber, charcoal, fish and shellfish associated with mangroves have mixed values as products for domestic use (subsistence) and/or commodities of trade (commercial).

3.2.2.2 Dependence on mangrove ecosystems and resources

Traditional uses of mangroves to support livelihoods in Tanzania are summarized in **Table 3.7**. they basically include provision of wood and non-wood products such as fuel wood, poles, timber, honey and traditional medicines as commodities for both domestic and trade (**Mainoya et al. 1986**; **von Mitzlaff 1989**; **Semesi 1998**; **Mangora et al. 2016**). Mangrove forests are among critical habitats that support fisheries, serving as home to a variety of fish, crab, shrimp, and mollusk species (**Lugendo et al. 2005**; **Mwandya et al. 2010**; **Kimirei et al. 2016**). There are limited reports from the local context on the direct function of mangroves in securing the coastline from storm surges, erosion and sea level rise. Similar to reports from other areas, the significant capacity of mangrove in Tanzania for carbon sequestration has been substantiated (**Alavaisha and Mangora 2016**; **Lupembe and Munishi 2019**). Mangroves are also reported to enhance marine pollution control from land-based sources (**Lugendo and Kimirei 2021**).

3.2.2.2.1 Direct uses and benefits

Table 3.8 summarizes socio-economic activities, products and uses of mangrove areas prior to the development of management plans drawn from **Mainoya et al. (1986)**, **von Mitzlaff (1989)**, **Semesi (1998)**, **Griffith (1949; 1950)** and **DCCFF (2009b)**. **Table 3.9** summarise the observations at different areas during the present assessment indicating that the traditional exploitation of mangrove resources to support local livelihoods and household economies has persisted all the times. Nonetheless, at the local area-specific level, it is understood that not all mangroves provide similar ecosystem services, nor perceived and appreciated in the same way in all areas where they occur. This is due to traditions and culture of dependent communities that are area-specific (**von Mitzlaff 1989**; **Table 3.8; Table 3.9**).

Poles, timber and fuelwood

Mangroves wood products are harvested for construction and fuelwood (firewood and charcoal), which has persisted for generations (**Mainoya et al. 1986**; **von Mitzlaff 1989**; **Semesi 1992**). Fuelwood products are harvested for both domestic use and as a commodity of trade for income generation. As much as available mangrove species of the family Rhizophoraceae together with Xylocarpus species (**Plate 3.3**) are the most preferred for fuel. But, where these species have become scarce or are limited, other species are consumed. Mangrove poles, logs and timber are traditionally used for local house construction (**Plate 3.4**), and are also important commodities of trade (**Plate 3.5**), albeit often illegal. **Griffith (1949, 1950)**, **Mainoya et al. (1986)** and **Sunseri (2005)** reported on the importance of mangroves during the colonial era and early post-independence times, indicating that mangrove poles, charcoal and bark were being exported to Arabia where the poles were an important building material and charcoal as a source of energy. This trade was majorly controlled by the then Sultan of Zanzibar who claimed and retained user rights of the Rufiji Delta and surrounding mangroves (**Beardall 1881**). The export income from mangrove ecosystems was considered to be of high economic importance for the government of the then Tanganyika. Although logging of mangroves for timber and charcoal making is not allowed by the forest regulations both in the mainland and Zanzibar, they continue to be harvested illegally (**Plate 3.6)** and remains to be a precious commodity of trade in Zanzibar **(Plate 3.7**). Common sources on the mainland are Rufiji Delta, Kilwa, Ruvu Estuary, and Mkinga-Tanga. Mangroves of Wami Estuary were also used as a common pool for irresponsible extractive harvesting for charcoal and timber in the years before it was declared part of the Saadani National Park in 2005 (**McNally et al. 2011**). Notwithstanding, the business

proceeds of these products are not openly available and the traders are reluctant to give information of even where the source of the products is. This presents one of the pertinent management challenges because there are no reliable estimates to quantify these uses and benefits. It is mainly from the expert knowledge that the limited information presented in this report were acquired.

Table 3.5. Summary population trend of coastal regions of Tanzania. Source: Basic Demographic and Socio-economic Profiles for Tanga, Pwani, Dar es Salaam, Lindi, Mtwara, Unguja and Pemba. Zanzibar regions are pooled into Unguja and Pemba for easy comparison of data. Regional totals are bolded. Source: URT (2016)

Region/District	1967	1978	1988	2002	2012	Household size 2012
Tanga	**771,060**	**1,037,767**	**1,280,212**	**1,636,280**	**2,045,205**	**435,583**
Mkinga				95,470	118,065	25,254
Tanga			186,818	242,640	273,332	61,307
Muheza			229,139	278,405	204,461	47,608
Pangani			37,670	43,920	54,025	12,964
Pwani	**428,041**	**516,586**	**636,103**	**885,017**	**1,098,668**	**254,810**
Bagamoyo			173,871	228,967	311,740	70,312
Mkurunga			114,973	186,927	222,921	51,101
Rufiji-Kibiti			153,938	202,001	217,274	48,164
Mafia			33,079	40,557	46,438	11,774
Dar es Salaam	**356,286**	**843,090**	**1,360,850**	**2,487,288**	**4,364,541**	**1,083,381**
Lindi	**419,853**	**527,624**	**646,494**	**787,624**	**864,652**	**224,316**
Kilwa			150,419	171,057	190,744	42,596
Lindi Urban			41,701	41,075	78,841	22,344
Lindi Rural			198,212	214,882	194,143	52,821
Mtwara	**621,293**	**771,818**	**889,100**	**1,124,481**	**1,270,854**	**342,165**
Mtwara Urban			76,686	92,156	108,299	27,968
Mtwara Rural			169,304	204,157	228,003	58,602
Zanzibar	**354,815**	**476,111**	**640,685**	**984,625**	**1,303,569**	**250,212**
Pemba			264,802	360,797	406,848	75,026
Unguja			375,873	623,957	896,721	175,186

Table 3.6. Summary socio-economic characteristics of coastal regions of Tanzania. Source: Basic Demographic and Socio-economic Profiles for Tanga, Pwani, Dar es Salaam, Lindi, Mtwara, Unguja and Pemba. Zanzibar regions are pooled into Unguja and Pemba for easy comparison of data. Source: URT (2016)

Region/District	Major Income sources (% of population)	Major staple food grown (% of Households)	Main Cooking Energy (% of population)
Tanga	**Farming (76.9)** **Service Workers (4.8)** **Crafts Workers (3.4)**	**Maize (71.7)** **Cassava (40.1)** **Banana (30.9)**	**Firewood (77.1)** **Charcoal (19.2)** **Paraffin (1.5)**
Mkinga	Farming (74.6) Service Workers (5.4) Elementary Occupations (4.1)		Firewood (89.0) Charcoal (9.0) Paraffin (0.1)

Region/District	Major Income sources (% of population)	Major staple food grown (% of Households)	Main Cooking Energy (% of population)
Tanga	Farming (21.9) Service Workers (20.4) Crafts Workers (14.1)		Charcoal (59.3) Firewood (29.5) Paraffin (3.4)
Muheza	Farming (82.0) Service Workers (4.2) Technicians & Crafts (2.4)		Firewood (82.3) Charcoal (14.6) Paraffin (1.5)
Pangani	Farming (58.5) Elementary Occupations (9.2) Service Workers (6.1)		Firewood (88.6) Charcoal (7.6) Paraffin (1.1)
Pwani	**Farming (61.2)** **Service Workers (6.4)** **Elementary Occupations (6.2)**	**Maize (44.7)** **Cassava (40.4)** **Paddy (30.2)**	**Firewood (67.2)** **Charcoal (28.9)** **Paraffin (1.8)**
Bagamoyo	Farming (57.8) Elementary Occupations (7.8) Service Workers (6.6)		Firewood (62.0) Charcoal (32.7) Paraffin (2.2)
Mkurunga	Farming (68.5) Elementary Occupations (6.3) Service Workers (5.3)		Firewood (75.2) Charcoal (22.3) Paraffin 1.4
Rufiji-Kibiti	Farming (77.1) Service Workers (3.9) Elementary Occupations (3.0)		Firewood (80.5) Charcoal (17.1) Paraffin (1.5)
Mafia	Farming (43.4) Fishing (22) Elementary Occupations (7.2)		Firewood (76.9)s Charcoal (21.4) Paraffin (0.6)
Dar es Salaam	**Service Workers 19.5** **Street Vendors (14.2)** **Crafts Workers (13.8)**	**Maize (3.6)** **Cassava (3.1)** **Paddy (2)**	**Charcoal (73.5)** **Electricity (7.2)** **Firewood (6.7)** **Paraffin (6.7)**
Lindi	**Farming (79.5)** **Elementary Occupations (4.1)** **Technicians (2.8)**	**Maize (71.1)** **Cassava (43)** **Paddy (26.2)**	**Firewood (84.9)** **Charcoal (12.7)** **Paraffin (1.0)**
Kilwa	Farming (71.6) Fishing (6.0) Elementary Occupations (4.3)		Firewood (81.6) Charcoal (16.1) Paraffin (0.8)
Lindi Urban	Farming (87.2) Service Workers (10.7) Elementary Occupations (6.6)		Firewood (57.8) Charcoal (35.5) Electivity (2.9)
Lindi Rural	Farming (87.2) Elementary Occupations (2.3) Technicians (2.1)		Firewood (94.2) Charcoal (3.8) Paraffin (1.2)
Mtwara	**Farming (79.6)** **Elementary Occupations (4.2)** **Technicians (3.5)**	**Cassava (62.1)** **Maize (58.4)** **Paddy (19.2)**	**Firewood (86.6)** **Charcoal (11.2)** **Paraffin (1.1)**
Mtwara Urban	Farming (27.7) Elementary Occupations (12.1) Crafts Workers (11.7)		Charcoal (61.9) Firewood (31.8) Electricity (2.2)

Region/District	Major Income sources (% of population)	Major staple food grown (% of Households)	Main Cooking Energy (% of population)
Mtwara Rural	Farming (83.2) Elementary Occupations (4.9) Fishing (3.7)		Firewood (95.5) Charcoal (3.2) Paraffin (0.8)
Zanzibar	**Farming (40.4)** **Elementary Occupations (12.5)** **Service Workers (11.1)**	**Cassava (44.3)** **Banana (38.9)** **Paddy (26.3)**	**Firewood (79)** **Charcoal (16.4)** **Electricity (2.1)**
Pemba	**Farming (44.9)** **Elementary Occupations (15.4)** **Fishing (10.5)**	**Cassava (70.3)** **Banana (63.2)** **Paddy (53.5)**	**Firewood (85)** **Charcoal (11.7)** **Paraffin (1.7)**
Unguja	**Farming (35.9)** **Service Workers (16.2)** **Elementary Occupations (9.5)**	**Cassava (33.2)** **Banana (28.5)** **Paddy (14.6)**	**Firewood (72.9)** **Charcoal (21.2)** **Electricity (3)**

Table 3.7. Summary of general traditional uses of different mangrove species occurring in Tanzania. Source: Mainoya et al. (1986); von Mitzlaff (1989); Semesi (1998); Mangora (2011, 2012); Mangora et al. (2016)

Scientific name	Family	Local name*	Local / Traditional uses
R. mucronata	Rhizophoraceae	Mkoko, Mkaka, Magondi, Mkoko pwani	Building poles, bark for dyes/tannin, firewood, charcoal, fish traps medicines, ointments, bow-nets, grain-sifting, baskets
C. tagal	Rhizophoraceae	Mkandaa, Mkoko mwekundu	Building poles, bark for dyes/tannin, firewood, charcoal, fish traps, paddles, oars, fencing, bedsteads
B. gymnorrhiza	Rhizophoraceae	Msinzi, Muia, Mkoko wimbi	Building and telephone poles, roof supports, firewood, charcoal, paddles, oars, tools handles, pounding poles, bee-hives, traditional drums; medicine
A. marina	Acanthaceae	Mchu	Trunks for canoes, carts, masts, bedsteads, chairs and tables legs, handles, fodder (foliage), fencing posts, crushing poles and mortar, serving dishes, boat ribs, board games (bao), bee-hives, traditional drums; medicine
X. granatum	Meliaceae	Mkomafi, Mtonga, Mkaumwa	Chows, furniture, canoes, charcoal, firewood, medicine
X. moluccensis	Meliaceae	Mkomafi dume	Timber for bed, window and door frames, charcoal, firewood
H. littoralis	Malvaceae	Msikundazi, Mkungu	Trunks for chow masts, construction timber, furniture, boats, charcoal, firewood
S. alba	Lythraceae	Mpira, Mpia Mlilana	Firewood, charcoal, construction timber, shoots for fishing-net floats, chow masts, canoes, boat ribs, paddles, masts, floating fishing gears, window and door frames
P. acidula	Lythraceae	Kilalamba kike	Firewood, charcoal, building wood
L. racemosa	Combretaceae	Kilalamba dume, Kikandaa	building wood, firewood, charcoal

* Communities in different places havedifferent names for the same species.

Table 3.8. Summary of socio-economic activities, uses and benefits of mangroves in selected mangrove dependent communities prior to the development of management plans. Source: Mainoya et al. (1986), von Mitzlaff (1989), Semesi (1998), DCCFF (2009b)

Region	District	Ward/ Village	Mangrove related Activities, Uses and Benefits	Preferred Mangrove species for different uses
Tanga	Pangani	Kipumbwi	Fishing, Fuelwood for drying fish Poles Craftworks and boat making. Salt production (8 saltpans were operating at Kipumbwi and each pan produced 90 sacks of 100kg in a month). Used bare areas behind mangroves	Fuelwood: *R. mucronata*, *X. granatum*, *A. marina*, and *C. tagal*) Building poles: *C. tagal* & *R. mucronata* Bed making: *A. marina* Boat making: *X. granatum*
Pwani	Bagamoyo	Magomeni	Salt trading, charcoal and fishing which was highly influenced by Dar es Salaam. Salt production had 17 registered salt producers, each had average area 50-200 acres and together produced 2000 tons per year. Selling fuelwood, craftwork.	Firewood: *A. marina*, *R. mucronata*, *X. granatum* Construction poles and roof (*C. tagal* & *A. marina*) Boat making ribs: *B. gymnorrhiza* Burning coral stones to produce lime: *A. marina*
	Rufiji Delta	Mfisini	Agriculture (rice fields) Fishing (prawns, *uduvi*), Pole cutting, Casual laborers, Poles and bark trading to Zanzibar and Arab countries Boat building Salt production	Big poles from Ceriops Small poles from Bruguiera Craftmen using Xylocarpus & Aviccenia to make dug-out canoe Barge building use (Heritiera, Bruguiera Rhizophora, & Xylocarpus Carpenters use Xylocarpus, Sonneratia and Heritiera Local beds made from Ceriops & Aviccenia Wooden frames and roofs use Ceriops Fuelwood from Ceriops
Lindi	Kilwa	Kivinje	Fishing (fish, prawns, sea cucumbers and lobster) Trading (fish, coconut) Craftworks/Artisans Boat making	Fuelwood from Ceriops, Aviccenia & Bruguiera Boat ribs use Sonneratia Traps (Wando) use (Rhizophora) saplings
Mtwara	Mtwara	Nalingu and Chuno	Fishing but limited Craftwork Trading mangrove poles Salt production (salt pans are developed behind the mangroves)	Construction poles form Ceriops, Rhizophora & Bruguiera) Boat making use Xylocarpus & Sonneratia Fuelwood from Rhizophora & Ceriops)

Region	District	Ward/ Village	Mangrove related Activities, Uses and Benefits	Preferred Mangrove species for different uses
Zanzibar			Fishing Mangrove fishery (prawns, crabs, shellfish (oysters, cockles and gastropods) Aquacultures in mangroves (fish, prawn and crab) Salt production Seaweed farming Honey from mangroves Handcraft Tourism and recreation-based businesses Woodcutting and trade Rice cultivation in Zanzibar is normally carried out behind the mangrove swamps, e.g., Micheweni, Makombeni and Muwambe in Pemba and Cheju in Unguja, in small scale production	Firewood preferred Rhizophora & Ceriops, Bruguiera & Avicenia) Charcoal preferred Rhizophora Building and Timber from Bruguiera, Ceriops, Avicenia & Rhizophora Tannin from Rhizophora & Ceriops Commercial wood cutters prefer Bruguiera, Ceriops, Avicenia & Rhizophora

Table 3.9. Summary of observed socio-economic activities, uses and benefits from mangrove areas in the present times.

Area	Mangrove Activities, Uses and Benefits	Area	Mangrove Activities, Uses and Benefits
Tanga Mkinga Pangani	Salt works Aquaculture Beekeeping Ecotourism Prawn fishery Sticks for seaweed farming	Kilwa	Salt works Poles Timber Ecotourism Beekeeping
Rufiji Delta	Poles Timber Agriculture (rice farming) Salt works Prawn fishery Beekeeping	Mtwara Rural	Salt works Beekeeping Aquaculture Ecotourism
Mafia	Beekeeping Traditional salt making by boiling	Pemba	Ecotourism Aquaculture Beekeeping Salt works Charcoal making Firewood Sticks for seaweed farming
Lindi Municipality Lindi Rural	Salt works Beekeeping Aquaculture	Unguja	Ecotourism Charcoal making Poles Aquaculture Beekeeping Salt works Firewood Sticks for seaweed farming

Food, tannin and traditional medicine

The use of leaves and propagules of *A. marina* as fodder for domestic animals, particularly goats and cattle were earlier reported by **Mainoya et al. (1986**). Fruits, barks and roots of some other mangrove species are used as herbal medicines to treat some ailments, mostly related to stomach aches, fever, malaria. **Griffith (1950)** reported that tannin from mangrove species *R. mucronata*, *C. tagal* and *B. gymnorrhiza* was one of the good sources of export revenue in Zanzibar, estimated to attract annual royalty of 8,550 USD. Due to their fungicidal properties, pigments from these *Rhizophoraceae* mangrove species were used to treat nets and fish traps. In the present time, mangroves support beekeeping (**Karengi 2012; Plate 3.8**). Mangroves are habitats for a variety of crustaceans that enhance household food and income security to local communities. Deltaic and estuarine mangrove forests of Pangani, Wami (Saadani), Ruvu, Rufiji Delta (Rufiji-Mafia Channel) and Kilwa are a prominent habitat for prawn fisheries (**Fig 3.1**), that offer a significant economic gain for the local communities and for the national revenue (**Masalu 2003**; **McNally et al. 2011**; **MLF 2020**).

Plate 3.3. Mangrove X. granatum is cut for firewood in the Kipumbwi-Sange mangrove forest, Pangani, destined mainly for Zanzibar market.

Plate 3.5. Mangrove poles from Rufiji Delta and Kilwa offloaded from the canoes and loaded into vehicles to supply local markets in Zanzibar where a piece is sold between 4000 – 10000 depending on the size.

Plate 3.4. House construction by mangrove poles and timber, pasted with mud and roofed by corrugated iron sheets are common in mangrove areas, for example, these ones were found at Mfisini Village in Rufiji Delta.

Plate 3.6. Confiscated mangrove timber (front) and charcoal bags (back) from Rufiji Delta kept at TFS Nyamisati field station waiting for public auction.

Mainoya et al. (1986) reported that the importance of mangrove areas as nursery grounds for many species of shellfish and fin fish that was exploited and commercially exported cannot be overemphasized, giving an example from Rufiji Delta where by in the earlier years more than 2,000 tons of prawns was harvested each year and 20 tons of live crabs per month. Recent inshore marine waters' fisheries frame survey counted 4,213 small scale primary fishers who were engaging in prawn fishing as source of both food and employment for income generation (**MLF 2020**). **Table 3.10** and **Table 3.11** present summary production and revenue collected from prawn fishery during the year 2019.

Plate 3.8. A traditional beehive full of bees in the mangroves of Makoba Bay, Zanzibar where beekeeping is an important activity for enhancing household income.

Recreation, tourist attraction and spiritual service

Eco-tourism is a considerable opportunity from mangrove forested sites. The construction and development of boardwalks and kayaks touring are noted as an opportunity to generate income from forest land that may otherwise be undeveloped. This has however not been fully exploited in the mangroves of Tanzania. A few mangrove boardwalks exist in different areas, some of which has turned dysfunctional (**Plate 3.9**) due to a number of different reasons. Inadequate construction knowledge with inappropriate materials, little or no returns and high operational and maintenance costs are some of the reasons. A strategic assessment of the feasibility of such investments in conservation is necessary in order to appropriately manage community expectations where they are part of such nature-based initiatives.

Plate 3.7. Mangrove wood products are a lucrative commodity of trade. Logs of *X. granatum*, *H. littoralis*, *B. gymnorrhiza* and *S. alba* are illegally harvested in Rufuji Delta (top right) and shipped to Zanzibar (top left) where they are supplied to local markets (middle right) and sawn into timber (bottom) with a piece of 2x6 inch and length of 7 feet is sold at an average price of TZS 34,000/=.

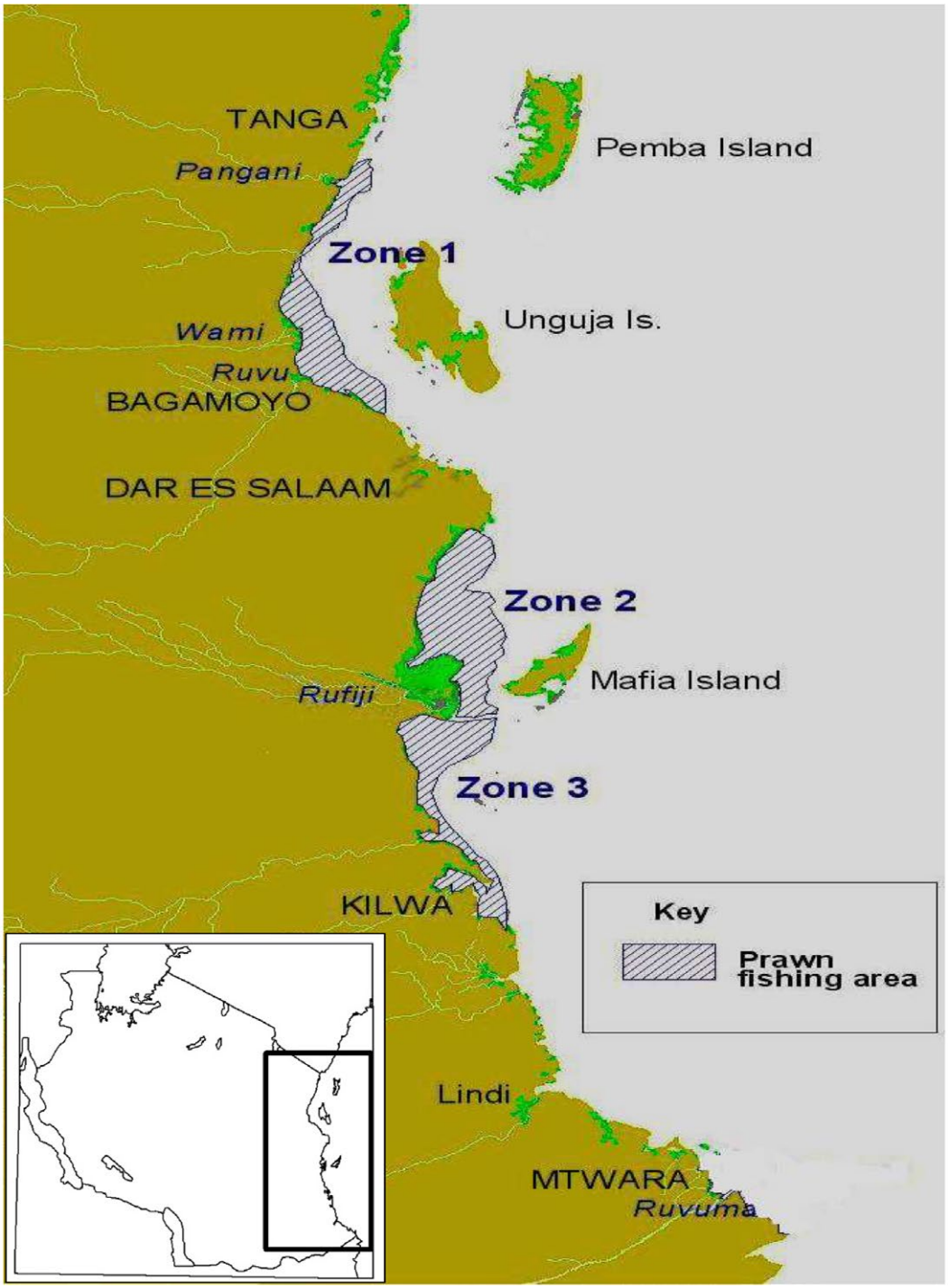


Figure 3.1. Map of coastal Tanzania showing important prawn fishing grounds associated with deltaic and estuarine mangrove areas. Source: Draft Prawn Fisheries Management Plan (MLF 2020).

Table 3.10. Production and values of prawn fishery for the year 2019 in different coastal districts. Source: Annual Fisheries Statistics Report (MLF 2020)

Variable/District	Muheza	Pangani	Tanga	Mkinga	Mafia	Kibiti	Mkuranga	Bagamoyo	Lindi Urban	Lindi Rural	Mtwara Urban	Mtwara Rural	Kigamboni	Kilwa	Ilala	Kinondoni	Total
Production (tons)	2.99	380.89	5.05	117.42	8.95	11.70	11.81	46.98	1.66	8.26	3.68	10.55	38.63	2.88	5.17	7.46	**664.05**
% composition to marine fisheries	0	0.62	0.01	0.19	0.01	0.02	0.02	0.08	0	0.01	0.01	0.02	0.06	0	0.01	0.01	**1.09**
Production Value (000's TZS)	14.08	1,790.19	23.77	551.92	42.07	54.99	55.53	220.82	7.79	38.84	17.31	49.61	181.59	13.54	24.31	35.07	**3,121.44**

Table 3.11: Export value of prawn fishery for year 2019. Source: Annual Fisheries Statistics Report (MLF 2020)

Product	Weight (Tons)	Fob (USD)	Fob (TZS)	Royalty (TZS)
Farmed Prawns	43.2	330,045.60	772,323,963.74	4,775,649.03
Frozen Prawns	87.97	1,852,202.73	4,442,971,291.80	62,027,392.56
Prawns H/ON	0.45	8,100.00	18,630,000.00	414,178.20
Prawns Head-on 61 and above	1.91	955.00	2,183,390.00	4,196,041.95
Total	133.53	2,191,303.33	5,236,108,645.54	71,413,261.74

Pete Community Mangrove Boardwalk (**Plate 3.10**) within Jozani-Chwaka Bay National Park and Biosphere Reserve in Unguja is one example of an active and well-maintained mangrove boardwalk in Tanzania that attracts tourists, researchers and students and accrue sustained income to support local community development. Twenty percent of applicable park entry fee, which is USD 12 for foreigners and TZS 5000 for residents is directed to the boardwalk, which is remitted to Pete community every six months. Available data for the past three years from 2018 – 2020 indicate an average revenue of TZS 229,467,431 went to Pete Community Boardwalk (**Table 3.12**), which exemplify one such component of the value of the associated mangrove forest. The funds are used to support community development projects, mainly in sectors of education, health and water. The sustainable operationalization of the boardwalk has attracted the potential for including kayaking through the creek connected to the boardwalk (**Plate 3.11**) and it was reported that plans to introduce the service are underway with expectations that it will double the interest and willingness to pay for the boardwalk. Another active eco-tourism site that includes mangrove stands is Ngezi-Vumawimbi Nature Reserve in Pemba where also part of the revenue collected from visitors are trickled back for community support.

Provision of space for education and research (**Plate 3.12**) is another significant cultural service of mangrove forests. Mangrove forests also serves as sacred sites for worship, spiritual consultations and sacrifice (**Mangora and Shalli 2014**). Although the law in Tanzania does not recognize sacred forests, they are tacitly thought of as communal or private forest reserves that have not undergone any official establishment process. **Mushi (2019)** reported from a study conducted in Moa and Mahandakini communities of Tanga that most of the identified sacred mangrove forests were owned by either a clan or

individual persons (**Plate 3.13**) and few by the community. Access and user rights for such sacred forests were governed by traditional frameworks through combination of local rules, taboos, norms and beliefs. Beliefs and taboos are parts of social customs abided by community so that to avoid spiritual retributions by offending their local gods and ancestors (**Mushi 2019**). Compliance to such traditions have served to protect mangroves from degradation (**Mangora and Shalli 2014**; **Plate 3.14**).

Table 3.12. Number of visitors to Jozani-Chwaka Bay National Park and respective entry fee collected and amount allocated for Pete Community Mangrove Boardwalk

Year	Number of Visitors		Total Entry Fee Collected				20% for Boardwalk
	Foreign	Tanzanians	TZS	USD (eqv TZS)[1]	EUR (eqv TZS)[1]	TOTAL (TZS)	
2018	56828	7995	860,879,370	321,119,100	6,288,300	1,188,286,770	237,657,354
2019	58652	6356	1,088,345,800	412,413,000	28,817,100	1,529,575,900	305,915,180
2020	26868	3460	548,255,900	155,894,000	19,998,900	724,148,800	144,829,760
Three-year average							229,467,431

[1]Payment is done in three major currencies of TZS, USD and EURO. A conservative exchange rate of USD 1 – TZS 2300 and EUR 1 – TZS 2700 was used for none TZS payments.

Plate 3.9. Mangrove boardwalks that became dysfunctional soon after construction. Left: great looking mangrove boardwalk once at Tanga Beach Resort, which no longer exists. Photo was taken on 22 August 2016, but the boardwalk cannot be traced today. Right: damaged mangrove boardwalk at Tongoni Ruins, Tanga where responsible authorities have not been active to operate it.

Plate 3.10. Active and sustainably managed Pete Community Mangrove Boardwalk in Jozani-Chwaka Bay National Park, Zanzibar.

Plate 3.11. A mangrove creek suitable for kayaking connecting the Pete Community Mangrove Boardwalk to the open sea in Jozani-Chwaka Bay National Park.

Plate 3.13. Individual sacred mangrove patch in Mahandakini village, Tanga. Source: Mushi (2019).

Plate 3.12. Accruing scientific knowledge through education and research in mangrove forests. Data collection in the Zigi Estuary mangroves of Tanga where die-back of the species R. mucronata was observed.

Plate 3.14. Kwamdoe sacred mangrove forest in Kojani Pemba. Left: photo taken in 2007 (Mangora and Shalli 2014). Right: photo taken in 2021 during the present assessment.

3.2.2.2.2 Indirect uses

Habitat for other life forms

Mangrove forests are recognised and appreciated as habitat grounds for breeding, nursery and camouflage of some of the fish species of importance for domestic and commercial use (**Lugendo et al. 2007; Nagelkerken et al. 2008**; **Kruitwagen et al. 2010**; **Mwandya et al. 2010; Kimirei et al. 2016**). Mangrove forests are also important roosting sites and feeding grounds for resident and migratory water birds. For example, Rufiji Delta complex is known as a prime habitat for feeding and nesting of shorebirds, both resident and migratory (**Semesi 1992**). As such, mangrove forests serve as tourist attractions in some of the coastal areas, such as Jozani-Chwaka Bay National Park (**Plate 3.10**).

Coastal protection, pollution control and climate amelioration

Ecologically, mangrove forests protect the coastline from erosion (**Wagner and Sallema-Mtui 2016**), store a significant amount of carbon **(Alavaisha and Mangora 2016**, **Lupembe and Munishi 2019**; **Gullström et al. 2021**), and control pollution, especially as a result of domestic and industrial sewage discharges (**Nyomora and Njau 2012**; **Kondo et al. 2013**; **Mahenge 2018**; **Lugendo and Kimirei 2021**).

3.2.3 VALUATION OF MANGROVE ECOSYSTEM SERVICES

Valuation of mangrove ecosystem services is masked by complications that emanate from the regulatory restrictions. The problem is that most of the extractable mangrove products that can be tagged with market prices are by regulation illegal commodities and therefore information on their market chain is not readily available as it is not openly spoken by communities. For example, the only wood product that is licenced by regulation are the mangrove poles. Nonetheless, there is not readily available record of mangrove pole harvests, the situation which made it difficult to estimate the economic value. This largely explains why there is very limited information in literature about the value of mangrove ecosystems in Tanzania, and if such information exists, it would largely be exaggerated.

In global terms, the economic value of mangroves is estimated to be over 58,000 US$ $ha^{-1}yr^{-1}$ (**Himes-Cornell et al. 2018**), which is not necessarily representative of the local situations in many areas due to the variations in perceptions, definitions and regulatory contexts on mangrove ecosystem services. Accordingly, socio-economic assessments, in particular valuation of ecosystem services at local levels have often been conducted in a fragmented manner following sectoral specific and/or time bound institutional needs. Apart from the direct use-values (e.g. wood products, fish catch), that have comparably received more attention, the other intrinsic indirect and non-use values of mangroves (e.g., coastal/shoreline protection, carbon sequestration, biodiversity, existence amongst others) have rarely been considered, if not neglected at all as they are characterized by being less readily quantifiable in market prices and therefore their contribution to society wellbeing is perceived invisible and continue to be debated, especially where political drivers are considered. For example, often political perceptions have rarely appreciated the ecological integrity of mangroves in safeguarding the social wellbeing of coastal communities in terms of storm protection. Such economic and political misperceptions continue to make mangrove forests vulnerable when the choices are made between conservation and development.

Due to these complexities in the perceptions and definitions of the economic domain of mangroves associated to social wellbeing and local economies, the choice of ecosystems services for economic valuation was guided by both traditional perceptions and regulatory provisions, which came up with the services listed in **Table 2.2** in the methodology section. **Table 3.13** presents their corresponding economic values with some further remarks to clarify their inclusion and/or omission.

Table 3.13. Estimated value of selected mangrove ecosystem services. This should cross reference with Table 2.2.

Ecosystem Service Category	Goods and Services	Ecosystem service value		Remarks
		(TZS)	Equiv USD	
Provisioning	Mangrove poles	14.6 billion yr^{-1}	6.4 million yr^{-1}	[1]Based on market surveys in Zanzibar for mangrove wood products harvested in Rufiji Delta
	Mangrove timber	48.2 billion yr^{-1}	21 million yr^{-1}	
	Fuelwood	8.8 billion yr^{-1}	3.8 million yr^{-1}	[2]**Turpie (2000)** pulled together firewood and charcoal
	Prawns	5.2 billion yr^{-1}	2.3 million yr^{-1}	MLF (2020)
	Mangrove crabs			Not assessed
	Honey	41.4 million yr^{-1}	18000 yr^{-1}	[2]Turpie (2000)
Regulating	Coastal protection	1.8 trillion yr^{-1}	795.6 million yr^{-1}	[3]Based on seawall construction to protect human properties and welfare using the recently constructed Pangani Seawall
	Carbon storage	2.6 trillion yr^{-1}	1.1 billion yr^{-1}	[4]Based on average ecosystem carbon stocks reported from different mangrove areas and based on market price in the voluntary carbon market.
Supporting	Biodiversity (restoration)	255 million yr^{-1}	111,400 yr^{-1}	[5]Based on cost of restoration project in Rufiji Delta
Cultural	Eco-tourism	382.5 billion yr^{-1}	165.9 million yr^{-1}	[6]Based on Jozani-Chwaka Bay National Park entry fee collections
Total		4.8 trillion yr^{-1}	2.1 billion yr^{-1}	Indicative because it included only ecosystem services that respective values were available from interviews, literature and market prices for resources.

Notes

[1]There is no proper and reliable record of mangrove wood products harvesting. Accordingly, estimate of the values based on the observations and informal reports from Rufiji Delta mangroves. Mangroves cover in the delta is estimated to represent 50% of the mangrove area in Tanzania (**Semesi 1992**, **Wang et al. 2003**, **Monga et al. 2018**). Observations at the Malindi Port in Zanzibar indicated that on average two large boats carrying an average of 1000 pieces of logs and timber land daily and load rich the local markets (**Plate 3.5; 3.7**), where each piece of timber is sold at an average price of TZS 33000. Two other boats (**Plate 3.23**) carrying on average 100 scores (20 poles/score) each reach the destined local markets in Zanzibar, where each score is sold at an average price of TZS 100000. Similarly, on average two vessels with average loads of 200 sacks of charcoal each land at different ports in Zanzibar from Ruvu Estuary, Kipumbwi-Sange, Kilwa in the mainland. Charcoal making is also characteristic in the mangroves of Zanzibar (Unguja and Pemba) where for example an estimate of 50 sacks is illegally produced every week from Chwaka Bay. A sack of charcoal is sold at TZS 30000.

[2]Based on household data, **Turpie (2000)** estimated the value of commercial mangrove timber and poles in the Rufiji Delta to be around USD 771789 yr^{-1}, fuel wood extraction at USD 156000 yr^{-1} and honey production at USD 9000 yr^{-1}. With the proliferation and promotion of beekeeping initiatives production is estimated to have doubled over the past 20 years.

[3]An example of the constructed seawall at Pangani Town and the mangrove planting Infront of it was used to demonstrate the value of mangrove for protection of human properties and life. Then the avoided cost of seawall construction and maintenance would ensure that more funds are available for other national priorities, such as health care, education, water supply etc.). A total project cost to construct and protect 1.750 km of seawall was TZS 2.9 billion comprising of TZS 2.8 billion for seawall, plus TZS 20 million for mangrove planting and 60 million for community awareness and capacity building. This translates to approximately TZS 1.5 billion km^{-1} of coastal protection value of mangroves. Of the 1424 km of the coastline length, approximately 1220 km is covered by mangroves, translating to TZS 1.83 trillion per of year.

[4]Price per ton of carbon credits from forestry and land-use projects that reduce emissions or remove carbon from the atmosphere range from US$ 4.33 to US$ 5.60 per credit (**www.ecosystemmarketplace.com**). For mangroves of Tanzania an average of 546.92 Mg C ha^{-1} of total ecosystem carbon stock which is equivalent to 2005.4 Mg C of CO_{2e} ha^{-1} $year^{-1}$ (**Alavaisha and Mangora (2016)**, **Mangora et al. (2016)**, **Lupembe and Munishi (2019)**, **Suleiman (2019)**, **Mangora (unpublished)**. Based on the Global Mangrove Watch estimate of 111,404.26 ha of mangrove cover in Tanzania (**Table 3.4**), the total carbon value would be TZS 2.6 trillion per year. Deduced value is here is vary from that reported from Peninsular Malaysia (**Hong et al. 2017**) and Lamu, Kenya (**Kairo et al 2021**) possibly due to variations in the base pricing and site specificity differences in mangrove types and conditions.

[5]A case of the Vice President's Office, Division of Environment project of mangrove restoration in the Rufiji Delta was used, where about TZS 350 million was spent to facilitate targeted planting on 1000 ha of degraded mangrove area resultant of clearance for rice farming. With the assumption of that mangroves are annually lost at 0,5%, which translates to 557 ha, the total annual coast of restoration would be TZS 255 million per year.

[6]A case of Pete Mangrove Boardwalk in Jozani-Chaka Bay National which is the most active (if not the only one) of all the boardwalk known to exist in Tanzania. The boardwalk has been embedded within the park revenue collection systems. A community representative is stationed to collect the designated percentage allocated to the community. Table 3.12 present a summary of three years collections allocated to the boardwalk, which on average is TZS 229 million. Considering that the Jozani mangrove forest cover that host the boardwalk is 68.9 ha (0.06% of the total mangrove area of the country), it translates to TZS 382.5 billion per year

[6]A conservative exchange rate of USD 1 for TZS 2300.

3.3 BUSINESS CASES IN MANGROVE AREAS

OVERVIEW

Evidence of business cases such as aquaculture (shrimp/prawn farming, mud crab fattening), eco-tourism (boardwalks, bird watching) was tracked as potential businesses that are being talked about and promoted, but least practiced. The same is construed with solar salt pans, which are characteristic in mangrove areas, and on which restoration of abandoned salt pans is often challenging.

3.3.2 SALT PRODUCTION: A CONTROVERSIAL WHITE GOLD INDUSTRY

Sea solar salt production is the major supplier of salt worldwide. While it has for a long time been reported that conversion of mangrove areas into solar salt pans is one of the major threats to mangrove forests and associated ecosystem services they provide (**Wolchok 2006**; **Liingilie et al. 2015**; **Mabula et al. 2017**; **Nehemia and Kochzius 2017**; **Msoka 2018**; **Nehemia et al. 2019**), field visits, observations and discussion with large producers during the present study indicated that there is a potential misconception on the socioecological importance of salt farms in mangrove areas in addition to the long-standing conflicting governance machinery for salt works operations. For example, field consultations in Mtwara revealed that of the socio-economic importance of mangroves appreciated in the region, commercial salt works ranked high, followed by beekeeping for both subsistence and commercial purpose, and aquaculture for commercial purposes.

Salt farming is done behind mangrove forests, on salt flat areas that would otherwise remain barren. Mangroves are also a necessary natural safety barrier to salt pans from strong and rough tides, although actual salt production is not dependent on the presence of mangroves. Expansion of salt farms across the coastline of Tanzania has increased tremendously since 1980s (**Msoka 2018**). Presently there is about 7250 ha of salt pans distributed almost all over the coastline (**Table 3.14**; **Fig 3.2**). Major solar salt pans relative to mangrove areas are in Bagamoyo, Kilwa, Lindi, Mkinga, Mkuranga and Mtwara (**Table 3.14**). The reported impact of such land use change is implied on the disrupted ecological patterns of both the vegetation and faunal communities (**Liingilie et al. 2015**; **Nehemia et al. 2019**). However, satellite imagery analysis (**Fig 3.3)** and field assessment (**Plate 3.15**) conducted during the present study indicated that construction of all large-scale salt pans operated by major salt producers is done behind mangrove areas in the bare salt flats that did not have mangroves before and would not support natural colonization, unless ecologically engineered. This observation was repeatedly echoed by all major salt pan operators across the visited areas. Accordingly, claims that salt pans are constructed at the expense of mangroves are not adequately substantiated (**Fig 3.3**). There are claims as well that restoration of abandoned salt pans is challenging given the changes of the environmental parameters that support mangrove colonization. This proposition is however not justifiable because as stated earlier the areas occupied by salt pans did not have mangroves before (**Fig 3.3**). What should literally have to be done is creating enabling conditions to support colonisation both through natural regeneration and planting. Mangroves can be planted along the dikes and they serve two purposes, one is protection of the salt pans and the other is attracting fish to the farms.

The sea salt production industry through solar salt pans (**Plate 3.16**) represents large business with investments of billions of TZS and supply over 90% of domestic and industrial consumption (**Plate 3.17**). Accordingly, operationalization of these salt pans raises mixed and conflicting perceptions from both the state agencies and operators that need further research studies on empirical implications on mangrove degradation and loss, habitat degradation through modified environments, support to dependent local livelihoods and nature, extent and position of salt pans, governance of the salt production industry, options for the industry to support conservation. State agencies and conservation actors maintain that in many areas salt pan operators tend to violate the conditions given along with the licences, often encroaching into non-licenced areas to illegally expand production areas. Accordingly, prominent issues that deserve further evidence-based studies on the merits and demerits of salt pans include:

- Engaging solar salt pans operators in the conservation of mangroves as they protect salt pans. Conservation practitioners can mediate policy dialogues between salt producers and policy/decision makers on the role that the industry can play to support conservation of mangroves through restoration and community development to incentivize local communities around mangroves areas as intact and healthy mangroves protect and safeguard salt pans.
- Salt pans use largely barren salt flats, that have remained without mangroves and have no indications of getting encroached due to lack of ideal tidal flow regime. Mangroves tend to come after abandonment of salt pans (**Plate 3.18**), conditions of which should be made favourable for afforestation.
- Integrated salt-fish farming with mangrove planting: Opportunities to convert abandoned salt pans into fish ponds (**Sullivan et al. 2007**). Seasonality on salt production provide opportunity to maximize the use of ponds between salt production and fish farming. in addition to the exemplary Siri Fish Farm at Pujini in Pemba (**Box 3.1; Plate 3.19**), this was demonstrated with salt producers in the south in Lindi and Mtwara where salt pans are converted into fish ponds during the rain season which is off season for salt production. The wild stock of fingerlings are allowed and captured into the ponds and farmers start feeding them throughout the rain period, harvesting shortly before the start of dry season ready for salt production. This is done in rudimentary way, but offers great potentials for investment into medium and large-scale fish production if well planned and managed.
- Support of salt pans operations to socio-economic development of neighbouring communities. For example, a rapid metal roof analysis of three villages of Mayomboni in Mkinga, Shungubweni in Mkurunga and Msimbati in Mtwara adjacent to salt pans operations indicated that there has been a significant increase of modern housing (**Fig 3.4**) that warrant a dedicated study to find out whether and how this change is associated with salt production operations.

Changes and/or unpredictability of whether conditions, in particular rain seasons (prolonged and/or shorted and/or out of time) experienced in the present times has become a major challenge to solar salt pans operations as investment and operational plans are significantly disrupted leading to major losses of capital investment. Salt production stops during rain season, when maintenance and repair of salt pans is done. In the northern zone of Mkinga, Tanga and Pangani, major salt production season is in January to April (*kaskazi*) and a minor season is from August to October. In the soutrhern zone of Lindi and Mtwara, the main salt production season is from July to October and sometimes to November, while the off season for salt production runs from December to May, when pond repair is done and some farmers attempt fish farming using the wild sticking of fingerlings.

3.3.3 MARICULTURE

Mariculture is emerging as a potential alternative income generating occupation. However, to a large extent fish farming and mangrove crab fattening in particular is still on pilot studies and local communities have not yet taken up the activities with due momentum. Many of the attempts to engage communities have failed to fulfil community expectations. Guidelines to facilitate establishment, management and development of the industry at different scales have been developed (**TCMP 2001a, b; Mutatina 2012, 2013**) but local investment into mariculture has not yet received adequate force, with many of the initiatives ending up at piloting and demonstration stages mainly due dependence on donor funding and local mismanagement. The Tanzania Coastal Management Partnership (TCMP) programme developed the baseline information, tools and procedures for undertaking mariculture to support livelihoods and local economies, but all these have remained more on paper than practiced. Sustained awareness is necessary to attract local investors into the venture and thereby engaging local communities.

Table 3.14. Mangrove area cover distribution with associated saltpans in Tanzania. Source: Global Mangrove Watch database accessed from www.data.unep-wcmc.org/datasets/45

District	Mangrove area (ha)	Saltpan area (ha)
Bagamoyo	3,424.73	1,253.44
Ilala	8.38	-
Kibiti	40,731.89	364.06
Kigamboni	1,034.02	63.62
Kilwa	23,353.85	980.55
Kinondoni	137.87	86.90
Lindi Rural	2,036.90	188.76
Lindi Urban	1,990.63	672.26
Mafia	2,575.58	79.54
Mkinga	5,656.72	754.50
Mkuranga	5,107.25	1,054.92
Mtwara Rural	8,259.32	800.02
Mtwara Urban	393.19	139.18
Muheza	21.17	-
Pangani	2,060.93	125.62
Pemba	7,615.93	165.93
Rufiji	495.76	12.49
Tanga	2,864.39	386.12
Temeke	246.32	-
Unguja	3,389.49	23.97
TOTAL	111,404.33	7,251.88

Field visits noticed that unlike in the southern regions of Lindi and Mtwara where fish farming is gaining pace, albeit still at small scale, mariculture is not pronounced in mangrove areas of Tanga in the north where many of the few fish ponds are abandoned (**Plate 3.20**). Only one mud crab fattening and fish pond was observed in the mangroves of Pangani River Estuary. Otherwise, artisanal prawn fishery is characteristic in mangrove estuaries of Mkurumuzi, Zigi, Ngole and Pangani rivers.

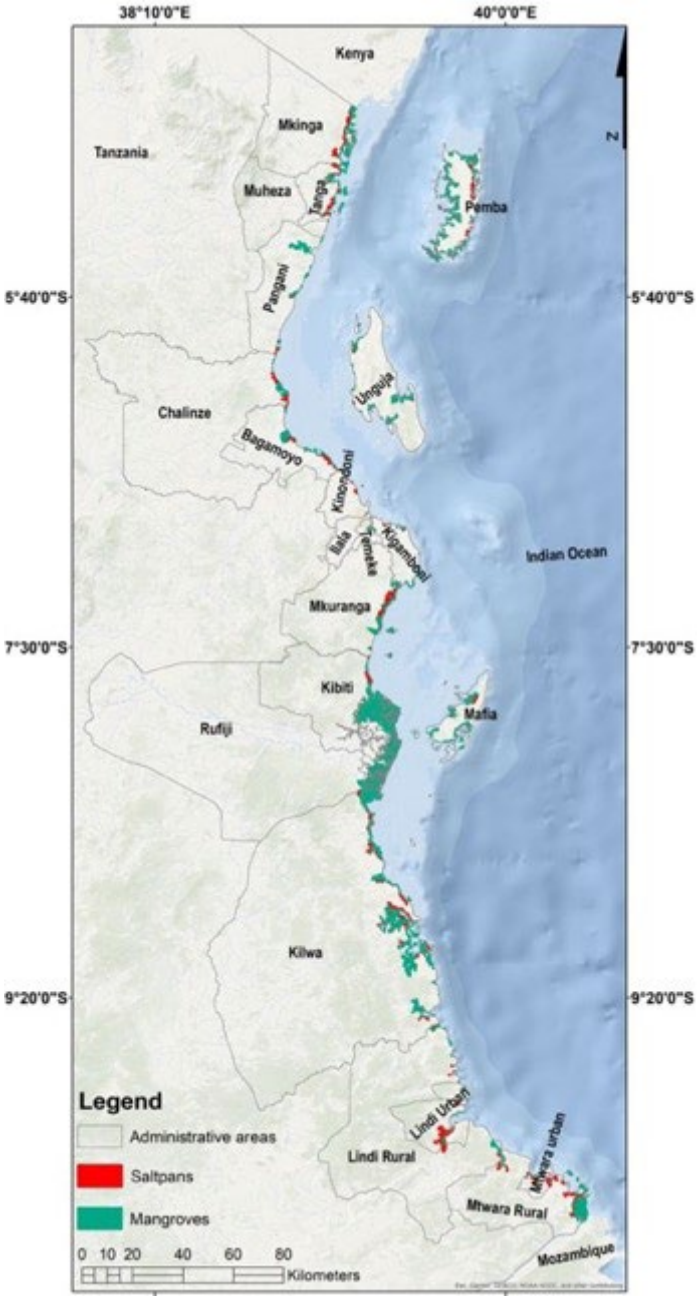


Figure 3.2. Map of coastal area showing location, distribution and coverage of salt pans associated with mangrove areas. Map created by Kelvin Kamnde of the Institute of Marine Sciences

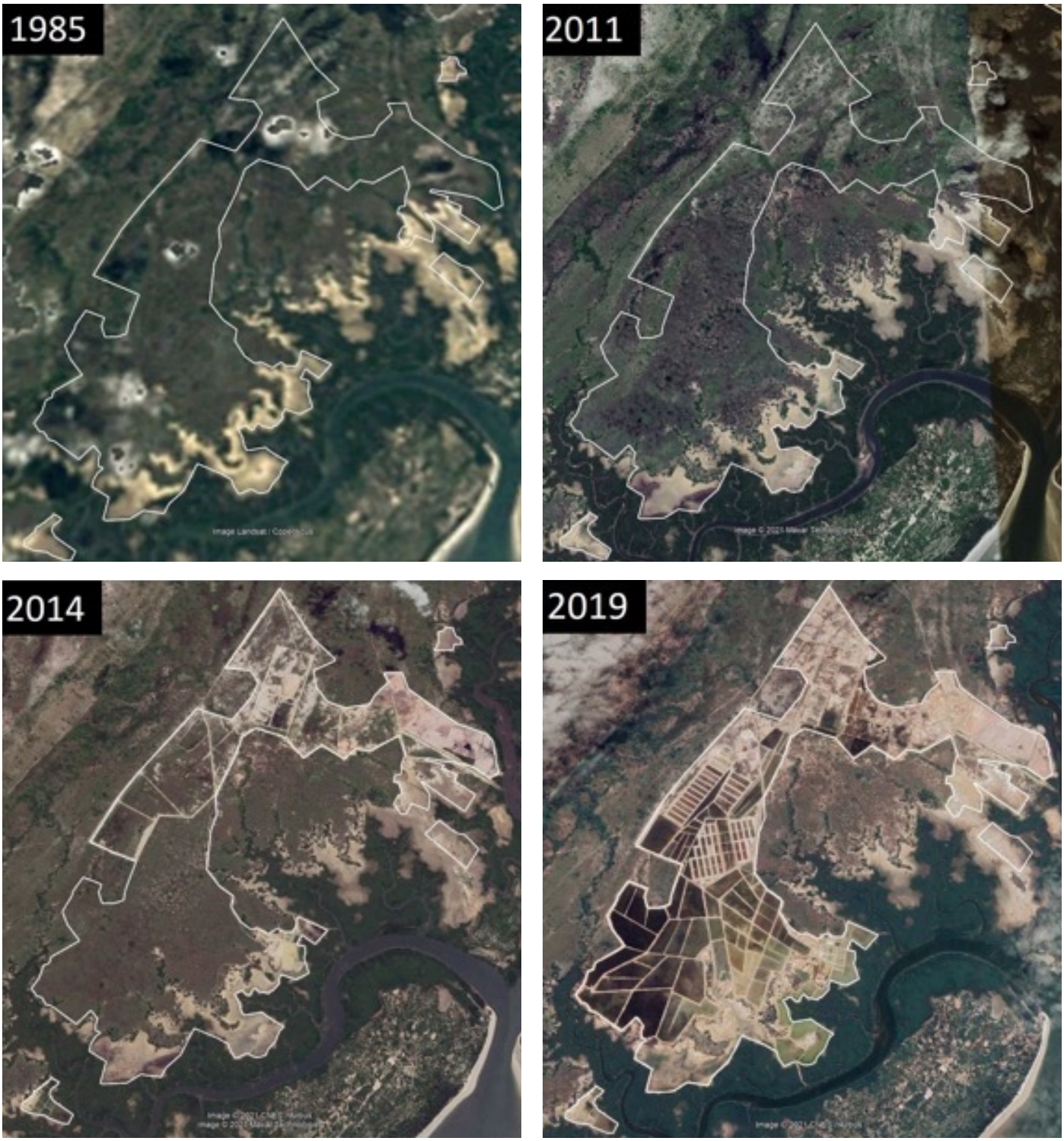


Figure 3.3. Reconstructed development of one of the largest salt pans at Shungubweni, Mkuranga District indicating that there has not been any shift of the mangrove boundary associated with the long-term operations of salt pans. Images downloaded and processed by Kelvin Kamnde of the Institute of Marine Sciences.

Plate 3.15. Salt pans are majorly constructed behind mangrove areas on bare salt flats. Operators claim that this is important because presence of intact mangroves in front of the salt pans ensure safety of the pans at times of rough and strong waves and tides that often break the dikes.

Plate 3.16. Large scale salt pans behind mangroves are spread along the coast of Tanga.

Plate 3.17. Large scale industrial sea salt production at Mahandakini and Mayomboni villages, Tanga for both domestic and export markets.

Plate 3.18. Abandoned salt pan at Ununio, Dar es Salaam, indicating signs of natural colonisation of mangroves, which can be assisted through ecological engineering by breaking of the dikes to allow optimal tidal flow.

Box 3.1. Siri Fish Farm: An integrated fish-salt-beekeeping farm at Pujini, Pemba Island

Siri Fish farm is a family small scale enterprise that started in 2000 run by Mr. Abdallah Salum Issa that integrate fish farming, salt production and beekeeping in the mangroves and adjacent terrestrial forest, realizing both ecological/biodiversity and socio-economic benefits. This is one of the local privately operated examples that can targeted for support to scale up. Siri Fish Farm can be supported to be a demonstration farm. Mr.Abdallah and family started the enterprise without any technical knowledge of fish farming and so it was trial and error until 2011 when he got a government sponsorship for a study tour to China.

The fish ponds are stocked by the wild fingerlings of mixed fish species driven in by the natural high tides. However, Mr. Abdallah indicate that this is an uncertain venture because there is no guarantee of enclosing the preferable stock of fingerlings this way at any time. Uncertain source of fingerlings is a major challenge that is compounded by unstable capital for pond management. There are 10 fish ponds, each with the stocking capacity of 1000 but they can never be sure that the maximum capacity is attained. Mr. Abdallah reported that harvests are between 2 – 3 ton of every six months, selling at TZS 8 – 10 million. There is a very good market. If a reliable source of fingerlings is secured, that would be a production from only one pond, he claimed.

Plate 3.19. Siri Fish Farm at Pujini, Pemba Island practice integrated fish farming, salt production and beekeeping.

Plate 3.20. Example of failed fish ponds at Chongoleani (left) and Machui (right) in Tanga.

3.3.4 ECO-TOURISM

As demonstrated in **section 3.2.2.2.1**, eco-tourism in mangrove areas is a promising enterprise that communities can benefit from for their socio-economic development. It is however challenged by inadequate operation knowhow (**Plate 3.9; 3.21**) and apparently high establishment costs that can seldomly be raised from local sources.

Plate 3.21. Opportunity for ecotourism at Tongoni Ruins in Tanga adjacent to a mangrove forest.

3.3.5 BEEKEEPING

While beekeeping in the mangrove forests is a promising enterprise, it is as well inadequately promoted and technically supported for commercialization. Many of the community groups engaged in beekeeping are of small scale in addition to basic need for knowledge on modern beekeeping including financial management, product marketing (branding and packaging) and technical knowhow of keeping bees. Community groups receive donor supported projects that often live short once the support ceases.

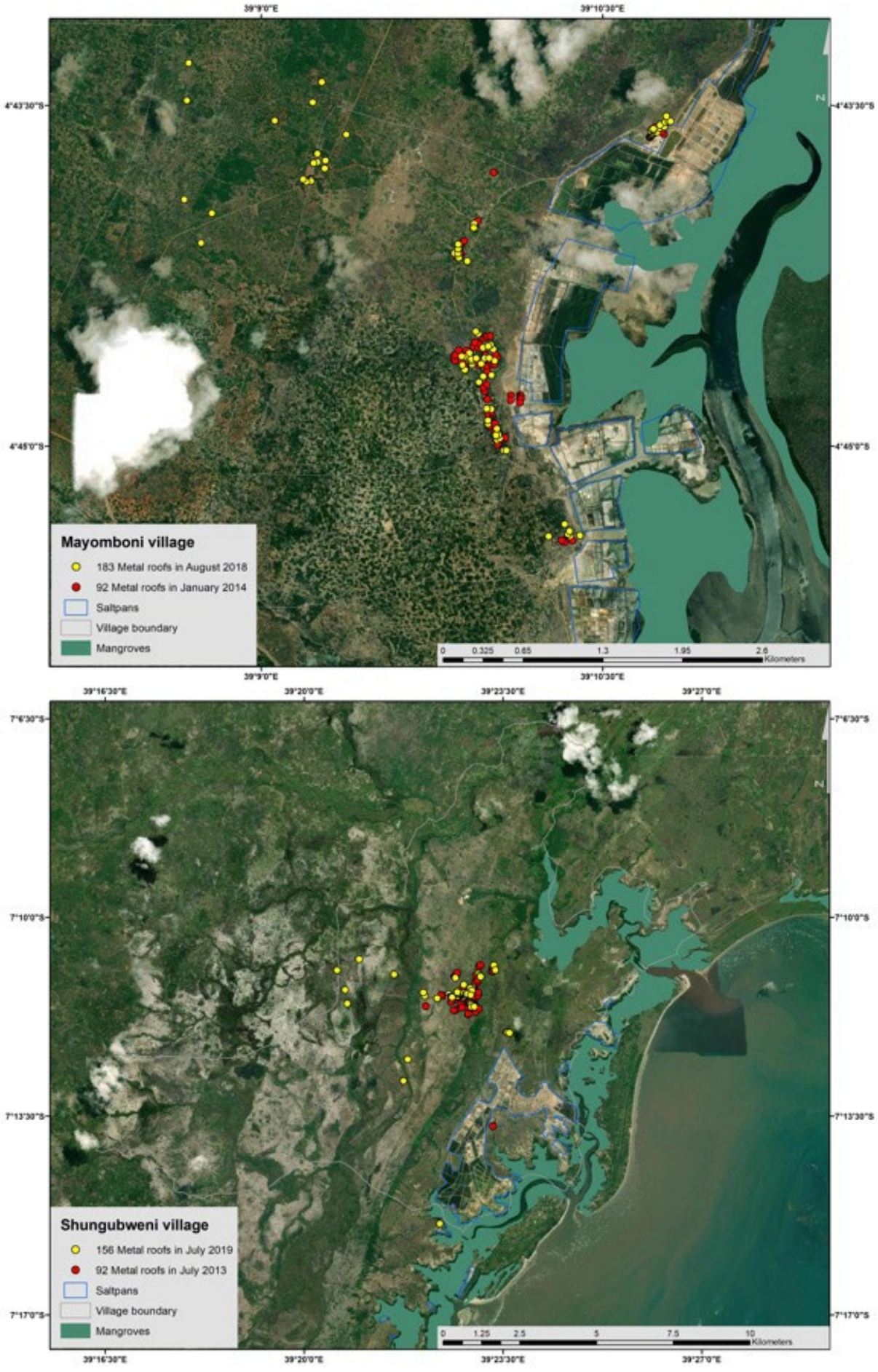


Figure 3.4. Metal roof analysis of Mayomboni village in Mkinga (top) and Shungubweni village in Mkuranga (bottom). Maps created by Kelvin Kamnde of the Institute of Marine Sciences.

Often, many groups like *Jikite kwa Maendeleo Endelevu* in Lindi collapse before they realize the core mission because of impatience (**Plate 3.22**). The field surveys realized however that, the southern zone of Lindi and Mtwara and the Mafia Island are comparatively faring well with beekeeping projects (**Plate 3.22**) than the northern zone (Mkinga, Tanga and Pangani), central zone (Bagamoyo, Dar es Salaam, Mkuranga, and Kibiti (former Rufiji)) and Zanzibar (Pemba and Unguja).

Beekeeping in mangrove areas has multiple advantages:

- Used as natural security to prevent mangrove cutting
- It acts as the alternative activity that generates income
- Helps in pollination/biodiversity maintenance
- Acts as a food and medicine

Plate 3.22. Beekeeping by a community group *Jikite kwa Maendeleo Endelevu* in Lindi is on small scale production, but the group has potential to be elevated with appropriate support particularly on group administration and product marketing.

3.4 CONSERVATION FRAMEWORK FOR MANGROVES

3.4.1 OVERVIEW

Government buy-in is essential as many policies that seek to achieve economic growth, fail to take into account the values of mangroves. To ensure that mangroves are conserved and restored, government agencies at all levels have to recognise them for what they are worth. In addition to the pressures exerted on mangrove to fulfil human demands for livelihoods, many of the problems and causes of mangrove loss in Tanzania are associated with ineffective enforcement of policy and laws (**Kulindwa et al. 2001**; **Mangora 2011**). For instance, although mangrove harvesting was banned for 10 years in all mangrove forests in mainland Tanzania in 1987 (**MNRT 1991**; **von Mitzlaff 1989**) and allow the development of national mangrove management plan (**MNRT 1991**; **Semesi 1992**), illegal cutting continued unabated during and after the ban, which triggered for another ban in September 2016 (**Mshale et al. 2017**), which again continued to witness illegal harvesting as usual (**Plate 3.23**). The natural phenomena such as sea level rise, flooding and increased sedimentation are also reported to transform and compound mangrove degradation (**Erftemeijer and Hamerlynck 2005**; **Punwong et al. 2013a**).

Plate 3.23. A boat full of illegally harvested mangrove poles in Rufiji Delta destined to Zanzibar despite the imposed ban.

3.4.2 THREATS TO MANGROVES: DRIVERS AND PRESSURES OF CHANGE

3.4.2.1 Anthropogenic threats

Common human-induced threats to mangrove forest degradation are related to utilization and include uncontrolled harvesting for firewood, charcoal-making, building poles, boat making and illegal commercial logging for timber (**Plate 3.3; 3.5; 3.6; 3.7; 3.23; 3.24**). Conversion of mangrove areas for other uses is another driving force behind mangrove forest degradation. A majorly cited example of illicit conversion of mangrove forests is in the Rufiji Delta for rice farming (**Kajia 2000**; **Nindi et al. 2014**; **Monga et al. 2018; Plate 3.25**). However, unlike agriculture, considering conversions of mangrove areas to mariculture ponds and solar salt pans as threats to mangroves is controversial (**Section 3.3**). Peri-urban mangroves in major cities like Dar es Salaam, Tanga and Zanzibar are suffering from coastal squeezing for settlement, property and infrastructure development (**Wang et al. 2003**; **Mabula et al. 2017**; **Plate 3.26**), and pollution including municipal sewage, and garbage dumping (**Plate 3.27**). Two main types of chemical pollutants are commonly reported in the mangroves; heavy metals and agro-chemicals (**Wolf et al., 2001**; **Kruitwagen et al., 2008**; **Rumisha et al., 2016**). Nonetheless, there are no records of evident death of mangrove trees directly associated with heavy metal pollution in Tanzania. Some pilot studies have indicated that mangroves can serve as biofilters of sewage (**Penha-Lopes 2009; Kondo et al. 2013; Nyomora and Njau 2013**). A recent report by **Lugendo and Kimirei (2021)**, indicate high capacity of mangroves to hold and withstand high level of nitrogen pollution, demonstrating the role of mangroves as natural solution to anthropogenic pollution, safeguarding the nearshore waters particularly for recreation and fisheries.

Persistent poverty coupled by population increase in coastal communities are root causes of the pressures (**Masanja, 2004**; **Sigalla, 2014**). About 25% of the population in the country live within 100 km of the coast. Coastal regions of mainland Tanzania and Zanzibar (Unguja and Pemba), including Tanga, Dar es Salaam, Pwani (Coast), Lindi and Mtwara are experiencing rapid population growth (**Madulu, 2003**; **NBS, 2013**; **Table 3.5**). This rapid increase in population,

Plate 3.24. Charcoal making area from the mangroves at Ukongoroni Village around Chwaka-Bay, Zanzibar.

Plate 3.25. Rice farming in Rufiji Delta at the expense of mangrove forest.

Plate 3.26. Aerial view of Zanzibar City showing coastal squeezing that expose the Maruhubi mangrove forest (in red box) to succumb to pressures from both land and sea. Settlement, property and infrastructure development continues unabated because apparently while the mangrove stand is protected, it occurs on unprotected land.

Plate 3.27. Dumping of solid wastes and sewage in the mangrove areas is characteristic in urban/peri-urban areas, like this one at Maruhubi, Zanzibar.

particularly in urban centres increases pressure to coastal ecosystems including mangroves due to increased demand for land for settlement, food and natural capital (**Mabula et al. 2017**). **Mangora (2011)** provides a detailed discussion on the poverty-environment nexus, demonstrating particularly that poverty poses a dilemma for sustainable utilization and conservation of mangroves in Tanzania. **Masanja (2004)** reported that most of the coastal communities are poor and depend mainly on the modest income obtained from the natural capital, citing a specific example of the ordinary fisherman in Rufiji who hardly earns US$ 160 per year. **Sigalla (2014)** estimated that an average rural coastal household earn and spend less than US$ 1 a day. This high level of poverty of the coastal communities drives demand for cheap resources such as mangroves for survival.

3.4.2.2 Natural threats

There are few reports of mangrove degradation associated with natural causes in Tanzania. Sea level rise is one of the most reported natural threats to mangroves caused by changing climate. According to **Mwaipopo (2000)**, about 1025 ha of mangroves in

Tanga were vulnerable to 0.5m of sea-level rise. In the Rufiji Delta, **Wagner and Sallema-Mtui (2016)** and **Ellison (2015)** reported that the mangroves therein are vulnerable to climate change, particularly sea level. Record of the Holocene mangrove dynamics and sea level changes by **Punwong (2013b)** indicated changes in species composition and retreating and advancing as response to sea level change at sampled areas of Rufiji Delta (**Punwong et al. 2013a**), Unguja Ukuu (**Punwong et al. 2013c**) and Makoba Bay (**Punwong et al. 2013d**). The impact of floods to mangroves has also been observed in areas where they occur. During the El Niño Southern Oscillation Event of 1997–98, heavy rains caused extensive floods, which resulted into extensive death of mangroves especially in the northern Rufiji Delta (**Erftemeijer and Hamerlynck, 2005**).

Mangrove die-back with indications of pathogenic attacks were personally observed at some specific sites (**Plate 3.28**) in Tanga at Zigi River Estuary and Unguja at Kibele Village and Chwaka Bay within Jozani-Chwaka-Bay National Park. Of particular concern with this observation is the nature of die-back of one species only, *Rhizophora mucronata*. This is of both socio-economic and conservation concern requiring specific assessment to identify measures to respond to the problem. Pest infestation and desiccation was also reported in Micheweni and Muwambe on Pemba, but details of which was not explored (**DCCFF 2009a**). **Diop et al. (2002)** also reported on a general observation of *S. alba* dieback associated with stem boring caterpillar *Salagena discada* in some mangroves of Tanzania, without further details.

Plate 3.28. Inspecting die-back of the mangrove *Rhizophora mucronata* in Zigi Estuary, Tanga.

3.4.2.3 Governance threats

Inadequate development policies oriented towards economic growth and which do not sufficiently address the subsistence needs of local people put pressure to the mangroves. For instance, in Bagamoyo District, growth of tourism activities is compounding pressure to mangroves by opening mangrove areas for construction of hotels and opening of beaches (**Okoth, 2015**). Institutional incapacity in terms of personnel and equipment to enforce protection regulations is characteristic. Of particular concern is the fact that unlike other forests formations, mangrove forests require additional skills and passion to work in such remote and difficult environment connecting both terrestrial and aquatic habitats. There is also widespread non-compliance to regulations governing mangrove exploitation, the is implicated in the persistent illegal harvesting of mangrove products (**Mangora 2011**; **Mshale et al. 2017**; **Nyangoko et al. 2021**).

3.4.2.4 Impacts of threats

There are disputed claims that salt making activities create wastelands because of the changes in soil chemical properties which make restoration of abandoned salt pans difficult. Sea level rise, flooding and erosion are also cited to cause loss of coastal habitats (**Ngusaru et al., 2001**; **Erftemeijer and Hamerlynck, 2005**; **Wagner and Sallema-Mtui, 2016**). Such degradation, deforestation and loss of mangroves affect the potential of mangroves in providing important goods and services such as directly wood products as sources of biomass fuel (**Liingilie et al. 2015**), support to fisheries (**Mwandya et al. 2009**), that leads to persistent of rural poverty (**Mangora 2011**). The loss of mangroves turn the areas from being carbon sinks to sources **(Sasmito et al. 2016**).

3.4.3 MANGROVE CONSERVATION OPPORTUNITIES AND CHALLENGES IN TANZANIA

3.4.3.1 Designation of mangroves as state forest reserves

In Tanzania, commercial cutting of mangroves for export dates back to the 1890's, when mangrove

products were major export commodities to Arab countries (**Villiers 1948**; **Curtin 1981**). As a result, formal management of mangrove forests was instituted in the then Tanganyika in 1893 and officially gazetted as forest reserves, first in Rufiji Delta between 1928 and 1932 through a declaration in a Government Notice No. 132 and later included in the Tanganyika Forestry Laws and Rules Handbook of 1947 (**Holmes 1995**; **Sunseri 2005; Table 3.15**). Two years after independence, the then Tanganyika (Tanzania mainland) formulated a forest policy in 1963 but continued to follow the colonial Forests Ordinance, Chapter 389 of 1957 that had maintained the recognition of mangroves as forest reserves (**Holmes 1995**). In 1998 the new National Forest Policy was formulated to replace the previous policy of 1963. Based on this new policy, the current Forest Act No. 14 of 2002 was enacted to repeal the Forests Ordinance of 1957, but maintained the status of mangroves as forest reserves in Tanzania mainland (**Table 3.15; Table 3.16**).

In Zanzibar, the forestry legislation was earlier covered under the Wood Cutting Decree of 1945 (Government Notice No. 18 of 1945). A subsidiary legislation in 1946 (Government Notice No. 99 of 1946) specifically provided for the protection and control of mangroves forests and in 1968 it was amended to list mangroves as reserves. The first mangrove working scheme (with two working cycles of Zanzibar and Pemba), placing the full mandate to the then Zanzibar Protectorate to the colonial government was developed in 1950 (**Griffith 1950**) with a primary focus on maintaining the interests of the colonial markets for the mangrove bark and poles. The Forest Resources Management and Conservation Act No. 10 of 1996 repealed the 1945 decree, but retained mangroves as reserved forests. The National Forest Policy was developed in 1999 to take into account the multiple uses and functions of forests on the islands (**DCCFF 2008; Table 3.16**). The legal categorization of mangroves as protected forests, is nevertheless inconsistent and inexplicit in situations where some mangrove stands occurs in unprotected lands, such as that of Maruhubi-Kinazini, which perception of misplaced forests by other sectoral actors (**Plate 3.26**).

Despite these protectionist policies and regulatory mechanisms, protection of mangrove forests has in overall achieved limited success, with prevalent frictions between people and the state (**Beymer-Farris and Basset 2012**), prompting the need of new management strategies. Desperate rural poor continue to exert pressures on mangroves in search for a living at the expense of mangrove forests, demonstrating a policy failure, weak or dysfunctional state institutions compounded by little participatory awareness and self-commitment of a multitude of stakeholders and actors (**Mangora 2011**; **EcoAfrica Environmental Consultants 2012a, 2012b**; **Mshale et al. 2017**; **Slobodian and Badoz 2019**), which warrant a re-assessment for other best conservation options. For example, there are questions on the policy and legal merit of imposing a total ban of harvesting of mangrove resources based on the misinformed assumptions that local communities are the main culprits responsible for the degradation and loss of mangroves. On the mainland Tanzania, a 10-year state ban was imposed in September 1987 (**MNRT, 1991**) and the re-imposed in September 2016 on mangrove harvesting did not bring significant difference. Similar to the report by **von Mitzlaff (1989)**, arguments on the operational effectiveness of these bans are around the persistent inadequate capacity of the responsible state agencies to enforce the bans and other related regulation that govern exploitation of forest resources (**Mangora 2011**). On the other hand, communities who depend on mangroves. In Rufiji Delta for example, who demonstrate that their livelihoods cannot be dissociated from mangroves, are outcrying that they are suffering at the benefit of elite mangrove traders who have continued with illegal harvesting, taking advantage of the inadequacy of surveillance by the responsible state agency. Based on this lens, the bans seem to have created more tension between the state and the people, than contributing to actual protection. This calls for rethinking for an inclusive conservation framework (**Slobodian and Badoz 2019)**.

3.4.3.2 Institutional, policy and legal instruments

As indicated above there are two parallel institutional and legal frameworks that oversee management of forest resources, one for the Tanzania mainland and the other for Zanzibar (Unguja and Pemba) (**Table 3.16**). In Tanzania mainland, Tanzania Forest Service (TFS) serves as a state agency that oversees the management of forest resources whereas the Forestry and Beekeeping Division (FBD) in the Ministry of Natural Resource and Tourism is charged with policy and legislative formulations for the forest sector. The principal policy and legal framework for the Tanzania

mainland forest sector encompasses: The National Forestry Policy of 1998 and Forest Act No. 14 of 2002. These frameworks categorize mangrove forests as state forest reserves. However, the management regulations are weakly enforced, resulting into irrational exploitation (**Semesi 1992**; **Mangora 2011**).

Table 3.15. Evolution of mangrove management and conservation measures for mainland Tanzania

Year	Mangrove Management Initiative
1898	Control of mangrove produce trade to Gulf states
1928	Gazettment of Rufiji Delta mangroves as reserves GN 132 pg 1350
1947	The law on mangrove forest reserves was Published in Tanganyika Forestry Laws and Rules Handbook).
1957	Scaling up of Mangrove Reserves law to all mangroves in Tanzania Mainland in the Forest Ordinance CAP 389
2002	Protection of Mangroves by the new Act No.14 of 2002 CAP 323
1987	Government Ban of Mangrove Forest Exploitation due to mismanagement of mangroves-FBD(LGA-CG)
1989	Inventory of mangroves prior to establishment of Mangrove Management on special project basis-FBD/ NORAD
1991	Inception of Mangrove Management Plan (need to be revised)
1991-2006	NORAD funded Mangrove Management Project
2006-2011	Management of mangroves solely by FBD
2011-2016	Centralization of Mangroves Management under TFS Zonal management
2017 to date	Decentralization of Mangroves Management under special regional administrative zone

In Zanzibar, the forest sector is under the Department of Forest Development (DFD) formerly Department of Forest and Non-Renewable Natural Resources (DFNRNR). The main policy and legal framework for the forest sector is the National Forest Policy for Zanzibar of 1999, and the Forest Resources Management and Conservation Act of 1996. Other important frameworks in management of mangrove forests in Zanzibar are indicated in **Table 3.16**.

This review is in agreement with **Mshale et al. (2017)** that Tanzania's policy and legal framework provides an architecture that is generally supportive of forest governance principles in general, but, there is a substantial implementation gap when it comes to the specific nature of mangroves. The assumption is that implementation in mangrove forests lags behind terrestrial forests due to their unique challenges, often neglected by responsible authorities for reasons of limited resources and capacity.

Table 3.16. Main policy and legal frameworks applicable in management of mangrove forests in Tanzania.

Part	Sector	Policy/Legal Framework
Mainland Tanzania	Forestry	National Forestry Policy of 1998 Forest Act No 14 of 2002
	Beekeeping	National Beekeeping Policy of 1998 Beekeeping Act No 15 of 2002
	Environment	National Environmental Policy of 1997 Environmental Management Act No. 20 of 2004 National Integrated Coastal Environmental Management Strategy of 2003
	Land	National Land Policy of 1997 Land Act No. 4 of 1999 Village Land Act No. 5 of 1999 Land Use Planning Act No. 6 of 2007
	Marine Protected Areas	Marine Parks and Reserves Act No. 29 of 1994
	Fisheries	National Fisheries Sector Policy and Strategy Statement of 1997 Fisheries Act No. 22 of 2003
	Mining	Mining Act of 2010
Zanzibar	Forestry	National Forest Policy for Zanzibar of 1999 Forest Resources Management and Conservation Act No 10 of 1996
	Environment	Zanzibar Environmental Policy of 2013 Zanzibar Environmental Management Act of 2015
	Land	Land Tenure Act No. 12 of 1992
	Fisheries and Marine Conservation Areas	Fisheries Policy of 2014 Fisheries Act No. 7 of 2010

3.4.3.3 Multiple institutions and sectoral complexity

As already indicated in **Table 3.16**, there are multiple institutions variously mandated to ensuring sustainable management of the natural resources associated with mangroves, which has created a maze of overlapping, uncoordinated, fragmented and vague responsibilities that deliver little protection on the ground (**Fig 3.5**) due to enforcement of inconsistent practices of governing mangrove forests and their ecosystem services. Due to the diverse objectives, goals, interests, priorities and enforcement mechanisms of the different sectoral organs such as forestry, fisheries, agriculture, wildlife, land, tourism, investment, settlement and mining, they tend to be limited in their coverage and scope to sufficiently and comprehensively address mangrove conservation issues that is also complicated by the multiple ecosystem services that they provide (**section 3.2.2**) and threats they face (**section 3.4.2**). This policy and legal disintegration compounds to the socio-economic misperception on the critical role of mangroves and further expose them to irresponsible exploitation, which has warranted a repeated call for a nationally harmonized policy and legal framework for mangrove conservation in order to reconcile the duplications and conflicts of interest to ensure that sound and sustainable measures are put in place to secure the future of mangroves.

Given the multidisciplinary nature of the mangrove ecosystems (**Fig 3.5**), several other sector policy and legal frameworks that have a role to play in protecting the mangrove forest ecosystems exist (**Table 3.16**). These include, for the mainland Tanzania, Environment Management Act No. 20 of 2004, Land Act 4 of 1999, Wildlife Management Act No. 12 of 1974, Fisheries Act No. 22 of 2003, Marine Parks and Reserves Act No. 29 of 1994, Local Authorities Act No. 7 of 1982, Land Use Act No. 6 of 2007 and Water Resources Act No.11 of 2009. For Zanzibar, other sector policies and acts that affect mangroves include those of the Environment, Fisheries and Marine

Conservation Areas (**Table 3.16**). While all these were set with good intentions of maximizing the protection of the resources, such multiplicity of policy, legal and institutional actors have instead resulted in complex and incoherent relationships that has often exposed mangroves to irresponsible exploitation.

Accordingly, there remains a major confusion in the notion of governance of mangrove forests among the stakeholders because the interrelationships of the socio-economic-political features that form sectoral organizations and institutions mandated with governing mangrove forests and their resources remain ambiguous and complex. Mechanisms to reinforce the relationships of the players or actors who have interests in the domain of mangrove forests and associated ecosystems (**Fig 3.5**) is yet to be fully understood and appreciated. For example, while majority of local communities living adjacent to mangroves areas in Tanzania have a positive attitude towards conservation of mangrove forest resources, they consider the existing policy and legal frameworks, that provide exclusive rights to the state, as a deprivation of their traditional rights to access and exploit the resource to secure their livelihoods (**Mshale et al. 2017**). It is therefore pertinent that in order to obtain the necessary support for the governance of the mangrove forests, the local communities must believe or perceive that there is a synergy between conservation and usage of the mangrove resources to support their livelihoods. The support can only be achieved if there is recognition that the objectives of governance of mangrove forests is to achieve the multiple goals of conservation of the ecosystem without neglecting local interests and priorities. While consideration for a harmonized policy and legal framework to govern mangrove ecosystems is of urgency, it is clear that this proposition may still take long time before sound decisions are made. Since mangroves are demonstratively multi-sectoral resource, the need to create and establish an appropriate institutional arrangement through a unified legal framework can be transitioned through local authorities, the level at which enforcement can easily be coordinated.

The complexity is compounded by the fact that mangrove boundaries are inconsistent as defined by the tidal range. This is problematic for other resource users adjacent to mangrove forests, who have repeatedly proposed a revision of this legal definition.

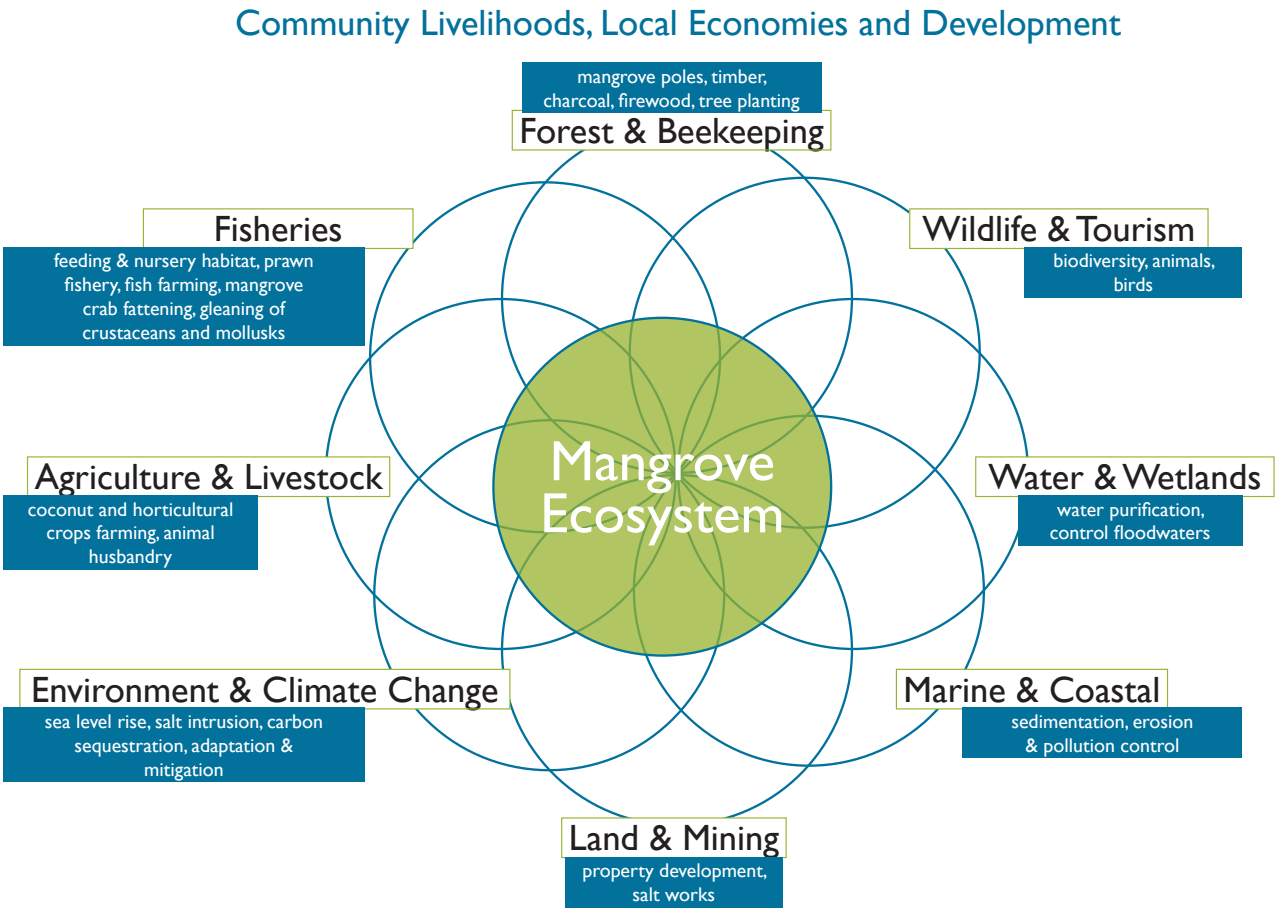


Figure 3.5. Sectoral institutional complexity for mangrove ecosystem and ecosystem services management and conservation.

Where one ecosystem and resource represent a diverse of sectors and so is governed by different specific policies, which are overseen by different government departments, overlap and inconsistencies arise (**Materu et al. 2018**), which is the case that have led to the dilemma in mangrove conservation in Tanzania (**Mangora 2011**). Conflicts exist between TFS and the Marine Parks and Reserves Management Unit (MPRU) on the management rights of mangrove forests that fall in marine protected areas, where exercising of the jurisdictional mandates occur without appropriate consultation with the principal forest resources management agency. Mechanisms for inter-sectoral and hierarchical discussions on issues of mutual interest concerning management of mangrove forests have not been efficient enough to avoid sectoral conflicts of interest (**Mangora 2011**). Field consultations with TFS, District and other authorities, agencies and programmes such as MPAs and Resident Mines Officers testified that sectoral conflicts have continued to be a major factor over the jurisdictional mandates on mangrove forests. A specific concern was cited by TFS officers that the removal of the TFS fee salt farms has escalated the institutional inferiority complex because salt farm investors are implicitly not the directives from TFS on issues of sustainable management of mangroves, because they have nothing to solicit from TFS. This is contrary to the reports from Tanga where it was indicated that salt farm operators have to secure a permit from TFS upon payment of a prescribed royalty before a production licence is issued. And that every bag of salt produced and sold is charge a fee of TZS 200 by the responsible District Council. While the legal mandate is entrusted to TFS, the forests cannot be dissociated with fisheries, MPAs, mining etc. in the context of an ecosystem and the multiple ecosystem services they provide.

3.4.3.4 Practicing mangrove management and conservation

3.4.3.4.1 Management plans

Tanzania was the first African country to carry out a detailed mangrove inventory, conduct socio-economic surveys of users and prepare a comprehensive management plan out of the two studies for the conservation and development of its mangroves in 1991 (**MNRT 1991**; **von Mitzlaff 1989; Semesi 1992**). The management plan categorized mangroves into four utilization management zones: Zone I is delineated for mangroves under total protection, Zone II for production mangroves, Zone III for mangroves under recovery and Zone IV for mangroves utilized for development activities (**Table 3.1**). implementation of the management plan was done through the 10-year donor funded Mangrove Management Project (MMP), which upon closure, more or less business as usual resumed (**Mangora 2011**; **Mshale et al. 2017**). The management plan actually served as the only policy and legal instrument on mangroves in the country. Although **Mshale et al. (2017)** suggests that there may not be such a burning need for laws and policies specific to mangroves, the outdated management plan calls for its revision designation of specific body to oversee its implementation due to the uniqueness of mangroves and the ecosystem services they provide. In response to this, TFS has embarked on redrawing the management plan, albeit in peace meals starting with Rufiji Delta and Kilwa mangrove blocks, the plans of which are ready. Drafting of the management plan for the Tanga mangrove block is underway.

3.4.3.4.2 Participatory forest management

From the perspective of costs, benefits, and incentives, the Participatory Forest Management (PFM) guidelines provide for two broad mechanisms through which people living in and around forests can directly benefit from forest management. These are Joint Forest Management (JFM) applicable to state owned forests including mangroves (**MNRT 2013**) and Community Based Forest Management (CBFM) applicable to non-state forests on community lands (**MNRT 2007**). Under the JFM approach, mangrove forest ownership rights remain with the state and the state enters into agreements with adjacent communities for managing and using mangrove forests, sharing the costs and benefits. While this contractual based approach could have served as the best practice to ensure sustainable community engagement in mangrove conservation, it has never been realized, with only a few known failed attempts (**Nurse and Kabamba 2000**; **Mshale et al. 2017**). Typical examples of community-based initiatives in mangrove conservation are that of Kisakasaka in Zanzibar (**Saunders et al. 2008**) and Kipumbwi-Sange in Pangani, Tanga (**Nurse and Kabamba 2000**; **Wells et al. 2010**) where communities were facilitated to establish specified management areas and local institutions for planning, decision making and enforcement

to govern participatory management of the mangroves. A major challenge facing the implementation of JFM in productive forests such as mangroves, is the state reluctance in instituting and adhering to the contractual benefit sharing mechanisms with communities that enter into agreements with. Unclear benefit sharing modalities, tenure and user rights, decision-making powers, sectoral segmentation and political interferences are major challenges (**Blomley and Iddi 2009**). It is high time that the provision for JFM be revisited to enable it realization. Lessons from other countries for workable models of community engagement can be taken advantage of. For instance, in Ecuador (**Rodriguez 2018**), concession models were communities granted rights to use mangrove forests for collection of seashells and crabs produced positive results in mangrove conservation, despite anthropogenic pressure from shrimp farming industry. Granting leases is one way of giving such an assurance, but another might be the formal recognition of customary communal user rights. The granting of tenure doesn't mean the withdrawal of the responsible state agency (TFS) from regulatory activities to protect the forest. There are currently tacit exemptions in the use of mangroves. For example, recognition that local villagers have traditional rights to use mangrove forests in a sustainable manner, but this is not well elaborated and do not amount to the requirements for JFM. In Zanzibar, new attempts are being practiced through establishment of Community Forest Management Agreements (CoFMAs), but which still do not contract communities with the full mandate to manage the exploitation and benefits accrued. This is complicated by the situation earlier described, that while mangroves forests are by law recognized as state reserves, there are some mangrove stands that occur outside protected areas and therefore on unprotected land, but still communities have no right to own such forests. Accordingly, it is suggested that there is a need to recheck the system and formula for revenue distribution between CoFMAs, government and villagers. It is recommended to let villages which usually bear more costs of conservation to significantly benefit from such efforts.

3.4.3.4.3 Restoration: what, when, where and how

The national mangrove management plan (**MNRT 1991**; **Semesi 1992)** set up the stage for sustainable mangrove conservation including rehabilitation of degraded areas. A number of initiatives towards mangrove restoration over the last three and half decades have been implemented as mechanisms to compensate degradation and losses discussed in **section 3.4.2**, but the impact cannot be adequately substantiated nor traced. Examples of the known major coastal and marine conservation programmes, which included components that attempted to address the problem of mangrove degradation and loss through various restoration campaigns include Rufiji Environmental Management Project (REMP) (**UNDP 2012**), Kinondoni Integrated Coastal Area Management Project (KICAMP) in Dar es Salaam (**Wagner 2007**; **Muhando et al. 2009**), Tanga Coastal Zone Conservation and Development Project (TCZCD) (**Wells et al. 2007**), Marine and Coastal Environment Conservation Project (MACEMP) (**Ruitenbeek et al. 2005**; **World Bank 2013)**. Wetlands International is current implementing its Mangrove Capital Africa which include a mangrove restoration component and is expected to reverse the bad experiences observed and reported from the delta. Other localized initiatives supported by government institutions and conservation NGOs and community-based organizations have been implemented in different places.

There are many failures reported and mixed reasons are given to explain most of the failures (**Table 3.17**), which are mainly related to complexities and inadequacies in institutions, enforcement measures, community awareness and/or lack of proper technical guidance including monitoring and evaluation (**Mangora 2011**; **Ngongolo et al. 2015**). Inadequate knowledge and technical guidance on the proper steps to ensure success is also a limitation. Poorly defined desired goal and objectives for mangrove restoration limit prospective adaptive management for the better future of mangroves (**Ngongolo et al. 2015**). Mangrove restoration has multiple goals that may include silviculture, forest products and sustainable utilization, coastal protection, ecosystem preservation and function, support to fisheries etc. However, these are often not well analyzed and explicitly understood from the inception stage, largely contributing to difficulties in evaluating the performance and outcomes of many restoration projects, which is necessary to be able to develop adaptive management for the better future of mangroves.

Major stakeholders and actors of mangrove restoration and conservation initiatives implemented in the past, present and/or planned for implementation include a mixture of state, non-state (local

and international NGOs and community-based organizations. International conservation NGOs have tended to seek collaboration with local NGOs (particularly WWF, IUCN and most recently Wetlands International), CBOs and government authorities. Major source of funds for these initiatives are international environmental and financial institutions and agencies including the World Bank, UN Environment, USAID, NORAD, DfID etc. In many cases though, such initiatives have been short-termed, often of 2 to 5 years period. Reports from the field consultations indicated many of the projects in addition to being short-termed, lasting 2-5 years, they are largely small scale covering a few hectares in many places (**Table 3.18**). Tanga, Rufiji and Zanzibar (Unguja and Pemba) have long experience of restoration activities, but Zanzibar has comparatively some success. In many places, it was easy and simple to report that so many acres/hectares were planted. But, when asked what has then happened after planting, a credible answer could hardly be secured, two, three and rarely five years later the business as usual would be a common phenomenon. Resolving the tenure (access and user rights) uncertainty would most likely secure and sustain the restoration initiatives. There are bad experiences in Rufiji Delta where planted mangroves are uprooted for planting rice, simply because communities claim that their future is not guaranteed if they support restoration.

Table 3.17. Summary factors of success and failure of mangrove restoration in Tanzania.

Factors of Success	Factors of Failure
• Adequate community involvement, awareness and willingness, supplemented with support for acceptable income generating activities. • Choice of appropriate species for right sites (soil type, salinity, hydrology) • Regular expert support visits and enforcement of "no encroachment" • Regular monitoring • Strong engagement and collaboration among local institutions – CBO/NGO and local institutions • Increased community awareness and commitment	• Project based, short-termed, time barred • Donor funded projects, often inadequately addressing interests and needs of local communities • Inadequate planning, community awareness and engagement and prioritization • Ambiguous tenure rights over ownership, access and user rights on forest resources, exacerbated by tacit recognition of community-based arrangements in conservation of mangrove forest • Inadequate knowledge and guidance on restoration measures, leading to poor site selection and species-site matching – high wave energy coastal fronts, salinity stress, hard pan substrate, poor tide pattern • Encroachment, irresponsible harvesting, animal and crab foraging • Misunderstanding of local institutions and communities • Little collaboration between sector institutions – forestry, fisheries and tourism to enhance integrated fish farming and eco-tourism in mangrove areas

Table 3.18. Average sizes, years of active restoration and survival rates for different areas in Tanzania

Area	Average Size of Restoration Sites (ha)	Average Survival Rate of Restored Sites (%)
Tanga	2	40
Bagamoyo-Dar es Salaam	2	20
Rufiji	20	30
Mafia	2	30
Kilwa	2	60
Lndi	1	60
Mtwara	8	50
Unguja	10	70
Pemba	23	60

3.4.3.4.4 Marine Protected Areas

Establishment of Marine Protected Areas is another effort by the government to conserve marine and coastal environment with high biological values. The establishment of Marine Protected Areas improves protection of mangroves in areas where mangroves form part of such protected areas. Marine Parks with mangroves within their boundaries include: Mafia Island Marine Park (MIMP), Mnazi Bay Ruvuma Estuary Marine Park (MBREMP) and Tanga Coelacanth Marine Park (TACMP. There are also Marine Reserves with mangroves within their boundaries, these include: Dar es Salaam Marine Reserve System, Tanga Marine Reserve System and Mafia Island Marine Reserve System. Strengthening collaboration with other state and non-state actors, ideally through the National Integrated Coastal Environment Management Strategy (NICEMS) (**URT 200**3) that is elaborated below is necessary to ensure sustainability of mangroves and their ecosystem services. This is however not been effectively undertaken.

3.4.3.4.5 Integrated coastal zone management

The National Integrated Coastal Environment Management Strategy (NICEMS) of 2003 (**URT 2003**) offers opportunities to resolve the sectoral institutional, policy and legal dilemma, but often it has been made a reference than being put in practice. This is demonstrated by the persistently observed and reported inconsistencies and uncoordinated decisions and planning for marine and coastal resources as many of the respondent officers revealed.

Recognizing the uniqueness of the coastal zone where land meets the sea and where mangroves are predominant, attracting a multiplicity of human activities and therefore multiplicity of sectoral policies including land, fisheries, forestry, water, minerals, agriculture, wildlife and tourism, industry, transport, energy and human settlement, calls for a coordinated platform for these sectors to make and implement "integrated" conservation and resource utilization measures. NICEMS clearly states that for a balance between development, conservation and utilization of coastal and marine resources; dependent communities and conservation stakeholder practitioners must be aware, respect, value and be responsible at all levels. For this, sectoral participation and involvement should remain central to effective coastal environment management. NICEMS calls for cross-sector planning and action through mainstreaming coastal environmental concerns by enhancing stakeholder participation. Accordingly, to effectively implement NICEMS, the strategy provided for establishment of Integrated Coastal Management Unit (ICMU) to support and strengthen sectors, rather than replacing them as it is well elaborated under Section 6 of the strategy. Operationalization of ICMU which is placed at NEMC is to be reviewed regularly to suit the prevailing conditions. It now calls for such revision.

In practical terms, the need for developing NICEMS was supported by the fact that despite of there being a number of locally based ICM programs in the country, such as REMP, TCZCDP, KICAMP, MMP, MPAs, it was still not demonstrable that there is robust institutional sectoral networking. This study found that the situation is still not any better.

3.4.3.4.6 Marine spatial planning

Marine Spatial Planning (MSP) requires to be a public process of analyzing and allocating the spatial and temporal distribution of human activities to achieve ecological, economic, and social objectives that are usually specified through a political process. At the national and local level, adoption of MSP is being conceptualized in Tanzania with practitioners conducting baseline studies for coastal and marine datasets to develop a database which would help to update Spatial Data and Environmentally Sensitive Area maps. Tanzania Sensitivity Atlas (TanSEA) of the coastal zone has been developed and is hosted at the Institute of Marine Sciences of the University of Dar es Salaam, which serves as the Tanzania National Oceanographic Data Centre (TzNODC) (https://ims.udsm.ac.tz/tansea/). This is an important tool to inform both policy and on-ground implementation for enhanced sustainable management of coastal and marine resources. The first national stakeholders' seminar was held last year 2020 to draw the roadmap for MSP and sustainable blue economy for the country. The objectives of this national seminar were twofold:

- To strengthen national institutional capacities in relation to marine spatial planning (MSP) and the sustainable blue economy

- To strengthen national institutional coordination for the adoption of the MSP roadmap

The essence of MSP that is of benefit to mangroves is based on its ability to:

- Reduce the many conflicts that prevail between sectors and create synergies between different activities
- Encourage investment, particularly from the private sector by instilling predictability, transparency and clearer rules and enforcement mechanisms on the ground
- Increase transboundary coordination between countries and sectors, through the use of a single instrument where ecosystems are borderless
- Provide opportunity for early identification of impact and opportunities for multiple use of space

Tanzania should take advantage of existence of a step-by-step approach to set up and apply MSP published by the Intergovernmental Oceanographic Commission (IOC) (**Ehler and Douvere 2009**) towards attaining a state approved MSP. In addition, the Nairobi Convention has developed a background document on MSP of the WIO Blue Economy that provides the rationale for MSP as an effective tool for sustainable ocean economy (**NC, WIOMSA and CSIR 2017**). Findings on the sectoral institutional, policy and legal complexities as revealed by this study call for urgency in completing the process of development and government approval of the MSP for the country. Together with other strategies such as ecosystem-based management, ICM and MPAs, MSP looks to complement management responses to multiple threats on coastal and marine ecosystems and resources for sustainable utilization and development.

Planted mangroves to rehabilitate degraded abandoned areas in Rufiji Delta

4. Conclusions and Recommendations

This study aimed at appraising the socio-economic and conservation of mangroves and their resources in Tanzania based on both the community, conservation practitioners and managers perceptions and empirical field observations. Dependence on mangrove resources for livelihoods driven by persistent poverty and coastal population growth are root causes of pressures on mangroves in Tanzania, which triggers overexploitation of the mangrove resources for wood products (poles, timbers, firewood, charcoal), conversion to other lands uses (salt works, agriculture, aquaculture, settlements, infrastructure) and pollution, particularly in urban areas. The consequent degradation and loss of this critical habitat and ecosystem services including disrupted fisheries, have implications in livelihoods of dependent communities. Lack of clear considerations of mangroves in the policy and legal mechanisms have exacerbated the complexities in enforcement of management and conservation measures, particularly, the recognition and inclusion of traditional community interests and priorities. Attempts to promote community engagement as a strategy to ensure effective and sustainable utilization and conservation have not been successful enough due to a variety of challenges that include unclear benefit sharing modalities, tenure and user rights, decision-making powers, sectoral segmentation and political sentiments.

Nevertheless, management of mangrove forests in Tanzania has a historical background stemming from the colonial era when they were first gazetted as forest reserves. Accordingly, current forest policy and legal frameworks have maintained the exclusionary protective model, designating mangrove forest reserves as state owned, with restricted use by local communities. Mangrove forests degradation continues unabated in many parts, mainly attributed to technical management incapacity, weak law enforcement, suggesting that expansion and strengthening of the tenure rights of local communities to mangroves should be a central component of their sustainable management and conservation. This goes in line with the growing recognition in Tanzania regarding the weakness of top-down mangrove protection approaches and the importance to promote more community-led management processes (**Mangora 2011**; **Mshale et al. 2017**).

While such policies may be appropriate in a way, inadequate institutional capacities often associated with budgetary and technical know-how limitations continue to jeopardize the governance of mangroves. These warrant repeated calls for action. The institutional inadequacy was for example, reflected by lack of well-organized management data on mangrove harvests in Rufiji Delta, implying that policy and administrative decisions are made without the support of data. For example, while the state ban on mangrove harvest was made with reference to the speculated alarming condition in the state of Rufiji Delta mangroves, it affected other areas that did not have similar issues, so to speak. Without data, such consideration was impossible. It is not known how much was being removed that triggered imposition of the ban, and now that the ban has been lifted for Rufiji Delta and Kilwa, still they have not been able to establish how much is bad or good for sustainability.

Recommendations for consideration that may nevertheless require further studies at the national and local levels include:

- Adopt a dedicated mangrove policy
- Promote state and non-state inter-agency and cross-sectoral coordination at different levels of governance
- Sustain and strengthen awareness raising and institutional capacity at all levels
- Explore and engage private sector in mangrove ecosystem conservation and restoration
- Redefine the legal basis for community co-management arrangements for mangrove ecosystem,
- Appraise feasibility of promoted alternative livelihoods for mangrove dependent communities

Recommended global call-to-action points for improvising local actions of best practices excerpted from the State of World's Mangroves 2021 (**Spalding and Leal 2021**) for the protection, management and development of mangrove ecosystems for socio-economic advancement:

- **Government**: Invest to protect and restore mangroves - integrate mangrove conservation and restoration into national laws, planning and policy processes, focusing on rural livelihoods and development
- **Donor community**: Promote and finance nature-based solutions by designating mangroves as one of the high-value coastal

ecosystems within existing regulatory and finance mechanisms and support inclusion of mangroves into reporting processes for global conventions – CBD, Paris Agreement

- **Private sector**: Engage with conservation community and invest in mangrove conservation and restoration by adopting and financing approaches that integrate mangroves into traditional infrastructure solutions to climate change.
- **NGO sector**: Secure the future of mangroves by supporting efforts to develop sustainable mangrove management and continue raising awareness, sharing, and promoting information about the value of mangroves.
- **Academic and research community**: Avail necessary data and information to drive reforms by development of information tools to support policy implementation, across sectors, including social and economic sciences, restoration approaches, and ecosystem service benefits.
- **Public**: Recognize and demand for protection of mangroves as vital to the health of the planet from all the frontiers – coastal development, heritage and restoration

These call-to-action points are further reinforced by the globally advocated mangrove principles (for details of the white paper visit **https://www.mangrovealliance.org/somn-mangrove-principles**) that provide guiding tips to the objective development and implementation of mangrove ecosystems conservation and management plans. The nine principles grouped in five fields of actions are underpinned by sustainable development principles; namely securing economic development, social equity and justice, and environmental protection.

Promote Good Governance: Policy and legal frameworks

Principle 1: Adopt a dedicated national level policy or plan to compel and coordinate action, legislation and intersectoral incentives to conserve and sustainably manage mangroves in priority areas.

Principle 2: Recognize the transboundary nature of mangrove ecosystems and their threats as well as and the need for effective cross-sectoral and multilevel coordination and cooperation through integrated management approaches.

Principle 3: Ensure that mangrove conservation and restoration actions & national commitments and obligations to international conventions mutually support and reinforce each other.

Ensure an Engaged and Equitable Society: People's participation and empowerment

Principle 4: Ensure that conservation is people-centred, meeting both environmental and socio-economic goals, and that legally recognized community stewardship is in place wherever-possible.

Use Sound Science and Knowledge: Credible knowledge base for science-based arguments and capacity-building

Principle 5: Use sound natural and social science and knowledge, including traditional knowledge, for decision-making and best practice in mangrove conservation and restoration.

Principle 6: Make the economic and resilience case and build capacity based on sound science.

Achieve a Socially Sustainable Economy within Environmental Limits: Sustainable use of natural resources

Principle 7: Select the most appropriate and effective conservation management and restoration approach for each specific site based on a comprehensive understanding of the socio-ecological characteristics and drivers of change influencing the mangrove ecosystem.

Principle 8: Ensure application of sustainable use schemes and economic benefits for local communities.

Implement Sustainable Conservation Financing: Innovative approaches and benefit-sharing

Principle 9: Apply appropriate conservation-financing and incentive-based mechanisms in sustainable mangrove ecosystem management, ensuring community rights and engagement and benefit sharing.

References

Alavaisha, E ., and Mangora, M . M . (2016) . Carbon stocks in the small estuarine mangroves of Geza and Mtimbwani, Tanga, Tanzania . International Journal of Forestry Research 2016, ID 2068283 .

Beardall W. (1881). Exploration of the Rufiji River under the Orders of the Sultan of Zanzibar. Proceedings of the Royal Geographical Society and Monthly Record of Geography, New Monthly Series, 3(11): 641-656. http://www.jstor.org/stable/1800137

Beymer-Farris BA, Bassett TJ (2012) The REDD menace: resurgent protectionism in Tanzania's mangrove forests. Global Environmental Change 22: 332-341

Blomley T, Iddi S (2009) Participatory forest management in Tanzania 1993-2009. Lessons learned and experiences to date. Ministry of Natural Resources and Tourism, Dar es Salaam. 70 pp

Curtin PD (1981) African Enterprise in the Mangrove Trade: The Case of Lamu. African Economic History 10: 23-33

Dahdouh-Guebas F, Ajonina GN, Amir AA, Andradi-Brown DA, Aziz I, Balke T, Barbier EB, Cannicci S, Cragg SM, Cunha-Lignon M, Curnick DJ, Duarte CM, Duke NC, Endsor C, Fratini S, Feller IC, Fromard F, Hugé J, Huxham M, Kairo JG, Kajita T, Kathiresan K, Koedam N, Lee SY, Lin H-J, Mackenzie JR, Mangora MM, Marchand C, Meziane T, Minchinton TE, Pettorelli N, Polanía J, Polgar G, Poti M, Primavera J, Quarto A, Rog SM, Satyanarayana B, Schaeffer-Novelli Y, Spalding M, Van der Stocken T, Wodehouse D, Yong JWH, Zimmer M and Friess DA (2020) Public Perceptions of Mangrove Forests Matter for Their Conservation. Front. Mar. Sci. 7:603651. doi: 10.3389/fmars.2020.603651

DCCFF (2008) Zanzibar National Forest Resources Management Plan (2008-2020). Department of Commercial Crops, Fruits and Forestry, Revolutionary Government of Zanzibar, Zanzibar. 51 pp

DCCFF (2009a) The Zanzibar Mangroves Inventory. Department of Fisheries and Marine Resources. The Marine and Coastal Environment Management Project (MACEMP), Zanzibar. 86 pp

DCCFF (2009b). The Zanzibar Mangroves Socio-economic Final Report. Department of Commercial Crops, Fruits and Forestry, The Revolutionary Government of Zanzibar.

Diop ES, Gordon C, Semesi AK, Soumare A, Diallo A, Guisse A, Diouf M, Ayivor JS (2002) Mangroves of Africa. In: de Larceda LD (ed) *Mangrove Ecosystems: Function and Management*. Springer -Verlag, Berlin. pp 61-121

Earth Trends (2003). www.earthtrends.wri.org

EcoAfrica Environmental Consultants (2012a). An Assessment of Legal and Institutional Framework for Effective Management of Marine Managed Areas in Tanzania. Mainland Tanzania Report. Marine Parks and Reserves Unit, Dar es Salaam, Tanzania.

EcoAfrica Environmental Consultants. (2012b). An Assessment of Legal and Institutional Framework for Effective Management of Marine Managed Areas in Tanzania. Zanzibar Report. Marine Conservation Unit, Zanzibar, Tanzania.

Ehler, C.N. and Douvere, F., 2009. Marine Spatial Planning: A Step-by-step Approach toward Ecosystem-based Management, Available at: http://www.vliz.be/imisdocs/publications/153333.pdf.

Ellison, J. (2015). Vulnerability assessment of mangroves to climate change and sea-level rise impacts. *Wetlands Ecology and Management,* **23:**115– 137.

Erftemeijer, P. and Hamerlynck, O. (2005). Die-Back of the Mangrove *Heritiera littoralis* Dryand, in the Rufiji Delta (Tanzania) Following El Niño Floods. *Journal of Coastal Research*, **42:** 228-235.

FAO and UNEP (1981). Tropical Forest Resources Assessment Project, Forest Resources of Tropical Africa. Part II: Country Briefs FAO, UNEP, 586 pp.

FAO and UNEP. 2020. The State of the World's Forests 2020. Forests, biodiversity and people. Rome. https://doi.org/10.4060/ca8642en

Friess, D. A., Yando, E. S., Alemu, J. B., Wong, L.-W., Soto, S. D., and Bhatia, N. (2020). Ecosystem services and disservices of mangrove forests and saltmarshes. Oceanogr. Mar. Biol. 58, 107–142. doi: 10.1201/9780429351495-3

GMW (2016). Global Mangrove Watch. https://data.unep-wcmc.org/datasets/45

Goldberg, L., Lagomasino, D., Thomas, N. and Fatoyinbo, T. (2020). Global declines in human-driven mangrove loss. *Global Change Biology*. DOI: 10.1111/gcb.15275.

Griffith AL (1949) Reconnaissance report on the forest problems of the Zanzibar Protectorate. The Government Printer, Zanzibar. 50 pp

Griffith AL (1950) Working scheme for the mangroves of the Zanzibar Protectorate. The Government Printer, Zanzibar. 42 pp

Gullström M., Dahl M., Lindén O., Vorhies F., Forsberg S., Ismail RO and Björk M. (2021). Coastal blue carbon stocks in Tanzania and Mozambique: Support for climate adaptation and mitigation actions. Gland, Switzerland: IUCN. x+80 pp

Herr, D., and Landis, E. (2016). Coastal Blue Carbon Ecosystems. Opportunities for Nationally Determined Contributions. Policy Brief. Gland; Washington, DC: IUCN, TNC.

Himes-Cornell A., Pendleton L., Atiyah P. (2018). Valuing ecosystem services from blue forests: A systematic review of the valuation of salt marshes, sea grass beds and mangrove forests. Ecosystem Services 30 (A): 36-48.

Holmes J (1995) Natural Forest Handbook for Tanzania. Volume II Forest Policy, Planning and Utilization. Faculty of Forestry, Sokoine University of Agriculture, Morogoro, Tanzania. 362 pp

Kairo J, Mbatha A, Murithi MM and Mungai F (2021) Total Ecosystem Carbon Stocks of Mangroves in Lamu, Kenya; and Their Potential Contributions to the Climate Change Agenda in the Country. Front. For. Glob. Change 4:709227. doi: 10.3389/ffgc.2021.709227

Kajia YS (2000) Assessment of the effects of rice farming in the mangrove forest of the Rufiji delta (mainland Tanzania). MSc Thesis, VUB: Brussel. 82 pp

Karengi S (2012) The productivity of honey bees and floristic characteristics in Rufiji District. MSc Thesis, Open University of Tanzania, Dar es Salaam

Kimirei I.A., Igulu M.M., Semba M. and Lugendo B.R. (2016). Small Estuarine and Non-Estuarine Mangrove Ecosystems of Tanzania: Overlooked Coastal Habitats?. In: S. Diop et al. (eds.), Estuaries: A Lifeline of Ecosystem Services in the Western Indian Ocean, Estuaries of the World. Springer. DOI 10.1007/978-3-319-25370-1_13

Kondo A. K., Nyomora A. and Njau K.N. (2013). Pollutants Removal Efficiency of two Mangroves Species (*Avicennia marina* and *Rhizophora mucronata*) in Treating Domestic Sewage. Huria: Journal of the Open University of Tanzania 15(3): 1-17.

Kruitwagen G, Nagelkerken I, Lugendo BR, Mgaya YD, Bonga SEW (2010) Importance of different carbon sources for macroinvertebrates and fishes of an interlinked mangrove-mudflat ecosystem (Tanzania). Estuarine, Coastal and Shelf Science 88: 464-472

Kruitwagen, G., Pratap, H. B., Covaci, A. and Bonga, S. E. (2008). Status of pollution in mangrove ecosystems along the coast of Tanzania. *Marine Pollution Bulletin*, **56(5):** 1022–1031.

Kulindwa, K., Sosovele, H. and Mgaya, Y.D. (2001). Socio-economic dimensions of biodiversity loss in Tanzania. Economic Research Bureau, Dar es Salaam University Press, Dar es Salaam.

Leskinen J, Pohjonen VM, Mbarouk SA (1997). Woody Biomass Inventory of Zanzibar Islands. Zanzibar Forestry Development Project Technical Paper No. 40. Commission for Natural Resources, Zanzibar and Forest and Park Services, Helsink. 103 pp.

Liingilie et al. 2015. Effects of salt making on growth and stocking of mangrove forests of south western Indian Ocean coast in Tanzania. Mediterranean Journal of Biosciences 1(1), 27-31.

Lugendo BR and Kimirei IA. (2021). Anthropogenic nitrogen pollution in mangrove ecosystems along Dar es Salaam and Bagamoyo coasts in Tanzania. Marine Pollution Bulletin 168:112415. DOI: 10.1016/j.marpolbul.2021.112415

Lugendo BR, de Groene A, Cornelissen I, Pronker A, Nagelkerken I, van der Velde G. MgayaYD (2007) Spatial and temporal variation in fish community structure of a marine embayment in Zanzibar, Tanzania. Hydrobiologia 586: 1–16

Lugendo BR, Pronker A, Cornelissen I, de Groene A, Nagelkerken I, Dorenbosch M, van der Velde G, Mgaya YD (2005) Habitat utilisation by juveniles of commercially important fish species in a marine embayment in Zanzibar, Tanzania. Aquatic Living Resources 18: 149–158

Lugo AE, Snedaker SC (1974) The ecology of mangroves. Annual Reviews of Ecology and Systematics 5: 39-64

Lupembe IB and Munishi PKT (2019). Carbon stocks in the mangrove ecosystem of Rufiji River Delta, Tanzania. BONOROWO WETLANDS 9(1): 33-36. DOI: 10.13057/bonorowo/w090104

Mabula, M. J., Mangora, M. M. and Muhando, C. A. (2017). Peri-urban Mangroves of Dar es Salaam-Tanzania are Highly Vulnerable to Anthropogenic Pressures. *Advances in Ecological and Environmental Research,* 141-172.

Madulu, F. N. (2003). Population distribution and density in Tanzania: Experiences from 2002 population and housing census, Institute of Resource Assessment University of Dar es Salaam, 19 pp.

Mahenge AS (2018). Nitrogen Removal in Mangroves Constructed Wetland. International Journal of Environment, Agriculture and Biotechnology 3(2) http://dx.doi.org/10.22161/ijeab/3.2.45

Mainoya, J. R., Mesaki, S. and Banyikwa, F. F. (1986). The distribution and socio-economic aspects of mangrove forests in Tanzania. MAN IN THE MANGROVES: The Socio-economic Situation of Human Settlements in Mangrove Forests (eds) Peter Kunstadter, Eric C. F. Bird, and Sanga Sabhasri. Proceedings of a workshop held at Nong Nuch Village, Pattaya, Thailand, 27-31 May 1985, sponsored by the United Nations University and the National Research Council of Thailand.

Mangora MM (2011). Poverty and institutional management stand –off: a restoration and conservation dilemma for mangroves forests of Tanzania. Wetlands Ecology and Management 19: 533-543.

Mangora MM, Lugendo BR, Shalli MS and Semesi S (2016). Mangroves of Tanzania. In: Bosire J. O., Mangora M. M., Bandeira S., Rajkaran A., Ratsimbazafy R., Appadoo C. and Kairo J. G. (eds.). Mangroves of the Western Indian Ocean: Status and Management. WIOMSA, Zanzibar Town, pp. 33-49.

Mangora MM, Shalli MS (2014) Sacred mangrove forests: who bears the pride? In: Behnassi M, Shahid SA and Mintz-Habib, N. (eds) Science, Policy and Politics of Modern Agricultural System: Global Context to Local Dynamics of Sustainable Agriculture. Springer, Dordretch, The Netherlands. pp 291-305

Mangora MM. (2012). Ecophysiology of Mangroves Seedlings: Responses to Waterlogging, Salinity, Light and Nutrient Enrichment. PhD Thesis. University of Dar es Salaam.

Masalu DCP (2003) Challenges of coastal area management in coastal developing countries—lessons from the proposed Rufiji delta prawn farming project, Tanzania. Ocean & Coastal Management 46: 175–188

Masanja. L. A. (2004). A socio-economic review of coastal forests in Tanzania. Technical report for WWF-Tanzania, 28 pp.

Materu SF, Urban B and Heise S. (2018) A critical review of policies and legislation protecting Tanzanian wetlands, Ecosystem Health and Sustainability, 4:12, 310-320, DOI: 10.1080/20964129.2018.1549510

Mayunga, J. and Uhinga, G.A. (2018). Mapping spatio-temporal distribution of mangroves in Mafia Island in Tanzania using landsat imagery. The International Archives of the Photogrammetry, *Remote Sensing and Spatial Information Sciences,* Volume XLII-4/W8.

McNally CG, Uchida E, Gold AJ (2011) The effect of a protected area on the tradeoffs between short-run and long-run benefits from mangrove ecosystems. Proceedings of the National Academy of Sciences 108: 13945–13950

MLF (2020). The Annual Fisheries Statistics Report (January – December) 2019. Fisheries Department, Ministry of Livestock and Fisheries, United Republic of Tanzania, Dodoma.

MNRT (1991). Management Plan for the Mangrove Ecosystem of Mainland Tanzania. Volume 11: Mangrove Management Plan for all Coastal Districts. Division of Forest and Beekeeping, Ministry of Tourism, Natural Resources and Environment.

MNRT (2007). Community Based Forest Management Guidelines. Forest and Beekeeping Division, Ministry of Natural Resources and Tourism, United Republic of Tanzania, Dar es Salaam.

MNRT (2013). Joint Forest Management Guidelines. Ministry of Natural Resources and Tourism, United Republic of Tanzania, Dar es Salaam.

MNRT (2015). National Forest Resources Monitoring and Assessment of Tanzania Mainland. Main Results. Tanzania Forest Services Agency, Ministry of Natural Resources & Tourism, Dar es Salaam.

Monga, E., Mangora, M.M. and Mayunga, J.S. (2018). Mangrove cover change detection in the Rufiji Delta in Tanzania*. WIO Journal of Marine Science,* **17**: 1-10.

Mshale, B., Senga, M. and Mwangi, E. (2017). Governing mangroves: Unique challenges for managing Tanzania's coastal forests. Bogor, Indonesia: CIFOR; Washington, DC: USAID Tenure and Global Climate Change Program.

Msoka, H.J. 2018. Impacts of salt extraction on selected mangrove forests along the coast of Tanzania. MSc Dissertation. University of Dar es Salaam.

Muhando C.A., Shalli M.S., Kitula R.A., Dubi A.M. and Mangora M.M. (2009). Habitats and Ecological Zones in the KICAMP Area. Institute of Marine Sciences, Zanzibar and Kinondoni Municipal Council, Dar es Salaam, Tanzania.

Mushi MF (2019). Social Values and Traditional Governance of Mangrove Forests in Moa and Mahandakini Communities of Tanga, Tanzania. MSc Dissertation, University of Dar es Salaam.

Mutatina, A. (2012). Decentralized Minor Permitting Procedure for Small Scale Mariculture activities for Bagamoyo District. Coastal Resources Center, Graduate School of Oceanography, University of Rhode Island, Narragansett, RI, 65 pp.

Mutatini, A. (2013). Decentralized Minor Permitting Procedure for Small Scale Mariculture activities for Pangani District. Coastal Resources Center, Graduate School of Oceanography, University of Rhode Island, Narragansett, RI, 76 pp.

Mwaipopo, O. U. (2000). Implications of accelerated sea-level rise (ASLR) and climate change for Tanzania. In: A.C. de la Vega-Leinert, R. J. Nicholls, A. Nasser Hassan and M. El-Raey (Editors), Proceedings of the SURVAS Expert Workshop on "African Vulnerability and Adaptation to Impacts of Accelerated Sea-Level Rise (ASLR)", Cairo, Egypt, pp 53-54.

Mwandya AW, Gullström M, Andersson MH, Öhman MC, Mgaya YD, Bryceson I (2010) Spatial and seasonal variations of fish assemblages in mangrove creek systems in Zanzibar (Tanzania). Estuarine, Coastal and Shelf Science 89: 277-286

Mwandya, A. W., Gullström, M., Öhman, M. C., Andersson, H, M. and Mgaya, D. Y. (2009). Fish assemblages in Tanzanian mangrove creek systems influenced by solar salt farm constructions. Estuarine, Coastal and Shelf Science, **82:** 193– 200.

Nagelkerken, A., Blaber, S. J. M., Bouillon, C. D., Green, P. E., Haywood, M. F., Kirton, F. L. G., Meynecke, J. O. H., Pawlik, J. I., Penrose, H. M., Sasekumar, J. M. K. and Somerfield, P. J. L. (2008). The habitat function of mangroves for terrestrial and marine fauna: A review. *Aquatic Botany,* **89:**155–185.

NBS (National Bureau of Statistics) and OCGS (Office of Chief Government Statistician), Zanzibar (2013) 2012 Population and Housing Census. Population Distribution by Administrative Areas, 264 pp.

NC, WIOMSA & CSIR (2017). A Case for Marine Spatial Planning in the Blue Economy of the Western Indian Ocean. Prepared by the CSIR for the Nairobi Convention Secretariat and the Western Indian Ocean Marine Science Association. 53pp.

Nehemia A and Kochzius M (2017) Reduced genetic diversity and alteration of gene flow in a fiddler crab due to mangrove degradation. PLoS ONE 12(8): e0182987. https://doi.org/10.1371/journal.pone.0182987

Nehemia A., Chen M., Kochzius M., Dehairs F. and Brion N. (2019). Ecological impact of salt farming in mangroves on the habitat and food sources of *Austruca occidentalis* and *Littoraria subvittata*. Journal of Sea Research 146(2): 24-32.

Ngongolo K, Mtoka S and Mahulu A (2015), Challenges and Opportunities for Restoring the Threatened Mangroves. Journal of Scientific Research & Reports 5(5): 352-360.

Ngusaru, A., Tobey, J. and Luhikula, G. (2001). Tanzania State of the Coast 2001: People and the Environment. Tanzania Coastal Management Partnership, Dar es Salaam, 53 pp.

Nindi, S. J., Machano, H. and Rubens, J. (2014). Remote sensing study of Rufiji Mangrove, Tanzania from 1990 to 2010. WWF Tanzania Country Office, Dar es Salaam, 49 pp.

Nurse M, and Kabamba J (2000) Defining institutions for collaborative mangrove management: a case study from Tanga, Tanzania. Forest and Social Perspectives in Conservation Working Paper No. 1. IUCN Eastern Africa Regional Office, Nairobi. 16 pp

Nyangoko, B.P.; Berg, H.; Mangora, M.M.; Gullström, M.; Shalli, M.S. (2021).Community Perceptions of Mangrove Ecosystem Services and Their Determinants in the Rufiji Delta, Tanzania. Sustainability, 13: 63. https://dx.doi.org/10.3390/su1301 0063

Nyomora AMS and Njau KN. (2012). Growth Response of Selected Mangrove Species to Domestic Sewage and Abiotic Stress. Western Indian Ocean Journal of Marine Science 11(2); 167-177.

Obura, D. et al. 2017. Reviving the Western Indian Ocean Economy: Actions for a Sustainable Future. WWF International, Gland, Switzerland. 64 pp.

Penha-Lopes, G.P. (2009) Effects of domestic sewage on characteristics of mangrove communities and their functioning in East Africa. PhD Dissertation, University of Lisbon, Portugal

Punwong (2013a) Holocene mangrove dynamics and sea level changes: records from the Tanzanian coast. PhD Thesis, University of York.

Punwong P., Marchant R. and Selby K. (2013c). Holocene mangrove dynamics from Unguja Ukuu, Zanzibar. Quaternary International 298: 4-19.

Punwong P., Marchant R. and Selby K. (2013d) Holocene mangrove dynamics in Makoba Bay, Zanzibar. Palaeogeography, Palaeoclimatology, Palaeoecology 379–380: 54–67.

Punwong, P., Marchant, A. R. and Selby, K. (2013a). Holocene mangrove dynamics and environmental change in the Rufiji Delta, Tanzania*. Vegetation History and Archaeobotany,* 22(5) DOI: 10.1007/s00334-012-0383-x.

Rodriguezi EFVL (2018). Mangrove Concessions: An Innovative Strategy for Community Mangrove Conservation in Ecuador. In: C. Makowski, C. W. Finkl (eds.). Threats to Mangrove Forests: Hazards, Vulnerability and Management. https://doi.org/10.1007/978-3-319-73016-5

Ruitenbeek, J., Hewawasam, I., and Ngoile, M. (2005). Blueprint 2050: Sustaining the marine environment in mainland Tanzania and Zanzibar. The World Bank, Washington DC.

Rumisha, C., Mdegela, R. H., Kochzius, M., Leermakers, M. and Elskens, M. (2016). Trace metals in the giant tiger prawn Penaeus monodon and mangrove sediments of the Tanzania coast: Is there a risk to marine fauna and public health? *Ecotoxicol Environ Saf,* **132:**77-86. doi:10.1016/j.ecoenv.2016.05.028.

Sasmito, S. D., Taillardat, P., Clendenning, J., Friess, D. A., Murdiyarso, D. and Hutley, L. B. (2016). Carbon stocks and fluxes associated with land-use and land-cover change in mangrove ecosystems: A systematic review protocol. Working Paper 211. Bogor, Indonesia: CIFOR.

Saunders F, Mohammed S, Jiddawi N and Sjöling S (2008). An examination of governance arrangements at Kisakasaka mangrove reserve in Zanzibar. Journal of Environmental Management 41(5): 663–75

Semesi AK (1992). Developing management plans for the mangrove forest reserves of mainland Tanzania. Hydrobiologia 247: 1-10.

Semesi, A. K. (1998). Mangrove Management and Utilization in Eastern Africa. *Ambio,* Vol 2 No. 8.

Sigalla, L. H. (2014). Poverty and livelihood of coastal communities in Tanzania Mainland and Zanzibar. *Journal of African Studies and Development,* **6(9):** 169-178.

Slobodian, LN ., Badoz, L, eds . (2019) . Tangled roots and changing tides: mangrove governance for conservation and sustainable use . WWF Germany, Berlin, Germany and IUCN, Gland, Switzerland . xii+280pp .

Spalding, M . D ., Blasco, F ., and Field, C . D . (1997) . World mangrove atlas . The International Society for Mangrove Ecosystems, Okinawa, Japan .

Spalding, M . D ., Kainuma, M., and Collins, L . (2010) . World atlas of mangroves . Earthscan, London, UK .

Spalding, MD and Leal, M. (editors), 2021 The State of the World's Mangroves 2021. Global Mangrove Alliance. www.mangrovealliance.org and www.globalmangrovewatch.org

Suleiman OJ (2019). Structure, Biomass and Carbon Stocks in the Mangroves of Boma and Mahandakini Villages in Tanga, Tanzania. MSc Dissertation, University of Dar es Salaam.

Sullivan K., Mmochi A.J. and Crawford B.. 2007. An Economic Analysis of Milkfish Farming in Tanzania: Potential for Economic Development and Policy Issues. The Sustainable Coastal Communities and Ecosystems Program. Coastal Resources Center, University of Rhode Island and the Western Indian Ocean Marine Science Association. 23p.

Sunseri T (2005) Working in the mangroves and beyond: scientific forestry and the labour question in early colonial Tanzania. Environment and History 11: 365–94

TANSEA (2016). Tanzania Sensitivity Atlas. www.ims.udsm.ac.tz/tansea/

Taylor M, Ravilious C, Green EP (2003) Mangroves of East Africa. UNEP-WCMC Biodiversity Series 13, Cambridge. 24 pp

TCMP (2001a) Tanzania Mariculture Guidelines Source Book. Working Document # 5048 TCMP. Tanzania Coastal Management Partnership and the Mariculture Working Group. Dar es Salaam, Tanzania. 222pp.

TCMP 2001b Tanzania Mariculture Investor's Guide. Working Document # 5049 TCMP. Tanzania Coastal Management Partnership, Dar es Salaam, Tanzania. 83pp.

Turpie, JK (2000). The use and value of natural resources of the Rufiji Floodplain and Delta, Tanzania. Technical Report No. 17.98

UNDP (2012). Rufiji Environment Management Project. Equator Initiative Case Study Series. United Nations Development Programme. New York, NY.

UNEP (2014). The Importance of Mangroves to People: A Call to Action. VanBochove, J., Sullivan, E., Nakamura, T. (Eds). United Nations Environment Programme World Conservation Monitoring Centre, Cambridge. 128 pp.

UNEP-Nairobi Convention/USAID/WIOMSA (2020). Guidelines on Mangrove Ecosystem Restoration for the Western Indian Ocean Region. UNEP, Nairobi, 71 pp.

URT (2003). The National Integrated Coastal Environment Management Strategy (NICEMS). United Republic of Tanzania, Vice President's Office, Dar es Salaam.

URT (2016). Basic Demographic and Socio-economic Profile (coastal regions and Zanzibar). National Bureau of Statistics, Dar es Salaam and Chief Government Statistician, Zanzibar.

Vegh T., Jungwiwattanaporn M., Pendleton L., and Murray B. (2014). Mangrove Ecosystem Services Valuation: State of the Literature. NI WP 14-06. Durham, NC: Duke University.

Villiers A (1948) Some aspects of the Arab dhow trade. Middle East Journal 2(4): 399-416

von Mitzlaff U. (1989). Coastal Communities in Tanzania and their Mangrove Environment. Forest and Beekeeping Division, Ministry of Tourism, Natural Resources and Environment, Dar es Salaam, Tanzania

Wagner, G.M. and Sallema-Mtui, R. (2016). The Rufiji Estuary: Climate Change, Anthropogenic Pressures, Vulnerability Assessment and Adaptive Management Strategies. *Western Indian Ocean, Estuaries of the World,*[DOI 10.1007/978-3-319-25370-1-12].

Wagner, M. G. (2007). The Dar es Salaam Seascape: A Case Study of an Environmental Management 'Hotspot. *Western Indian Ocean J. Mar. Sci. Vol,* **6:** 85–109.

Wang, Y., Bonynge, G., Nugranad, J., Traber, M., Ngusaru, A., Tobey, J., Hale, L., Bowen, R. and Makota, V. (2003). Remote Sensing of Mangrove Change Along the Tanzania Coast. *Marine Geodesy,* **26:** 35-48.

Wells S, Samoilys M, Makoloweka S, Kalombo H (2010) Lessons learnt from a collaborative management programme in coastal Tanzania. Ocean & Coastal Management 53: 161–168

Wells S., Makoloweka S. and M. Samoilys (eds.) (2007). Putting Adaptive Management into Practice: Collaborative Coastal Management in Tanga, Tanzania. IUCN-EARO.

Wolchok, L. (2006). "Impacts of Salt Production on Pemba". Independent Study Project (ISP) Collection. 329. https://digitalcollections.sit.edu/isp_collection/329

Wolf H.D, Ulomi S.A., Backeljau T., Pratap H.B. and Blust R. (2001). Heavy metal levels in the sediments of four Dar es Salaam mangroves Accumulation in, and effect on the morphology of the periwinkle, *Littoraria scabra* (Mollusca: Gastropoda). Environment International 26: 243-249.

World Bank (2013). Implementation Completion and Results Report for a Marine and Coastal Environment Management Project. World Bank, Africa Region.

Annexes

ANNEX 2.1. LIST OF PARTICIPANTS TO THE STAKEHOLDERS MEETING TO RAISE AWARENESS ON MANGROVE CONSERVATION FOR TANZANIA HELD ON 26-27 NOVEMBER 2020, PROTEA HOTEL COURTYARD, DAR ES SALAAM

No	Name	Affiliation
1.	Mohamed Shelisheli	TFS District Forest Conservator- Mtwara
2.	Ezra Chomola	TFS District Forest Conservator - Tanga
3.	Stephan Malima	TFS District Forest Conservator - Rufiji
4.	Frank Sima	TFS – Headquarter, Dar es Salaam
5.	Hassan Kalombo	Retired Fisheries Officer - Tanga Regional Office
6.	Gidion Zakayo	Environment Officer - Kibiti District Council
7	Twahiru Mkongo	District Forest Officer - Pangani
8.	Jonas Nambua	District Forest Officer - Rufiji
9.	Njabha Lyatura	District Forest Officer - Kilwa
10.	Besta Msumange	Mafia Island Marine Park
11.	Nelson Mdogo	Tanga Marine Reserves System
12.	Theodora Regnald	Tanga Coelacanth Marine Park
13.	Musa Ally	Mnazi Bay-Ruvuma Estuary Marine Park
14.	Amina Ussi	Revolutionary Government of Zanzibar
15.	Dr. Mwita Mangora	Institute of Marine Sciences - Zanzibar
16.	Dr. Sware Semesi	University of Dar es Salaam
17.	Omar Kombo	Community member - Chongoleani, Tanga
18.	Mariam Mbwana	Community member- Mafuriko, Tanga
19.	Bakari Njenge	Community member - Mlongo, Mafia
20.	Abdul Mohamed Mlawa (Njule)	Community member - Mfisini, Rufiji Delta
21.	Jabiri Zumo Mwinyihija	Community member of BMU - Bweni, Pangani
22.	Gumbo Majubwa	Director of Ambakofi NGO - Bagamoyo
23.	Simon Lugazo	Tanzania Forest Conservation Group – Dar es Salaam
24.	Jumanne Mohamed	WWF – Dar es Salaam
25.	January Ndagala	WWF – Dar es Salaam
26.	Modesta Medard	WWF – Dar es Salaam
27	Grace Mgimba	WWF – Dar es Salaam
28.	Elia Sabura	WWF – Dar es Salaam
29.	Lydia Mwakanema	WWF – Dar es Salaam

ANNEX 2.2. LIST OF PARTICIPANTS TO THE NATIONAL STAKEHOLDERS MEETING TO RAISE AWARENESS ON THE WESTERN INDIAN OCEAN MANGROVE NETWORK HELD ON 17 NOVEMBER 2021, DOUBLE TREE HOTEL, ZANZIBAR

No	Name	Affiliation
1.	Upendo Hamidu	Ministry of Fisheries and Livestock, Dodoma
2.	Yusuf Semguruka	President's Office - TAMISEMI
3.	James S. Nshare	Forest and Beekeeping Division, MNRT, Dodoma
4.	Ali Abdi Mohamed	Department of Environment Pemba
5.	Massoud Bakar Massoud	Department of Forest Development Pemba
6.	Sharif Mohamed Faki	Department of Fisheries Pemba
7.	Omar Juma Suleiman	PECCA Pemba
8.	Davis G.Orio	MPRU - MBREMP
9.	Mathew Ntilicha	TFS Kibiti
10.	Danford Mwaiteleke	TFS Kilwa/Lindi
11.	Nelson J. Mdogo	MPRU - TMRs
12.	Yusuph Kajia	TFS Northern Zone Same
13.	Theodora R. Abraham	MPRU - TACMP
14.	Claire Haule	Wetlands International Tanzania
15.	Mary Gemela	Women Against Poverty
16.	Frank V.A. Sima	TFS HQ
17.	Sware Semesi	NEMC
18.	Pagu Julius	MPRU HQ
19.	Simon Lugandu	TFCG
20.	Emelda Adam	VPO Dodoma
21.	Tamrin A. Said	HIMA Project Unguja
22.	Said Juma Ali	Department of Forest Development Unguja
23.	Daud A. Songwa	Department of Forest Development Unguja
24.	Rahika H. Suleiman	Department of Forest Development Unguja
25.	Aziza Y. Nchimbi	Department of Forest Development Unguja / Jozani-Chwaka Bay National Park
26.	Fatma S. Ali	Department of Fisheries Unguja
27.	Said A. Fakih	WCS Zanzibar
28.	Sheha Indrisa Hamdani	Ministry of Blue Economy and Fisheries Zanzibar
29.	Khamis A. Hussein	ZEMA Unguja
30.	Amina U. Khamis	WIOMN Consultant
31.	Saleh Kombo	ZARI Unguja
32.	Is-Hak Ameir Keis	AB Technologies Unguja
33.	Ali Said Ali	ZAFIRI Unguja
34.	Wahira J. Othman	SUZA
35.	Ahmed Khalid Abdul	Office of Registrar of Societies Unguja
36.	Makame Kitwana	Ministry of Blue Economy and Fisheries Zanzibar

No	Name	Affiliation
39.	Mahfoudh S.H. Haji	ZACCA Unguja
39.	Mondy C. Muhando	TNC Unguja
40.	Mwita Mangora	WIOMN Zanzibar
41.	Edward Senkondo	WWF Tanzania
42.	Modesta Medard	WWF Tanzania
43.	January Ndagala	WWF Tanzania
44.	Elia Sabula	WWF Tanzania
45.	Abbasi Khalid	WWF Tanzania
46.	Aboud S. Jumbe	Ministry of Blue Economy and Fisheries Zanzibar

ANNEX 2.3. LIST OF FIELD CONSULTED INDIVIDUALS AND THEIR AFFILIATIONS

SN	Name	Institute And Designation
1.	Zawadi Mbwambo	TFS HQ
2.	Frank Sima	TFS HQ
3.	Catherine Mwakosya	TAFIRI Dar es Salaam
4.	Twahiru Mkongo	Pangani District Forest Officer
5.	Hassan Kalombo	Retired Regional Fisheries Officer
6.	Ezra Chomola	Mangrove Forest Manager – Tanga
7.	Jared Obado	Acting Resident Mineral Officer – Tanga
8.	Masudi Yunus	FA-MOA
9.	Rashid Gembe	Mkinga District Executive Director
10.	Burhan Son	Dawson Salt Works (Burhan)
11.	Ndaro Kisusu	Fakhri Salt Mayomboni
12.	Mwanaidi Nondo	Acting Pangani District Executive Director
13.	Musa Sanga	TFS Pangani District
14.	Burhan Dawson Gulham	Dawson Salt Works
15.	Rashid Liemba	Neelkath Salt Ltd.
16.	Irene Mushi	RMA TFS Tanga
17.	Mussa Ally Hamis	MBREMP
18.	Mohamed Shelisheli	TFS Mtwara
19.	Eng. Ephraim Mushi	Mtwara Region Mineral Officer
20.	Damian Dick Chembe	General Secretary Mangrove Beekeepers (Vikundi Biashara Mtwara VIBIM)
21.	Samwel Zenda	VIBIM Mtwara
22.	Gray Nanauka	VIBIM Mtwara
23.	Kassim Mbwana	Mtwara District Council Development Officer
24.	Yahaya Ali Seif	Makonde Salt Works
25.	Jennifer Simbua	Chief Wadern MBREMP
26.	Amos Singo	MBREMP
27.	Abdalah Mkwamba	Songambele Group Aquaculture Behind Mangrove
28.	Ismail Lyakuti	Hawa Ghasia and Yahya Muhata Salt Farms
29.	Maria Ngatata	Acting Fisheries Officer Mtwara DC/ Ag. DLFO
30.	Ahmad Hamis Mtiori	Kantutuma Salt Works
31.	Rashid Manzi Mnape	Tujitume Fish Farm Group
32.	Thomas Malima	TFS Manager Lindi
33,	Godwin Sabas Mwacha	FA TFS Lindi
34.	Irene Malunda	Jikite Beekeeping Group
35.	Athuman Ismail	Chairperson Mingoyo Village
36.	Dr Ninzar Idd	Fisheries and Livestock Officer Lindi (MLFDO)
37.	William Mangire	Fisheries Officer – Lindi
38.	Fikiri- Nanguvile	Chairman Usaka Group (Umoja Wa Ufugaji Samaki Na Kaa)

SN	Name	Institute And Designation
39.	Ayubu Singoye	Programme Officer Swiss Aid
40.	Felician Hyagila	Magereza Lindi
41.	Aziza Y. Nchimbi	Warden Jozani-Chwaka Bay National Park
42.	Haji Masoud	FO Misitu Pemba
43.	Omar Suleiman	PECCA Manager Pemba
44.	Moh'd Said Suleiman	PECCA Ranger Pemba
45.	Khamis Hamad Said	PECCA Ranger Pemba
46.	Mihayo Ususu K	Tour guide Ngezi forest Pemba
47.	Khamis Ally Khamis	Tourism Officer Ngezi Forest Pemba
48.	Kombo Salim	Katibu Tumbe IPO Sababu
49.	Abdallah Salum	SIRI Fish Farm, Pujini Pemba
50.	Khalifa Nasor	SIRI Fish Farm Pujini Pemba
51.	Ally Nsuma	Beekeeper Mlongo Mafia
52.	Mwanema Athumani	WWF Mafia Volunteer
53.	Thomas Chale	PE WWF Mafia
54.	Besta Msumange	Warden Mafia Island Marine Park
55.	Mbwana Shabani	Mafia District Forest Conservator
56.	Saidi Mwichobe	Salt farm operator, Mafia
57.	Silima Juma	VLO MMP Mafia
58.	Burhan Mbary	Secretary Hifadhi Chemchem Mafia

ANNEX 2.4. SUMMARY OF FIELD NOTES OF SELECTED ACTIVITIES

Salt Works

Company / Group	Operation status
Dawson Salt Works of Tanga	• Mkinga District Council receive royalty of TZS 200 for each bag sold. • Commissions Corporate Social Responsibility through support to local schools through construction and rehabilitation of class rooms and toilet facilities. • Operates 232 ha, with average season production of 15000 tonnes if the weather is stable • Market demand surpasses production • Production is for local and export mainly for industrial purposes, with major supplies to medical, preservative (leather and fish), animal feeds, and clothing industries. • The standard price is TZS 5000 per 50kg bag • Employs 50 permanent workers, majority of whom are from the nearby communities. • The investment cost roughly TZS 100 million for 10 ha farm size
Neelkanth Salt Ltd – Shungubweni, Mkuranga and Mahandakini, Mkinga	• Largest producer and own the biggest brand of sea salt (Neel salt) in the country and one of the largest in the East Africa region • Operates salt pans at Shungubweni village in Mkurunga District and Mahandakini in Mkinga District and the processing and packaging factory at Dundani Village in Mkuranga District • The factory produces around 240,000 tonnes of table salt annually • Processed salt is sold at an average price of TZS 10000 for a 50 kg bag. • With all the raw salt produced from the company's salt pans at Shungubweni and Mahandakini, it still has to buy more from other local producer companies, which still meets only 30% of the factory demands, necessitating the importation of about 60% from India and Namibia. Exemplify that sea salt production is still an opportunity that has not yet been fully exploited. • The company has an investment level of more that TZS 15 billion and plans to elevate this to TZS 20 billion, by expanding the salt pan area at Mahandakini village up to 1000 ha in addition to the current 1000 ha at Shungubweni in Mkuranga, but the current production uses hardly half of it. • Employment level is between 300 – 5000 workers including permanent and temporary. • For Shungubweni, season's target production level is 150,000 tonnes of salt, but hardly reached 10000 tonnes. • Commissions Corporate Social Responsibility through support to local schools in construction and rehabilitation of class rooms and toilet facilities and provision of desks.
Makonde Salt Works - Ndumbwe Village, Mtwara	• Established in 1984 as a small scale family business, operating on 13.5 ha. • Depends on tidal flow to fill in the pans • Construction cost of pans, at TZS 12000 per meter • Annual maintenance cost of TZS 7 million • 10 permanent staff • Recruit 150 labourers during production from nearby communities of Ndumbwe and Changarawe, • They harvest 15,000 bags of 50 kg and they sell 1 bag of 50 kg for TZS 5000 • Local market is Songea and Sumbawanga and export to Congo DRC • Supply iodized salt, but limited availability of iodine is a challenge to quality.
Kantutuma Salt Works of Mtwara	• Salt farm area is 3.5 Ha • Group of 6 individuals, all of them are permanent workers on their farm • They employ other 16 people during harvesting • They harvest 200-300 sacks of 50 kg in every pan • Customers are from Songea, Mbeya, Njombe, and Mara
Hawa Ghasia and Yahya Muhata Salt Farms	• Have 5 pans each of a quarter to half acres size • Harvest 2 to 3 times a year and each pan can produce 700 to 800 bags of 50 kg per year • One permanent worker and 4 temporary workers during production season • Recruit 100 to 200 labourers during salt harvesting • All workers come from the surrounding villages

Beekeeping

Community Group	Operation status
Vikundi Biashara Mtwara (VIBIM) – Mbuo, Ndumbwe Maweni and Ndumbwe Mdanga Villages, Mtwara	• 72 group members (25 men and 47 women) • 320 beehives placed in mangroves. • 4 bandas for keeping the beehives, each can take up to 100 beehives • For 1 top bar beehive harvest is about 7-12 kg twice year. • First harvest was not good as the group was still learning. Was supported without adequate prior experience. • Demand for mangrove honey is higher that supply, because it is considered without impurities unlike the produce of miombo woodlands where chemicals from crop farms are treated with herbicides. • Production is throughout the year due to different mangroves species flowering times. • This demonstrate that it would be a great business, should adequate investment and proper management be secured. • No threat of wildfires • Plant mangroves in collaboration with TFS

Fish farming

Community Group	Operation status
Songambele Group - Mtwara	• They keep milkfish (*Mwatiko/Mkuyu*) species • Pond size 100*160 and 100*180 • They get from the wild during high tides then they select the *Mwatiko* species. • Within 6 months they harvest when they reach around 700 gram per fish • Mangroves help cool and protect the ponds
Tujitume Fish Farm Group - Mtwara	• Is the group of 6 people, started in 2003 • The species they keep is *Mwatiko* • Their pond size is 100*100 meters, harvesting three times a year with average weight of 250 grams • Presence of mangroves support availability of fingerlings, food and ponds protection
Umoja wa Ufugaji Samaki na Kaa (USAKA) - Lindi	• Group has 30 members. 10 youth, 10 elders and 10 women • Integrate fish farming, salt farms and mangrove restoration • Has been selected as the case study group with TFS and Lindi District Council


Fly
Emirates