



Republic of Kenya

MINISTRY OF ENVIRONMENT, NATURAL RESOURCES AND REGIONAL DEVELOPMENT AUTHORITIES

NATIONAL MANGROVE ECOSYSTEM MANAGEMENT PLAN



2017 - 2027



APPROVAL PAGE

This mangrove management plan is approved for implementation and will be amended as need arises.

Emilio N. Mugo

DIRECTOR, KENYA FOREST SERVICE,

Date  20/2/2017

Foreword

For a long time, utilization and management of mangrove resources in Kenya was based on harvesting of wood products and not on other essential roles they play in fishery production, climate change regulation, and shoreline protection. Although this has slowly changed over time, lack of a Plan to guide sustainable management of mangroves has led to deforestation and degradation of mangrove ecosystem, and loss of their essential services.

The World Bank, through Kenya Coastal Development Project (KCDP), supported the development of this mangrove ecosystem management plan for Kenya. Stakeholders including government agencies, Non-Governmental Organizations (NGOs), private sector, expert groups, and community based groups played a significant role in preparation of the Plan by providing invaluable information through consultative meetings.

A nationally constituted Mangrove Technical Committee (MTC) coordinated the development of the Plan. Members of the committee included designated persons from lead government institutions implementing KCDP and whose roles were interested in mangrove management. A member nominated from the Forest Conservation Committee (FCC) at the coast represented community interests in the Plan. Expert working groups (Annex I) in each of the identified thematic areas assisted the committee in analyzing issues impacting on mangroves and developing possible interventions.

Mangrove Technical Committee

Chairman	James G. Kairo	<i>Kenya Marine and Fisheries Research Institute</i>
Co-chair	Albert Nyabuti	<i>Kenya Forest Service</i>
Members	Agnes Mkazalla	<i>State Department of Fisheries</i>
	Mohamed Omar	<i>Kenya Wildlife Service</i>
	Mbuvi Musingo	<i>Kenya Forestry Research Institute</i>
	Mohamed Pakia	<i>Forest Conservation Committee – Coast</i>

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1. Mangrove wood products, Gazi bay
2. A mangrove nursery, Gazi Bay
3. Mangrove planting campaign, Port Reitz
4. 20-year *Rhizophora* plantation, Gazi Bay
5. Fishing activity around mangrove area, Vanga
6. Students learning about the mangrove ecosystem, Gazi Bay
7. Mangrove ecotourism, Gazi Bay
8. Mariculture activity in a mangrove area, Kilifi Creek
9. Riverine mangrove with *Avicennia*, Mwache Creek

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The Nature Conservancy and WWF are thanked for sharing structural data for Lamu County that was used in the Plan.

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Executive summary

Mangrove forests in Kenya cover about 61,271 ha, representing approximately 3.0% of the natural forest cover or less than 1.0% of the national land area. About 59% of these forests occur in Lamu County. There are nine mangrove species in Kenya, with *Rhizophora mucronata* (or mkoko) and *Ceriops tagal* (mkandaa) being the most dominant. Mangrove ecosystems offer a range of benefits and opportunities for local and national economic development; hence they should be protected and conserved. This ecosystem, however, faces serious threats associated with their deforestation and degradation. Root causes of mangrove loss and transformations have been identified as; increased population, weak governance, inadequate awareness of the true value of mangrove ecosystems, high levels of poverty, lack of alternative livelihoods, and inadequate management prescriptions. Mangrove losses in turn have negative impacts on fisheries, shoreline stability, and resource sustainability.

The development objective of this management plan is to sustain the supply of mangrove goods and services for local and national development. The Plan is prepared in compliance with Forests Act (2005), which provides for preparation of management plans for all gazetted forests. It provides a road map towards sustainable management of mangrove ecosystems in Kenya for enhanced livelihoods. The Plan embraces collaborative and participatory approaches in natural resource governance that leads to ownership of the initiatives by the stakeholders. It takes cognizance of other existing policies relating to land and land use, agriculture, fisheries, energy, environment, mining, wildlife, and water. Ecosystem-Based Management (EBM), as defined by Convention on Biological Diversity, was largely used to guide the development of this Plan. It recognizes the inter-connectivity among ecological, socio-cultural, economic, and institutional arrangements.

For effective management of mangroves in the country, the Plan has proposed six programmes including; forest conservation and utilization; fisheries development and management; community; tourism development; research and education; and human resource and operations. These programmes prescribe measures for rehabilitation, conservation, and sustainable management of mangrove ecosystems in Kenya. Implementations of this Plan will be led by Kenya Forest Service (KFS); but will also include other key actors such as Kenya Wildlife Service, State Department of Fisheries, Research Institutions, Academia and Community Forest Associations through a specially constituted National Mangrove Advisory Committee.

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Abbreviations and Acronyms

AWP	Annual Work Plans
BMU	Beach Management Unit
CBD	Convention on Biological Diversity
CBO	Community Based Organization
CDA	Coast Development Authority
CERs	Carbon Emission Reduction
CFA	Community Forest Association
COP	Conference of Parties
EACC	East African Coastal Current
ECC	Equatorial Counter Current
EIA	Environmental Impact Assessment
EMCA	Environmental Management and Coordination Act
GoK	Government of Kenya
HOC	Head of Conservancy
ICZM	Integrated Coastal Zone Management
IGAs	Income Generating Activities
IPCC	Intergovernmental Panel on Climate Change
KCDP	Kenya Coastal Development Project
KEFRI	Kenya Forestry Research Institute
KES	Kenya Shilling
KFMP	Kenya Forestry Master Plan
KFS	Kenya Forest Service
KMFRI	Kenya Marine and Fisheries Research Institute
KMNR	Kiunga Marine National Reserve
KTB	Kenya Tourism Board
KWS	Kenya Wildlife Service
M&E	Monitoring and Evaluation
MEA	Millennium Ecosystem Assessment
MoU	Memorandum of Understanding
MPAs	Marine Protected Areas
NCCRS	National Climate Change Response Strategy
NEM	North East Monsoon

NEMA	National Environment Management Authority
NFP	National Forest Programme
NGO	Non-Governmental Organization
NWFP	Non-Wood Forest Product
PES	Payment for Ecosystem Services
PFM	Participatory Forest Management
PFMP	Participatory Forest Management Plan
REDD+	Reducing Emissions from Deforestation and Forest Degradation
SDF	State Department of Fisheries
SDGs	Sustainable Development Goals
SEC	Southern Equatorial Current
SEM	South East Monsoon
SLR	Sea Level Rise
TEV	Total Economic Value
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States Dollar
WIO	Western Indian Ocean
WRMA	Water Resources Management Authority

Glossary

Crown closure: (also crown cover) – Ground area covered by tree canopy. High dense forests have greater than 80% cover, while degraded forests have less than 40% cover.

Deforestation: The clearing of forests, conversion of forestland to non-forest uses.

Ecotourism: Nature friendly tourism, low impact tourism, sustainable tourism.

Forest: A land declared or registered as a forest, a woody vegetation growing in close proximity in an area of over 0.5ha including a forest in the process of establishment, woodland, thickets

Forest degradation: Biotic or abiotic processes that result in the loss of productive potential of natural resources in areas that remain classified as forests. Degraded forest may take a long time to recover thus requiring human intervention

Mangrove ecosystem: A tidal habitat comprised of salt-tolerant trees and shrubs. This ecosystem occurs in the tropical and subtropical coasts; between high and low watermarks of spring tides.

Mangrove formation: (also **cover type** or **forest types**) a descriptive term used to group stands of similar characteristics and species composition by which they may be differentiated from other groups.

Mangrove forest management plan: A concise plan setting out all the requirements, controls and activities to be applied over space and time in a logical sequence to arrive at the desired objectives.

Multiple use: More than one use of an area at one time.

Poles: The merchantable part of the mangrove stem categorized and marketed based on their diameter classes.

Supratidal: That portion of a tidal flat that lies above the level of mean high water mark for spring tides, which is inundated only occasionally by exceptional tides.

1 GENERAL INTRODUCTION

1.1 Background Information

Mangrove forests along the Kenya coast cover approximately 61,271 ha. These forests offer a range of benefits and opportunities to both local and national economic development, improved livelihoods and provision of environmental goods and services such as habitat for fish and other wildlife, shoreline protection, and carbon sequestration. For these reasons, mangroves should be protected and conserved so that they can continue providing the desired goods and services. This management plan is aimed at providing a road map towards sustainable management of the mangrove ecosystem in Kenya and enhanced livelihood of local communities that are dependent on mangrove resources.

1.2 Title of the Plan and Duration

This plan is referred to as the National Mangrove Ecosystem Management Plan. The Plan covers all gazetted mangrove forest reserves in Kenya and will be implemented over 10 year period (2017 – 2027); commencing from date of approval by the Director, Kenya Forest Service.

1.3 Justification of the Plan

Effective management of mangrove resources in Kenya is a challenge due to inadequate management prescriptions. However, the need for development of these prescriptions is implied in various policy documents. The Kenya Forestry Master Plan (KFMP) of 1994 formulated guidelines for the development of the forests sector in Kenya. Issues identified in the Master Plan, including deforestation and degradation of forests, are still pertinent today and are reflected in the Forest Conservation and Management Act (2016) and Kenya's Vision 2030. Likewise, Forest Policy (2014) stresses management of forests for the benefit of present and future generations. This management plan is prepared in compliance with the legal requirement under section 35 of the Forest Conservation and Management Act (2016), which provides for preparation of management plans for all State forests. It seeks to balance the needs of the people of Kenya with opportunities for rehabilitation, conservation, and sustainable utilization of mangrove resources.

This is the first Plan in Kenya to consider the entire mangrove ecosystem. Previously, plans were focused only on reducing cutting pressure, targeting specific mangrove sites along the coast. Mangrove exploitation was thus based on a quota system; whereby the Kenya Forest Service approved the quantity of mangrove poles to be removed from a particular area relying on subjective assessment of forest conditions. The first mangrove forest survey for the entire Kenya coast was carried out in 1950. This was followed by a survey of Lamu mangroves in 1967 and 1982. Later, in 1993 the entire mangroves of Kenya were surveyed again; but no management plan was developed.

This management plan addresses the lack of ecosystem-based management approaches for mangroves in Kenya, and supports sustainable utilization of mangrove resources while enhancing biodiversity conservation and ecosystem integrity. The Plan has taken cognizance of other existing policies relating to land and land use, tenure, agriculture, fisheries, energy, environment, mining, wildlife, and water. It also embraces collaborative and participatory approaches in natural resources governance that leads to ownership of the initiatives by the stakeholders.

1.4 Approach to Plan Development

The Government has demonstrated continued commitments towards sustainable management of natural forests in Kenya through the development of National Forest Programmes (NFP) across the country. At the Coast, the Government has developed an Integrated Coastal Zone Management (ICZM) framework. The ICZM identifies various measures and strategies that need to be implemented in order to reverse environmental degradation and promote sustainable utilization of coastal and marine resources, including mangrove forests.

The World Bank, through Kenya Coastal Development Project (KCDP), supported the development of a mangrove management plan for Kenya. A National Mangrove Task Force was constituted comprising of various government institutions including; the Kenya Forest Service (KFS), Kenya Wildlife Service (KWS), Kenya Marine and Fisheries Research Institute (KMFRI), Kenya Forestry Research Institute (KEFRI), and State Department of Fisheries. In addition, a member from Forest Conservation Committee (FCC) was co-opted in the committee to represent community interests. The task force worked consultatively through a series of workshops, fieldworks, literature reviews and personal contacts with expert groups and agencies. Overall, 24 consultative meetings and workshops were held from August 2012 to December 2016. The initial drafts of the Plan were circulated to internal and external experts for reviews. A final national stakeholders' workshop comprising of representatives from the national and county governments, non-governmental organizations, local communities, and policy makers was held in October 2016 to review and validate the final draft plan.

Ecosystem-Based Management (EBM) approach was largely used to guide the development of this Plan as defined by the Convention on Biological Diversity. The approach involves integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. It focuses on the inter-connectivity between ecological, socio-cultural, economic and institutional arrangements. The approach states that ecosystems must be managed within the limits of their functioning.

1.5 Data and Information Sources

The available information on mangroves of Kenya was gathered and reviewed with respect to the vegetation structure, community composition, and utilization. Additional information was

generated through GPS mapping including correction of vegetation boundary, and review of stocking and regeneration rates.

In order to review the current mangrove stocking rates and forest regeneration, systematic field sampling was conducted. The field measurements included tree height, stem diameter, vegetation cover, and natural regeneration, from which stand density and volume were estimated. During field sampling, plot sizes of 20 m x 20 m were chosen depending on stand density; otherwise smaller plots of 10 m x 10 m were used. A total of 567 plots covering approximately 16.8 ha were sampled to represent the mangrove forest conditions. The sample plots were distributed such that they allowed coverage of the entire mangroves in the country.

1.6 Map Making and Validation

Mangroves were mapped based on their geomorphic and physiographic features, associated water body and channel patterns. These features are clearly recognizable from aerial photographs and in the field; and are critical in distinguishing different mangrove formation. The adopted mapping categories in this Plan are summarized in Box 1.1.

Box 1.1: Categories used in mapping mangrove formations

Mangrove forest types	Non- mangrove forest categories
1. <i>Ceriops</i> almost pure stands	1. Saline with halophytic herbs
2. <i>Avicennia</i> almost pure stands	2. Un-vegetated
3. <i>Rhizophora</i> almost pure stands	3. Mudflats
4. <i>Sonneratia</i> almost pure stands	4. Sandbank
5. Mixture of <i>Ceriops</i> and <i>Rhizophora</i>	5. Beach
6. <i>Sonneratia</i> – <i>Rhizophora</i>	6. Channels (creeks)
7. <i>Rhizophora</i> dominant, with occurrence of <i>Ceriops</i> , <i>Avicennia</i> , <i>Sonneratia</i> and <i>Bruguiera</i>	7. Lagoon (water ponds)
8. <i>Ceriops</i> dominant, with occurrence of <i>Rhizophora</i> , <i>Avicennia</i> , and/or <i>Bruguiera</i>	
9. <i>Avicennia</i> dominant, with occurrence of <i>Rhizophora</i> , <i>Bruguiera</i> , <i>Ceriops</i> and <i>Xylocarpus</i> .	

In order to evaluate the growing stock and regeneration, forest types were divided into density and height classes (Table 1.1). In the text, density has subjectively been assessed as very dense when greater than 80% or scarce when less than 40%. Likewise, height was categorized as very low when the vegetation was <5.0 m and high when greater than 20 m. Most often a given forest would have composite stands of all density and height classes.

Table 1.1: Density and height classes

Attributes	Classification	Range	Description
Densities	a	< 40	Scarce
	b	40 – 80	Dense
	c	> 80%	Very dense
Height	1	> 20	High
	2	15 – 20	Medium
	3	5 – 15	Low
	4	< 5	Very low

2 DESCRIPTION OF THE FOREST

2.1 Legal and Administrative Status

Mangroves were declared government reserve forests by the Proclamation No. 44 of 30th April 1932, and later by Legal Notice No. 174 of 20th May 1964. Under this “Gazette Notification for Mangrove Forests in Kenya” all land between high water and low water marks (ordinary spring tides) are described as mangrove areas.

The responsibility to manage mangroves is bestowed on the Kenya Forest Service either singly, or in partnership with the Kenya Wildlife Service (KWS) when they occur in the Marine Protected Areas (MPA). Mangroves occur in five Counties namely Lamu, Tana River, Kilifi, Mombasa and Kwale; each managed by an Ecosystem Conservator (EC).

2.2 Geographical Location

Kenya has approximately 536 km long coastline extending from the Kenya-Tanzania border in the south to the Kenya-Somalia border in the north; between latitudes 1°40'S and 4°25'S and longitudes 41°34'E and 39°17'E (Fig. 2.1). Along this coastline, mangrove forests are found in tidal estuaries, creeks, and protected bays as outlined below:

- On the mainland and islands adjacent to the coast from Kimbo Creek in the south, to the village of Kiunga on the mainland in the north;
- On the banks of Tana River (northern branch) between Kipini and Kao (Kau);
- On the mainland and islands to the coast from the mouth of the northern Kilifi river in the north, to Ras Ngomeni in the south;
- The following creeks and all branches thereof: Mida (Uyombo), Kilifi (Southern), Takaungu and Mtwapa;
- All tidal areas lying to the north west, west and south west of the straight line between Ras Kinangone (Flora point) at the entrance of Port Reitz, and Ras Junda (southern-most point mainland north at the entrance to Port Tudor, but excluding any portion of the shore of Mombasa island);
- On the mainland and islands adjacent to the coast from Chale point in the north, to the south boundary of the Republic of Tanzania.

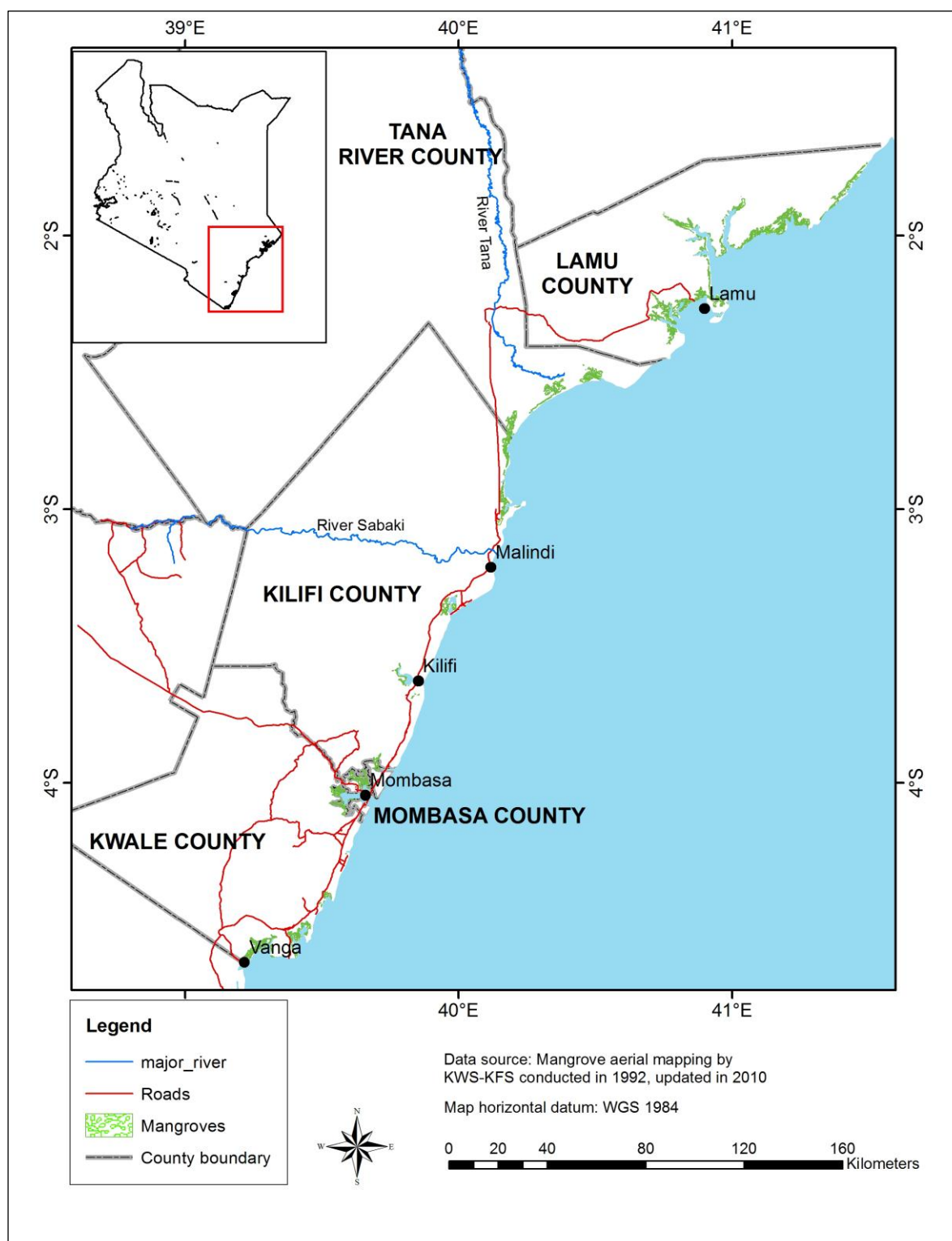


Figure 2.1: Mangrove distribution within the five counties along the coastal strip

2.3 Mangrove Resources and Biodiversity

Nine mangrove species are found in Kenya (Table 2.1). *Rhizophora mucronata* (Mkoko) and *Ceriops tagal* (Mkandaa) are the most dominant species and are represented in almost all mangrove formations. The rare species are *Heritiera littoralis* and *Xylocarpus moluccensis*. In this Plan, only generic names of the species have been used unless when referring to the genus *Xylocarpus* which has two species.

Table 2.1: Mangrove species found in Kenya and their uses

Species	Local name	Main use
<i>Rhizophora mucronata</i>	Mkoko	Poles, dye, firewood, fencing, charcoal
<i>Bruguiera gymnorhiza</i>	Muia	Poles, firewood, charcoal
<i>Ceriops tagal</i>	Mkandaa	Poles, firewood, charcoal
<i>Sonneratia alba</i>	Mlilana	Boat ribs, poles, firewood
<i>Avicennia marina</i>	Mchu	Firewood, poles
<i>Lumnitzera racemosa</i>	Kikandaa	Fencing poles, firewood
<i>Xylocarpus granatum</i>	Mkomafi	Furniture, poles, firewood
<i>Xylocarpus moluccensis</i>	Mkomafi dume	Fencing poles, firewood
<i>Heritiera littoralis</i>	Msikundazi	Timber, poles, boat mast

Mangroves of Kenya display horizontal distribution of species or zonation. This is greatly influenced by levels of inundation, geomorphology, and the salinity. A typical zonation of mangrove in Kenya starts with *Sonneratia alba* on the seaward margin, followed by large *Avicennia marina* and *Rhizophora mucronata*. In the creeks, *Rhizophora-Avicennia* mix is the most dominant. *Avicennia* expresses a double zonation but mostly found in the landward side (Fig. 2.2). Knowledge of mangrove distribution across the intertidal area is important in their management.

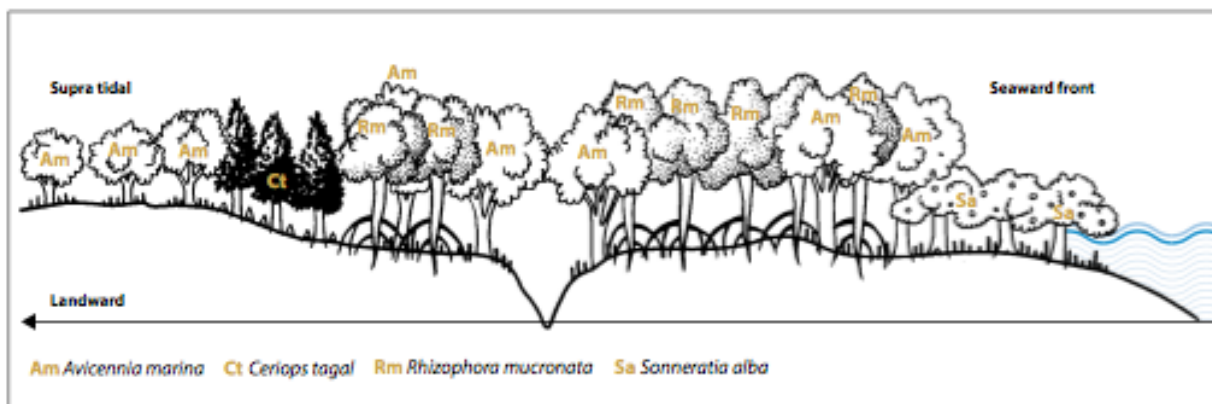


Figure 2.2: Distribution of mangrove vegetation across the intertidal area typical of the Kenyan mangrove forests

Based on the current assessment, the total mangrove area in Kenya is about 61,271 ha; with Lamu County accounting for the largest cover (37,350 ha), followed by Kwale, Kilifi, Tana River and Mombasa counties (Table 2.2, Fig. 2.1). Mangrove area estimates may vary from other sources; mostly due to differences in estimation techniques, time of the survey, classification, and delineation of areas considered as the mangrove ecosystem. In this Plan the area occupied by mangrove trees is mapped separately from areas without the forests but constituting important parts of the mangrove ecosystem; such as the creek waters, sand banks, and mud flats.

Table 2.2: Mangrove areas in the five counties along the Kenyan coast

County	Forested mangrove area (ha)	Percentage mangrove cover	Non-mangrove areas (water ways, salt pans, bare saline areas) (ha)
Lamu	37,350	61	61,836
Tana River	3,260	5	1,382
Kilifi	8,536	14	12,092
Mombasa	3,771	6	5,513
Kwale	8,354	14	7,205
Total	61,271		80,823

Other plant species associated with mangrove trees include *Acrostichum aureum*, often occupying degraded sites, *Sesuvium portulacastrum*, a fleshy herb common in elevated open sandy areas and *Salicornia* spp., grasses, rushes and sedges. Other species include; *Ipomoea pes-caprae*, *Vigna marina*, *Juncus* spp and *Athrocneumum* spp found on the bare higher shore areas. Some epiphytes occur on the trees such as ferns, orchids, lichens and mistletoe.

Seagrasses and the associated epiphytic algae occur in patches on the submerged mangrove floor, in creeks and in the sub-tidal areas in front of the mangroves. These plants help in stabilizing

sand, providing habitat for sessile organisms, and providing food and shelter for many marine species.

The diversity of fauna within mangroves is high due to ample food resources and a wide range of microhabitats in the system, such as; soil surface, permanent and temporary tidal pools, tree roots, trunks, and canopies. In Kenya these animals are represented by different phyla, ranging from protozoa and nematodes to molluscs, insects, crustaceans, birds, fish and mammals. The main groups are molluscs, crustaceans, fish, and birds. Among the epifauna, crustaceans are probably the most important. The predominant crab families in the mangroves of Kenya include; *Grapsidae*, *Ocypodidae*, *Portunidae*, *Xanthidae*, and *Gecarcinidae*.

Mangrove forests receive thousands of migratory birds during winter every year. The common groups of birds occurring in mangrove areas in Kenya include; wading birds (herons, egrets, ibises), shore birds (plovers, sandpipers), floating and diving birds (pelicans, cormorants, terns, gulls, kingfishers), birds of prey (fish eagle, osprey) and arboreal birds (bee-eaters, sunbirds).

Mangroves support high biomass of fish, molluscs and crabs of significant economic value to artisanal and commercial fisheries. In Kenya, the principal groups of fish and crustacean associated with mangroves include snappers, grouper, rabbit fish, grant, milkfish, mullet, terapons, carangids, shrimp, crabs, and oysters (see also section 2.9 below).

2.4 Biophysical Characteristics

One of the distinctive features of coastal Kenya is a fringing reef system that runs parallel to the coastline. The Tana and Sabaki rivers are two notable rivers in Kenya draining into the Indian Ocean. The Lamu archipelago with its extensive mangrove forests, Mombasa Island, the southern complex of Gazi Bay, Chale Island, Funzi Bay, and Wasini Island are other distinct features of the Kenya coast. The mangrove forests occur within a number of distinct coastline geophysical categories; (1) within sheltered bays and reef patches (Vanga, Funzi, Shimoni and Gazi), (2) in drowned river valleys at Mombasa, Mtwapa, Kilifi, Mwachema, Takaungu and Dodori, (3) in creeks (Mida Creek), (4) behind marine influenced barrier dunes (Ngomeni), (5) in estuaries (Sabaki and Tana deltas), (6) on abrasion (reef platforms) behind protective outcrops of coral limestone (mangroves of Lamu) and (7) in offshore islands (e.g. Sii Island). The influence of alluvial deposition, particularly from River Tana; coupled with the effects of coastal currents and geomorphology contribute to structural variations of the mangroves along the Kenyan coast.

2.5 Climate

The coastal area of Kenya is characterized by hot and humid tropical climate with mean temperatures ranging from 24°C to 30°C. Mean annual rainfall ranges from 500 to 900 mm yr⁻¹ in the north coast and 1000 to 1600 mm yr⁻¹ in the south coast. Relative humidity is constantly high throughout the year, with an optimum of up to 90% during the rainy season. Monsoon winds strongly influence rainfall seasons at the coast. The long rain season (March to May)

occurs during the South East Monsoon while the short rains occur during the North East Monsoon (October to December).

2.6 Geology and Geomorphology

The coastal zone of Kenya is characterized by three physiographic zones namely the Nyika plateau, the foot plateau and Coastal Plain. The Nyika lies at 600 m above sea level and represents the highest ground covered by the Duruma sandstone series. The foot plateau occurs at an elevation between 140 m and 600 m above sea level while the Coastal Plain is the lowest and rises from sea level to 140 m.

Generally, mangrove soils are saline and thus not ideal for agriculture. The major soil types found in mangrove areas in Kenya are kaolinitic and montmorillonitic. The soils were developed from marine alluvial deposits dating from Jurassic to Pleistocene age. Kwale, Mombasa and the southern areas of Kilifi County predominantly have kaolinitic soils, with a few areas that are interstratified with both soil types (Fig. 2.3). The north of Kilifi, Tana River and Lamu counties have mostly montmorillonitic soils with a few areas that are interstratified. Soils in Tana basin are classified in the floodplain as thionic, fluvisols, and gleysols; and are characterized by very poor drainage, deep sediment and high organic matter due to alluvial deposition.

2.7 Hydrology and Oceanography

Rivers draining into the coastal zone of Kenya exhibit a high degree of seasonal variability. Tana and Sabaki rivers are the only permanent rivers draining into the Indian Ocean (Fig. 2.4). Tana is the longest river (~1100 km), with a total catchment area of ~96,000 km² and a mean annual river discharge of 156 m³s⁻¹. About 30 km downstream, before entering the ocean, Tana River branches to a complex of tidal creeks, flood plains, coastal lakes and mangrove swamps that form the Tana Delta. Tana River discharges ~ 6.8 million tons of sediment annually. Sabaki is the second-longest river (~590 km) with a total catchment area of ~47 000 km² and a mean annual river discharge of 48.8 m³ s⁻¹. It drains into the West Indian Ocean near the Malindi–Watamu reef complex. Due to a combination of changing land use practices, highly variable climatic conditions and highly erosive soils, Sabaki River discharges sediment ranging between 7.5 and 14.3 million tons yr⁻¹. High levels of sedimentation is unfavorable for mangrove development explaining why there is limited cover of mangroves at Sabaki estuarine compared to the Tana Delta. Other small rivers draining into the Indian Ocean in Kenya include Ramisi, Uмба, Mwache and Mkurumudzi. The Uмба is a trans-boundary river originating from Usambara Mountains in Tanzania.

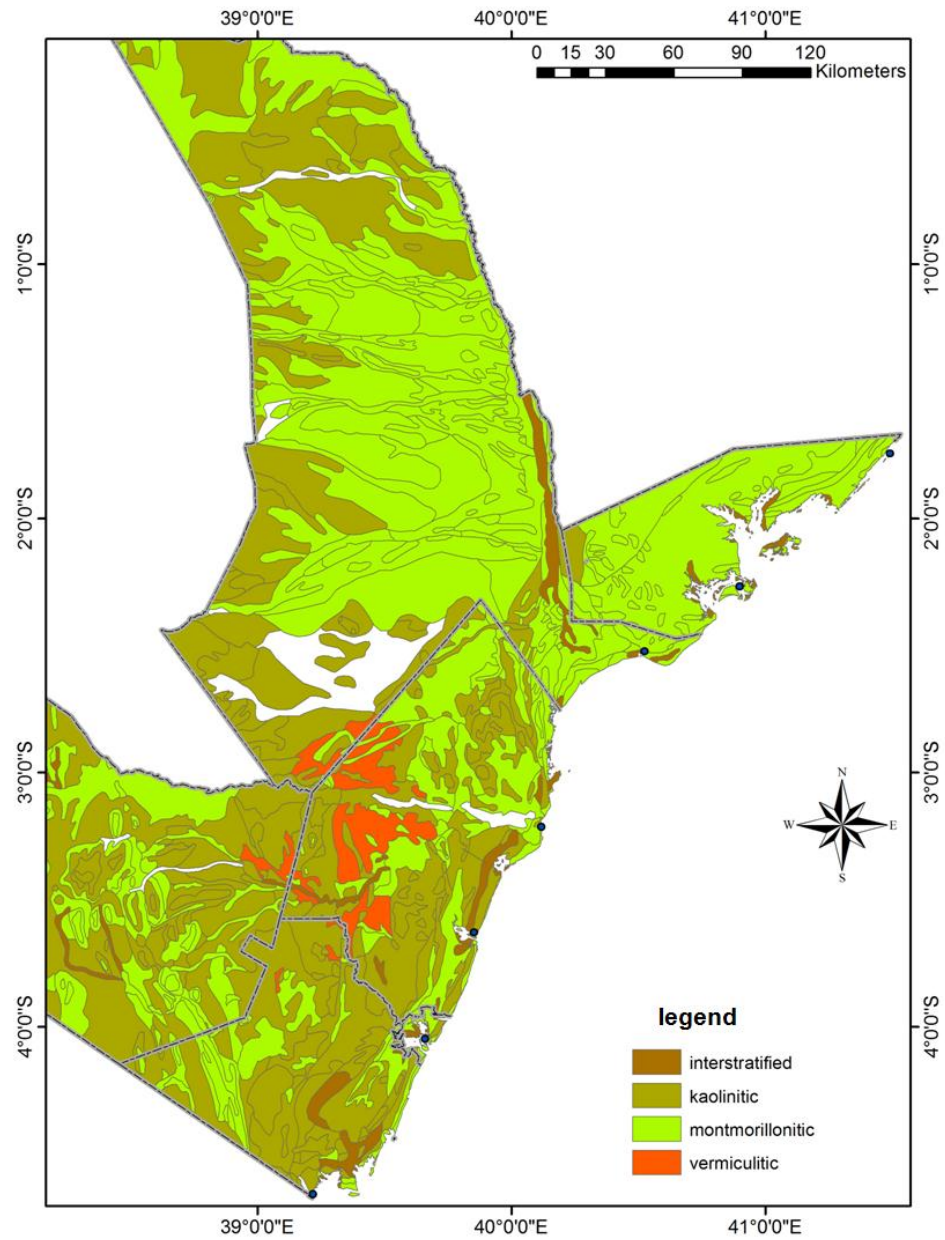


Figure 2.3: Geology of the Kenyan Coast

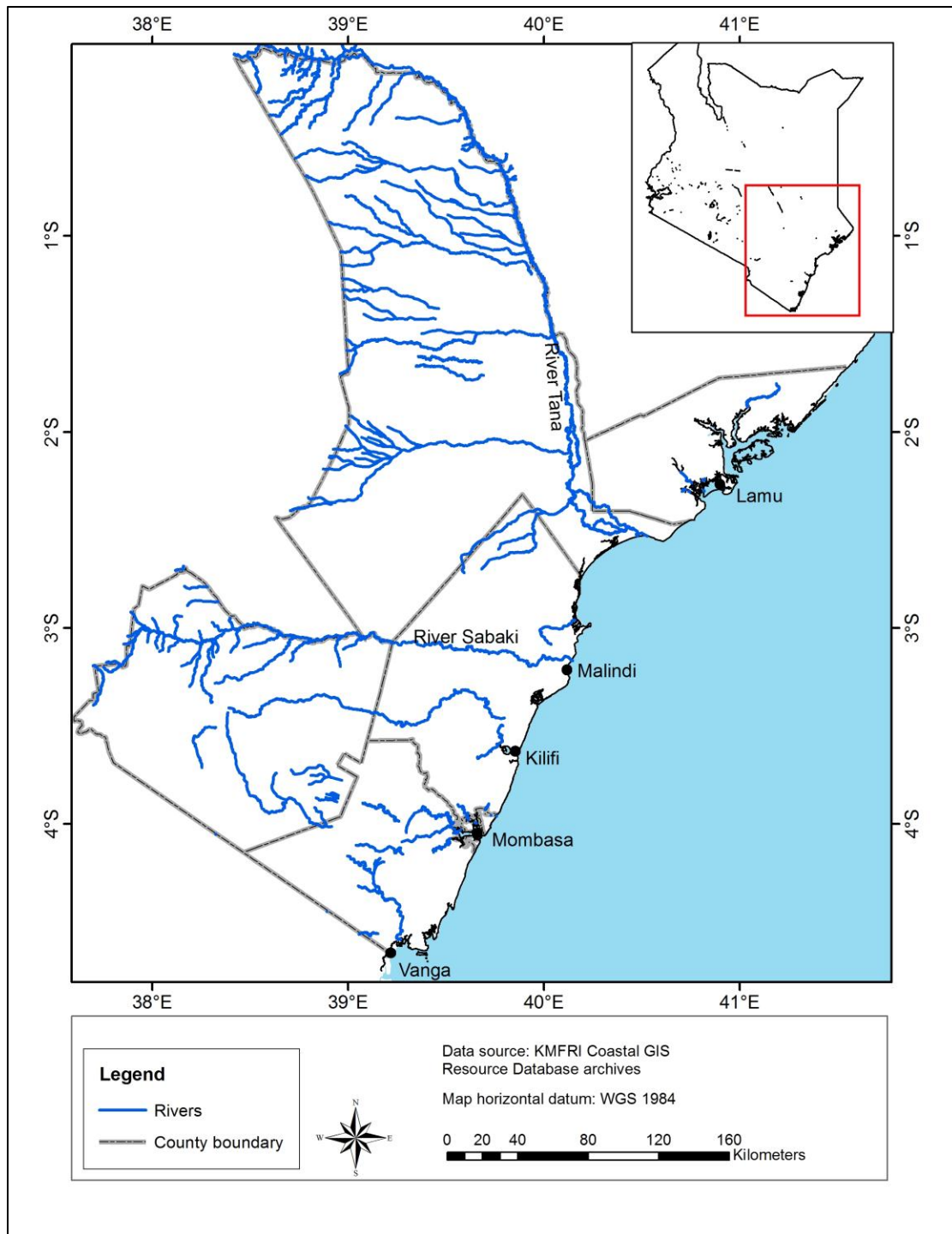


Figure 2.4: Drainage network along the Kenyan Coast. Inset is the map of Kenya with the coastal area highlighted

There are four wind-driven oceanic currents affecting the Kenyan coastline namely: the East African Coastal Current (EACC), the Somali Current (SC), the Southern Equatorial Current (SEC) and the Equatorial Counter Current (ECC) (Fig. 2.5). During the northeastern monsoon (NEM) season the northwards extent of EACC is restricted by the south flowing SC (which changes direction under the influence of the monsoon). Two currents converge between Malindi and Lamu depending on the strength of the monsoon in any particular year, and turn eastward and flow offshore as the ECC. During the SEM the SC reverses its flow and it appears as the northward extension of EACC flowing as far as the Horn of Africa. Generally, the net onshore currents result in the sinking of surface waters along most of the Kenyan coast, with the exception of Kiunga where a mild upwelling is thought to occur during NEM.

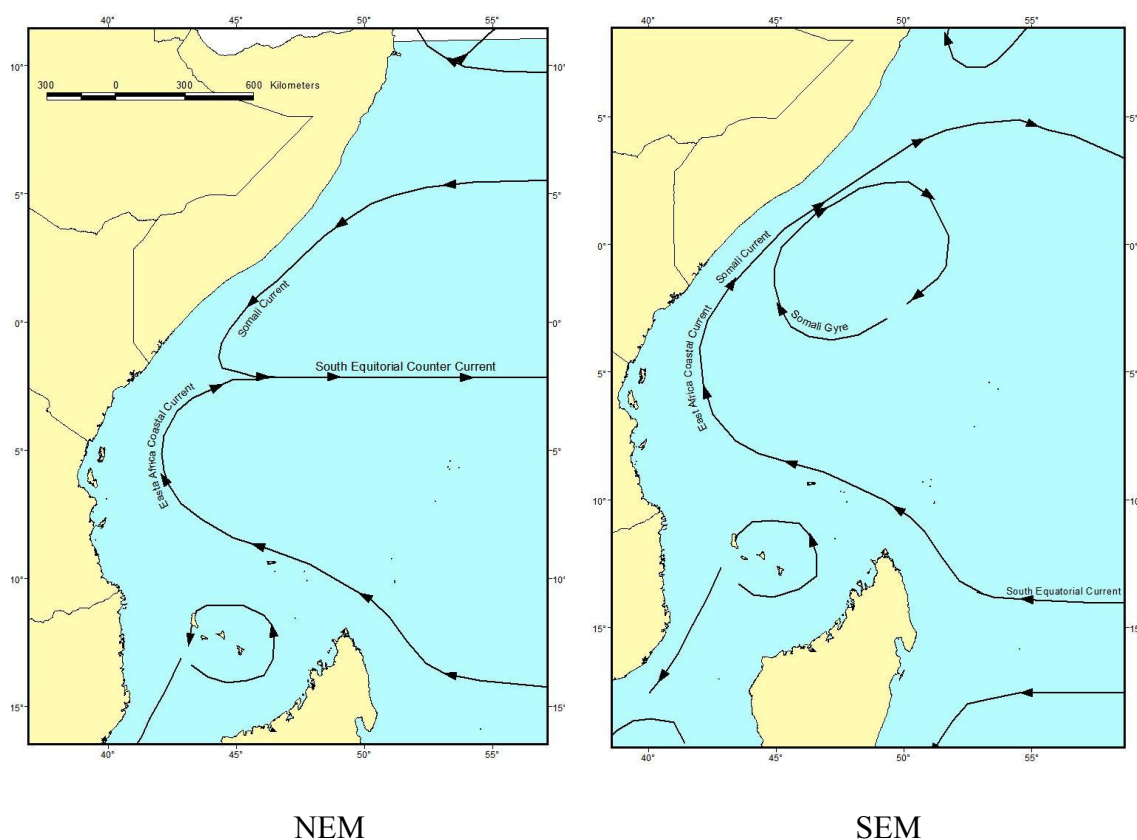


Figure 2.5: Major current at Kenya coast during North Eastern and South Eastern Monsoon seasons

2.8 History of the forest

Mangroves have played a long and important role in the history of human activity on the East African coast. Records indicate that along with slaves and ivory, mangrove poles made up a major regional trade by the 9th Century. Mangrove exploitation for building poles forms a subsistence livelihood for local people along the coast, with Lamu County exhibiting the highest

dependence. For many years, house construction in Arab countries was dependent on mangrove poles brought by dhows (traditional Arab boats) from the East African coast. By the beginning of the 20th century, Kenya was exporting an annual average of 24,150 scores of mangrove poles from Lamu forests, equivalent to 483,000 poles per year. Between 1941 and 1956 this export averaged 35,451.3 scores, then dropping to 13,774.4 scores in the period 1991/96 (Fig. 2.6).

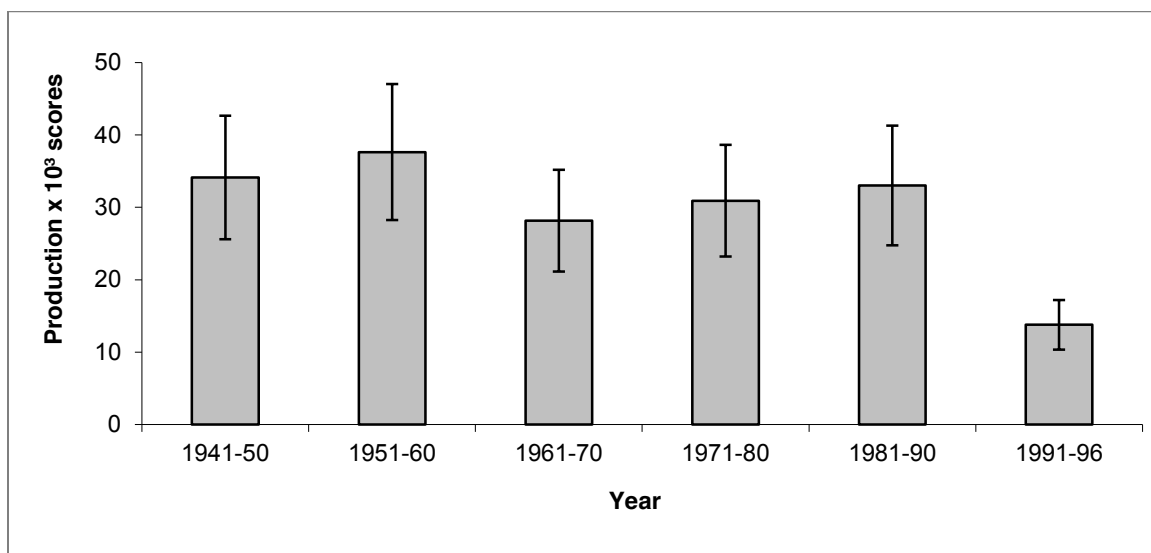


Figure 2.6: Trends in production of mangrove poles in Lamu, Kenya. Last complete data set is from 1996

Like most products of the oceans, coastal people still regard mangroves as a free resource. There is a general tendency to over-exploit a resource that has no restriction of access. As early as 1947, the colonial government in Kenya took strict controls of mangrove exploitation by granting concession to private firms whose activities could be monitored. This was a highly unpopular move among the mangrove cutters because of the general belief that mangroves were inexhaustible, and the long established custom of freedom from any sort of control.

These restrictions were of temporary nature until trained officers could be availed to make thorough assessment of forest stock and prepare a workplan for the future. In 1951, the colonial government introduced the first working plans for the mangroves of Lamu. These working plans constituted an annual cut of one-twentieth of the total 40,000 ha of mangroves available in Lamu. The 20 year rotation cycle started at Mkunumbi in 1951, the annual plot shifting northwards to Kiunga.

A thorough inventory of Lamu mangroves was carried out in 1967 by the then Forest Department in collaboration with Spartan Air services of Canada. This was repeated by the Forest Department in 1982. The entire Lamu mangrove forests were surveyed and divided into five geographical regions namely Southern Swamps, Northern Swamps, North Central Swamps, Mangoni and Dotori creek swamps and Pate Island Swamps. The total area of mangroves in Lamu district was estimated at 46,184 ha comprising of 25% (or 11,504 ha) non-forested and

34,680 ha as forested area. An important observation of 1967 and 1982 inventories were the escalating deforestation of mangroves in parts of Lamu particularly in the Southern Swamps; and there were warnings of possible depletion of the resource if the management did not intervene.

From the inventories of 1967 and 1981, it became clear that the growing stock in Lamu mangroves had depleted significantly. This happened primarily because of the over-exploitation of the two principal species i.e., *Rhizophora* and *Ceriops*. In order to arrest the escalating deforestation trend, a presidential ban was placed on the foreign export of mangrove poles in 1982 followed by a national ban in 1997. Despite these efforts, the problems of mangrove deforestation intensified and spread throughout the coast; including within Marine Protected Areas. Considering the current social and economic situation, management of mangroves in Kenya needs to focus attention on ecological restoration and poverty alleviation.

2.9 Socio Economic Status

The inhabitants of the coast of Kenya are culturally diverse. The largest indigenous ethnic group is Mijikenda comprising of nine sub-tribes namely; Giriama, Digo, Rabai, Duruma, Kauma, Chonyi, Kambe, Ribe, and Jibana. Other coastal ethnic groups include Taita, Taveta, Pokomo, Bajuni, Orma, Swahili, Aweir and Watha. Each of these ethnic groups has a distinct culture. Other communities living along the coast originated from other parts of Kenya, as well as communities of European, Indian and Arab origins.

The available livelihood options and natural resources along the coast have attracted high human population especially at the urban centres of Ukunda, Mombasa, Mtwapa, Kilifi and Malindi. However, the population is unevenly distributed with Lamu and Tana River counties being the most sparsely inhabited due to poor infrastructure, harsh climatic conditions, and security issues (Table 2.3).

Compared to other parts of the country, literacy level at the coastal region is low. Disparity in literacy levels exists both between males and females as well as urban and rural populations. Other community characteristics that are essential yet limited along the coast include; access to health care, water supplies and sanitation, infrastructure and communication networks, housing and energy.

Table 2.3: Coastal human population and poverty rates by county

County	Population		Total	Density per km ²	Poverty rate (%)
	Male	Female			
Lamu	53,045	48,494	101,539	16	32.7
Kwale	315,997	333,934	649,931	79	74.9
Kilifi	535,526	574,209	1,109,735	88	71.4
Tana River	119,853	120,222	240,075	6	76.9
Mombasa	486,924	452,446	939,370	4,294	37.6

Source: Kenya population census, 2009 and Kenya Integrated Household Budget Survey, 2011

These demography trends coupled with the community's cultural backgrounds and the proximity to the shoreline significantly influence their social and economic status. The major economic activities at the coast are tourism, ports and shipping, subsistence and commercial crop farming, livestock rearing, artisanal fisheries, handicraft, small-scale businesses, forestry and mining (Table 2.4). Most women are engaged in small-scale businesses including selling of foodstuffs (both in the open air market and food kiosks), palm thatch (*makuti*) and other household wares, while men are mostly involved in fishing, mangrove cutting and subsistence farming.

Table 2.4: Major economic activities at the coast and their relative contribution to the local economy

Economic activity	Contribution (%)
Tourism	45
Ports and shipping	15
Agricultural industries including small scale businesses	8
Fisheries	6
Farming	5
Forestry	4
Mining	2
Other services	15

Source: GoK, 2009

2.10 Stakeholder Analysis

Key stakeholders involved in the management of mangrove ecosystem in Kenya are identified in Table 2.5. During the development phase of this Plan, various stakeholders were involved at different stages of plan preparation. Similar participatory approaches will be adopted to ensure successful implementation of the Plan and subsequent reviews.

Table 2.5: Key stakeholders consulted during development of the national mangrove management plan

Beneficiaries	Implementers	Partners/collaborators	Policy makers
CFAs	KFS	KEFRI	County assembly
BMUs	KWS	KMFRI	National assembly
WRUA	County governments	Universities	
KAHC	SDF	NGOs	
KATO	CFAs	State administration	
Boat operators		WRMA	
Hoteliers		NEMA	
		NMK	

3 PLANNING CONSIDERATIONS

This section reviews policies, legislations and conventions relevant for sustainable conservation, management and utilization of mangroves forests in the country.

3.1 Policy and Legal Framework

3.1.1 Constitution of Kenya

The Constitution of Kenya offers guiding principles on the governance of land and the environment. Article 60 (1) (e) provides for sound conservation and protection of ecologically sensitive areas while Article 69 (1) has provisions with direct relevance to environment. The State is obliged to (a) Ensure sustainable exploitation, utilization, management and conservation of the environment and natural resources, and ensure equitable sharing of the accruing benefits; (b) Work to achieve and maintain a tree cover of at least 10% of the land area of Kenya; (d) Encourage public participation in the management, protection and conservation of the environment; (f) Establish systems of environmental impact assessment, environmental audit and monitoring of the environment; (g) Eliminate processes and activities that are likely to endanger the environment; and (h) Utilize the environment and natural resources for the benefit of the people of Kenya. The mangrove management plan is linked to various policies, strategies and legislative instruments relevant to national development, and seeks to support some of the environmental provisions in the Constitution of Kenya. The requirements of the Constitution of Kenya in ensuring environmental management, protection and conservation by involving the public and securing equitable sharing of the accruing benefits will be addressed by this management plan.

3.1.2 Forest Policy and Legislation

Forest Policy (2014), Forest Conservation and Management Act (2016) and the Kenya Forest Service (KFS) Strategic Plan (2014/2017) provide the legal framework for the management of forest resources in the country. The Act provides the establishment, development, sustainable management, utilization and conservation of forest resources for the socio-economic development of the country and environmental sustainability through the KFS. Under the Act all forests in Kenya are required to be managed through approved management plans and participation of stakeholders. Part IV (Articles 46 – 49) of the Forests Act provides for comprehensive community participation in forest management in the country, including mangroves. Through the National Forest Programme (NFP) the government seeks to complement and strengthen ongoing initiatives, identify emerging issues and develop a framework for involvement of partners in implementation of the forest sector strategic plan in all Forest Conservancies in the country. The support from the facility will also develop, test and refine joint forest management models for the ecologically sensitive forests while involving local communities.

3.1.3 Wildlife Conservation and Management Act, 2013

The Wildlife Conservation and Management Act, 2013 provides for the protection, conservation, sustainable use and management of wildlife in Kenya and for connected purposes. The Act applies to all wildlife resources on public, community and private land, and Kenya territorial waters. The Act authorizes Kenya Wildlife Service (KWS) to enter into agreements with other competent Authorities for the protection of wildlife and their habitats. A number of mangrove forests fall within Marine Protected Areas (MPAs), managed under the jurisdiction of this Act.

3.1.4 Environmental Management and Coordination Act, 1999

The Environmental Management and Coordination Act (EMCA) of 1999 is the framework law for environmental management in the country. The Act addresses the environmental concerns and safeguards against environmental degradation within and outside gazetted forest reserves. Further, the Act obliges the National Environment Management Authority in consultation with the relevant lead agencies to undertake a survey of the coastal zone and prepare the State of the Coast Report every two years. It also emphasizes maximum participation of stakeholders in the development and implementation of policies, plans and processes for the management of the environment. This management plan will be geared to uphold and ensure the achievements of these objectives.

3.1.5 Fisheries Policy and Legislation

The Fisheries Act 2012 provides the framework for the development, management, exploitation, utilization and conservation of fisheries and for connected purposes. Article 50 (1) and 59 of the subsidiary regulations has provisions for the protection of fish breeding areas, including mangroves. The National Oceans and Fisheries policy (2008) aims at promoting conservation and management of oceans and fisheries resources, enhancing food supply and food security, and developing aquaculture. The policy has implications for coastal mangrove forests, which act as breeding and feeding ground for a number of marine fish species.

3.1.6 Land policy and legislation

Article 11(1) of Land Act (2012) mandates National Land Commission to take appropriate action in maintaining public land that has endangered or endemic species, and critical habitats or protected areas. Under Article 127 and 128 of National Land Policy (2007) the government recognizes a myriad environmental challenges facing the country; including, degradation of natural resources. As part of ecosystem protection and management the Government is required to undertake surveys and develop sustainable land uses. Fragile ecosystems are to be managed and protected through development of integrated land use plans. This management plan acknowledges and addresses the important role played by mangroves for fishery production, biodiversity conservation and shoreline protection; and that they are to be managed in an integrated manner.

3.1.7 County Governments Act, 2012

The system of devolved governance ensures adequate environmental protection through integrated county planning and management. Article 102 (d) obliges County governments to protect and develop natural resources in line with national policies. Article 103 (i) has provisions of County planning to work towards the achievement and maintenance of a tree cover of at least ten per cent of each County area. Article 110 (2) (j) obliges the County government to develop spatial plans indicating the areas designated for conservation and recreation. Article 115 (1)(b) (i, ii)) ensures mandatory public participation through clear strategic environmental assessments and environmental impact assessment reports. Activities proposed in this management plan will ensure provisions of the Act are met, by ensuring integrated management of mangrove areas for environmental sustainability and development of various counties.

Table 3.1: Other Kenyan legislations relevant to mangrove conservation

Legislation	Section relevant to mangroves
Energy Act, No. 12 of 2006	The Act promotes the development and use of renewable energy including providing an enabling framework for efficient and sustainable production, distribution and marketing of biomass and other renewable energy.
Coast Development Authority (CDA) Act, Cap 449	Section 8 of the Act outlines the core functions of CDA, which include Integrated Regional Planning for sustainable utilization, and management of coastal resources, including mangroves.
Water Act, No. 8 of 2002	Article 15 of the Act has provisions geared towards management, conservation and protection of water catchment areas therefore securing mangroves.
Physical planning Act of 2012, Cap 286	Act provides for the preparation and implementation of physical development plans. Sections 4 and 5 of the Act provide for protection of the environment and that development should be in harmony with environmental considerations.
Crops Act, No. 13 of 2013	Seeks to promote and maintain stable agriculture, to provide conservation of the soil and its fertility and to stimulate the development of agricultural land in accordance with the accepted practices of good land management and good husbandry. Farm Forestry Rules, 2009 aim at promoting and maintaining farm forest cover of at least 10 per cent of every agricultural land holding and to preserve and sustain the environment in combating climate change and global warming.

3.2 Links to National Development Plans

3.2.1 Integrated Coastal Zone Management (ICZM) Policy and Action Plan

One of the major challenges facing the management of resources at the coast is the sectoral governance system which does not recognize the interconnectedness of ecosystems in resource management. Consequently, the sectoral approach to development planning and management, combined with population pressure and the intensity and complexity of human activities have resulted in resource user conflicts and adverse socio-economic and environmental effects. The draft Integrated Coastal Zone Management (ICZM) Policy and the Action Plan have identified various measures and strategies for implementation to reverse environmental degradation and promote sustainable utilization of coastal and marine resources. Development of this mangrove management plans is therefore contributing to the implementation of the ICZM Policy and Action Plan.

3.2.2 Kenya Vision 2030

Kenya's development blueprint, Vision 2030, aims at making the country an industrialized middle-income nation, providing high quality of life for all citizens. It aims at ensuring a clean, secure and sustainable environment by 2030. In particular, Vision 2030 aims at increasing forest cover and promoting a clean and healthy environment for every citizen. The vision also aims at improving the country's capacity for adapting to global climatic change and harmonization of environmental laws for improved environmental planning and governance. Forestry development cuts across components of the social pillar and is likely to get central position in driving the country to achieving Vision 2030. Issues of conservation, rehabilitation and sustainable utilization of mangrove resources addressed by this management plan are, therefore, in line with the country's vision 2030.

3.2.3 National Climate Change Response Strategy (NCCRS)

Forests have increasingly been highlighted for their significant role in climate change mitigation. They play a major role in carbon cycling and serve as a major carbon sink that accounts for 60 percent of carbon storage on land. The National Climate Change Response Strategy (NCCRS) provides a framework for re-orienting national programmes towards a low carbon development pathway. The Strategy aims at a climate-proof socioeconomic development anchored on a low-carbon path. The forestry sector has been highlighted as a major vehicle in addressing this goal. Mangrove forests store up to 5 times more carbon than many tropical forests. Most carbon in mangroves is stored as large pools of soil carbon and within roots below-ground. Conservation of mangroves through this management plan can both reduce emissions and facilitate carbon sequestration.

3.3 Links to international Agreements and Conventions

Kenya has ratified several international agreements, protocols and Conventions that impact on forestry. Only five international agreements and conventions that are considered most important for mangroves are discussed below. The rest are summarized in Table 3.2.

3.3.1 Sustainable Development Goals

The Plan puts into consideration Category 13 of the global sustainable development goals (SDG) that concerns mitigations of climate change impacts through activities in the Agriculture, Forestry and Land-use (AFOLU) sectors. The Plan also advocates for activities that incorporate goals 12 (responsible consumption and production) through sustainable forest management, 14 and 15 through protection of mangroves as biodiversity habitats and supporting life below water and on land.

3.3.2 United Nations Framework Convention on Climate Change (UNFCCC)

The United Nations Framework Convention on Climate Change (UNFCCC) sets an overall framework for intergovernmental efforts to tackle the challenge posed by climate change. The Intergovernmental Panel on Climate Change (IPCC) has identified increasing levels of atmospheric carbon dioxide (CO₂) as a major cause of global warming. In 2005, a set of policies known as ‘Reducing emissions from avoided deforestation and forest degradation’ or REDD+ were introduced during COP11 of UNFCCC. REDD+ is concerned with both reducing emissions and enhancing carbon stocks through actions that address deforestation, forest degradation, forest conservation and sustainable forest management. Kenya’s ratification of Kyoto Protocol opens the door to trading in carbon emission reduction credits (CERs) through both compliant and voluntary carbon markets. Evidence from research studies worldwide have shown that mangrove forests are efficient carbon sinks and hence their protection and conservation is vital for climate change mitigation under REDD+ mechanisms.

3.3.3 The Nairobi Convention

The Convention encompasses an ecosystems approach to the management of marine and coastal resources in the Western Indian Ocean (WIO) region. The approach recognizes the effect of the environment on the resource being exploited and the effect of resource exploitation on the environment. This approach ensures that there is a balance between sustainable use and the fair and equitable sharing of the benefits arising out of the utilization of marine and coastal resources over time. The activities postulated in this management plan for mangroves in Kenya are aligned to conform to the Convention.

3.3.4 Convention on Biological Diversity

Biological diversity is a global asset of tremendous value to present and future generations. However, the threat to species and ecosystems is currently very high. General environmental

degradation and in some cases species extinction caused by human activities continues at an alarming rate. In appreciation of the value of global biodiversity and the continued degradation, the United Nations Environment Programme (UNEP) led a process that culminated in the formation of the Convention on Biological Diversity (CBD) in 1992 at the United Nations Conference on Environment and Development (the Rio "Earth Summit"). The Convention on Biological Diversity was inspired by the world community's growing commitment to sustainable development. It represents a dramatic step forward in the conservation of biological diversity, the sustainable use of its components, and the fair and equitable sharing of benefits arising from the use of genetic resources. The implementation of this Plan will greatly contribute to CBDs' Aichi Target 15 that focuses on carbon stock enhancement, biodiversity conservation and ecosystem resilience. Implementation of the management programs outlined in this plan will lead to restoration of degraded mangrove habitat and conservation of biodiversity.

3.3.5 Convention on Wetlands of International importance (Ramsar Convention), 1971

The Ramsar Convention provides the framework for national and international cooperation for the conservation and wise use of wetlands and their resources. In Kenya, Tana River Delta has been designated as a Ramsar site due to its unique and diverse range of coastal wetlands that includes mangroves. Activities proposed in this management plan are in line with the objectives of the Ramsar Convention.

Table 3.2: International agreements, protocols and Conventions that impact on forestry in Kenya

Convention/Agreement	Focus Area	National Focal Institution
African Convention on the Conservation of Nature and Natural Resources, 1968 (as revised in 2003).	Natural Resource Conservation	Kenya Wildlife Services (KWS)
International Convention on Oil Pollution Preparedness, Response and Cooperation (1990)	Oil Pollution at Sea	Transport and Infrastructure
Convention for the Protection, Management and Development of the Marine and Coastal Environment of the East African Region with its Protocols (Nairobi Convention, 1985)	Coastal and Marine Conservation	National Environment Management Authority (NEMA)
Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (1998)	Chemicals	Ministry of Environment and Mineral Resources
Global Programme of Action for the Protection of the Marine Environment from Land Based Activities (1995)	Marine Environment	National Environment Management Authority (NEMA)

3.4 Institutional Capacities

The current and required level of human capacity and infrastructure of the two government institutions responsible for the management of mangroves in Kenya are presented in Table 3.3. From this data, there is an obvious deficit in management resources and personnel in the two lead institutions to effectively manage mangroves in the country. This Plan proposes measures to mobilize resources and address the deficit.

Table 3.3: Human capacity and infrastructure/equipment of KFS and KWS

Institution	KFS			KWS		
	Current No	Required	Deficit	Current No	Required	Deficit
Human Capacity						
HOC	1	1	0			
Ecosystem Conservators	5	5	0			
Zonal manager	1	1	0			
Forest Station Manager	8	11	3			
AD				1	1	0
Senior Warden (2)				4	4	0
Warden				6	8	2
Assistant Warden				6	8	2
Scientists	0	0	0	6	10	4
Forest I	1	7	6			
Rangers	74	125	51	92	253	161
Drivers	4	15	11	20	28	8
Coxswains	2	10	8	14	20	6
Plant operators	0	2	2	0	2	2
Support staff	53	80	27	12	14	2
Infrastructure						
Offices	17	20	3	5	10	5
Resource centers	1	5	4	0	5	5
Boats	2	10	8	8	12	4
Vehicle (4 x 4)	9	20	11	6	12	6
Lorry (Plain and water Bowser)	0	2	2	1	4	3
Grader	0	1	1	0	1	1
Minibus	0	2	2	0	2	2
Motorbikes	9	20	11	0	4	4
Outposts	2	30	28	7	13	6
Housing	2	20	18	2	36	34
Nurseries	0	26	26	0	5	5
HIF- trans receiver radio	0	150	150	6	153	147
Armories	1	16	15	7	26	19
ICT facilities	2	13	11	8	20	12
Water supply system	4	23	19	4	6	2
Electrical installations	2	13	11	6	15	11
Jetties	0	5	5	0	6	6

4 MANGROVE GOODS AND SERVICES

4.1 Values of the forest reserve

Mangroves provide goods and services that are of economic, ecological, and environmental values at local, national and international levels. Some of the important goods and services provided by mangroves in Kenya are discussed below based on the broad Millennium Ecosystem Assessment (MEA, 2015) categories of provisioning, regulatory, supporting, and cultural functions.

4.1.1 Provisioning services

Mangroves provide diversity of wood and non-wood forest products; including building poles, firewood, local medicine, and fishery resources. The most preferred mangrove species for poles are *Rhizophora* and *Ceriops* due to their excellent wood quality and resistance to termites. The same species are preferred for fuel wood because of their high calorific value, good burning characteristics under wet conditions, which reduce unnecessary wood processing cost and time (especially drying) before use.

Building poles and firewood constitute the major wood products extracted from the mangrove forests and, hence, their extraction contributes the most in terms of economic importance through revenue generation and job creation. It is estimated that 70% of the wood requirement by the local communities adjacent to the forest is met by mangroves. Tables 4.1 and 4.2, below show the amount of mangrove wood products extracted in each of the coastal counties in the last 12 years. While the tables provide trends for extraction of mangrove wood products, there were major data gaps between 2003 and 2007. The missing data coincided with the period when most forest officers were put on compulsory leave across the country. The same period coincided with major destruction of forests across the country including mangroves. For the sake of planning, the missing data have been adjusted using correlation values. Overall there is limited data available for Mombasa County on pole removal from mangrove forests.

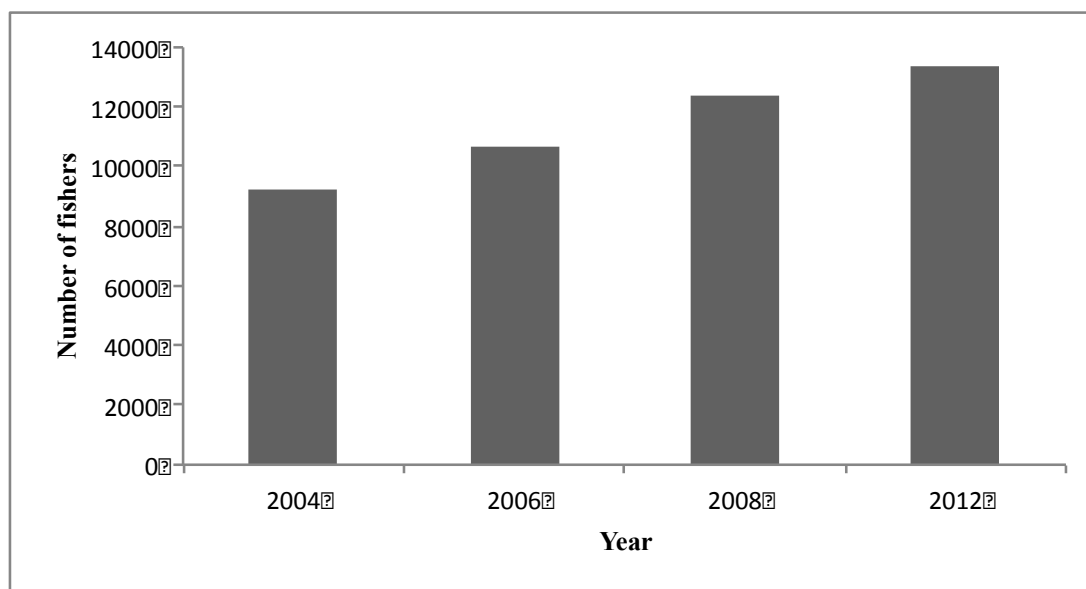
Non-wood forest products extracted from mangrove forests include fisheries, herbal medicines, tannins, and fodder. More than 85% of fishing activities along the coast are carried out by artisanal fishermen in the shallow inshore areas within and adjacent to the mangroves directly employing more than 20,000 fishers. The number of artisanal fishers has increased progressively between 2004 and 2012 (Fig. 4.1).

Table 4.1: Wood products extracted from mangrove forests in the last 12 years

County	No. of scores of poles											
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Kwale	560	660	363	960	1029	704	478	387	456	472	478	454
Mombasa	-	-	-	-	-	-	-	-	-	-	-	103
Kilifi	120	150	184	98.4	111	152.5	135	122	91.5	96	100	95
Tana River	110	120	250	379	111	74	90	50	70	82	92	87
Lamu	4250	4200	3400	3660	3003.5	2284	3768	21577	72984	23224	96531	96103
TOTAL	5040	5130	4197	5097	4255	3215	4471	22136	73601	23874	97201	96739

*(Source: KFS records)***Table 4.2:** Fuel wood products extracted from mangrove forests of Lamu in the last 12 years

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Volume (m ³)	153.7	666.6	358	63	130	48.5	15.9	1300	2623	970	519	277

(Source: KFS records)**Figure 4.1:** Trends in number of artisanal fishers at the Kenyan coast

Additionally, local communities harvest honey from mangrove forests. At Gazi Bay, local communities are reported to harvest more than 2.0 tons of honey per year from 24 hives installed

in mangrove areas. Similar initiatives have been implemented in Mida creek and Kwetu in Kilifi County.

4.1.2 Regulating services

Mangroves play an important role in shoreline protection; as such, they are increasingly being promoted and used as a tool in coastal defense strategies. It has been reported that mangroves can reduce the height of wind and swell waves by up to 66% over 100 m. Diminished energy of incoming waves lessens the risk of flooding to communities that live behind mangroves. Using the replacement cost method, the value of mangroves to shoreline protection in Kenya has been estimated at KES 120,000 ha⁻¹ yr⁻¹ (Table 4.3). Planting mangroves for shoreline protection has been undertaken at Gazi bay and Ngomeni with good success.

In the context of climate change, the global role of mangroves as carbon sinks has become more appreciated as they sequester more carbon than any productive terrestrial forest. Carbon stocks in mangroves of Kenya has been found to range from 500 – 1000 tC ha⁻¹; which is 10 times higher than the average carbon content of terrestrial forests in the country. Consequently, degradation and conversions of mangroves would lead to large-scale carbon emissions. As such, halting the current decline and restoring degraded areas of mangroves may form an important part of National Appropriate Mitigation Actions (NAMA) on climate change. The carbon that is captured by mangrove could also be accounted for and sold into the international carbon markets. For instance, a local community group at Gazi is engaged in the trading of mangrove carbon credits into voluntary market. Annual sale of 3000 tCO₂-equivalent from mangroves of Gazi is generating an income of more than KES 1.0 million every year to the community. This initiative could be up-scaled to other mangrove areas under the national REDD+ scheme. Mangroves are also capable of absorbing pollutants such as heavy metals and other toxic substances, as well as nutrients and suspended matter. This makes them natural wastewater filters, preventing many pollutants from reaching deeper waters.

4.1.3 Supporting services

Mangrove ecosystems provide numerous support services which include; structural habitat, nutrient cycling, primary production, soil formation, among others. They support sustenance of coastal biodiversity by acting as nurseries, breeding, spawning, hatching and feeding habitats for fish, as well as refuge for juvenile fish. Materials from mangrove forests are pumped into the aquatic system as leaves, twigs, flower buds, detritus etc. These materials then enter in sequence through the detritus feeders (shellfish and other invertebrates), primary consumers and secondary consumers. Coastal communities harvest various components of this food web as food. It is estimated that 70% of commercial fishery species depending in one way or another on the mangroves as breeding and feeding habitats. Other fauna supported by mangrove environment include mollusks, crustaceans, reptiles, mammals and birds. Based on empirical data, the value of mangroves to fisheries in Kenya has been estimated at KES 9,612 ha⁻¹ yr⁻¹ (Table 4.3).

Table 4.3: Valuation of mangrove ecosystem in Kenya

Product and services	KES ha⁻¹yr⁻¹
Building poles	30,659.5
Fuel wood	4,505.0
Onsite fisheries	9,612.7
Beekeeping	1,249.5
Integrated aquaculture	408.0
Education & Research	65,469.6
Tourism	782.0
Carbon sequestration	21,896.0
Shoreline protection	134,866.1
Total	269,448.3

(Source: KMFR)

4.1.4 Cultural services

Mangrove ecosystem represents a closely woven long-term relationship between people and the environment. The rich biodiversity of mangrove ecosystems has provided a variety of food and material resources, which had sustained ecosystem balance as well as traditional and sustainable means of livelihoods for centuries. Some mangrove areas such as Chale Island in Kwale County, have been set aside by communities as sacred sites (Kaya forests) where tree extraction is forbidden by customary laws. Mangrove ecosystems support research activities and education, in addition to providing opportunities for tourism and recreation. The tourism industry around the mangrove ecosystem promotes employment both directly and indirectly. Some local community groups in areas such as in Wasini, Gazi and Mida creek have exploited the ecotourism potential of mangroves through the construction of boardwalks. At Wasini boardwalk alone, the income generated through mangrove tourism has been estimated to be more than KES 2.5 million per annum. Similar ventures are being promoted in other mangrove areas of Mombasa and Lamu. The biggest challenge in using mangrove areas for ecotourism has been the failure to sustain the number of visitors.

4.2 Threats to mangroves

Mangrove forests in Kenya face a number of threats arising from both anthropogenic and natural factors. Between 1985 and 2009, the country lost about 20% of its mangrove cover; translating to about 450 ha of mangrove cover loss and degradation per year. The loss was exceptionally high in the peri-urban mangroves of Mombasa where more than 70% cover loss was recorded; mostly due to human factors. The threat on mangrove ecosystems in Kenya is mainly posed by human and natural factors as discussed below.

4.2.1 Human-induced threats

a. Over-exploitation of wood products

The quantity of mangrove poles to be removed from a particular mangrove area is based on subjective assessment of forest conditions rather than actual resource base. As a result, good quality wood is rapidly diminishing and in some areas there is a risk of local extinction of some mangrove species. The most likely species to be depleted are *Xylocarpus granatum* and *Heritiera* due to their rarity and high quality wood. On the other hand, *Rhizophora* and *Ceriops* are the most targeted hence might suffer over-exploitation. In most mangrove areas of Kwale and Mombasa counties, the proportion of harvestable poles of mazio and boriti has reduced to less than 10% of the total stand density (Fig. 5.7). At Manda Island in Lamu, non-selective harvesting of fuel wood for traditional chalk making has created contiguous blank areas with no natural regeneration. Urban areas including Tudor Creek in Mombasa has recorded losses averaging to 80% of the vegetation cover mainly through over exploitation for fuel wood.

b. Conversion of mangrove areas to other land uses

Clearing of mangroves for salt extraction is quite extensive at Gongoni-Kurawa area in Malindi. Large rectangular tracts of mangroves are converted into salt pans where seawater is fed and allowed to evaporate after which the salt is collected. A total of eight operational salt works operate in Kenya and occupy more than 7,922 ha of tidal swamps between Gongoni and Kurawa, producing some 70,000 ton yr⁻¹ of raw salt. Large-scale salt production has contributed to loss of mangroves and creation of discontinuous patches of forest in Tana River and Kilifi counties. In addition, conversion of mangroves for salt works has resulted in social problems in these areas such as restriction of access to the sea and contamination of freshwater tables through increased salinities.

c. Aquaculture

Trial shrimp aquaculture in mangrove areas was initiated by State Department of Fisheries at Ngomeni in 1980s. The trials recorded a production of 4.0 t ha⁻¹ yr⁻¹; which is comparable to yield obtained in South East Asia. However, this venture did not proceed beyond trial stage leading to a loss of 100 ha of mangrove forests. The heightened interests in aquaculture across the country has seen many communities along the coast partnering with the government and NGO's to establish pond aquaculture in mangrove areas. Juvenile fish and crabs caught from the wild are stocked in the pond and fed with commercial feeds. Sustainability of these small-scale aquaculture enterprises in mangrove areas is yet to be achieved, as many communities never proceed beyond the first harvest, leaving out ponds to be silted. On conservative terms, 1.0ha of pond aquaculture requires approximately 160 ha of mangroves to be sustainable. This factor has to be considered before venturing into aquaculture in mangrove areas.

d. Pollution and sedimentation

Mombasa is a major sea port in Kenya housing the largest oil refinery in the East African region. The port is subject to accidental oil spills from vessels during loading, discharging, and bunkering. These accidental spills severely damages mangrove ecosystems. Clean-up operations after such calamities are costly and difficult. Oil spills in mangroves have a number of significant consequences including death of trees and associated fauna.

Between 1983 and 1993, the port of Mombasa and its adjacent waters experienced 5 tanker accidents spilling a total of 391,680 tons of oil. A major spill in 1988 totally destroyed the mangroves of Makupa Creek. The Makupa Creek mangrove system has not fully recovered 27 years later; while the oil has sunk into sediment causing frequent re-oiling. This observation is consistent with conditions observed in major oil spills in mangrove areas around the world. Another oil spill occurred in 2005 when a ship hull was punctured releasing 200 tons of crude oil into the marine environment. Due to an extremely high tide, oil penetrated far into the mangrove forests of Port Reitz coating leaves as well as stems, trunks, and sediment; and causing immediate death of fish and crabs. With the development of the Lamu Port, which will be larger than Mombasa Port, and the discovery of oil in the region, spills incidences are expected to increase.

Development projects in urban areas are also likely to lead to increased sediment loading of the adjacent marine environment, including in the mangroves. Some of the activities that result in increased sediment loads downstream include poor agricultural practices in the river basin and forest degradation upstream among others. The lack of functional sewage treatment plants in most urban areas has resulted in mangrove swamps being used as sewage dumping sites.

Mangroves in peri-urban areas are exposed to solid waste dumping due to laxity in the enforcement of environmental best practices. The Makupa Creek mangrove system is under threat of extinction mainly due to the encroachment of the Kibarani dumpsite.

e. Diversion and damming of rivers

The diversion and damming of rivers leads to hydrological changes, which in turn affects the ecosystems associated with the rivers. In Kenya, one example is demonstrated in Kwale County, the R. Mkurumudzi that drains into the Indian Ocean through the Gazi Bay mangroves is being dammed to irrigate sugar plantations and process mining of titanium. This will impact negatively on the Gazi Bay mangroves, altering their structure and functions. The mining activities will result in physical alterations of habitats, atmospheric discharges, and increased sediment loads into the mangroves while plantation agriculture and major development projects are likely to lead to reduced fresh water flow as well as increased deposition in the mangroves.

f. Infrastructure and development

The rapid urbanization of the coastal zone potentially threatens the mangrove resources through both human encroachment and increased demand for mangrove resources. The increasing levels of infrastructure development, including the Lamu port, could be a potential environmental threat. Similarly, Mombasa Port Area Road Development Project (MPARD) will traverse across Port Rietz Creek and adjacent creeks that are of high resource values; and inhabited by various assemblages of mangrove species. A compensatory planting of 64 ha of mangroves is proposed to mitigate mangrove lost through MPARD.

4.3 Natural threats

Mangroves in Kenya do not seem to suffer a great deal from natural causes. However, a few cases have occurred, for example where mangroves have died due to massive sedimentation caused by extreme events. During the 1997/8 El Niño phenomenon, sedimentation and prolonged water stagnation triggered by abnormally heavy rainfall caused widespread mangrove die-backs in Lamu, Tana River, Mombasa and Gazi Bay. In Mwache creek, for example, at least 500 ha of mangroves were affected by the El Niño rains. Natural regeneration of the affected areas has proved to be slow because of the loss of mature trees for producing seed and in changed hydrological patterns. Other reported natural causes of mangrove degradation in Kenya include pest infestation and desiccation. Predicted sea-level rise (SLR) due to climate change is likely to affect the low-lying mangrove areas. However, mangroves may adapt to SLR by landward transgression (subject to local topography and coastal development) and/or sediment accretion (depending on local sediment supply) to keep pace. Land-use planning in general and mangrove management specifically will need to incorporate different scenarios of SLR.

4.4 Problem analysis

Degradation of mangrove forests is due to multiple causes that disrupt the natural equilibrium leading to depletion of the resource. This depletion does not only occur within the mangrove boundaries, but also in the adjacent coastal and marine ecosystems. Identification of root causes of mangrove degradation is important in the development of mitigation strategies. Some of the root causes of mangrove degradation are described below.

4.4.1 Weak governance

Governance and institutional frameworks play an important role in forestry management in Kenya. The enactment of the Forest Conservation and Management Act (2016) provided a framework in which sustainable forest management, including mangroves, could be achieved. However, governance and institutional problems still persist which have exacerbated mangrove degradation. These issues include: (i) weak enforcement of existing legislations; (ii) lack of mangrove management policy; (iii) an uncoordinated sectoral approach to management due to overlapping or conflicting mandates; (iv) lack of effective coastal planning; (v) inadequate

institutional capacities; and (vi) poor stakeholder or community participation.

4.4.2 Poverty and economic development

Poverty and loss of livelihoods are some of the strongest underlying root causes of widespread degradation of natural resources throughout the country and the coast in particular. Many counties at the coast record some of the highest rates of poverty (>70%); leading to high dependence on primary resources with limited alternatives. Mangrove degradation has been found to be higher in peri-urban ecosystems (e.g. Mombasa mangroves) where they suffer from compounded pressures. Population increase due to immigration and setting up of informal settlements without supporting amenities has become a common feature in many urban areas in the region leading to elevated discharge of domestic wastes and direct pressure on contiguous coastal ecosystems. Increasing development has also precipitated environmental and mangrove degradation. Dredging, port expansion and development have led to mangrove degradation in Mombasa and Lamu. Provision of alternative livelihoods in addition to compensatory restoration provided for under EMCA (1999) will need to be enforced in order to mitigate the loss.

4.4.3 Inadequate knowledge and awareness

While the services and goods provided by mangroves have been appreciated over the years, the resources continue to be degraded and transformed. Mangroves tend to be appreciated by direct goods extracted from the forest (e.g. wood and fisheries); and yet their intrinsic value (e.g. shoreline protection, carbon sequestration, biodiversity conservation, among others) have even higher values but they are not easily quantifiable in terms of market prices. This paucity in information makes mangrove forests vulnerable when choices have to be made between conservation and development.

In many cases, there is lack of awareness on the extent of ecosystem degradation due to limited survey and mapping data. Lack of spatial-temporal data impairs management and policy decision-making.

5 SITUATION ANALYSIS OF THE MANGROVES OF KENYA

5.1 Mangroves of Lamu County

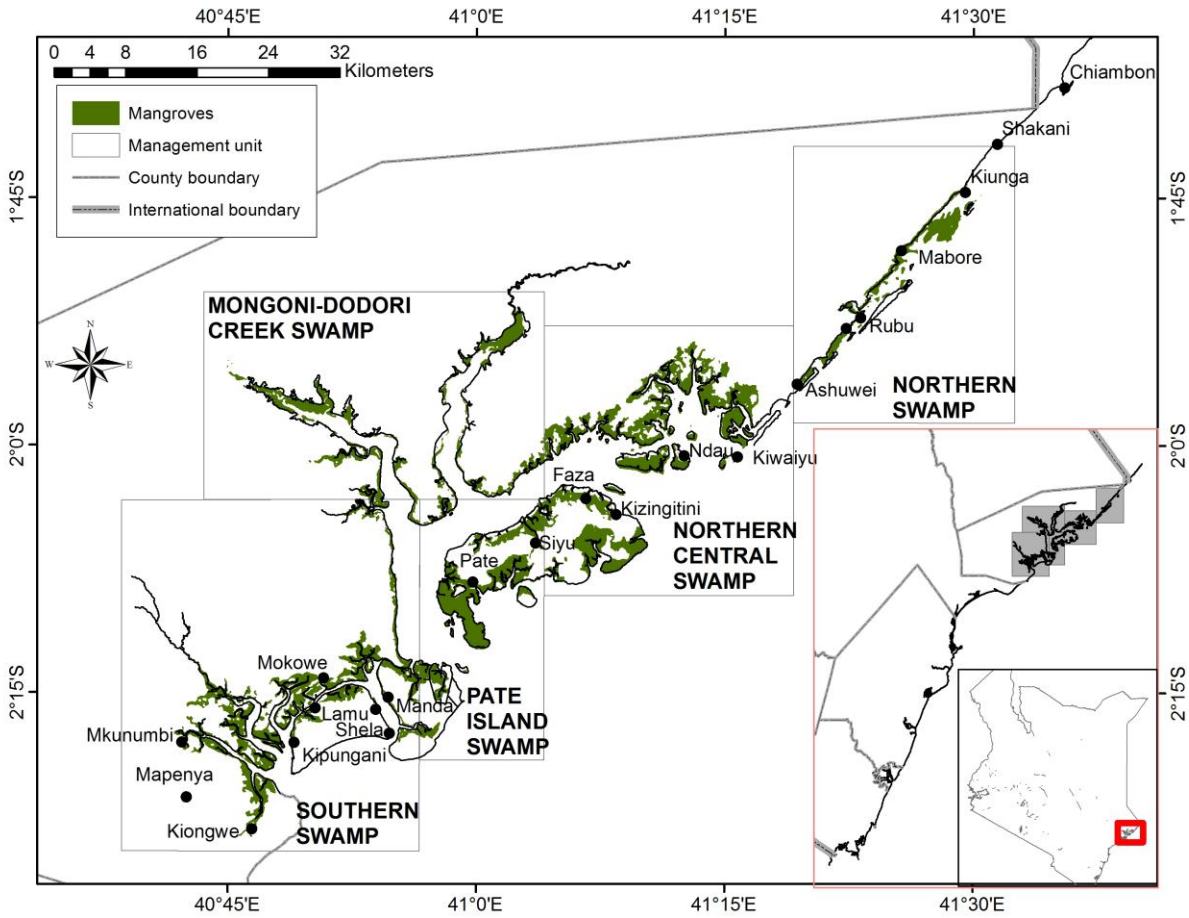


Figure 5.1: Distribution of mangrove forests in Lamu County within the five mapping units

Mangroves of Lamu County cover approximately 37,350 ha, equivalent to 62% of the mangrove coverage in Kenya. These forests are dominated by mixed stands of *Rhizophora* that accounts for 8,649 ha (approximately 23%) of the total forest formation (Table 5.1). Other prominent forest formations in Lamu are pure stands of *Avicennia*, particularly on the landward side with freshwater inflows as well as stands of *Ceriops* in the mid-zone of the forest.

Table 5.1: The area of mangrove formation in Lamu County

Classification	Area (ha)	% cover
<i>Avicennia</i>	6,966	18.7
<i>Avicennia</i> mix	1,961	5.3
<i>Ceriops</i>	5,155	13.8
<i>Ceriops</i> mix	1,901	5.1
<i>Ceriops-Rhizophora</i>	5,138	13.8
<i>Rhizophora</i>	5,558	14.9
<i>Rhizophora</i> mix	8,649	23.2
<i>Sonneratia</i>	1,165	3.1
<i>Sonneratia-Rhizophora</i>	856	2.3
Total Mangrove cover	37,350	100

5.1.1 Major mangrove areas in Lamu County

Mangroves of Lamu County are classified into five mapping units namely; Northern Swamps, Pate Island Swamps, North Central Swamps, Southern Swamps, Mongoni and Dodori Creek Swamps (Fig. 5.1; Table 5.2). For the purpose of this plan, the mangroves are divided into those inside Kiunga Marine National Reserve (KMNR), occurring mostly in the Northern Swamps and parts of the Northern Central Swamps; and those outside the reserve. Total mangrove forest area in the KMNR is estimated at 7,628 ha equivalent to 20.4% of the total mangrove coverage in Lamu County. This area is dominated by pure stands of *Rhizophora* and is relatively pristine with an average stand density and volume of 2,225 stems ha⁻¹ and 382.8 m³ ha⁻¹ respectively (Table 5.3). The mangroves of the KMNR, particularly at Mambore and Rubu, are the most complex mangroves in Kenya in terms of tree height, diameter and productivity.

Mangrove exploitation within KMNR is restricted to traditional uses owing to its protection status as an MPA.

Table 5.2: Description of the five mangrove management units of Lamu County and their respective areal coverage (Values in parenthesis are % proportion cover of each block).

Management block	Description	Areal cover (ha)
Northern swamps	Extends from Kiunga to Mlango wa Chano and is dominated by pure stands of <i>Rhizophora</i>	3,160 (8)
Northern Central swamps	Extends from Mlango wa Chano to the mouth of Dodori Creek, including Uvondo and Ndau islands. The dominant trees are <i>Ceriops</i> and <i>Rhizophora</i> .	12,850 (34)
Mongoni and Dodori Creek swamps	Comprise the mangroves found on the banks of Mongoni-Dodori Creek and Manda Bay. Stocked mainly with <i>Ceriops</i> stands.	6,400 (17)
Pate Islands swamps	Includes the mangroves surrounding Pate Island, Shindabwe, Kizingitini and Chongoni.	9,740 (26)
Southern swamps	Largest of the five mangrove regions of Lamu. Include mangroves of Mkunubi and Kimbo Creeks.	5,200 (14)

Mangrove forest outside KMNR comprises Southern Swamps, Mongoni-Dodori Creek Swamps, Pate Island Swamps, and North Central Swamps, covering a total of 29,722 ha, equivalent to 79.6% of the total mangroves in Lamu County. These forests are dominated by pure stands of *Ceriops* and *Rhizophora* with an overall standing volume of $220.1 \text{ m}^3 \text{ ha}^{-1}$, of which only $9.64 \text{ m}^3 \text{ ha}^{-1}$ (or 4.4%) are merchantable. There is however a huge opportunity to increase the cover of mangrove outside the reserve through enrichment planting and improved management with a total area of 14,407 ha requiring restoration.

Commercial harvesting of mangroves occurs in the North Central Swamps at Ndau, Uvondo, and Siyu areas. Further, use of mangroves in traditional chalk kiln has depleted mangroves at Pate, Yowea, and Manda Islands. Clear felling for fuelwood is carried out in parts of Manda and Pate Islands while huge areas impacted by the 1997-98 El-nino rains in Dodori Creek and parts of Southern Swamps have not recovered to-date due to poor natural regeneration.

Table 5.3. Stand tables for the mangrove forests of Lamu County

Species	Kiunga Marine National Reserve									Density Stems ha ⁻¹	Volume m ³ ha ⁻¹
	<7.5	7.5-10	10-12.5	12.5-15	15-17.5	17.5-20	20-25	25-30	>30		
<i>Avicennia marina</i>	21	20	12	6	8	13	12	4	3	90	9
<i>Bruguiera gymnorhiza</i>	2	6	6	3	4	3	2	3	2	42	5
<i>Ceriops tagal</i>	328	143	74	24	13	6	6	0	0	594	15
<i>Rhizophora mucronata</i>	339	195	139	165	124	112	145	77	99	1,393	332
<i>Sonneratia alba</i>	13	18	19	13	9	10	13	8	10	107	22
Total	702	381	248	209	157	144	178	92	114	2,225	383
Species	Outside Kiunga Marine National Reserve									Density Stems ha ⁻¹	Volume m ³ ha ⁻¹
	<7.5	7.5-10	10-12.5	12.5-15	15-17.5	17.5-20	20-25	25-30	>30		
<i>Avicennia marina</i>	200	44	38	21	13	10	18	21	21	385	42
<i>Bruguiera gymnorhiza</i>	8	3	0	3	5	0	3	0	0	21	2
<i>Ceriops tagal</i>	459	77	31	13	8	0	3	3	3	595	8
<i>Rhizophora mucronata</i>	582	164	95	72	38	49	74	36	41	1,151	128
<i>Sonneratia alba</i>	49	18	26	13	31	26	28	13	21	223	41
Total	1,297	305	190	121	95	85	126	72	85	2,371	220

5.1.2 Utilization patterns of mangroves in Lamu

Use of mangrove wood products for construction and fuelwood are ranked highest among benefits accrued from mangrove forests by the local community (Table 5.4). Illegal harvesting of mangroves is perceived as the major threats facing mangroves of Lamu County. Illegal harvesting is common in Pate and Manda Island where removal of mangrove wood for use in traditional lime making has led to contiguous bare mangrove areas that may take a long time to recover naturally.

Table 5.4. Ranking of benefits and major threats of mangroves in Lamu County

Rank	Benefits	Threats
1	Construction poles	Illegal harvesting
2	Fuelwood	Pollution (Oil spills)
3	Fish production	Overexploitation
4	Coastal protection	Coastal development
5	Beekeeping	Sedimentation

5.1.3 Action Points specific to Lamu County

- a. Ensure strict enforcement of laws and regulations especially licensing of mangrove harvesting to control over harvesting.
- b. Initiate reforestation programmes to restore degraded mangrove areas.
- c. Empower communities adjacent to the mangrove to form CFAs and partner with the government in the management of mangroves of Lamu.
- d. Develop and implement harvesting plans that would guide mangrove exploitation.

5.2 Mangroves of Tana River County

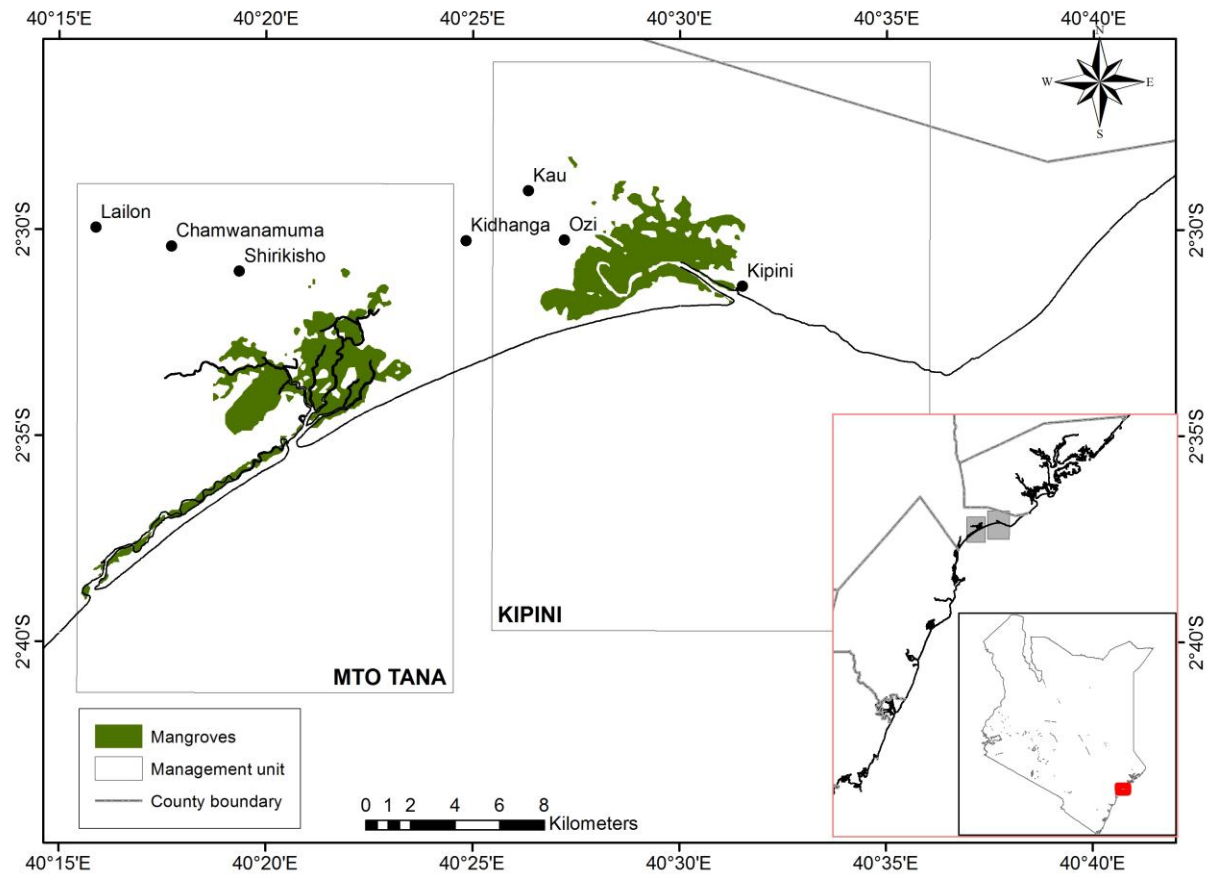


Figure 5.2: Distribution of mangroves forests in Tana River County within the two mapping units

Tana River County mangrove forests cover a total area of 3,260 ha stretching from Ngomeni to Kipini (Fig. 5.2), with around 87% of the forest composed of pure stands of *Avicennia*; followed by stands of *Bruguiera* mixed with *Heritiera* and *Xylocarpus* (Table 5.5). Tana River basin is unique in its mangrove resources especially in the area around Kipini, since it has the only large stand of *Heritiera* in Kenya. Mangrove associated species in Tana River include *Barringtonia racemosa* and *Thespesia sp.* that exists such thick shrubs on the water side of the river; as well as *Sueda monoica* on the landward side. In 2012 the Tana River Delta was designated a Ramsar site because of the uniqueness of the delta in terms of biodiversity and support to humankind.

5.2.1 Major mangrove forest areas in Tana River County

i. Kipini

Kipini is an estuarine system where the larger Tana River opens into the ocean with a total mangrove forest cover of 1,257 ha. The stocking rate of mangroves in Kipini is 990 stems ha^{-1} with a volume of $162.88 \text{ m}^3 \text{ ha}^{-1}$ of which only 11% are merchantable. While forests fringing the waterways have tree heights exceeding 25 m; on average canopy height in Kipini is 5.0 -7.4 m with a DBH of 5.0 -10.0 cm. Due to heavy cutting, conversion to agriculture, and siltation, almost 50% of the forest area in Kipini is degraded. With juvenile density of 5,000 to 10,000 individual ha^{-1} natural regeneration in the degraded areas of Kipini is considered adequate as per FAO guidelines on mangroves. Nevertheless enrichment planting is required in areas with poor regeneration.

ii. Mto Tana

Mangrove forest of Mto Tana covers 2,003 ha; and includes the forests in Challa, Samakiru and Elephant point. The forest is dominated by pure stands of *Avicennia* most of which are of dwarf form with average tree height of less than 5.0 m. The stocking density of mangroves in Mto Tana is 1,224 stems ha^{-1} with an average stand volume of $43.64 \text{ m}^3 \text{ ha}^{-1}$ of which only 21% are merchantable. As low-lying coastal areas, mangroves of Mto Tana may face considerable threat by sea level rise as well as pressure to convert mangrove land for other land uses, including; salt works and mariculture.

Table 5.5: The area of mangrove formation in Tana River County

Classification	Area (ha)	% cover
<i>Avicennia</i>	2,848	87.4
<i>Avicennia mix</i>	159	4.9
<i>Bruguiera; Heritiera; Xylocarpus</i>	253	7.8
Total Mangrove	3,260	100

*Mangrove associates

The average stocking density of the mangroves in Tana River County is 2,218 stems ha^{-1} , with a standing volume of 206.5 $\text{m}^3 \text{ha}^{-1}$ (Table 5.6); out of which 23% is merchantable. *Heritiera* is heavily harvested for timber as mast for boats. The harvested timber is transported to Malindi and other urban centers.

**Plate 1:** A replanted mangrove stand at Gazi Bay, Kwale County

Table 5.6: Stand table for the mangrove forests of Tana River County

Species	Size / utilization classes								Density Stems ha ⁻¹	Volume m ³ ha ⁻¹
	Fito	Pau	Mazio	Boriti	Nguzo1	Nguzo2	Nguzo3	Banaa		
	2.5-3.9	4.0-7.9	8.0-11.4	11.5-13.9	14.0-16.9	17.0-20.4	20.5-30.4	>30.5		
<i>Avicennia marina</i>	265	646	214	50	47	43	50	6	1321	59
<i>Bruguiera gymnorhiza</i>	8	17	7	0	4	0	10	8	54	18
<i>Ceriops tagal</i>	299	229	22	7	10	7	1	1	576	8
<i>Heritiera littoralis</i>	19	36	11	24	11	14	32	29	176	103
<i>Rhizophora mucronata</i>	1	1	3	0	0	0	0	0.0	5	<1
<i>Xylocarpus granatum</i>	13	49	10	4	3	0	1	6	85	19
Total	605	978	267	85	75	64	94	50	2218	207

5.2.2 Utilization pattern and major threats

Mangrove harvesting is a livelihood activity for local communities living in Kipini and Ozi villages. Amongst accrued benefits of mangroves of Tana River, use of mangrove wood for construction is ranked highest. Community groups in the delta are also engaged in non-consumptive utilization of mangrove resources such as beekeeping, small-scale fisheries, and integrated aquaculture. There is high potential for tourism development in the mangrove areas of Tana. Illegal harvesting as well as sea-level rise are perceived as the major threats facing mangroves of Tana (Table 5.7).

Table 5.7: Ranking of benefits and major threats of mangroves in Tana River County

Rank	Benefits	Threats
1.	Construction poles	Illegal cutting
2.	Fishing	Climate change (flooding, sea level rise, salt water intrusion, sedimentation)
3.	Fuel wood	Encroachment of mangrove areas for human settlement
4.	Medicinal	Dams upstream
5.	Tourism	

5.2.3 Actions specific for Tana River County

Being the only extensive riverine mangrove forest in Kenya, Tana River is exceptional and as such conservation of the ecosystem is recommended. This is where the only mature stands of *Heritiera* forests in the country are found. Conservation actions specific to Tana river include the following:

- a. Promote agro-forestry and woodlots on individual farms to reduce pressure on mangrove resources
- b. Partner with communities and other stakeholders in the rehabilitation of degraded mangrove areas with suitable species
- c. Promote programmes that help in adaptation of climate change effects

5.3 Mangroves of Kilifi County

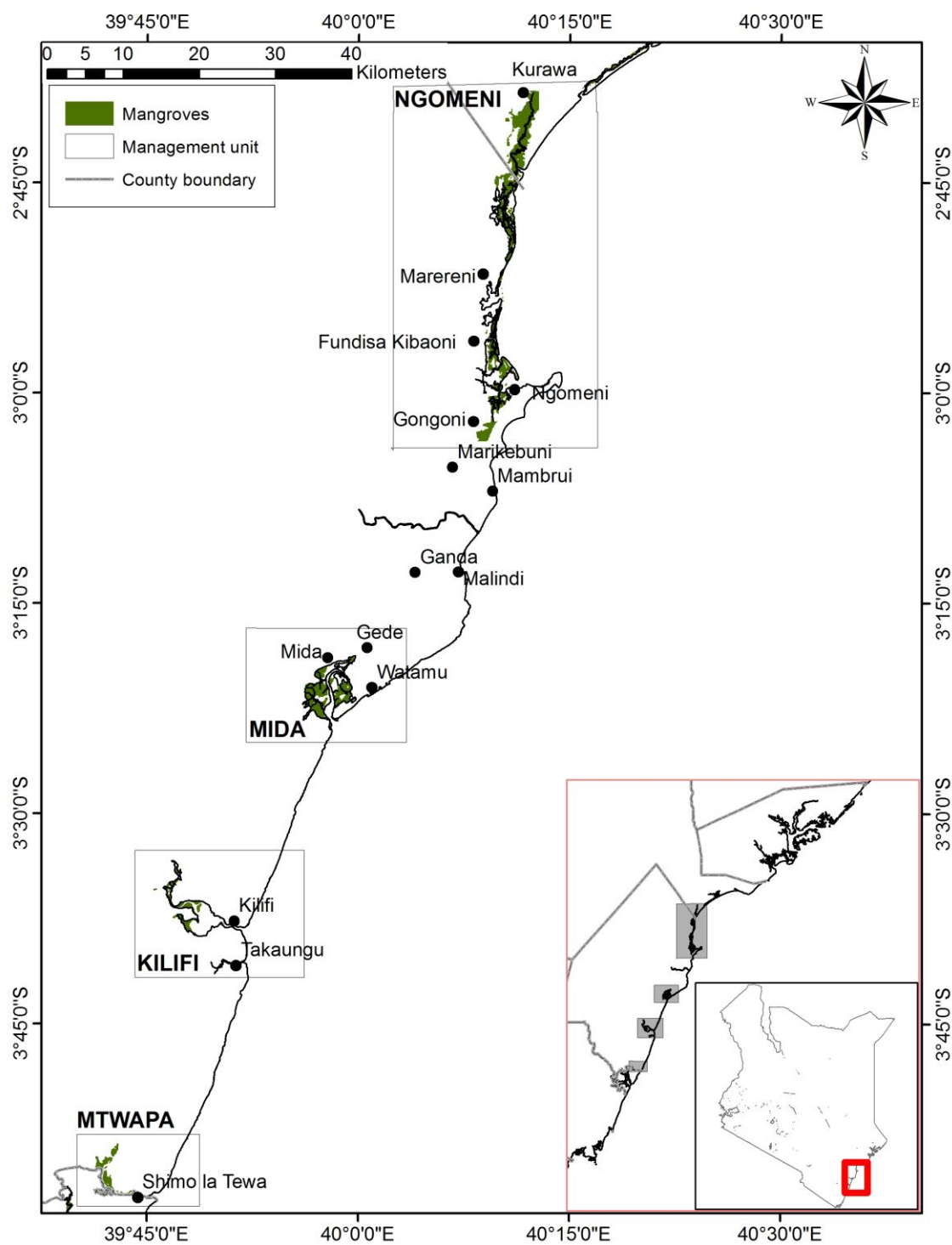


Figure 5.3: Distribution of mangrove forests in Kilifi County within the four management units

In Kilifi County, mangroves occur in small patches stretching from Mtwapa creek to Ngomeni. Major mangrove areas in the county include, Mtwapa, Kilifi-Takaungu, Mida and Ngomeni (Fig. 5.3). In general, there are approximately 8,535 ha of mangroves in Kilifi County with Ngomeni covering almost 50% of the total area. The major forest types are pure stands of *Avicennia* followed by mixed *Rhizophora* stands (Table 5.8).

5.3.1 Mangrove areas in Kilifi

i. Mtwapa

Mtwapa is a peri-urban mangrove forest at the border of Kilifi and Mombasa counties. The forest covers an area of 716 ha and is highly fragmented. Mean tree height in Mtwapa is 3.1 m with diameter of 4.3 cm; which are lower as compared to other areas of Kilifi County. The stocking density of mangroves in Mtwapa is 6,568 stems ha⁻¹ with a standing volume of 32.8 m³ ha⁻¹; out of which only 17% are merchantable. An area of 394 ha of this mangrove system requires rehabilitation.

ii. Kilifi –Takaungu

The area of mangroves in Kilifi-Takaungu area is about 1,834 ha. Most of these forests are dwarf stands of tree height 3.9 m with a diameter of 6.6 cm. Nearly 80% of the forests in Kilifi-Takaungu are of crooked nature with tree heights of less than 5 m. The stocking rate of the forest in the area is 2,584 stems ha⁻¹ with a volume of 101.2 m³ ha⁻¹; of which only 22% is merchantable. The major threat to this mangrove forest is sedimentation brought about by poor farming system on adjacent agricultural land. Nearly 1,100 ha of degraded areas of Kilifi-Takaungu require rehabilitation.

iii. Mida Creek

Mangroves of Mida Creek are part of Watamu Marine Protected Area (WMPA). Total mangroves area in Mida is estimated at 1,746 ha and is dominated by *Rhizophora-Ceriops* type forest. The average stocking rate of mangroves in Mida is 3,511 stems ha⁻¹, with a volume of 92.7 m³ ha⁻¹; of which 42% is merchantable. The major threats of mangroves in Mida have been identified as illegal logging as well as land encroachment. The area requiring assisted rehabilitation is 402 ha.

iv. Ngomeni

Ngomeni has the largest mangrove area in Kilifi County, covering a total area of 4,240 ha. The stocking density of the mangroves in Ngomeni is 2,015.2 stems ha⁻¹, with a volume of 187.5 m³ ha⁻¹ of which 34% is merchantable. The mean height is 6 m, with a mean diameter of 8.1 cm. The area is prone to wind throw causing siltation and eventually death of the mangroves.

Mangroves at Ngomeni are also under threat from land conversion for aquaculture and solar salt pond. The area requiring rehabilitation is 1,526 ha.

Table 5.8: The area of mangrove formation in Kilifi County

Classification	Area (ha)	% cover
<i>Avicennia</i>	2,714	31.8
<i>Avicennia</i> mix	898	10.5
<i>Ceriops</i>	439	5.1
<i>Ceriops</i> mix	1,038	12.2
<i>Ceriops-Rhizophora</i>	737	8.6
<i>Rhizophora</i>	318	3.7
<i>Rhizophora</i> mix	1,920	22.5
<i>Sonneratia</i>	271	3.2
<i>Sonneratia-Rhizophora</i>	201	2.4
Total mangrove forest area	8,536	100

The average stocking density of the mangroves in Kilifi County is 3,227 stems ha⁻¹ with an average volume of 101.5 m³ ha⁻¹; 32% of which is merchantable (Table 5.9). Natural regeneration seems adequate in some degraded areas of Kilifi, particularly Mida Creek where replanting is not necessary. The area requiring restoration in Mtwapa, Takaungu and Ngomeni, is 3,244 ha (38%).

Table 5.9: Stand table for the mangrove forests of Kilifi County

Species	Size / utilization classes								Density Stems ha ⁻¹	Volume m ³ ha ⁻¹
	Fito	Pau	Mazio	Boriti	Nguzo1	Nguzo2	Nguzo3	Banaa		
	2.5-3.9	4.0-7.9	8.0-11.4	11.5-13.9	14.0-16.9	17.0-20.4	20.5-30.4	>30.5		
<i>Avicennia marina</i>	84	135	44	15	16	12	23	12	342	26
<i>Bruguiera gymnorhiza</i>	24	32	9	5	1	3	7	6	87	12
<i>Ceriops tagal</i>	720	508	56	12	5	5	5	1	1,311	12
<i>Rhizophora mucronata</i>	595	593	95	34	14	18	45	12	1,407	46
<i>Sonneratia alba</i>	7	20	8	5	6	3	4	0	52	3
<i>Xylocarpus granatum</i>	5	8	2	2	2	3	5	0	28	3
Total	1,436	1,295	214	73	44	45	88	32	3,227	102

5.3.2 Utilization pattern

Mida and Mtwapa creeks are the only mangrove areas in Kilifi that have active community groups interested in mangrove conservation. Traditional uses of mangrove wood for construction and fuelwood are ranked highest among the benefits accrued from the forest. Illegal harvesting of mangroves is ranked as the main threat to mangroves in the area (Table 5.10).

Table 5.10: Ranking of benefits and major threats of mangroves in Kilifi County

Rank	Benefits	Threats
1.	Fuel wood	Illegal harvesting
2.	Construction poles	Climate change
3.	Fish production	Soil erosion
4.	Shoreline protection/ Erosion control	Encroachment
5.	Tourism	Pollution

5.3.3 Action points specific for Kilifi County

Kilifi county has the longest coastline in Kenya with mangroves distributed in small patches of creeks and river opening. These forests border urban centers in Mtwapa and Kilifi; as such, they are threatened by cutting pressure and pollution. In Ngomeni and Marereni areas mangrove are threatened by conversion pressure for solar salt works, aquaculture, and human settlement. Specific conservation actions for mangroves in Kilifi include the following:

- a. Rehabilitate degraded mangrove areas with suitable species in partnership with communities and other stakeholders.
- b. Promote law enforcement through surveillance and patrols.
- c. Undertake periodical monitoring of the mangroves areas
- d. Promote best farming practices in the areas adjacent mangroves and the hinterlands.
- e. Use spatial plans to map out areas for future development. This will include areas for expansion of salt works without encroaching into mangrove areas.
- f. Empower community through formation of Community Forest Associations (CFAs), where there are none and strengthen existing ones to enhance partnership with government in management of mangroves.

5.4 Mangroves of Mombasa County

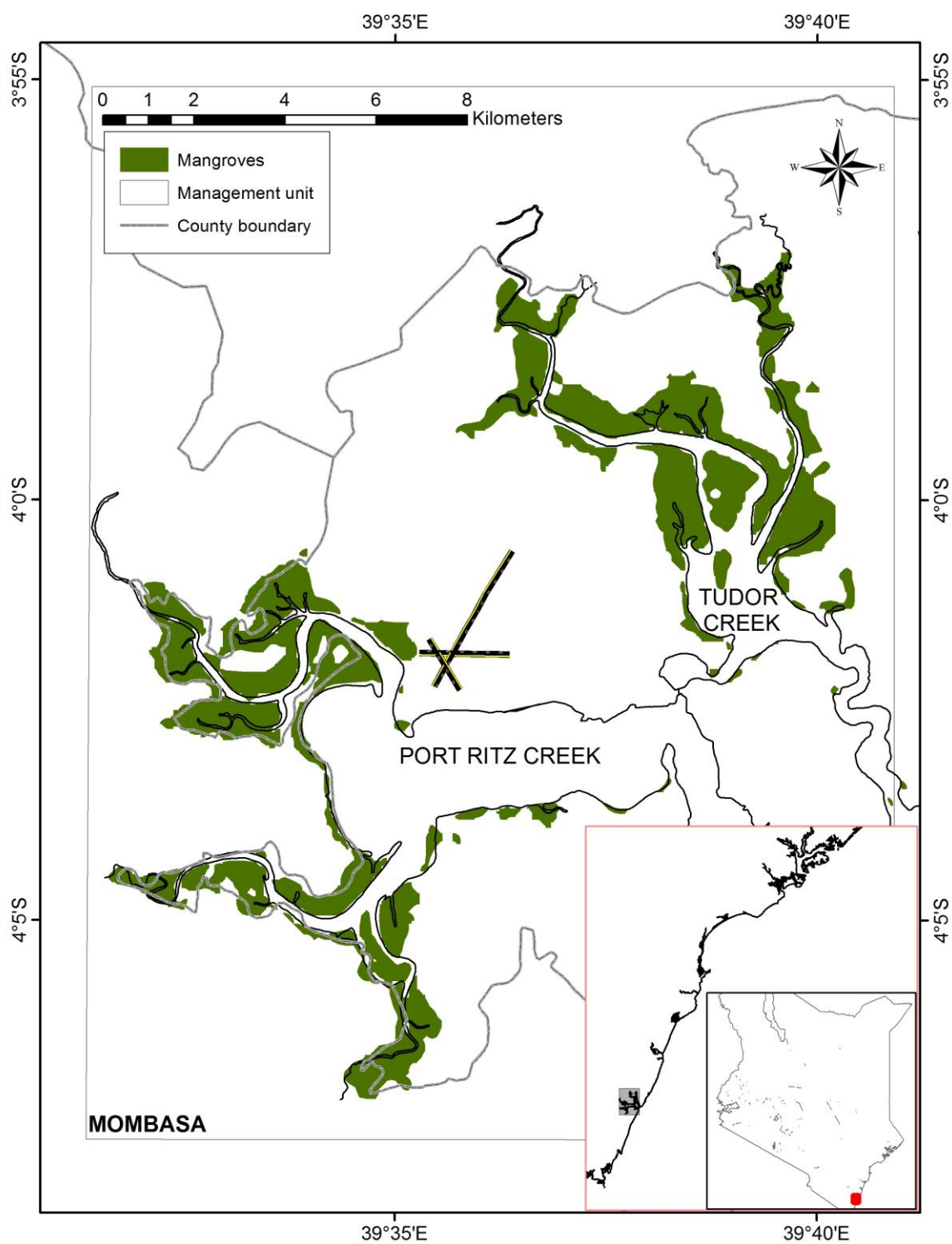


Figure 5.4: Distribution of mangrove forests within Mombasa County

Mombasa County has 3,771 ha, distributed mostly along Port Reitz and Tudor Creeks. This peri-urban forest is dominated by *Ceriops* - *Rhizophora* and mixed stands of *Rhizophora* (Table 5.11). The forest is heavily degraded through illegal harvesting, land-encroachment and pollution. Nearly 1,850 ha of mangroves in Mombasa County are degraded and in urgent need of rehabilitation.

Table 5.11: The area of mangrove formation in Mombasa County

Classification	Area (ha)	% cover
<i>Avicennia</i>	465	12.3
<i>Avicennia</i> mix	77	2.0
<i>Ceriops</i>	318	8.4
<i>Ceriops</i> mix	127	3.4
<i>Ceriops-Rhizophora</i>	1,729	45.9
<i>Rhizophora</i>	202	5.4
<i>Rhizophora</i> mix	580	15.4
<i>Sonneratia</i>	100	2.6
<i>Sonneratia-Rhizophora</i>	173	4.6
Total mangrove	3,769.7	100

The average stocking rate of mangroves in the county is 1,636 stem ha⁻¹ with a volume of only 7 m³ ha⁻¹ (Table 5.12); which is significantly lower than the 350-400 m³ ha⁻¹ estimated potential of the forest. Tree height ranges from 1.5 m to 11 m (mean=3.5 m) with stem diameter of 6.5 cm. Natural regeneration is inadequate (< 2500 individuals ha⁻¹) in most areas where forest degradation has taken place following cover loss. In Mwache, Bonje and Mishomoroni, for instance, terrigenous input of sediment has significantly reduced the regeneration potential of the forest to less than 1000 individuals ha⁻¹. In Tsunza forest, however, juvenile density is adequate to support forest recovery.

Table 5.12: Stand table for the mangrove forests of Mombasa County

Species	Size / utilization classes								Density Stems ha ⁻¹	Volume m ³ ha ⁻¹
	Fito 2.5-3.9	Pau 4.0-7.9	Mazio 8.0-11.4	Boriti 11.5-13.9	Nguzo1 14.0-16.9	Nguzo2 17.0-20.4	Nguzo3 20.5-30.4	Banaa >30.5		
<i>Rhizophora mucronata</i>	586	458	53	16	18	13	31	4	1,180	3
<i>Ceriops tagal</i>	69	49	2	1	0	1	0	0	121	<1
<i>Avicennia marina</i>	20	43	19	8	8	5	10	7	120	1
<i>Sonneratia alba</i>	4	56	55	27	23	20	15	4	204	2
<i>Bruguiera gymnorhiza</i>	3	4	0	0	0	0	1	0	9	<1
<i>Xylocarpus granatum</i>	0	0	1	0	0	0	0	0	1	<1
Total	683	610	129	52	50	39	57	16	1,636	7

5.4.1 Utilization pattern

The mangrove forests of Mombasa County are mostly exploited for construction and energy. They are also valued for their contribution to fisheries as fish breeding grounds and habitat (Table 5.13).

Mangrove forests of Mombasa County have continued to be degraded with over 80% loss reported in Tudor Creek (Fig 5.5). The loss has been attributed to illegal felling of trees to meet the demand for poles and fuelwood. Physico-chemical changes in the degraded mangrove areas, either through sedimentation or increased salinity, have resulted in very low recovery of the forest.

Table 5.13: Ranking of benefits and major threats of mangroves in Mombasa County

Rank	Benefits	Threats
1.	Construction poles	Illegal harvesting, uncontrolled cutting for domestic use
2.	Fish production	Pollution: oil and waste
3.	Fuel wood	Sedimentation
4.	Coastal protection/ erosion control	Encroachment
5.	Climate change mitigation	Climate change

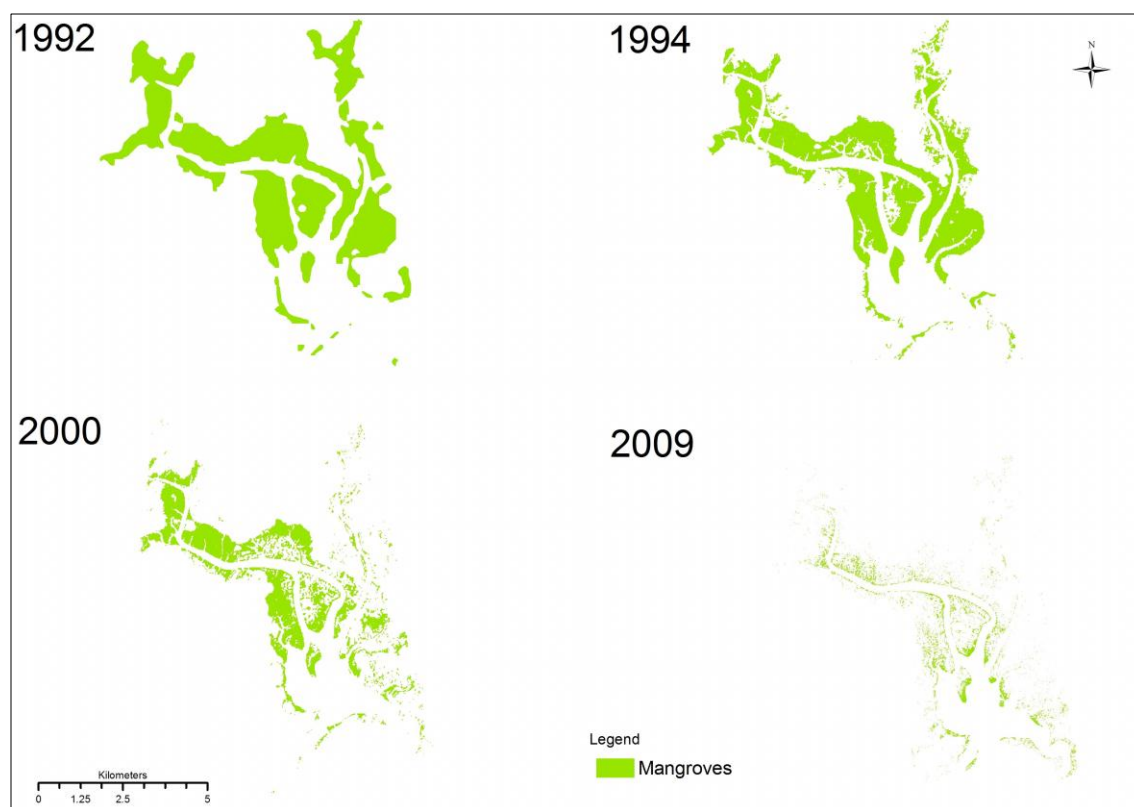


Figure 5.5: Mangrove cover change in Tudor Creek in the years between 1992 and 2009 (Source KMFRI)

5.4.2 Actions specific to Mombasa County

Initiatives to save mangroves of Mombasa have included awareness creation, reforestation of degraded areas, as well as empowering the community through establishment of CFA. However, there still remains many challenges associated with the conservation and management of peri-urban mangroves of Mombasa. It is therefore important to increase resources, both human and capital, to manage the forests. More specifically, the following recommendations are made for Mombasa:

- a. Empower CFA engaged in mangrove conservation in Mombasa County, through training, study tours and financing to implement PFMP
- b. Initiate program to rehabilitate all degraded mangrove areas in the County
- c. Develop mangrove harvest plans specific for Mombasa
- d. Partner with CFA for increased surveillance of mangrove areas

5.5 Mangroves of Kwale County

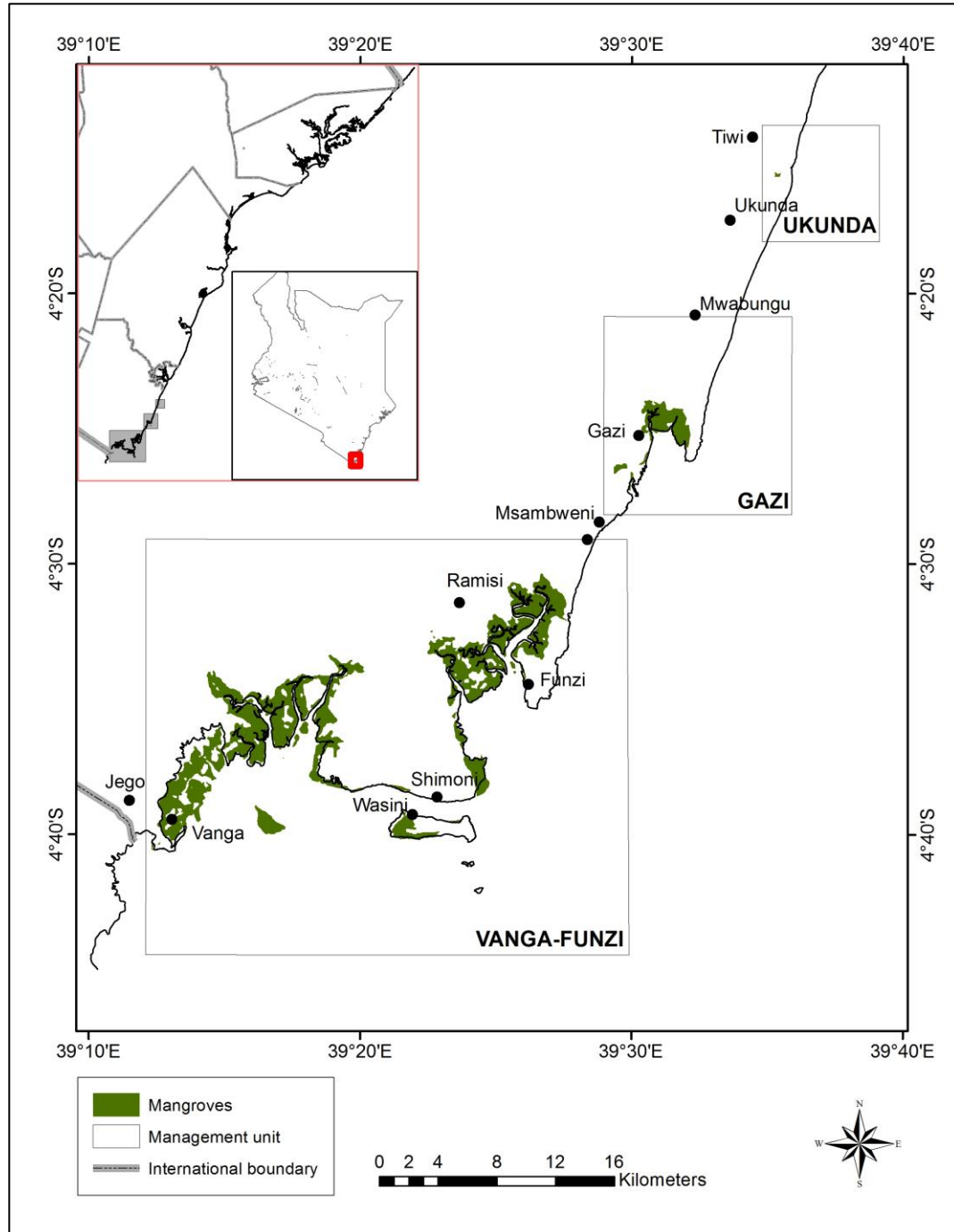


Figure 5.6:

Distribution of mangrove forests in Kwale County within the three management units

The mangroves of Kwale County comprise Vanga-Funzi, Gazi Bay, and Ukunda areas (Fig. 5.6) covering an area of approximately 8,354 ha. These forest patches are dominated by mixed stands of *Ceriops* and *Rhizophora*; as well as pure stands of *Avicennia* (Table 5.14).

Table 5.14: The area of mangrove formation in Kwale County

Classification	Area (ha)	% Cover
<i>Avicennia</i>	1,376	16
<i>Avicennia</i> mix	72	1
<i>Ceriops</i>	1,197	14
<i>Ceriops</i> mix	3,344	40
<i>Ceriops-Rhizophora</i>	185	2
<i>Rhizophora</i>	160	2
<i>Rhizophora</i> mix	1,481	18
<i>Sonneratia</i>	256	3
<i>Sonneratia-Rhizophora</i>	283	3
Total Mangroves	8,354	100

The average stocking rates of mangroves in Kwale County is 3,327 stems ha⁻¹ with a volume of 94.4 m³ ha⁻¹; of which only 25% is merchantable (Table 5.15). There is a high demand for *mazio* and *boriti* sized poles in Kwale County, leading to near depletion of these size classes. The area of mangroves requiring rehabilitation in Kwale is 3,725 ha (45%).

Table 5.15: Stand table for the mangrove forests of Kwale County

Species	Size / utilization classes								Density Stems ha ⁻¹	Volume m ³ ha ⁻¹
	Fito	Pau	Mazio	Boriti	Nguzo1	Nguzo2	Nguzo3	Banaa		
	2.5-3.9	4.0-7.9	8.0-11.4	11.5-13.9	14.0-16.9	17.0-20.4	20.5-30.4	>30.5		
<i>Avicennia marina</i>	108	123	23	8	4	8	10	5	291	14
<i>Bruguiera gymnorhiza</i>	50	67	31	8	9	3	8	1	176	6
<i>Ceriops tagal</i>	760	625	61	12	8	4	1	0	1,471	8
<i>Lumnitzera racemosa</i>	<1	<1	0	0	0	0	0	0	1	<1
<i>Rhizophora mucronata</i>	415	521	151	53	41	25	43	10	1,259	51
<i>Sonneratia alba</i>	3	14	13	4	9	5	9	6	63	12
<i>Xylocarpus granatum</i>	15	31	9	3	3	2	3	1	67	3
Total	1,353	1,381	288	88	73	48	74	22	3,327	94

5.5.1 Major mangrove areas in Kwale County

The major mangrove areas in Kwale County are in Gazi Bay, and Vanga-Funzi system, including; Sii Island. An isolated stand of mangroves (less than 2 ha) occurs at the mouth of R. Mwachema at Diani.

i. Gazi Bay

Mangroves of Gazi Bay include the basin forest at Chale Island that boasts of the tallest *Bruguiera* trees (> 35 m) in the country. The total mangrove area in the bay is 715 ha, with 27% of this (or 166 ha) requiring rehabilitation.

The stocking density of mangrove in Gazi Bay is 3,534 stems ha^{-1} ; with a volume of $143 \text{ m}^3 \text{ ha}^{-1}$. Of this volume, only 29% ($41 \text{ m}^3 \text{ ha}^{-1}$) of the mangroves in the bay is merchantable. Community in Gazi have partnered with the government institutions and NGO to restore mangrove of Gazi. An innovative project at Gazi (Mikoko Pamoja) initiated in 2013 is aimed at restoring and protecting mangroves through sale of carbon credits. With a contractual period of 20 years, Mikoko Pamoja is able to offset 3000tCO₂-equivalent per year thus generating KES 1.2 million per annum to the community. Similar initiatives are being planned for Kilifi and Vanga mangrove areas in Kenya.

ii. Vanga- Funzi mangroves

The Vanga-Funzi system occupies 7,638 ha, constituting 40% of the entire mangroves in Kwale County. These forests include the mangroves of Ramisi, Majoreni, and the Sii Island. The standing volume of mangroves in Vanga-Funzi system is $87 \text{ m}^3 \text{ ha}^{-1}$, out of which only 25% (or $21.8 \text{ m}^3 \text{ ha}^{-1}$) are merchantable. Mazio and boriti sized poles (8-14 cm) are limited in the area due to illegal harvesting that is rampant and noticeable in the area.

Increased demand of mangrove wood products in the area has led to degradation of the forest in many parts of Kwale County. There are approximately 3,559 ha of degraded mangrove areas in Vanga-Funzi system that needs rehabilitation. Active CFA's exists in Vanga-Funzi area which can be promoted to participate in mangrove rehabilitation in the area. Natural regeneration is adequate in areas with parental stocks to serve as seed trees; otherwise it was found to be inadequate where clear cutting had taken place for instance in Ramisi and Majoreni areas.

The mangroves of Sii Island are worth mentioning here as they constitute one of the most pristine mangroves in the south coast. This 119 ha mangrove forest falls within the conservation area of Kisite-Mpunguti Marine Protected as such enjoys duo protection of both KWS and KFS. However, illegal harvesting in the Kwale mangroves has not spared the mangroves of Sii Island.

Due to high fishing activities in Vanga area, the role of mangrove to fisheries was ranked highest among benefits provided by mangroves. However, illegal harvesting and conversion of mangrove for rice farming were ranked as major threats of mangroves in Vanga (Table 5.16).

Table 5.16: Ranking of benefits and major threats of mangroves in Kwale County

Rank	Benefits	Threats to Mangroves
1.	Fish production	Illegal harvesting
2.	Construction poles	Conversion to rice farms
3.	Firewood	Climate change
4.	Air purification	Destructive fishing methods
5.	Shoreline protection	Strong winds

5.5.2 Actions specific to Kwale County

Much of the research on mangroves of Kenya has been carried out in Kwale County, particularly in Vanga and Gazi mangroves. Result output from these sites have been used to inform restoration and management of mangroves resources in other areas of Kenya. Further, the transboundary mangroves stretching from Gazi in Kenya to Tanga (Tanzania) have received regional and international recognition for their significance in biodiversity conservation, fishery shoreline protection, and support to fishery and livelihood. There are efforts to establish a Transboundary Conservation Area (TBCA) encompassing the two countries. Some of the priority actions for Kwale county are listed below:

- a. Promote community participation in the management of mangrove areas at Majoreni, Shimoni, and River Mwachema
- b. Designate mangroves on Sii Island as seed bank
- c. Work with the community to restore degraded mangrove areas
- d. Enforce legislation to curb conversions of mangrove areas for agriculture especially in Vanga.
- e. Enhance capacity of local community on sustainable mangrove forest management
- f. Promote PES schemes in mangrove areas, including carbon trading
- g. Through research, ascertain connectivity of transboundary mangroves at Vanga

5.6 Combined analysis across the entire coast

Analysis of mangrove forestry data along the coast displays two distinctive characteristics. Mangroves north of Tana River, are structurally more complex in terms of canopy height and basal area, than those south of the delta. This distinction is highly influenced by geomorphology, amount of freshwater input, and wind-induced upwelling caused by oceanic currents. These upwellings are also known to influence biological productivity, particularly fisheries. Variations in forest structure between the sites can also be argued in the light of human pressure. Although there is limited access to the mangroves of Kiunga, increased logging activities are observed in human settlement adjacent to the reserve in Ndau, Mkokoni and Siyu. Using a similar argument, we find accessible mangroves of Kwale, Mombasa and Kilifi depleted of quality poles, particularly *mazio* and *boriti* (Fig. 5.7).

Currently, quotas of mangrove harvests are based on expert knowledge of the carrying capacity of the forest. The forest personnel (due to inadequacy of resources) rarely know illegal harvesting activities in their areas. Without routine monitoring it is difficult for managers to assess illegal activities in the mangroves of their areas. Cumulatively, increased demand of mangrove wood products plus the un-monitored illegal activities have led to loss and transformations of mangrove forests along the coast. The most affected areas are the peri-urban mangroves of Mombasa; as well as the mangroves of Kwale and Kilifi (Table 5.17).

Table 5.17: Areal coverage of mangrove forest areas per county and the degraded proportion

County	Mangrove area (ha)	Degraded mangrove (ha)	% Degraded area
Lamu	37,350	14,407	38.6
Tana River	3,260	1,180	36.2
Kilifi	8,536	3,422	40.0
Mombasa	3,771	1,850	49.1
Kwale	8,354	3,725	44.6
Total (ha)	61,271	24,585	40.1

Mangrove trees should be viewed as part of the total ecosystem. Over-harvesting of trees disrupts forest stability and its support role to fisheries and ecosystem services. Since there is limited information on the relationship between mangrove forests and other elements of the ecosystems guidelines for proper management of mangrove ecosystem are difficult to establish.

Data on forest production over a range of mangrove forest types is lacking in Kenya. The only possibility of establishing estimates of biomass production is based on literature on similar environments and estimates detailed in the 1967 survey report for Lamu which is rather too old. These estimates result in a possible production of approximately 5.0-6.0 tons ha⁻¹yr⁻¹ for

productive vegetation types. In young plantations at Gazi, however, biomass accumulation rates of $8.9 \text{ tons ha}^{-1}\text{yr}^{-1}$ have been achieved in a 12 years old *Rhizophora* plantation. Using these estimates, the rotation cycle of mangroves in Kenya is placed at about 30 years for poles and 50 years for fuelwood.

The relationship between stem density per hectare and harvestable poles is shown in Fig. 5.7. While Kilifi and Mombasa County have relatively higher stocking densities than other counties, the harvestable quantities are significantly low. This is explained by the fact that most of the mangroves in these counties are stocked with crooked trees of low market demand. The average % of crooked trees against straight poles is approximately 70% in Kilifi and Kwale.

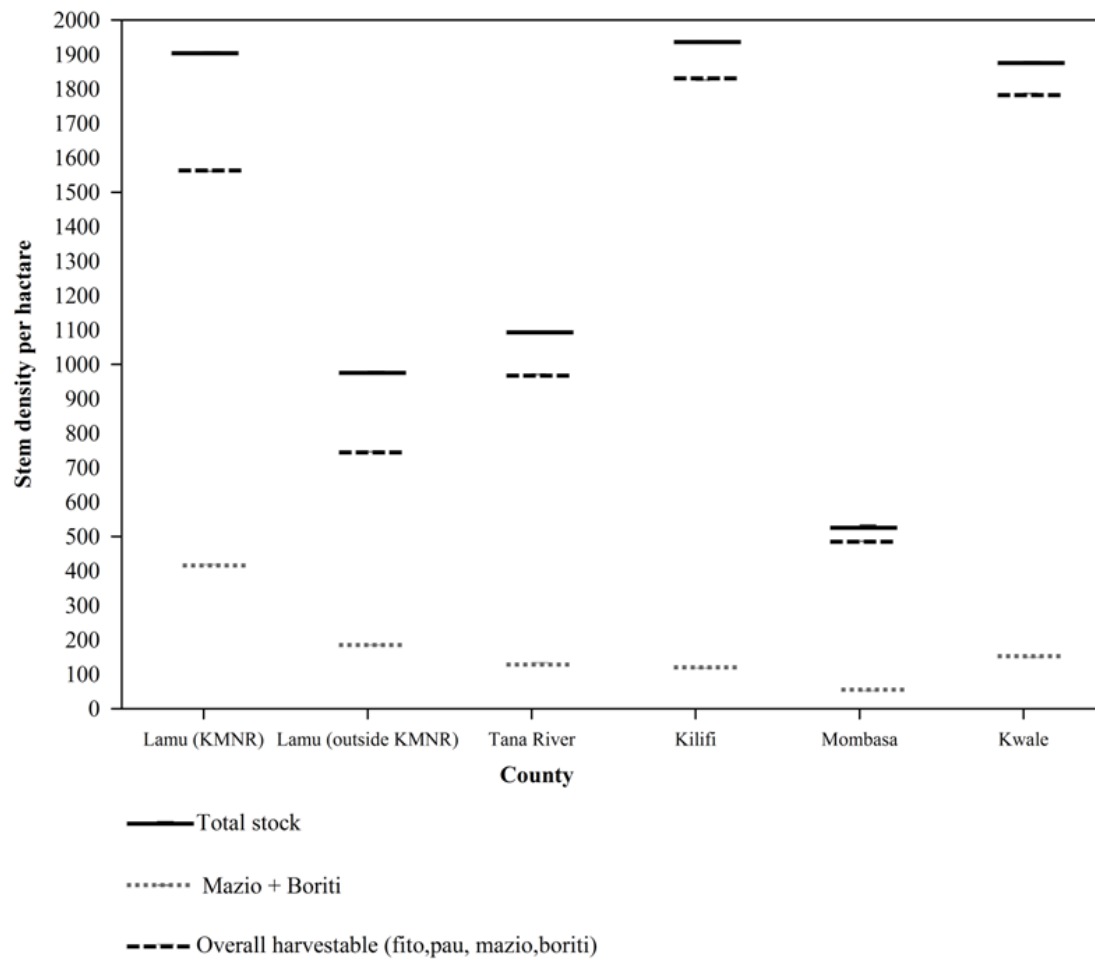


Figure 5.7: Harvestable mangrove poles in the five counties along the coastal strip of Kenya (mangroves of Lamu County were divided into those inside and outside KNMR)

Conclusion

County analyses provide good information that could be used to improve the management of mangroves in Kenya. In spite of the constraints faced during data and information acquisition for this management plan, results achieved could be used to strengthen the capability of the forestry institutions on the one hand, and improve sustainable management of mangrove resources on the other. This section mainly focuses on broad recommendations rather than refinement of county specific actions already elaborated above:

- a. Correct mangrove maps must be prepared using medium-scale areal photographs (1:25000) in order to clearly mark out zones for development, utilization, protection, and rehabilitation
- b. Strength institutional capabilities of KFS, KWS and other agencies in the management and exploitation of mangrove ecosystem within an integrated use context
- c. Control unregulated exploitation of mangroves for fuelwood and building purposes
- d. Conduct community training programs in order to provide knowledge and experience on rehabilitation, conservation, and sustainable utilization of mangrove resources
- e. Establish permanent sample plots (PSP) in the counties in order to provide incremental data on growth dynamics for forest management planning
- f. Surveys on mangrove wildlife should be conducted and plans be developed for their management
- g. Tourism development plans and other forms of recreational activities in mangrove areas should be formulated and implemented

6 MANAGEMENT GOAL AND OBJECTIVES

6.1 Goal

The overall goal of this management Plan is to enhance mangrove ecosystem integrity and its contribution to the economy of Kenya through sustainable management and rational utilization.

6.2 Purpose

The purpose of this Plan is to enhance sustainable management of the mangrove ecosystem for improved livelihoods.

6.3 Development Objective

The overall objective of the Plan is to sustain supply of mangrove goods and services; for local and national development.

6.4 Management Objectives

Mangrove sites identified in Chapter 5 of the Plan constitute a rich natural and national heritage for Kenya. Mangroves are habitat for fish and other wildlife. They provide many environmental services, such as; coastal protection, erosion control, and serve as a major sink for carbon; thus mitigating effects of climate change. In addition, mangroves provide direct economic products to the people in terms of firewood, building poles, charcoal; as well as habitats and nursery grounds for many commercially important fish and crustaceans. Communities also derive benefits from sustainable tourism. For these reasons, they should be protected and their natural ecology conserved. Any threats to the survival of mangroves must be mitigated.

The objectives of this management plan are therefore:

1. To **conserve and manage mangrove wood and non-wood resources** on a sustained yield basis;
2. To **manage and protect mangrove areas for fisheries, erosion control**, coastal stabilization and biodiversity conservation;
3. To **promote community participation** in mangrove resource management for improved livelihoods;
4. To **strengthen institutional capacities** of the institutions responsible for mangrove management;
5. To **promote tourism and recreation** in mangrove areas; and
6. To **promote research and education** on conservation and management of mangrove and associated ecosystem.

6.5 Zonation

Zoning is an important tool that can be used for effective forest management. While air and water temperatures determine global distribution of mangroves; flooding regime, soil nature, and salinity are critical factors that govern distribution and zonation of mangroves ecosystem at local level. Knowledge of mangrove species distribution, structure, stocking levels and zonation is important in prescribing programs of different management zones. Many different uses of mangrove area (such as small scale wood harvesting, bee keeping, shoreline protection and small scale capture fisheries) are more compatible and can be carried out simultaneously in the same area. Others, including; large scale aquaculture, protection of wildlife habitat and intensive forest operations are less compatible and requires zonation of the area according to priority uses. This management plan, integrates these different uses of mangrove ecosystem while minimizing conflicts and recognizing that the forest needs to provide a wide range of goods and services for improved livelihood and mitigation of climate change.

Table 6.1 provides the four (4) broad zones identified in the management plan. The criteria for zonation, management objectives and management actions for each zone are presented. However, some zones may have multiple objectives due to other subsidiary management objectives.

Table 6.1: Forest management zones, criteria, management objectives and management options

Zone	Criteria	Management objective	Management options
Protection	Existing designated Protected mangrove forests Forest with unique features and species diversity beyond 50m from the seafront and fringing areas	Biodiversity conservation	Conserve and enrich the unique biodiversity of the mangrove forest Promote research and education
	Seafront and fringing areas less than 50m Fragile geophysical features	Coastal stabilization	Conserve and protect mangrove areas which serve protective functions
	Marine breeding habitats	Habitat management and improvement	Protect areas for nursery, feeding and refuge grounds for fishery resources and other fauna
	Degraded areas designated as mangrove protected areas	Forest rehabilitation	Protection for natural regeneration Enrichment planting
Utilization	Forest areas with extractable material Accessible areas not under protection zone	Commercial and subsistence wood extraction	Contribute to meeting community subsistence needs Improve and develop forest condition and utilization potential Generate revenue for sustainable forest management
	Accessible areas not under protection zone with NWFP Accessibility	Non-wood utilization	Contribute to meeting community subsistence needs Improve livelihood Improve and develop forest condition and utilization potential
	Sites known for bird watching and any other unique features Accessibility	Ecotourism and recreation	Manage mangrove areas for recreation and tourism Generate revenue
	Degraded forest areas	Forest rehabilitation	Protection for natural regeneration Enrichment planting
Development	Proposed areas for infrastructure development	To have minimal negative environmental impact	Ensure ecosystem integrity of adjacent mangroves To have minimal negative environmental impact
Intervention/Buffer zone	3 kilometer buffer area along forest boundary	Promotion of on farm tree planting and IGAs	On farm tree planting Promotion of IGAs

7 MANAGEMENT PROGRAMMES

7.1 Mangrove Forest Conservation and Utilization Programme

Background

Mangroves are of high environmental importance and constitute a major resource for local and national development. Nonetheless they face multiple challenges, including; over-exploitation of wood products, conversion of mangrove forest areas to other land uses, pollution and sedimentation. For these reasons, mangroves should be protected and conserved so that they can continue providing their inherent goods and services. The purpose of the Forest Conservation and Utilization Program is to ensure that:

Mangrove forests are managed sustainably for wood and non-wood forest products while maintaining environmental integrity

Management Issues and Challenges

The following issues and challenges affecting mangrove forest conservation were identified in a series of stakeholder meetings:

1. Lack of mangrove management plans
2. Over-exploitation of some mangrove forest species leading to loss and degradation of the habitats
3. Inadequate knowledge on balancing different uses of mangrove and the associated ecosystems
4. Vulnerability of mangroves to climate change and other natural calamities, including (pest and diseases).
5. Encroachment and conversion of mangrove areas to other land-uses
6. Inadequate inventory data that could be used for mangrove forest management

Specific objectives

1. Conserve and protect mangrove forests for sustained ecosystem integrity and climate change mitigation
2. Promote sustainable harvesting of mangrove wood products
3. Rehabilitate degraded mangrove forest areas
4. Improve policing and protection from human activities

Table 7.1: Summary of management actions for mangrove forest conservation and utilization programme

Management objective and action	Unit	10 yr targets	Means of verification	Budget KES. (million)	Time frame (yrs)									
					Y1	Y2	Y3	Y4	Y5	Y7	Y8	Y9	Y10	
Conserve and protect mangrove forests for sustained ecosystem integrity and climate change mitigation														
Identify and map out mangrove areas with unique habitats and species diversity. for biodiversity conservation.	No.	5	Maps	40	5									
Promote planting of appropriate mangrove species for diversification.(000)	No.	1000	Unique species	30	100	100	100	100	100	100	100	100	100	
Identify and map mangrove areas prone to coastal erosion, sedimentation and other natural threats	Map	5	Maps/report	10	2	3								
Undertake restoration programmes in the identified mangrove areas.	Ha	1000	Report	11	100	100	100	100	100	100	100	100	100	
Delineate areas earmarked for infrastructure development	Map	5	Report, Map	5			5							
Develop guidelines for licensing/leases for mangrove areas delineated for infrastructure development	No.	1	Report	5		1								
Creating awareness through meetings on the developed guidelines to relevant stakeholders	No.	10	Report	10			5		5					

Management objective and action	Unit	10 yr targets	Means of verification	Budget KES. (million)	Time frame (yrs)									
					Y1	Y2	Y3	Y4	Y5	Y7	Y8	Y9	Y10	
Promote sustainable harvesting of mangrove wood products														
Undertake Mangrove forest resource assessment to ascertain availability of various products and qualities by Counties	No.	5	Report	25		5								
Prepare annual sustainable harvesting plans by Counties.	Ha	5	Reports	12.5			5							
Implement the harvesting plans	No.	5	Reports	10				5						
Rehabilitate degraded mangrove forest areas														
Identify and map the degraded mangrove areas	No.	5	Reports & maps	5		1	2	2						
Delineate areas for natural regeneration.	Ha	1000	Reports	7		500	500							
Undertake tree nursery establishment	No.	5	Reports	2.5				5						
Prepare and implement annual restoration plan by counties.	No.	5	Reports	5				5						
Improve policing and protection of mangrove areas from human activities														
Establish mangrove beacons for all areas under mangroves as per forest legislation	No.	2500	Beacons/ Maps	12	2500	1250	1250							
Carry out routine policing patrols (0)	MDs	18650	Report	373	1865	1865	1865	1865	1865	1865	1865	1865	1865	

Management objective and action	Unit	10 yr targets	Means of verification	Budget KES. (million)	Time frame (yrs)								
					Y1	Y2	Y3	Y4	Y5	Y7	Y8	Y9	Y10
Train scouts and promote community policing	No.	200	Training reports	24	20	20	20	20	20	20	20	20	20
Establish mangrove forest surveillance outposts.	No	34	Outposts	100		6	6	6	6	6	4		
Establish surveillance communication systems	No	5	Communication system	5		2			3				
Undertake joint training of KFS rangers and KWS.	No.	20	Training reports	60	2		10			8			
Organise and implement community awareness barazas in all counties.	No.	200	Report on Barazas	10	20	20	20	20	20	20	20	20	20
Plant mangrove associates to delineate mangrove boundary areas.	Km	500	Report on areas marked	5	50	50	50	50	50	50	50	50	50
Procure infrastructure for mangrove patrols	No.	39	Asset register	10	10	10	19						
Total				817									

7.2 Fisheries Development and Management Programme

Background information

Mangroves ecosystems support fisheries resources by acting as nurseries, breeding, refuge and feeding habitat. However, degradation of mangrove areas, coupled with other factors such as destructive fishing methods has contributed to decline in fish stocks in the inshore waters where artisanal fishery is carried out. The lead implementing agencies for this programme are SDF, KMFRI and communities through BMU in collaboration with other related stakeholders.

Program purpose

The purpose of the Fisheries development and management programme is to ensure that:

Sustainable management and conservation of mangroves as habitat and breeding grounds for fisheries and other wildlife

Management issues and challenges

1. Protection of fish habitats and breeding grounds
2. Degradation of fish habitats
3. Overexploitation of inshore fisheries
4. Inadequate capacity of community in enforcement of fishery regulations
5. Declining fish stocks and species diversity

Management objectives

1. Identify and map degraded fish habitats for restoration
2. Promote adoption of silvo-aquaculture in mangroves areas
3. Promote active participation of communities in fisheries resources management

Table 7.2: Summary of management actions for fisheries management programme

Management objective and action	Unit	10yr targets	Means of verification	Budget (KES) (millions)	Time frame (yrs)									
					Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10
Identify and map degraded fish habitats for restoration														
Identify and map key mangrove fish breeding areas	%	100	Maps	15	25	25	25	25						
To promote adoption of silvo-aquaculture in mangroves areas														
Inventorise and map mangrove areas suitable for integrated aquaculture	No	1	Reports and maps	10	1									
Support development and use of mariculture guidelines	No	1	Reports	5		1								
Support community-based integrated aquaculture enterprises in mangrove areas	No	25	Reports	50		2	3	5	5	5	5			
Promote active participation of communities in fisheries resources management														
Support development and implementation of fisheries co-management guidelines	No	1	Reports	5	1									
Support development and operationalization of fisheries co-management plans	No	15	Plans	7	2	3	3	3	3	1				
Enhance capacity of BMUs in fisheries management through training, exchange visits, demonstration of best practice, etc.	No	9	Workshop reports, community monitoring, control & surveillance unit	10	1	1	1	1	1	1	1	1	1	
Total				102										

7.3 Community Programme

Background information

Effective mangrove management requires elaborate participatory engagement with the community. Currently, community engagement is largely spontaneous and uncoordinated while institutional capacity at the local level is inadequate. Effective awareness should therefore be undertaken to facilitate development interpretation, enforcement of regulations, development of well-established community structures and enforcement of cost and benefit sharing mechanisms. Mangrove forest conservation should be enhanced through establishment of rationalized management units jointly by KFS and local communities through CFAs and operationalized through PFMPs and legalized through FMAs. The existing and proposed CFA's per county are provided in Table 7.3.1.

Table 7.3.1: A list of Community Forest Associations (CFA) engaged in mangrove activities at the Coast

County	Existing CFAs	Forest areas covered	Proposed Area of operation for new CFAs
Mombasa	MOKICFA	Tudor Creek, Port Reitz, Majaoni, Junda	Bombo
Kwale	VAJIKI	Vanga, Jimbo, Kiwegu	Buda, Mwanzaro, Bodo, Funzi
	MFMCCO	Mwandegwa, Mwamdudu, Tsunza, Bonje	
	GOGACOFA	Gazi Bay	
Lamu	LAMACOFA	Mkunumbi, Lamu Island, Manda, Siyu, Magongoni, Dodori Creek, Wange Creek, Pate Island	Mkokoni, Kiunga, Ndau, Kiwaiyu, Unga, Mkokoni
Tana River			Kipini, Chara, Ozi, Kilelengwani
Kilifi	GECOFA	Mida Creek	Ngomeni, Mambrui
	MTAKIMAU CFA	Mtwapa, Takaungu, Kilifi, Matsangoni, Uyombo	
	MAMACOFA	Sabaki, Gogoni, Marereni, Kurawa	
TOTAL	8		9

The purpose of the community programme is to:

Promote community participation and local institutional capacity in mangrove resource conservation and management for improved livelihoods and ecological integrity.

Management Issues and Challenges

1. Increasing population leading to increased demand for mangrove ecosystem goods and services
2. Inadequate community involvement in mangrove conservation and management
3. Low levels of community involvement in formulating and implementing policy and legal framework governing conservation and management of mangrove ecosystems.
4. Inadequate knowledge and initiatives on integrated use of mangrove areas
5. Conflicts between different mangrove resource users/stakeholders
6. High levels of poverty
7. Inadequate alternative community livelihoods
8. Socio-cultural attachment to mangrove resources

Management Objectives

1. Strengthen local community institutions capacity in mangrove conservation and management
2. Promote community nature based enterprises and networking for sustainable livelihood diversification and improvement
3. Develop and implement community awareness strategies and training programmes
4. Strengthen community participation in formulation and implementation of relevant policy and legislative processes
5. Develop conflict resolution mechanisms to address emerging disputes

Table 7.3.2: Summary of management actions for community participation programme

Management Objective and action	Unit	10 yr targets	Means of verification	Budget (millions)	Time frame (yrs)									
					Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10
Strengthen local institutional capacity in mangrove conservation and management														
Develop PFMPs and form CFAs and implement	No.	10	PFMP development and CFA formation	20			5				5			
Develop Community Action Plans	No.	17	Action plans, Reports	8.5	3	3	3	3	3	2				
Training on Governance (leadership, resource mobilization, financial management, group dynamics, IGAs, value addition, PFM sustainability, etc.)	No.	100	Training Reports	10	10	10	10	10	10	10	10	10	10	10
Capacity build CFAs on PES including carbon trading	No.	17	Capacity building reports; No. of CFAs benefited from PES	10	3	3	3	3	3	2				
Promote community nature based enterprises and networking for sustainable livelihood diversification and improvement														
Develop farm forestry strategy	No.	5	Strategic plan	5	2	3								
Identify and Map out target farmers	No.	5,000	Reports	4	500	500	500	500	500	500	500	500	500	500
Promote terrestrial tree nursery establishment & seedlings production	No.	50	Reports	85	10	10	10	10	10					
Promote on-farm tree farming for domestic and commercial	Ha	10,000	Hectares of trees planted	60	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000

Management Objective and action	Unit	10 yr targets	Means of verification	Budget (millions)	Time frame (yrs)									
					Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10
uses as per the strategy														

Management Objective and action	Unit	10 yr targets	Means of verification	Budget (millions)	Time frame (yrs)									
					Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10
Promote alternative IGAs (charcoal production, fishing, bee keeping, ecotourism, canoeing, boat building, chalk making)	No.	51	No. of IGAs initiated Reports	100	6	5	5	5	5	5	5	5	5	5
Promote establishment of NWFP based cottage industries and/or ecotourism markets	No.	17	No. of industries or activities initiated/enhanced	70	3	3	3	3	3	2				
Develop and implement community awareness strategies and training programmes														
Develop community awareness and training strategy	No.	1	Strategy	1										
Carry out Awareness creation on livelihood opportunities in mangrove ecosystems	No.	100 meetings	Reports	25	10	10	10	10	10	10	10	10	10	10
Carry out Training on forest policy and other legal frameworks	No.	10 training meetings	Reports, Policy briefs	10	2	2	2	2	2					
Conducting education and exchange tours	No.	25 visits	Reports	25		5	5	5	5	5				
Establish community resource centers	No.	5	Resource centres operational	25					3	2				
Strengthen community participation in formulation and implementation of relevant policy and legislative processes														

Management Objective and action	Unit	10 yr targets	Means of verification	Budget (millions)	Time frame (yrs)									
					Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10
Carry out sensitization to communities on various policies and laws governing management and use of mangroves	No.	15 Meetings	Reports	6	3	3	3	3	3					

Management Objective and action	Unit	10 yr targets	Means of verification	Budget (millions)	Time frame (yrs)									
					Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10
Carry out translation of policy briefs into Swahili	No.	5 briefs	Translated briefs	3		2		3						
Identify community views for incorporation to policy review through existing CBOs	No.	51 CBOs involved	CBO participation, Reports	51		15	15	15	6					
Incorporate the socio-cultural values of mangroves in policy	No.	5 policies	Policy documents incorporating socio-cultural values	5		1		3	1					
Develop conflict resolution mechanisms to address emerging disputes														
Establish conflict resolution committees	No.	5 committees	Operational committees in place	10	5									
Training on conflict resolution	No.	17 training meetings	Reports	17	2	3	3	3	3	3				
Establishing benefit sharing guideline	No.	1 guideline	Operational guideline Report	5		1								
Organize meetings to define roles of each stakeholder in mangrove utilization and conservation	No.	5 meetings	Reports	10	1		2		2					
Total				565.5										

7.4 Research and Education Programme

Background information

This programme provides the information base upon which other management programmes carry out intervention activities. It ensures that the integrity of mangrove ecosystems is enhanced and the issues of concern on the key ecological features of these ecosystems are addressed through integrated management.

The purpose of the research and education programme is to:

Promote conservation and management of mangrove ecosystems through problem oriented research, education and training.

Research related issues and Challenges

1. Habitat loss and degradation
2. Loss of biodiversity
3. Inadequate resources and capacity to undertake research and monitoring
4. Poor adoption of research findings by stakeholders.
5. Weak linkages between research and management of mangrove resources
6. Poor dissemination of research findings to potential users including communities
7. Inadequate knowledge on interaction of mangroves and associated ecosystems
8. Lack of information on true economic value of mangrove ecosystem
9. Lack of long-term ecological data on mangroves to inform management
10. Climate change

Specific objectives

1. Promote habitat and biodiversity protection and conservation
2. Enhance ecological, social and economic research, monitoring and dissemination
3. Promote inter-institutional cooperation in research, monitoring and management
4. Create awareness on the environmental and economic value of mangroves

Table 7.4 Summary of management actions for research and education programme

Management objective and Action	Unit	10 yr targets	Means of verification	Budget KES (millions)	Time frame (yrs)									
					Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10
Promote habitat and biodiversity protection and conservation														
Undertake research on stocking level, density and growth dynamics of mangroves.	%	100	Reports	9	50	30	20							
Identify and map conservation target areas based on key ecological attributes	%	100	Reports	12	20	40	40							
Identify causes and levels of habitat degradation	%	100	Reports	3	50	50								
Prepare training manuals in biodiversity protection and conservation for communities	No.	180	People trained	15	30	30	30	30	30	30				
Enhance ecological and socio-economic research, monitoring and dissemination														
Mainstream mangrove research into institutional work plans	No.	10	Work plans	10	1	1	1	1	1	1	1	1	1	1
Development of competitive proposals to mobilize funds from development partners	No.	50	Number funded	5	5	5	5	5	10	10	5	5		
Undertake research on improved quality of mangrove poles (silvicultural treatments)	%	100	Incremental	10	10	20	30	40						
Establish ecologically representative long-term monitoring plots	No.	15	Reports	14	7	4	4							
Collaborate with institutions of higher learning to develop relevant education and training programs (curricular, apprenticeship, in-service training)	No.	20	Reports	5	4	4	4	4	4					
Capacity building for scientists and managers on mangrove monitoring reporting and verification (MRV)	No.	50	No. Trained	100	5	10	15	20	25	30	35	40	45	50
Establish a national mangrove network for information sharing	No.	1	Reports	2		1								

7.5 Tourism development Programme

Background information

Tourism development activities provide benefits to communities but have negative impacts on mangrove ecosystems. The programme seeks to maximize benefits through marketing, develop tourism infrastructure, and build capacity of communities to effectively manage tourism enterprises in mangroves. The programme shall guarantee sustainable use of mangrove ecosystems and ensure ecosystem integrity. The key institutions that will be charged with the implementation of this programme include KFS, KWS and local communities.

The purpose of the development program is to:

Enhance tourism development and management to maximize benefits and revenue streams, while safeguarding ecosystem integrity.

Management issues and challenges

1. Lack of tourism plans for mangrove ecosystems
2. Lack of or inadequate tourism infrastructure
3. Inadequate marketing plans and/or strategies for mangrove products and services
4. Inadequate benefits from tourism for local communities
5. Inadequate planning and training in small and medium enterprises
6. Inequitable benefit sharing among stakeholders

Specific objectives

1. Develop an effective tourism plan and infrastructure
2. Develop and enhance marketing strategies
3. Improve and diversify tourism products
4. Enhance community capacity in tourism entrepreneurship
5. Develop and implement stakeholder benefit sharing strategies

Table 7.5: Summary of management actions for tourism development programme

Management objective and action	Unit	10 yr targets	Means of verification	Budget (millions)	Time frame (yrs)									
					Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10
Develop an effective tourism plan and infrastructure														
Develop and implement tourism master plan	No.	1	Report	10		1								
Conduct studies to assess carrying capacity and impact	No.	2	Report	3										2
Develop code of conduct for responsible tourism	No.	1	Report	3	1									
Develop ICT system to promote tourism	No.	1	Report	15		1								
Develop roads to open up the area for tourism	Km	50	Report	200	10	10	10	10	10					
Develop and upgrade tourism facilities (board walks, picnic sites, bandas)	No.	5	Reports	20	2	2	1							
Mobilize financial resources for tourism development	No.	50	Resources mobilized	5	5	5	5	5	5	5	5	5	5	5
Develop and enhance marketing strategies														
Develop tourism marketing strategy	No.	1	Reports	10	1									
Establish local tourism related database	No.	1	Report	5		1								
Develop, design & produce tourism marketing materials	No.	10	Publications	10	1				5					4
Improve and diversify tourism products														
Create or enhance existing nature trails	No	2	Plan											
Develop an inventory of tourism products (services, facilities)	No	2	Plan	5	1									2
Establish community cultural centres	No	1	Cultural centre established	10		1								
Develop visitor use zonation	No	1	Map	5		1								

Management objective and action	Unit	10 yr targets	Means of verification	Budget (millions)	Time frame (yrs)									
					Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10
Capacity building on tourism diversification	No	20	Reports	10	4	2		4		2	4			4
Market mangrove ecosystem as bird watching destination.	No.	10	Report	20	1		3		3			3		
Develop marketing brochures	No.	1,500	Report	2	200	200	200	200	300					400
Enhance community capacity in tourism entrepreneurship														
Develop community tourism facilities	No.	6	Report	40										
Organize and promote local tourism events	No.	10	Report	20	1	1	1	1	1	1	1	1	1	1
Promote community participation (license)	No.	10	Licenses	25	2	2	2	2	2					
Conduct community training on tourism entrepreneurship	No.	10	Report	10	1	1	1	1	1	1	1	1	1	1
Develop and implement stakeholder benefit sharing strategies														
Undertake study to guide development of cost and benefit sharing schemes	No.	1	Report	3										
Promote public private partnerships in the management of ecotourism ventures	No.	5	MoUs	2					3					
Collaborate with key stakeholders	No.	10	Reports	14	1	1	1	1	1	1	1	1	1	1
Monitoring of tourism activities	No.	10	Report	10	1	1	1	1	1	1	1	1	1	1
Diversify tourism activities among Youth and Women groups	No.	10	Report	40		2		2		2		2		2
Initiating funding of community projects with revenues accrued from tourism	No.	3	Projects	30			1		1			1		
Total				527.0										

7.6 Human Resource and Operations Programme

Background information

Successful implementation of the national mangrove management plan requires coordinated work by effective and well trained personnel from the key institutions involved in mangrove conservation and management. Adequate and modern infrastructure is necessary to ensure proper operations and effective monitoring on the activities that impact on the mangrove forests. The current state of infrastructure at KFS and KWS is in need of refurbishment particularly the offices and residential buildings. Some areas will require new jetties and some existing ones shall require repairs and maintenance. The staff in-charge of mangrove ecosystem is inadequate and requires additional skills for effective management.

The purpose of human resource and operations programme is to ensure;

Skilled motivated personnel adequately equipped with appropriate tools and equipment to support best practices in mangrove management

Management issues and Challenges

1. Inadequate provision and maintenance of infrastructure
2. Inadequate staff, training and motivation
3. Inadequate stakeholder involvement and collaboration
4. Weak enforcement of regulations and guidelines

Specific objectives

1. Provide and maintain adequate infrastructure and equipment in key institutions involved in mangrove conservation and management
2. Develop and maintain adequate and competent human resource
3. Strengthen institutions involved in mangrove management and promote collaboration among stakeholders

Table 7.6: Summary of management actions for human resource and operations programme

Management objective and action	Unit	10 yr target	Means of verification	Budget (millions)	Time frame									
					Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10
Provide and maintain adequate infrastructure and equipment in key institutions involved in mangrove conservation and management														
Prepare infrastructure development plan	No.	1	Development plan	2	1									
Construct Buildings	No.		Completion certificate											
• Non-residential-offices	No.	8	Inventory	40			3	5						
• Residential	No.	52	Inventory	200		5	5	5	5	10	10	10	2	
• Outposts	No.	34	Inventory	100		6	6	6	6	6	4			
• Resource centers	No.	9	Inventory	45		1	1	2	2	3				
• Observatory towers	No	6	Inventory	30										
Procure Transport														
• Vehicles (4x4)	No.	17	Logbooks	85	4	3	5	5						3
• Lorry	No	5	Logbooks	40		2	2	1						
• Grader	No	2	Logbooks	40		2								
• Minibus	No	4	Logbooks	30		2	2							
• Motor cycles	No	24	Logbooks	12	2	3	3	3	3	3	3	2	2	
• Boats& equipment	No.	12	Logbooks	120		3	4	4	1					
Communication and surveillance equipment sets (Smart phones, GPS VHIF radios)	No.	297	Records	25	20	20	40	40	40	40	40	40	17	
ICT sets (computer, printer, UPS, LCDs, TVs)	No	23	Records	4.6	13		10							
Armories	No.	34	Records	34	20	14								
Water supply	No.	21	Records	11	5	10	6							
Electricity installations/solar	No	22	Records	15	10	10	2							
Jetties	No.	11	Records	220		3	3	3						
Access roads	Km	200	Records	300		50	60	60	30					

Management objective and action	Unit	10 yr target	Means of verification	Budget (millions)	Time frame									
					Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10
Develop and maintain adequate and competent human resource														
Conduct needs assessment on human resources	No.	2	Staff Report	4	2								1	1
Train and deploy staff on identified deficit areas	No.	584	Trained staff report	12	58	58	58	58	58	58	58	58	58	62
Organize seminars and workshops for information sharing and joint planning	No.	50	Report	20	5	5	5	5	5	5	5	5	5	5
Team building	No.	10	Report	10	1	1	1	1	1	1	1	1	1	1
Reward staff with exemplary performance	No.	40	Annual Report	10	4	4	4	4	4	4	4	4	4	4
Strengthen institutions involved in mangrove management and promote collaboration among stakeholders														
Identify Institutions involved in mangrove management	No	1	Report	0.1	1									
Develop and implement institutional strengthening plan	No.	1	Report	1		1								
Total				1,410.7										

8 PLAN IMPLEMENTATION

The success of this Plan lies in its being implemented through actualizing of the management programmes and activities. Priority activities per Counties have been identified, including areas that need rehabilitation. This calls for resource commitment and mobilization on the part of key stakeholders. The roles and responsibilities of the stakeholders have been identified for smooth implementation of the management actions. The activities in each programme have been prioritized and resources identified for mobilization. This plan will be implemented for 10 years (2017 – 2027) through Annual Work Plans (AWP) in each of the management units; and with support from other sectoral plans. A success matrix is included in the Plan to ensure its effective implementation.

The Plan will be reviewed after 10 years and amendments undertaken as need arise. Both review and amendments will be carried out in conformity with the Plan objectives by lead agencies in consultation with other stakeholders.

8.1 Funding of the management plan

Effective implementation of the national mangrove management plan will require substantive funds for the recurrent and the capital development expenditure. The estimated budget for implementing the Plan over the next 10 years is KES 3.8 billion (See Chapter 7). The main sources of finance will come from the Government consolidated funds as well as funds from external partners. Government funds will include:

- I. Funds appropriated to the national institutions for mangrove conservation and management; including KWS, KEFRI, and SDF
 - II. Revenue generated from wayleaves; licenses, levies and royalties imposed on forestry related activities and services; as well as funds generated from investments in mangrove areas
 - III. County Government funds appropriated by the County government for forest conservation, management and extension.
- a) The Plan proposes to access additional funds from the National Management and conservation Trust fund established under the Forests Conservation and Management Act of 2016 to support implementation. An administrative structure will be established to manage the funds to ensure accountability.
 - b) Additional resources will also be solicited from the users/beneficiaries of the mangrove goods and services including sale of carbon credits.

8.2 Environmental impact assessment (EIA)

All development activities proposed in mangrove ecosystems shall be subjected to EIA as per EMCA (1999). For activities already in place an Environmental Impact Assessment and Audit will be carried out before their licenses can be renewed. In the short-term KFS and

KWS shall review the existing criteria for assessing proposed development activities before evaluating their suitability as proposed in this management plan.

8.3 Monitoring and Evaluation

Monitoring and evaluation (M&E) is a key aspect to determine successful implementation of management programmes of the Plan; and for informing adaptive adjustments ensuring that overall benefits of the Plan are maximized and any negative impacts are appropriately mitigated. Quarterly and annual M&E will address the Management Programmes outlined in the Plan (See tables in Chapter 7). The tables below present **outcome-oriented** matrices of what successful implementation of the Plan would look like. The matrices define programme objectives, indicators of success, verifiable indicators, sources and means of verification and lead agency responsible for implementation of each Management Programme.

a) Mangrove Forest Conservation and Utilization Programme

Objective	Indicators of Success	Verifiable Indicator	Sources and means of verification	Lead Agency
Conserve and protect mangrove forests for sustained ecological integrity and climate change mitigation	Stabilized shorelines Protected areas remain undisturbed Increased abundance of fauna in restored mangrove areas	Digital maps Satellite imagery Technical reports	Measurement, digital maps, Aerial surveys and satellite imagery	KFS, KMFRI
Promote sustainable harvesting of mangrove wood products	Felling plans availed to the five counties	Maps, reports and felling plans	Availability of maps, reports, operational felling plans	KFS
Rehabilitate degraded mangrove forest areas	Increase in mangrove planted areas Increase in mangrove regeneration Presence of community mangrove tree nurseries	Number of hectares planted increased, Increased mangrove coverage	Measurement, digitized maps, aerial surveys and satellite imagery cover	KFS, KWS, KMFRI

Improve policing and protection of mangrove areas from illegal human activities	Equipment availed Rangers deployed at strategic new built out posts Reduced illegal extraction	Number of boats, pickups, lorries increased Communication gadgets available and increased number of rangers	Reports Asset records Staff records	KFS, KWS
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b) Fisheries management programme

Objective	Indicators of success	Verifiable Indicator	Sources and means of verification	Lead agency
Identify and map degraded fish habitats for restoration	Degraded fish habitat prioritized for restoration	Maps for degraded fish habitat Catch/Landing Per Unit Effort (CPUE)	Maps and Catch assessment reports	KMFRI & County Government Fisheries offices
Promote adoption of silvo-aquaculture in mangrove areas	Increased food security Reduced forest degradation Integrated use of mangrove area	Number of operational ponds and other cultural techniques Total harvest from mariculture ventures	Site plans, inspection and environmental audits Harvest reports	SDF
Promote active participation of communities in fisheries resources management	Improved co-management in fisheries	Operational management plans and guidelines	Management plans and guidelines	SDF

c) Community Programme

Objective	Indicators of success	Verifiable Indicator	Sources and means of verification	Lead agency
Strengthen local institutional capacity in	Improved institutional	Number of functional CFAs	KFS reports and database	KFS CFAs

mangrove management and conservation	operations Stable local institutions Improved public private partnerships	registered Approved PFMPs Signed Forest Management Agreements Number of public private partnerships Number of stable local institutions	CFA reports CBO reports	CBOs County governments
Promote nature based enterprises and networking for livelihood improvement	Improved Livelihoods Improved poverty index Reduced pressure on the mangrove ecosystem	Poverty Index Income levels Number of hectares of on-farm woodlots established	Kenya National Bureau of statistics socio-economic surveys KFS records	Kenya National Bureau of statistics KFS County government
Develop and implement community awareness strategies and training programmes	Informed community on issues of mangrove management Reduced illegal extraction	Number of successful community driven conservation activities	KFS records CFA records	KFS County governments
Strengthen community participation in formulation and implementation of relevant policy and legislative processes	Community mainstreamed in policy making Reduction in conflicts	Number of policy briefs shared with communities Number of policies incorporating socio-cultural aspects	KFS records County government records	KFS County governments
Develop conflict resolution mechanisms to address emerging disputes	Reduction in conflicts Operational community institutions	Number of conflicts resolved	Conflict resolution guideline Minutes	KFS CFAs

d) Research and Education Programme

Objective	Indicator of success	Verifiable Indicator	Source and means verification	Lead agency
Promote research and education on conservation and management of mangrove and associated ecosystem	High interest (support) on mangroves Increased funding for mangrove research and management Mangrove units in the university curricula Improved livelihoods for communities Less forest patrols Less poaching Teams involved in mangrove research Funded multi-institutional research proposals	Reports (Research meeting, workshops) Funded research proposals Publications Economic valuation reports Survey reports Minutes MoU MoA	KFS Universities KMFRI, KEFRI KWS Bank statements Receipts Brochures, Leaflets Journal papers	KEFRI KMFRI KWS KFS

e) Tourism development Programme

Objective	Indicators of Success	Verifiable Indicator	Sources and means of verification	Lead agency
Develop an effective tourism plan and infrastructure	Increased tourism activities Improved tourism infrastructure	Tourism numbers Number and type of infrastructure in place Tourism plan	KFS Records KWS Records	KWS KFS
Develop and enhance marketing strategies	Increased tourism activities	Tourist numbers. Marketing strategy	CFA Reports KTB Reports KWS Reports KFS Reports	KFS KWS

Improve and diversify tourism products including culture and ecotourism	Increased revenue streams/sources	Number of tourism products. Brochures	CFA records KWS Records KFS Records KTB Records	KWS KFS KTB
Enhance community capacity in tourism entrepreneurship	Community owned tourism enterprises established Improved household income	Number of community owned tourism enterprises established Income levels	CFA records KFS records KWS records	KFS KWS CFAs
Develop and implement stakeholder benefit sharing strategy	Gender equity in development projects Equity in benefit sharing	Reduced conflicts Benefit sharing strategy	KFS reports CFA reports	KFS

f) Human Resource and Operations Programme

Objective	Indicators of success	Verifiable Indicator	Sources and means of verification
Provide and maintain adequate infrastructure and equipment in key institutions	Improved working environment	Asset records	Supply and procurement departments at respective institutions
Develop and maintain adequate and competent human resource	Improved service delivery	C.Vs of Officers Number of trainings	Human resource departments at relevant institutions
Strengthen institutions involved in mangrove management and promote collaboration among stakeholders	Improved forest ecosystem status Reduced incidents of illegal activities	Number of arrests Records of patrols Number of forest Rangers	KFS surveillance and operations offices

8.4 Institutional arrangements for plan implementation

As per Forests Conservation and Management Act 2016, forestry in Kenya constitutes KFS Directorate as the highest office for management plans implementation. Below the Director, the forest management plans are implemented through a command chain from the Heads of

Conservancy (HOC), the Ecosystem Conservators (EC) to Zonal Managers. These existing structures will be infused in the proposed implementation of the mangrove management plan, only with slight additions to specifically address mangrove ecosystem, as discussed below.

Director KFS remains the overall overseer of the implementation of mangrove management plan. A National Mangrove Management Committee (NMC) will be constituted, with membership of technical experts for mangrove ecosystem relevant disciplines, including; Forestry, Fisheries, Wildlife, Water, Land, and Climate, etc). The NMC will serve as advisory organ to inform HOC on the technical issues regarding mangrove management. The HOC will be the secretary for the NMC.

Similar to other forest management plans, Head of Conservancy (HOC) will be the regional focal-point for the mangrove management plan implementation. HOC will be responsible for ensuring sustainability and perpetuity of the mangrove ecosystem. The HOC will provide a platform for inter-county dialogue, regional consensus building, priority setting and balancing of the various interests involved. Below HOC, a Mangrove Management Coordinator will be responsible for coordinating different mangrove management programmes. The coordinator will have advanced training on mangrove conservation and management.

At County level there will be County Management Committees (CMC), headed by the ECs. The CMC will be responsible for the technical guidance for the plan implementation at the County level. Membership of CMC will include technical persons from the County Government, KWS, SDF; as well as CFAs/community representative and Private sector. CMC will also guide the development and implementation of the operational plans, in compliance with the National Management Plan frameworks. The CMC will have the power to incorporate the user groups and other stakeholders concerned with the mangrove ecosystem resources.

Each management plan implementation level will have an obligation to inform the level above it, and to advice/guide the level below it. A centralized data/reports point must be identified, where best practices can be picked and shared across. A diagrammatic organogram is indicated below.

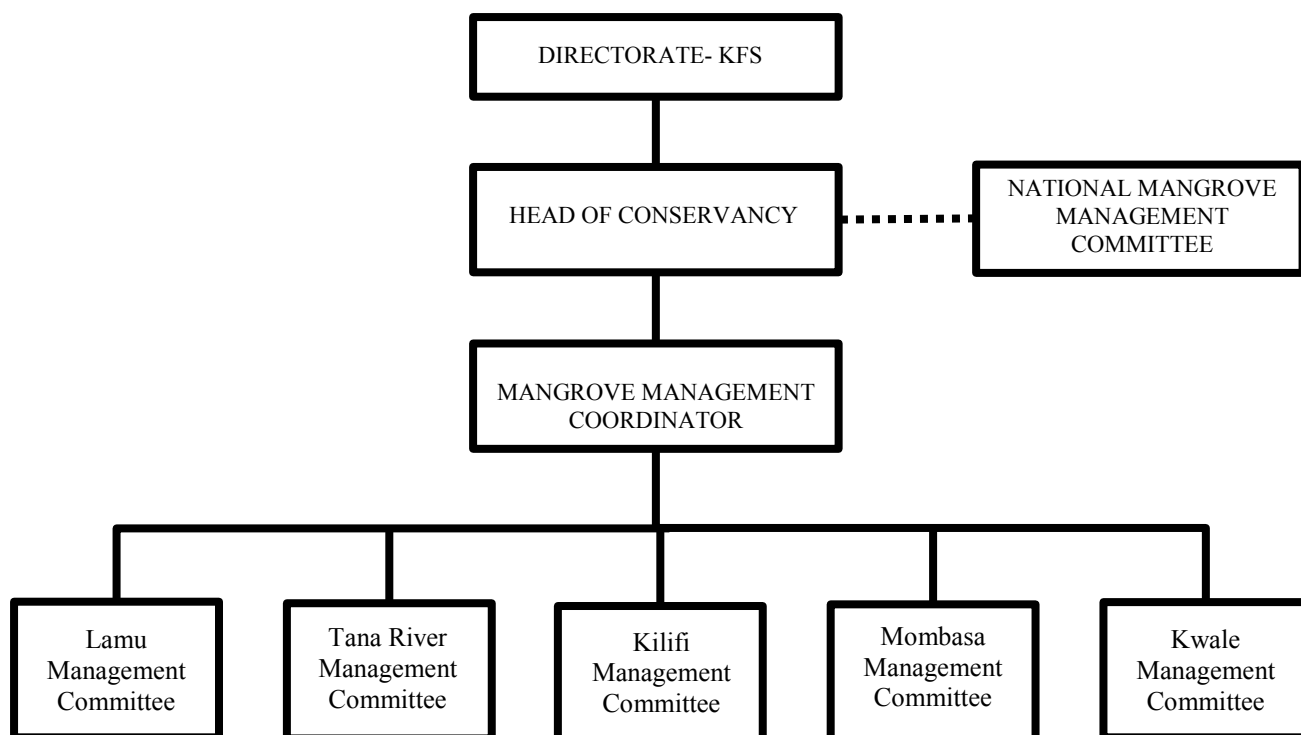


Figure 8.1: Implementation Structure for the Mangrove Management Plan

8.5 Guiding principles for the implementation of the plan

The following principles shall guide the implementation of the Plan:

Equity

Gender considerations are integrated at all levels of plan implementation. The plan underscores the need for equitable representation of all groups in meetings and decision-making processes to enhance the role played by them in the conservation of the mangrove forest resources. Gender balance is established where possible and all groups (youth, elderly, disadvantaged) are considered during the composition of the various sub-committees and in management activities. Awareness creation among the groups is enhanced to highlight the importance and value of involving all interest groups in conservation and other activities. The minority interests are weighed in relation to the well-being of the larger communities. Benefits accrued from the ecosystem are shared equitably among stakeholders especially paying due regard to the communities living within and around the ecosystem.

Transparency

This is observed in all decision-making processes to ensure that key stakeholders are well informed on the on-going activities and of future envisaged plans. This approach is essential towards developing, maintaining and improving rapport between the institutions/organizations that are involved in the implementation of the management plan.

Participatory

A coordinated approach to ecosystem conservation and management is enhanced to ensure that the national and county governments, private sector and community are involved in planning, implementation and decision making process, while respecting the jurisdiction and responsibilities of the various government agencies, private investments, the rights of communities and individual landowners.

Effective implementation of the Plan need full support by the community. The Plan recognizes the crucial role of the forest adjacent communities who participate in the implementation through the Community Forest Associations (CFAs).

An integrated ecosystem approach

Plan implementation must ensure an integrated ecosystem approach for the purpose of protection and conservation of the biodiversity within all the areas managed by the Plan.

Scientific knowledge and expertise

Research is a dynamic exercise as it is part of ecosystem conservation, management planning, implementation and decision making process. It aims at helping bring new information as well as strengthening areas with weak documentation, including indigenous knowledge.

Social acceptability

The implementation of this plan recognizes and promotes intellectual property rights: safeguards the rights and interests of vulnerable and marginalized groups

Sustainability

The plan encourages conservation, protection and utilization, of the mangrove ecosystem taking cognizance that this ecosystem and the associated resources are finite. National policies and international environmental agreements underpin the implementation of this plan.

Objectivity

Plan addresses the set objectives that are quantifiable and focused, attainable, realistic and time bound.

Plan is an on-going dynamic process

The plan is flexible enough to accommodate shifts in demand/supplies and priorities. Long term as well as medium term plans are embraced. Review of this plan is important so as to identify the challenges and solutions for the good of the mangrove ecosystem.

Planning functions and responsibilities

The implementation of the plan follows due responsibility as outlined in the plan implementation structure or any other that may arise which is consistent with national governance structures.

ANNEXES

Annex I: Members of the Expert Working Group

Name	Affiliation
Dedan Ndiritu	Kenya Forest Service
Elizabeth Wambugu	Kenya Forest Service
Bernard Orinda	Kenya Forest Service
John K. Macharia	Kenya Forest Service
Jamleck K. Ndambiri	Kenya Forest Service
Judith Okello	Kenya Marine and Fisheries Research Institute
Leila Akinyi Ndalilo	Kenya Forestry Research Institute
Jane Wamboi	Kenya Wildlife Service
Erastus Kanga	Kenya Wildlife Service
Apollo Kariuki	Kenya Wildlife Service
Fredrick Tamoooh	Kenyatta University - Mombasa
Bernard Kirui	Egerton University
Joseph Langat	Bomet County
Jared Bosire	World Wildlife Fund (WWF-Kenya)
Harrison Ong'anda (mapping)	Kenya Marine and Fisheries Research Institute
Stella Choge (mapping)	University of Eldoret
Safi Ibrahim (mapping)	Kenya Forest Service

Annex II: Stand table data for the mangroves in Lamu County**1. Kiunga Marine National Reserve**

Species	Size/Utilization classes									Density
	Fito	Pau	Mazio	Boriti	Nguzo1	Nguzo2	Nguzo3	Nguzo4	Banaa	Stems ha ⁻¹
	<7.5	7.5-10	10-12.5	12.5-15	15-17.5	17.5-20	20-25	25-30	>30	
<i>Avicennia marina</i>	21	20	12	6	8	13	12	4	3	90
<i>Bruguiera gymnorhiza</i>	2	6	6	3	4	3	2	3	2	42
<i>Ceriops tagal</i>	328	143	74	24	13	6	6	0	0	594
<i>Rhizophora mucronata</i>	339	195	139	165	124	112	145	77	99	1,393
<i>Sonneratia alba</i>	13	18	19	13	9	10	13	8	10	107
Total	702	381	248	209	157	144	178	92	114	2,225
2. Outside Kiunga Marine National Reserve										
<i>Avicennia marina</i>	200	44	38	21	13	10	18	21	21	385
<i>Bruguiera gymnorhiza</i>	8	3	0	3	5	0	3	0	0	21
<i>Ceriops tagal</i>	459	77	31	13	8	0	3	3	3	595
<i>Rhizophora mucronata</i>	582	164	95	72	38	49	74	36	41	1,151
<i>Sonneratia alba</i>	49	18	26	13	31	26	28	13	21	223
Total	1,297	305	190	121	95	85	126	72	85	2,371

Annex III: Stand table data for the mangroves in Tana River County**1. Kipini****Size/Utilization Classes**

	Fito	Pau	Mazio	Boriti	Nguzo1	Nguzo2	Nguzo3	Banaa	Density
Species	2.5-3.9	4-7.9	8-11.4	11.5-13.9	14-16.9	17-20.4	20.5-30.4	>30.5	Total stems/ha
<i>Avicennia marina</i>	135	396	113	8	10	13	19	1	694
<i>Bruguiera gymnorhiza</i>	3	14	1	0	3	0	8	8	38
<i>Heritiera littoralis</i>	19	36	11	24	11	14	32	26	174
<i>Xylocarpus granatum</i>	13	49	10	4	3	0	1	6	85
Total	169	494	135	36	26	26	61	42	990

2. Mto Tana

<i>Avicennia marina</i>	131	250	101	42	38	31	31	3	625
<i>Bruguiera gymnorhiza</i>	6	3	6	0	1	0	1	0	17
<i>Ceriops tagal</i>	299	229	22	7	10	7	1	1	576
<i>Rhizophora mucronata</i>	1	1	3	0	0	0	0	0	6
Total	436	483	132	49	49	3	33	4	1,224

Annex IV: Stand table data for the mangroves in Kilifi County

1. Mtwapa									
Size/Utilization Classes									
	Fito	Pau	Mazio	Boriti	Nguzo1	Nguzo2	Nguzo3	Banaa	Density
Species	2.5-3.9	4-7.9	8-11.4	11.5-13.9	14-16.9	17-20.4	20.5-30.4	>30.5	Total stems/ha
<i>Avicennia marina</i>	4	12	16	12	8	4	8	0	64
<i>Ceriops tagal</i>	1424	700	20	0	0	0	0	0	2144
<i>Rhizophora mucronata</i>	2156	1816	180	52	20	16	0	0	4240
<i>Xylocarpus granatum</i>	44	56	8	8	4	0	0	0	120
Total	3628	2584	224	72	32	20	8	0	6,568
2. Kilifi-Takaungu									
<i>Avicennia marina</i>	107	232	66	14	30	32	77	11	568
<i>Bruguiera gymnorhiza</i>	23	23	0	0	0	0	0	0	45
<i>Ceriops tagal</i>	500	280	2	0	0	0	0	0	782
<i>Rhizophora mucronata</i>	434	384	73	27	14	27	41	14	1014
<i>Sonneratia alba</i>	34	73	20	14	18	7	9	0	175
Total	1098	991	161	55	61	66	127	25	2,584

3. Mida

Utilization Classes

	Fito	Pau	Mazio	Boriti	Nguzo1	Nguzo2	Nguzo3	Banaa	Density
Species	2.5-3.9	4-7.9	8-11.4	11.5-13.9	14-16.9	17-20.4	20.5-30.4	>30.5	Total stems/ha
<i>Avicennia marina</i>	98	128	37	9	10	4	6	3	295
<i>Bruguiera gymnorhiza</i>	33	41	7	8	0	0	8	9	106
<i>Ceriops tagal</i>	889	688	87	19	4	4	3	1	1695
<i>Rhizophora mucronata</i>	331	426	90	37	15	13	41	6	959
Total	1351	1283	221	73	29	21	58	19	3,055

4. Ngomeni

<i>Avicennia marina</i>	62	102	42	24	17	12	14	27	300
<i>Bruguiera gymnorhiza</i>	15	29	21	5	3	9	12	8	102
<i>Ceriops tagal</i>	202	214	47	12	9	11	11	3	508
<i>Rhizophora mucronata</i>	395	405	68	20	9	18	61	23	998
<i>Sonneratia alba</i>	0	220	12	8	8	6	6	0	59
<i>Xylocarpus granatum</i>	2	5	3	5	5	11	18	2	48
Total	676	773	194	73	50	67	121	62	2,015

Annex V: Stand table data for the mangroves in Mombasa County

Species	Size / utilization classes								Density Stems ha ⁻¹
	Fito	Pau	Mazio	Boriti	Nguzo1	Nguzo2	Nguzo3	Banaa	
	2.5-3.9	4.0-7.9	8.0-11.4	11.5-13.9	14.0-16.9	17.0-20.4	20.5-30.4	>30.5	
<i>Avicennia marina</i>	20	43	19	8	8	5	10	7	120
<i>Bruguiera gymnorhiza</i>	3	4	0	0	0	0	1	0	9
<i>Ceriops tagal</i>	69	49	2	1	0	1	0	0	121
<i>Rhizophora mucronata</i>	586	458	53	16	18	13	31	4	1,180
<i>Sonneratia alba</i>	4	56	55	27	23	20	15	4	204
<i>Xylocarpus granatum</i>	0	0	1	0	0	0	0	0	1
Total	683	610	129	52	50	39	57	16	1,636

Annex VI: Stand table data for the mangroves in Kwale County**1. Gazi Bay**

Species	Size / utilization classes								Density Stems ha ⁻¹
	Fito	Pau	Mazio	Boriti	Nguzo1	Nguzo2	Nguzo3	Banaa	
	2.5-3.9	4.0-7.9	8.0-11.4	11.5-13.9	14.0-16.9	17.0-20.4	20.5-30.4	>30.5	
<i>Avicennia marina</i>	3	26	6	8	5	11	11	2	71
<i>Bruguiera gymnorhiza</i>	72	175	97	29	37	14	20	2	446
<i>Ceriops tagal</i>	637	445	69	15	5	3	2	0	1175
<i>Rhizophora mucronata</i>	689	517	140	78	62	42	69	12	1609
<i>Sonneratia alba</i>	15	23	15	3	11	6	11	2	86
<i>Xylocarpus granatum</i>	26	65	14	6	9	9	11	3	146
Total	1,443	1,251	345	140	128	85	123	20	3,534

2. Vanga-Funzi

Species	Size / utilization classes								Density Stems ha ⁻¹
	Fito	Pau	Mazio	Boriti	Nguzo1	Nguzo2	Nguzo3	Banaa	
	2.5-3.9	4.0-7.9	8.0-11.4	11.5-13.9	14.0-16.9	17.0-20.4	20.5-30.4	>30.5	
<i>Avicennia marina</i>	124	138	26	8	4	8	10	5	323
<i>Bruguiera gymnorhiza</i>	47	51	21	4	4	2	7	0	136
<i>Ceriops tagal</i>	778	651	60	11	9	4	1	0	1515
<i>Lumnitzera racemosa</i>	1	1	0	0	0	0	0	0	2
<i>Rhizophora mucronata</i>	375	521	152	50	38	23	39	8	1205
<i>Sonneratia alba</i>	2	13	12	5	8	5	8	6	59
<i>Xylocarpus granatum</i>	14	26	8	3	2	1	2	0	55
Total	1,341	1,401	279	80	65	43	67	20	395



**For more information of the national mangrove ecosystem management plan, please
contact:
Director
Kenya Forest Service
P.O.Box 30513-00100, Nairobi Kenya
info@kenyaforestservice.org**