A Blue Carbon Primer

The State of Coastal Wetland Carbon Science, Practice, and Policy

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CRC Press
Taylor & Francis Group
Boca Raton London New York

CRC Press is an imprint of the
Taylor & Francis Group, an **informa** business

CRC Press
Taylor & Francis Group
6000 Broken Sound Parkway NW, Suite 300
Boca Raton, FL 33487-2742

Printed on acid-free paper

International Standard Book Number-13: 978-1-4987-6909-9 (Hardback)

CHAPTER 24

Mikoko Pamoja

A Demonstrably Effective Community-Based Blue Carbon Project in Kenya

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HIGHLIGHTS

1. Mangrove and associated blue carbon ecosystems are highly productive ecosystems with potentials to mitigate climate change through carbon capture and storage
2. Mangroves in Kenya are threatened by human-induced stresses ranging from over exploitation of resources, conversion pressure, and pollution leading to a 18% loss in the forest from 1985 to 2010
3. Incentive-based schemes, such as Payment for Ecosystem Services, can help reverse these threats
4. Mikoko Pamoja, is the first community-type project in the world to restore and protect mangroves through sales of carbon credits
5. The project is regulating climate, helping communities, and conserving biodiversity

24.1 INTRODUCTION

Mangrove forests in Kenya provide a range of ecosystem goods and services. These **blue carbon ecosystems** are important nurseries and breeding grounds for many varieties of fish and other wildlife (Kimani et al. 1996; Huxham et al. 2004; Mirera & Moksnes 2015). They also play a key role in combating effects of rising sea levels, coastal erosion, and flooding from storm surges and tsunamis (Huxham et al. 2015). As an important source of renewable resources—notably fisheries and wood products—mangroves are important in coastal development (Kairo et al. 2001).

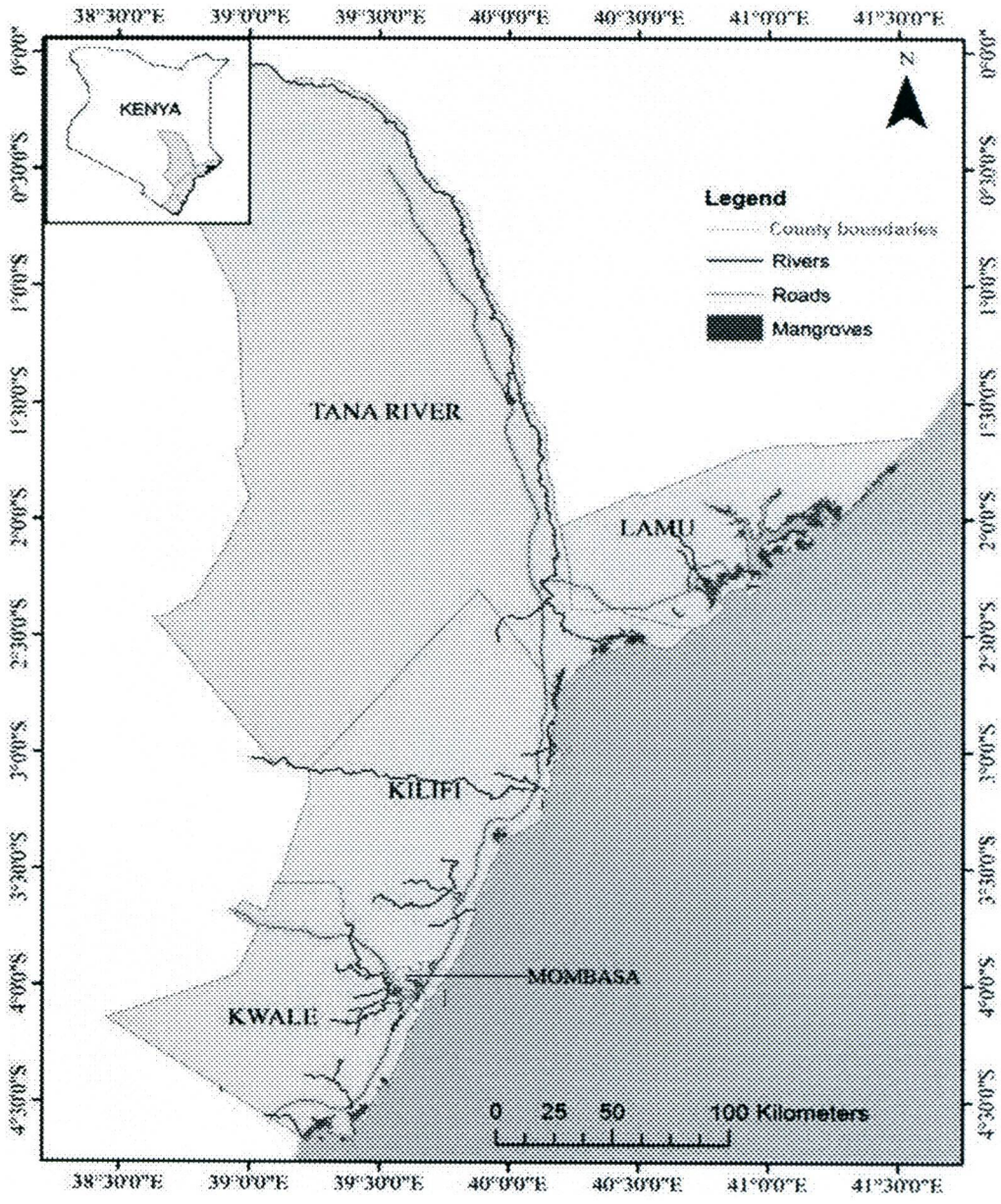

Figure 24.1 Mangrove distribution within the five counties along the coastal strip in Kenya.

There are 60,323 ha of mangrove forests distributed all along the 536 km Kenyan coastline as shown in Figure 24.1. These forests represent approximately 3% of the natural forest cover or less than 1% of the national land area in Kenya. As shown in Table 24.1 below, a large part of mangroves in Kenya (about 61%) occur in Lamu county, followed by Kwale (14), Kilifi (14), Mombasa (6), and Tana River (5) Counties.

There are nine mangrove species in Kenya as shown in Table 24.2 below. Two of the species, *Rhizophora mucronata* and *Ceriops tagal* are the most dominant and are represented in almost all mangrove formations. The rare species are *Heritiera littoralis* and *Xylocarpus moluccensis*. Major use of mangrove wood products include firewood, building poles, fencing and furniture.

Naturally growing mangroves exhibits horizontal distribution of species (or zonation). This is greatly influenced by levels of inundation, geomorphology, and the salinity (Tomlinson 1986). A typical zonation of mangrove in Kenya starts with *Sonneratia alba* on the seaward margin, followed by large *Avicennia* 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 Knowledge of mangrove distribution across the intertidal area is important in their management.

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 (Bosire et al. 2016). 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. Common groups of birds occurring in mangrove areas are: 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). Further, mangrove forests receive thousands of migratory birds during winters every year (Huxham 2013).

Table 24.1 Main Mangrove Areas per County along the Kenya Coast

County	Forested Mangrove Area (ha)	%	Major Mangrove Areas in the County
Lamu	37,350	61	Northern Swamps, North-central swamps, Southern Swamps, Mongoni and Dodori Creek, Pate Island
Tana River	3,260	5	Kipini and Mto Tana
Kilifi	8,536	14	Ngomeni, Mida, Kilifi, Mtwapa
Mombasa	3,771	6	Tudor and Port Ritz creeks
Kwale	8,354	14	Gazi, Funzi, Vanga
Total	61,271	100	

Source: GoK (2017).

Table 24.2 Mangrove Species Found in Kenya and Their Uses

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

The principal groups of fish and crustacean associated with mangroves of Kenya are snappers, groupers, rabbit fish, grant, milkfish, mullet, terapons, carangids, shrimp, crabs, and oysters (Kimani et al. 1996; Mirera et al. 2010). The high biomass of fish, molluscs, and crabs that mangroves support has significant economic value to artisanal and commercial fisheries.

24.2 THREATS TO MANGROVES IN KENYA

In Kenya, mangroves are being lost and degraded due to a combination of human and natural factors, ranging from over-harvesting of wood products to conversion of mangrove land to other land uses, particularly for agriculture, pond aquaculture, and infrastructure development (Abuodha & Kairo 2001; Kirui et al. 2013). Conditions are worse in peri-urban areas, such as Mombasa, where mangroves are being cleared to pave ways for infrastructure and human settlement (Bosire et al. 2014). Less than half of the original mangrove forests in Kenya remain, and the current rate of loss (about 0.7% per year) is a major cause of concern (Kirui et al. 2013).

Climate change effects such as sea level rise, increased rainfall, and storm surges are expected to negatively impact the remaining mangrove areas in Kenya (Kairo & Bosire, 2016). Site-based responses to climate change effects such as the construction of hard civil structures are likely to exacerbate these effects. Of the predicted impacts to occur due to climate change, sea level rise is perhaps the greatest threat to the ecological integrity of mangroves and associated biological resources (Gilman et al. 2008). In addition to shortages of harvestable wood products, declines in fisheries and increased shoreline erosion, destruction of mangrove forests in Kenya release huge quantities of stored carbon into the atmosphere, contributing to global warming and other climate change trends (Lang'at et al. 2014). Fortunately, compensation for conservation and restoration can potentially help reverse these trends.

24.3 MARKETING MANGROVE SERVICES

Currently, the value of mangrove ecosystems in Kenya is captured mostly for provisioning services, such as wood products, capture fisheries, and some value-added cultural services such as ecotourism (Kairo et al. 2009). There is still a big gap in approaches for capturing the value of much of the regulating, supporting, and cultural services provided by mangroves. Payments for ecosystem service (PES) are emerging resource management tools that provide incentives for behavioral changes to increase the provision of ecosystem services, e.g., by discouraging losses and degradation of forests (Locatelli et al. 2014).

The Government of Kenya is pursuing market-based approaches to environmental protection, with a strategic focus on Ecosystem Services (ES), including biodiversity, carbon sequestration, food provision, recreation, and shoreline protection (GoK 2017). Specifically, the country's conservation strategy is to "identify the benefits of environmental services and to seek a system where beneficiaries of such services pay service providers." PES schemes are attractive because they reward those that supply or provide ES. However, the potential of forestry based PES schemes is hugely untapped in Kenya. Through the UK's Ecosystem Service for Poverty Alleviation (ESPA) funded projects in Kenya (www.espa.ac.uk), experience has been gained in facilitating the development and implementation of small-scale mangrove PES projects, with carbon credits supporting community development and mangrove conservation at Gazi Bay. This work led to the establishment of **Mikoko Pamoja**—the world's first community-based mangrove project funded by carbon credits (www.planvivo.org/project-network/mikoko-pamoja-kenya/)—Project timelines and achievements of Mikoko Pamoja are illustrated in Figure 24.2.

Mikoko Pamoja is being executed in Gazi Bay area of the southern coast of Kenya, about 55 km south of Mombasa in Kwale County. Figure 24.3 shows the project area. The bay is bordered by 620 ha

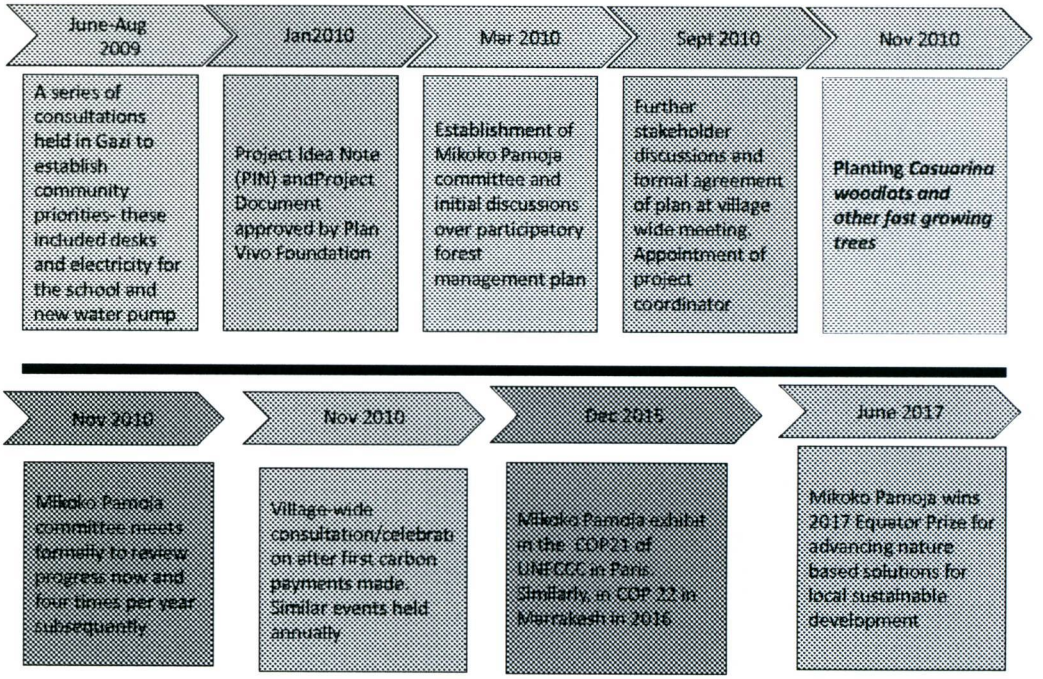

Figure 24.2 Mikoko Pamoja timeline and achievements.

of mangrove forests, which are heavily used by local people as fishing ground and source of wood for building and fuel (Dahdouh-Guebas et al. 2000). These forests have been extensively used and degraded—with large areas clear-felled in the 1970s and have not naturally recovered to-date. Selective logging of mangroves for commercial and subsistence use are still continuing in some stands and forest degradation continues through illegal harvesting of firewood and building poles. This has resulted in shortages of building poles and firewood, decreased fishery resources, and increased coastal erosion.

24.4 SOCIAL ECONOMIC CHARACTERISTICS OF GAZI BAY

There are approximately 6,000 residents in the two villages adjacent the bay, Gazi and Makongeni. The main ethnic group is the Swahili, while the Mijikenda of Bantu origin is the second commonest. Livelihoods are provided predominantly by fishing, farming, and tourism. Some 25% of households receive remittances from kin outside of the area, and around one-third of people are recent immigrants, who have come mostly to exploit the reef-based fisheries. Other sources of employment are provided by titanium mining and sugar cane farming companies. Historically, local communities have exploited mangrove forests for firewood, construction poles, and medicine. The net benefits of mangroves in Kenya have been estimated to have a value of over US$2,500 per hectare every year. Shoreline protection functions of mangroves is allocated the highest value when compared to other habitat functions provided by the ecosystem as demonstrated in Table 24.3. It is therefore vital that mangroves are protected for their benefits to community and the ecosystem functioning.

According to the Project Design Document (PDD) submitted to Plan Vivo (Huxham 2010), the overall objective of **Mikoko Pamoja** is to channel finance for the protection and restoration of mangrove ecosystems through the provision of and payments for quantifiable ecosystem services (PES). Specific objectives are:

Table 24.3 Valuation of Mangrove Ecosystem in Kenya

Product and Services	KES $ha^{-1}year^{-1}$
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: Kairo et al. (2009).

- To preserve the current quality and extent of the mangrove forests of Gazi Bay and of the services they provide to local communities
- To restore degraded areas of mangrove forest in Gazi Bay
- To raise income from forest resources, including carbon credits, for community benefit
- To establish alternative sources of timber and firewood in the Gazi area
- To work with the Kenya Forest Service and other government agencies to determine policy about engaging communities in land management, particularly through the provision of ecosystem services through international carbon offset markets

24.5 ELIGIBLE ACTIVITIES FOR CARBON FINANCING

Mikoko Pamoja activities are implemented through three distinct and interlinked project activities in Gazi Bay as shown in Figure 24.3 and Table 24.4.

- **Activity 1: Avoided deforestation and forest restoration.** This involves protection of existing natural *Rhizophora mucronata* forest over an area of 107 ha. The area has previously suffered from deforestation and forest degradation.
- **Activity 2: Reforestation and forest protection**. This has involved establishment of 10.0 ha of *Rhizophora mucronata* stand in formerly deforested area.
- **Activity 3: Reforestation and forest protection**. Replanting of a *Sonneratia alba* fringing forest of 40–70 m depth and 800 m length, along a wave-exposed beach. Mangrove wood was originally removed from parts of the area for industrial use, leaving open areas of sand, which have not regenerated naturally, and exposing adjacent agricultural field to erosion. As part of community commitments in the project, replanting of about 4,000 seedlings is undertaken in a succession of planting areas of about 0.4 ha every year. Cumulatively, over the 20 years contracting period, the activity would have replanted a total of 8 ha of mangroves.

24.6 CARBON BASELINE

Mangrove forests develop and sustain above- and belowground carbon pools. The latter constitutes a very long-term sink, with large amounts of carbon held in peat (Gress et al. 2017). Gazi Bay is among the best-studied mangrove system in the world (Kairo 2001), and there is detailed information on above- and belowground biomass carbon for different forest types (Tamooh et al. 2008;

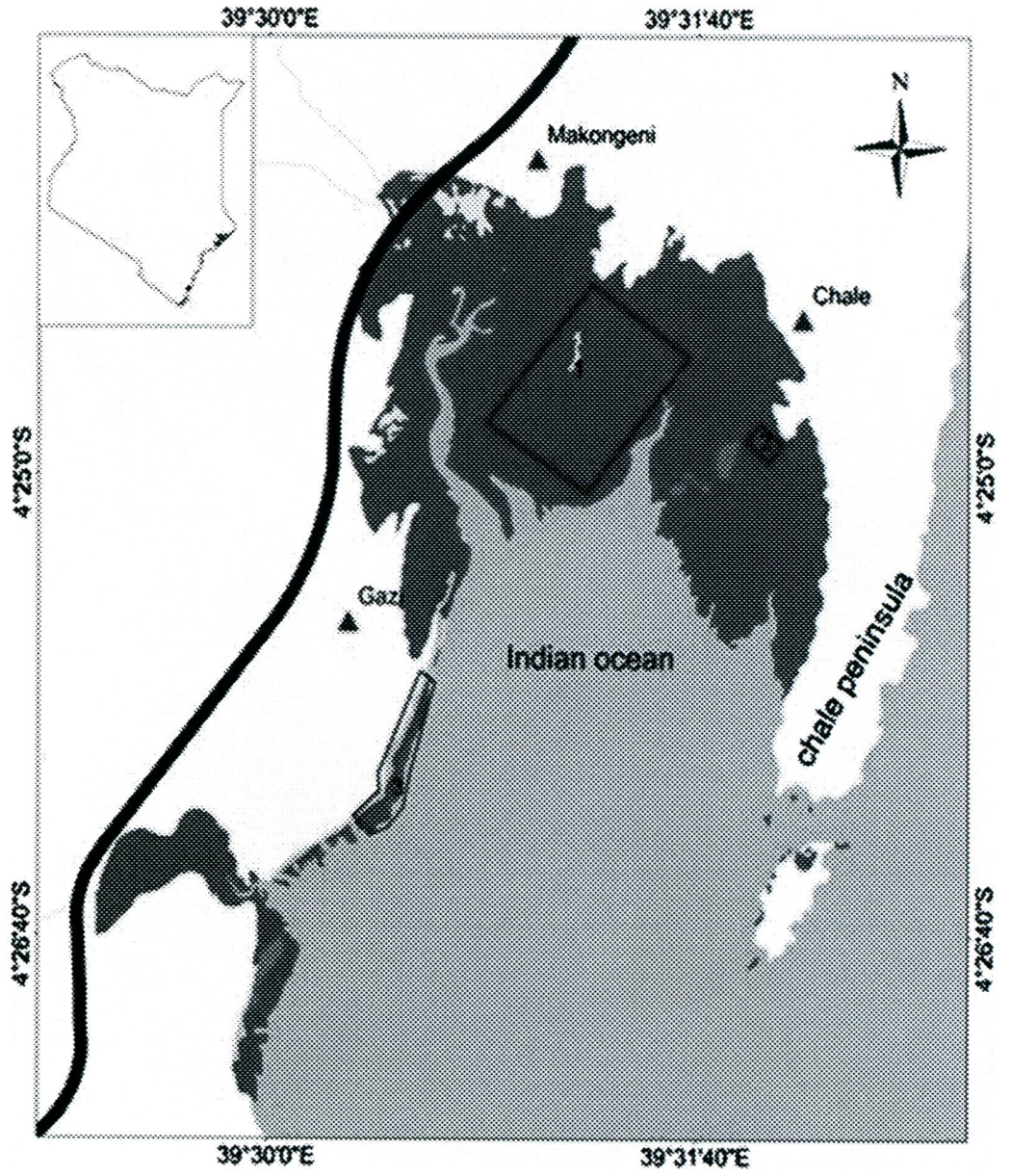

Figure 24.3 Map of Gazi showing Mikoko Pamoja activity areas within lined boundaries.

Cohen et al. 2013). The aboveground biomass of mangroves in Gazi is estimated at 250 t ha^{-1}, although this varies depending on age, species, and location in the intertidal area. Belowground biomass (to 60 cm depth) varies from 7.5 to 75 t ha^{-1}. This equates to approximately 155,000 t aboveground and 23,250 t belowground (178,250 t total) in the Gazi area. In addition, mangroves sequester around 1.5 t C ha^{-1} $year^{-1}$ in accretion of new sediment, and approximately 5 t C ha^{-1} $year^{-1}$ in new biomass (for a mature forest—rates are higher for young forests and plantations).

Table 24.4 Carbon Benefits and Projected Income from Mikoko Pamoja

Activity	Forest Type	Area (ha)	Carbon Benefit ($t\ CO_2 ha^{-1} year^{-1}$)	Total Annual Project Carbon Benefit From Initial Activities ($t\ CO_2 year^{-1}$)	Income ($)[a]
Avoided deforestation	Natural mixed	100	18 (based on mature forest, so conservative given this is a recovering forest)	1,800	10,800
Reforestation	*Rhizophora* plantation	7	29 (based on 12-year-old plantation)	203	1,218
Reforestation	New plantation (*Sonneratia*)	5 (after 5 years)	Four (but increasing to ~10 after 10 years)	20	120
			Total	2,023 tCO_2	$12,138

[a] Assumes a conservative price of $6 $tonne^{-1}$ CO_2.

24.7 OWNERSHIP OF CARBON RIGHTS

All mangroves in Kenya are recognized under statutory laws as government reserve forests. Management of these forests is vested with the Kenya Forest Serve (KFS), either alone, or in partnership with Kenya Wildlife Service (KWS) whenever they occur within marine protected areas (MPA). Under the provisions of Forest Conservation and Management Act (2016), Community Forest Associations (CFAs) are designated specific forest areas that they could co-manage for the desired goods and services. Mikoko Pamoja is managed through GOGACOFA, a local CFA that has been involved in the development of participatory forest management plan (PFMP) for forests within and adjacent to Gazi Bay, and in the signing of Forest Management Agreement (FMA) with KFS. The management agreement enables Mikoko Pamoja to engage in sale of carbon credits from the designated mangrove area. Mikoko Pamoja is verified under the Plan Vivo System and Standards, a framework for supporting communities to manage their natural resources more sustainably with a view to generating climate, community, and biodiversity benefits through payments for environmental services; in this case carbon. Income from carbon credits, worth over US$12,500 each year, is used to fund continued mangrove conservation activities as well as priority projects chosen by communities, such as water and sanitation, health, and education (Abdalla et al. 2015). Communication of the value of blue carbon in both economic terms and in terms of ecosystem services provided by mangrove habitats was key to community uptake of Mikoko Pamoja. The building blocks of Mikoko Pamoja, which could be replicated to other mangrove areas, have been identified as good science, community buy-in, and government support (Abdalla et al. 2015).

24.8 GOVERNANCE STRUCTURE OF MIKOKO PAMOJA

Mikoko Pamoja is governed by a 13-member committee democratically elected from participating villages every two years during a village consultative meeting and in adherence to regional balance and gender equity (Figure 24.4). A paid project coordinator who also serves as a link between the group and the steering committee coordinates day-to-day project activities. The steering committee provides technical expertise in carbon accounting and socio-economic monitoring and also coordinates scientific and educational activities.

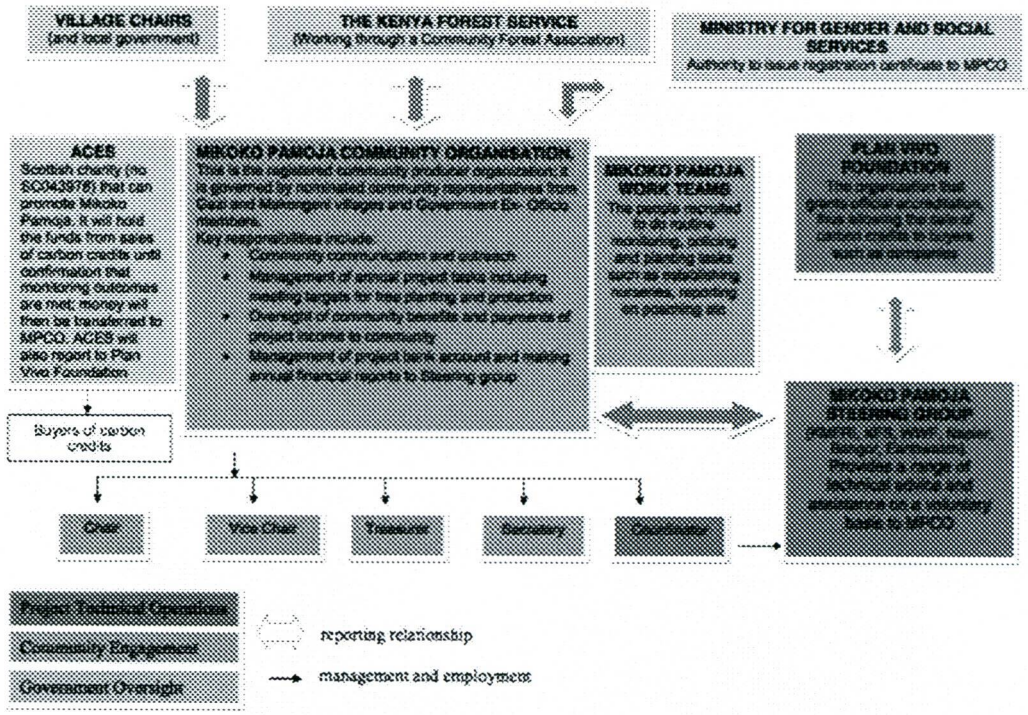

Figure 24.4 Mikoko Pamoja organization structure and governance.

24.9 SHARING BENEFITS FROM MIKOKO PAMOJA

Revenue generated through Mikoko Pamoja is divided such that 36% of the funds are utilized for project activities, including mangrove replanting, while 26% is for supporting community development activities as illustrated in Figure 24.5. Community projects to be supported through Mikoko Pamoja are decided annually through village-level consultative meetings. Mikoko Pamoja has improved education, water and sanitation systems, as well as the management of mangrove ecosystem in Gazi Bay. The purchased books and stationery for local schools have helped improve the education standards in the area. The achievements of the project are outlined in Table 24.5 below. Overall, Mikoko Pamoja is meeting the demand of 73% of 4,000 resident population by supplying water through water points or connecting water pipes directly into people's houses. The project is also supporting nature-based enterprises such as mangrove ecotourism and integrated aquaculture, leading to improved livelihood for the local people living in area.

24.10 CONCLUSION

Unsustainable exploitation of mangrove forests in Kenya has led to shortages of firewood and building materials, decline in fisheries, and increased shoreline erosion. Mikoko Pamoja is reversing this trend by attracting carbon finances and channeling them to the conservation and restoration of degraded mangrove areas as well as initiating community development projects in Gazi Bay. The

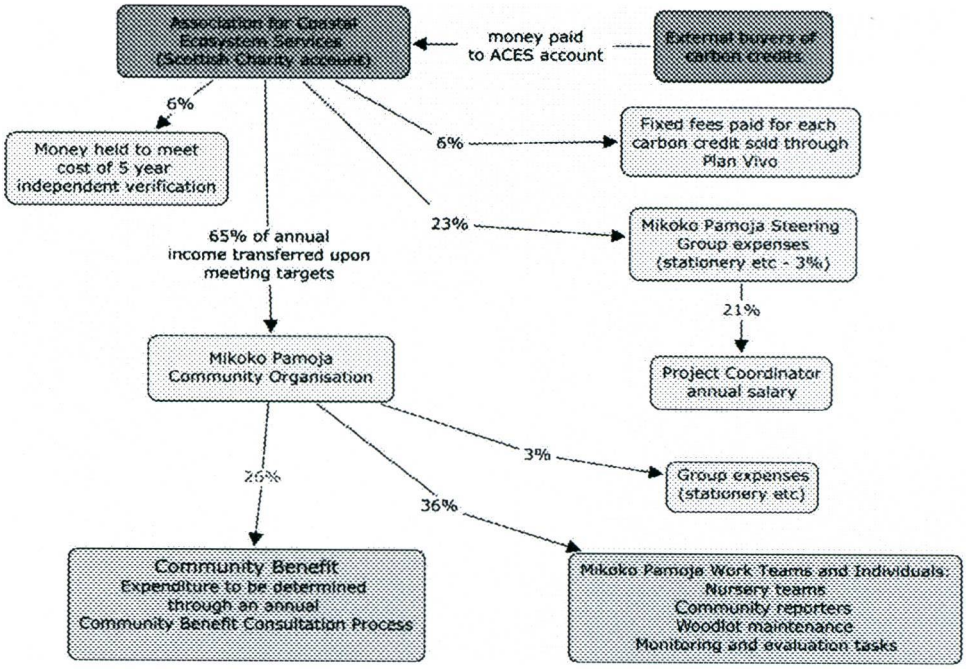

Figure 24.5 Benefit sharing scheme for Mikoko Pamoja.

project is supported by the village community, consisting largely of largely fishers whose livelihoods are connected to the health of the mangroves, with whom there is a clear payment arrangement for sold carbon credits. These payments partially cover dedicated staff time for the project, with the remaining funds being allocated to community projects and additional mangrove activities overseen by village leaders.

Success of Mikoko Pamoja stems from strong community support for the project, well established and ongoing scientific research on the mangroves in the area, knowledgeable government agencies interested in partnering with the local community on the project, and a supportive national policy that promotes participatory forest management.

One of the strengths of the project is the approach taken to reduce illegal harvesting of mangroves, by including the cultivation of fast-growing terrestrial forest plantations to serve as alterative wood sources and leakage control. The project has also established a mangrove boardwalk—a community-based ecotourism facility managed by the Gazi Women Group for recreation and educational activities. Recently, the project partnered with World Wide Fund for Nature (WWF) to promote energy saving stoves and solar lights that would further reduce community dependency on mangrove forests for wood. This is in addition to carrying out of integrated aquaculture as well as beekeeping (apiculture) in the mangrove areas as alternative livelihood activities. Mikoko Pamoja provides an excellent example of a **triple-win** situation in Kenya with benefits to community, climate, and biodiversity.

Table 24.5 Direct Impacts of the Mikoko Pamoja Project on Multiple Ecosystem Services and Public Health

Community Development Project	Input	Output	Outcome	Impact
Installation of clean water	Purchase of 2 PVC water storage tanks, two water pumps, piping, and creation of three water points	Two water sellers employed Generation of revenue from the sale of water Piped water into the community health center and primary schools	Clean water made available to about 70% of the community 47% reduction in the incidences of water-borne diseases Improved enrolment of students into local school Better learning environment	Improved Livelihood as a result of reduction of the price of water from KES 20- 3 per 20l jerican Reduced number man-hours lost in drawing water
Purchase of books and Renovating classrooms	Purchase of *ca.* 600 textbooks, roofing materials, and security doors for local primary schools	Classrooms renovated, increased number of books in a class	Reduction in the ratio of students sharing a textbook Better learning environment	10% increase in number of students joining national schools. Improved living standards as a result of improved education
Environment education	Community education on importance of mangroves in schools Engagement of students in marking environmental events Mangrove competitions (local and international) e.g., by Mangrove action project	~1,500 students from 15 schools educated on mangroves in 2016. Two international training efforts: 55 trained in 2016 and 13 teachers trained in 2017	Participation in more environment competitions and events from 1 event in a year to 3 Improved knowledge of the marine environment	Increase in mangrove conservation
Link with external communities	Three interested community conservation group visited and educated on mangroves (Big Ship in Mikindani, Madagascar and Mwikamba in Diani)	300 mangroves planted with Mwimkamba	Increased knowledge on importance of mangroves	Increase in areas under mangrove conservation
Woodlot	2,500 Casuarina planted BSc student recruited to monitor the woodlots	Data on the status of the forest gotten	Casuarinas currently providing building poles and firewood for the communities	Reduction in mangrove degradation
Livelihood	Employment	Four directly employed: project Co-ordinator, Assistant co-ordinator and 2 community scouts 32 indirectly employed in 2016 through planting and monitoring activities	Minimal cutting as a result of Increased surveillance in the project area	Increased conservation of the mangroves Improved livelihood