VANGA

BLUE FOREST PROJECT

PROJECT DESIGN DOCUMENT (PDD)




For validation using Plan Vivo Standards

Executive Summary

This Project Design Document (PDD) is being submitted by the Association of Coastal Ecosystem Services (ACES), on behalf of the Community Forest Association (CFA) of Vanga Jimbo and Kiwegu, hereinafter referred to as VAJIKI, who are the owners of the carbon credits derived from the Vanga Blue Forest project. The project is located in the south coast of Kenya, some 110 km from Mombasa city, in Kwale County.

The objectives of the project are to restore and protect the mangroves of Vanga; to prevent emissions that would otherwise occur were these mangroves to be degraded or removed through over-harvesting or land encroachment, as is typical for other mangrove areas in Kenya; and to promote long-term sustainable development of the local communities that live within and adjacent to the mangrove areas of Vanga.

The project has been submitted under the Plan Vivo Systems and Standards following the approved VCS methodology VM0033: Methodology for Tidal Wetlands and Seagrass Restoration; CDM tool AR-Tool14 Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities, as well as IPCC (2013) Guidelines for National Greenhouse Gas Inventories: Wetlands.

The C stocks of the Vanga mangroves range from 174 to 904 Mg C ha-1 with a mean of ~469 + 176 Mg C ha-1 for both above and below ground components (down to 1 m depth). The forest is impacted by uncontrolled exploitation such as wood removals by the local community and outsiders for energy and building. A decline in forest area, from 3685 ha to 3234 ha, occurred from 1991 to 2016, translating to 18.04 ha yr-1, and multiple lines of evidence show that the forest is degraded and far from its productive potential. High rates of population growth in the area, combined with strong local reliance on forest products, suggest that the rates of deforestation and degradation are likely to escalate if serious management interventions are not undertaken.

Through a combination of sustainable mangrove management and community livelihood activities, this project is expected to avoid emissions of over 100,379 t CO2-eq over the 20 years' crediting period, or approximately 5,019 t CO2 yr^{-1} across the carbon pools of above and below ground biomass, as well as soil carbon, after allowing for a 20 % risk reduction and 5% leakage buffer. In addition to the climate mitigation benefits, the project is expected to generate multiple community and biodiversity benefits in the area, including support for local services (education, sanitation and clean water), and increased fishery stocks and resilience.

The project will be implemented by VAJIKI CFA in partnership with KFS. Technical support will be through KMFRI, who have knowledge and experience of developing and implementing similar Blue Carbon Projects in the region; with additional expertise from partners at Edinburgh Napier University and ACES. The design of the project has been participatory and has included a series of community consultation workshops, in order to guarantee the involvement and commitment of all stakeholders.

Table of Contents

List of abbreviations

C	Degree Celsius
ACES	Association for Coastal Ecosystem Services
AGB	Above Ground Biomass
BGB	Below Ground Biomass
C	Carbon
CDM	Clean Development Mechanism
CFA	Community Forest Association
CO_2	Carbon Dioxide
DBH	Diameter at Breast Height
DFID	Department for International Development
EAWLS	East Africa Wildlife Society
EIA	Environment Impact Assessment
EMCA	Environmental Management & Coordination Act
FAO	Food and Agriculture Organization
FINNIDA	Finish International Development Agency
GEF	Global Environmental Fund
GoK	Government of Kenya
GHG	Greenhouse Gases
GPS	Global Positioning System
GVI	Global Vision International
ha	Hectares
IGA	Income Generating Activity
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
KCFCF	Kenya Coastal Forest Conservation Forum
KFS	Kenya Forest Services

KMFRI	Kenya Marine & Fisheries Research Institute
KNBS	Kenya National Bureau Statistics
NGO	Non-Governmental Organization
PC	Project Coordinator
PDD	Project Design Document
PES	Payment for Ecosystem Services
PFMP	Participatory Forest Management Plan
PV	Plan Vivo
PVC	Plan Vivo Certificate
REDD+	Reducing Emission from Deforestation and Forest Degradation
SDG	Sustainable Development Goals
SEAs	Strategic Environmental Assessments
SLR	Sea Level Rise
UK	United Kingdom
UNEP	United Nation Environment Programme
USD	United States Dollar
VAJIKI	Vanga Jimbo Kiwegu
VBF	Vanga Blue Forest
VCS	Voluntary Carbon Standards
WIO TDA	Western Indian Ocean Transboundary Diagnostic Analysis
WWF	World Wildlife Fund

List of tables

List of figures

Conversion table

1 Hectare (ha)	= 10 000 square metre (m^2)
1 Tonne (t)	= 1 Megagram (1 Mg)
1 CO_2	= 1 CO_2e

Definition of terms

Additionality

Whether an emissions reduction or removal would have occurred in the absence of new incentives, such as a payment for emissions reductions.

Afforestation

Direct human-induced conversion of land that has not been forest for a period of at least 50 years to forest through planting, seeding and/or human-induced promotion of natural seed sources.

Baseline scenario

Conditions that are expected to occur in the absence of any project intervention.

Carbon pool

A system that can store and/or accumulate carbon.

Carbon sequestration

Direct removal of carbon dioxide from the atmosphere and storage in a *carbon pool* in forests or in soils (biological sequestration only).

Ecosystem services

The benefits people obtain from the environment. They are classified as provisioning, regulating, cultural, or supporting, that maintain the conditions for life on Earth.

Forest

Land containing a vegetation association dominated by trees of any size whether exploitable or not, capable of producing wood or other products, potentially capable of influencing climate, excising an influence on the soil, water regime and providing habitat for wildlife.

Leakage

The unintended increase in GHG emissions or decrease in carbon stocks outside project intervention areas, which is attributable to the project and results in a lower provision of climate services being attributable to the project.

PES or Payments for Ecosystem Services

A model for compensating or incentivising individuals or groups for management activities that generate ecosystem services, by providing staged, performance-related cash or in-kind payments or rewards

REDD+

Reducing Emissions from Deforestation and Forest Degradation, and the role of Conservation, Sustainable Forest Management and Enhancement of Carbon Stocks.

Reforestation

The direct human-induced conversion of non-forested land to forested land through planting, seeding and/or the human-induced promotion of natural seed sources, on land that was previously forested but that has been converted to non-forested land.

Part A: Aims and objectives

The Vanga Blue Forest (VBF) Project aims to generate benefits in the areas of climate, community and biodiversity under the Plan Vivo System and Standards. The key aim of the project is to sustain the flow of mangrove goods and services by halting further deforestation and degradation. This loss is mainly caused by overexploitation of mangroves by the local communities to meet their household requirements for wood and energy. VBF also seeks to contribute to improved community livelihood. Specific objectives of the project are:

1. To **restore degraded mangroves** in the Vanga project area through education, awareness creation, and community participation
2. To **prevent continued emissions** from the deforestation and degradation of mangroves in Vanga in a way that can be measured, reported, and verified
3. To **conserve high quality** mangrove forest from encroachment and degradation, for conservation, carbon enhancement, and scientific purposes
4. To **promote long-term socio-economic development** of the local communities through income generation from mangrove forest resources, including sales of carbon credits
5. To **enhance community capacity** on joint mangrove management.

Part B: Site Information

B.1 Project location and boundaries

The project is located in the south coast of Kenya in Kwale County (4 39’ 00” S and 39 13’ 00’’ E), approximately 110 km from Mombasa city (Figure 1). The project area is part of the transboundary mangrove extending from Diani in Kenya, to Tanga in Tanzania. The project site covers the mangroves of Vanga, Jimbo, Kiwegu and Majoreni with a total cover of 4,428 ha; out of which 460 ha have been set aside for the Vanga Blue Forest. Adjacent to the mangroves are a large number of villages, and subsistence and commercial agriculture activities. The area is also active in coastal tourism where visitors frequent the area for snorkelling in the coral reefs, as well as canoeing in mangrove creeks.

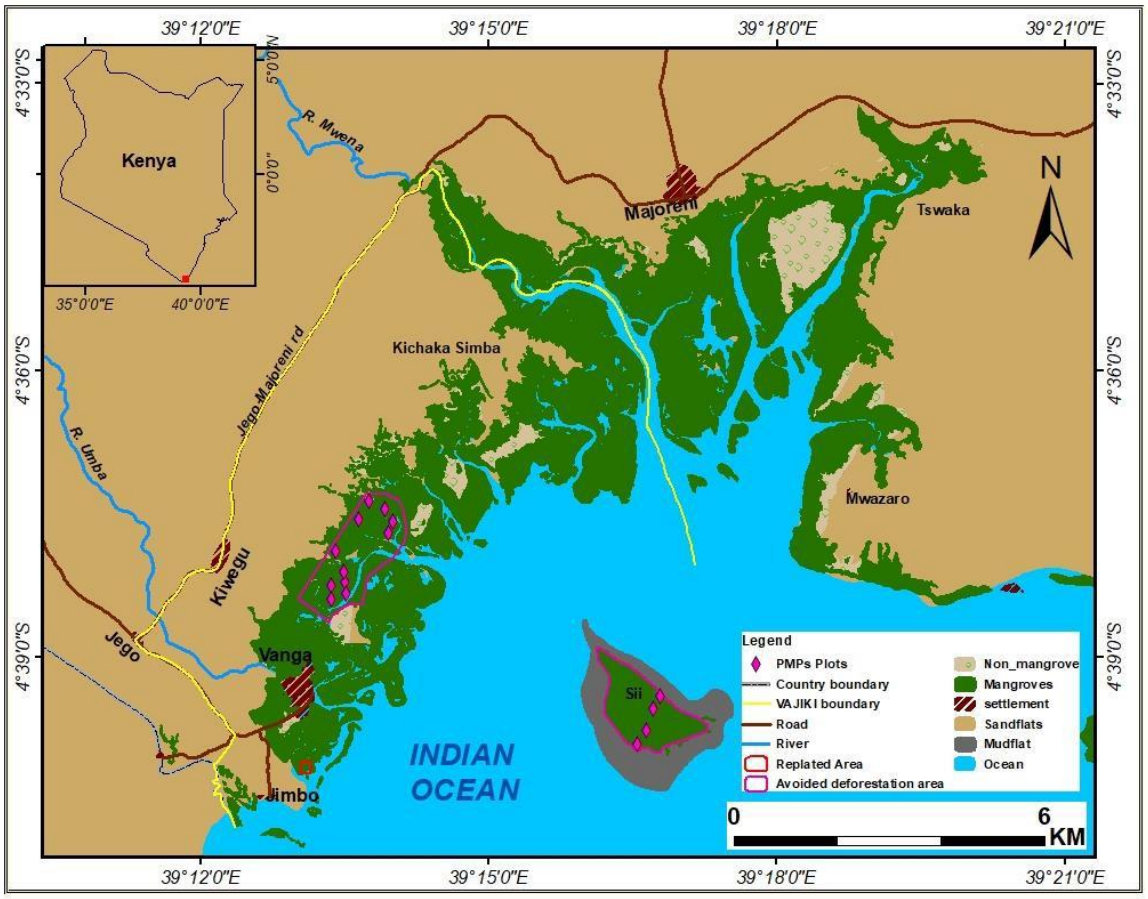


Figure 1: Map of Vanga mangrove ecosystem showing the project areas in red

This Project Design Document (PDD) focuses on mangrove forest conservation in Vanga, Jimbo and Kiwegu villages (Figure 1), with activity co-managed by the local community forest association, VAJIKI, and the Kenya Forest Service (KFS). The project area also includes Sii Island, a small uninhabited island near Vanga whose mangroves have not yet been heavily exploited due to its inaccessibility, although it is at risk from cutters using small boats. The forest on the island contains excellent stands of *Rhizophora mucronata,* a species that has been heavily exploited in all other sites of the south coast. We will work with the project participants to protect mangroves of Sii Island from illegal activities to enhance carbon stocks in the island. There are several administrative locations involved in the project area.[1] Population within 5 km of the project area is estimated at 8,700.

B.2 Description of the project area

Vanga project area experiences a tropical wet and dry climate with seasons strongly influenced by monsoon winds. Rainfall is bimodal with long rains falling between April and June, and short rains between October and December. The mean rainfall and temperature are 1,200 mm yr^{-1} and 26 C, respectively (Figure 2). The area has been categorised as an agro-ecological zone L2, which is the most favourable category for agricultural activities within Kwale County.

1 KNBS (2013). Exploring Kenya's Inequality: Pulling Apart or Pooling Together? Kwale County report, KNBS & SID, Nairobi

The River Umba flows through the area from the Usambara Mountains in North-eastern Tanzania into the Indian Ocean (Figure 1). This is a major but semi-permanent river that has a surface area of approximately 2,000 m² within the project area. The River Mwena also passes through the project area into the Indian Ocean.

The geology of Vanga region is composed of residual coral limestone and columns of sand with rocky outcrops, particularly along the intertidal areas. There are quaternary deposits along the flood plains ranging from estuarine deposits to sands, clays and coral limestone. The soils vary in structure and depth but are generally well drained.

The ample rainfall and porous soils provide great potential for ground water in the area (Figure 2). The climatic and edaphic conditions are favourable for forestry and agricultural activities. Rain-fed rice and maize farming is carried out within the project area at a subsistence level.

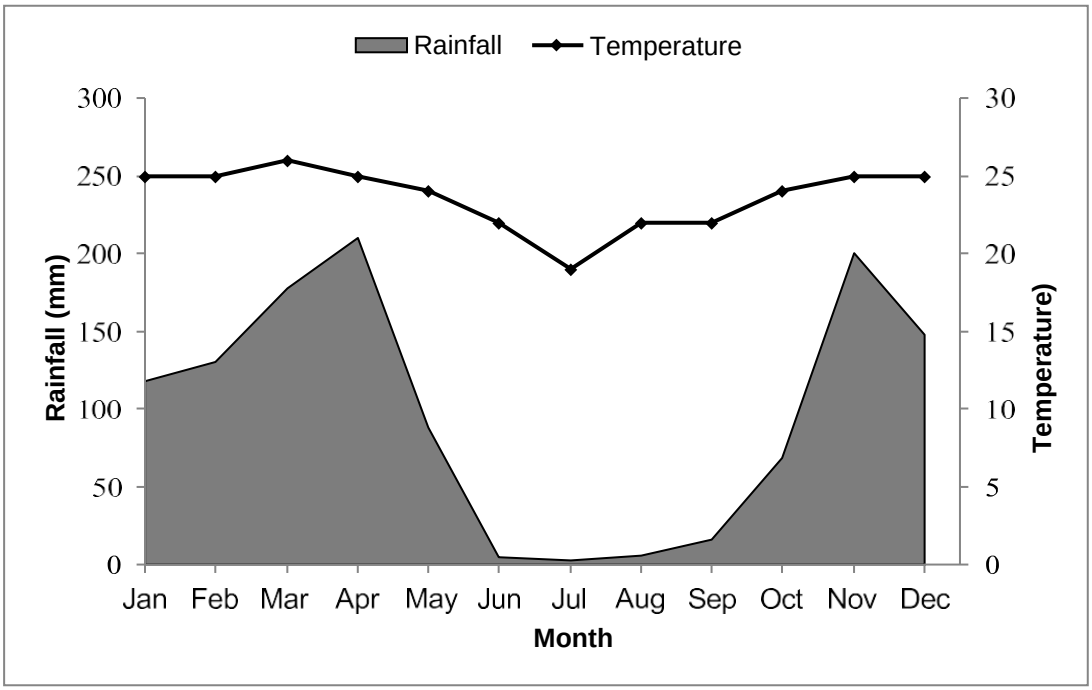


Figure 2: Climate of the project area

Mangrove Biodiversity

Based on Importance Value (IV), the principle mangroves in Vanga are *Rhizophora mucronata*, *Ceriops tagal* and *Avicennia marina* (Table 1). These forests occur in pure or mixed stands and are harvested for building poles and for energy. In addition to mangroves, the area is rich in terrestrial coastal forests that are sources of firewood, forage and non–timber forest products (e.g. fruits) for the local community. Some of the cultivated tree species in the area include mango (*Mangifera indica*), cashew (*Anacardium occidentale*) and neem tree (*Azadirachta indica*).

Table 1: Mangroves of Vanga[a]

Species	Relative Dominance	Relative Density	Relative Frequency	Importance Value
Avicennia marina	24.80	12.26	20.21	57.27
Brugueira gymnorhiza	6.05	3.11	10.80	19.97
Ceriops tagal	21.10	51.07	27.53	99.70
Rhizophora mucronata	35.99	30.65	28.92	95.56
Sonneratia alba	8.33	1.92	6.62	16.87
Xylocarpus granatum	3.73	0.99	5.92	10.64
Total	**100**	**100**	**100**	**300**

[a]Data based on survey of 132 forest plots, covering a total area of 24,675 m^2 with 8,767 individual trees surveyed.

The project area is home to numerous species of wildlife, including some marine fauna that are endangered and of high conservation importance,[2] including turtles, dolphins and dugong (Table 2).

Table 2: Endangered species sighted within the project area

Animal group	Scientific Name	Common Name	Local Name	Status
Reptiles	*Chelonia mydas*	Green turtle	Ziwa	Endangered
	Eretmochelys imbricate	Hawksbill turtle	Ng'amba	Critically endangered
Mammals	*Tursiops aduncus*	Bottle nose dolphin	Pomboo mwenye pua ya chupa	Endangered
	Sousa chinensis	Indopacific Humpback dolphin	Pomboo wa nundu	Endangered
	Dugong dugon	Dugong	Nguva	Endangered

Infrastructure, amenities and hazards

The project area is accessible by a fairly well-maintained dirt road through private or public means. The road network is, however, prone to flooding during the rainy seasons. Motorised boats are also available for use along the seaward routes. Electricity, internet connection, water and other social amenities are available in Vanga town, but less accessible in Jimbo and

2 GVI Kenya. Conserving Kenya 2011. http://gvikenya.wildlifedirect.org/category/bird-surveys/

Kiwegu villages. Flooding during rainy seasons is a frequent climate-mediated hazard in the area. The area is generally low lying making it vulnerable to sea level rise (SLR). As a protection against SLR the government has erected seawalls along Vanga and Jimbo villages to control flooding. Restoring and protecting fringing mangroves of the area as proposed by the project would help buffer Vanga against the anticipated hazards of climate change.

Figure 3: A section of the seawall at Vanga village

B.3 Recent changes in land use and environmental conditions

Mangroves in the area are exploited for wood and non-wood resources. About 87 % of the population living within or adjacent to the mangroves of Vanga depends on mangroves for building and energy.[3] Changes in land-use practices upstream impact both directly and indirectly on the mangrove ecosystem downstream. Further, Vanga has witnessed a rise in human population that has increased the demand for marine resources including mangroves.

Analysis of Landsat data from the project area shows a decrease of mangrove forest cover over time. Overall, the area of mangroves in Vanga has declined by 451 ha from 1991 to 2016; translating to a loss of 0.5 % yr^{-1} over the last 25 years. The loss was particularly high between 1991 and 2003, as compared to the 2003-2016 period (Figure 4). High rates of mangrove cover change were observed within Jimbo, Ngoa, Majoreni, Kikomani Ndogo and Tswaka areas.

3 Government of Kenya, (2017). *National Mangrove Ecosystem Management Plan*. Nairobi, Kenya

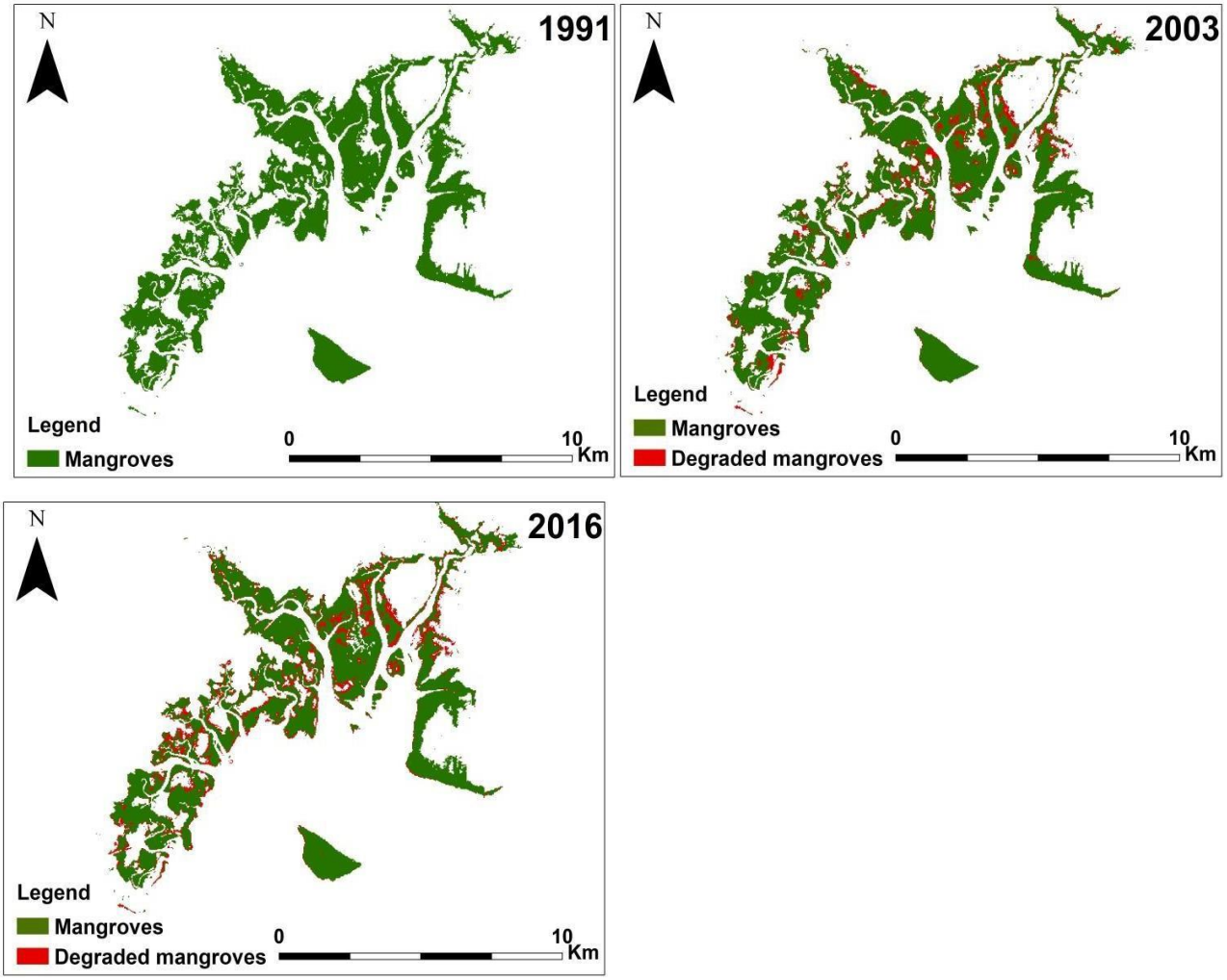


Figure 4: Vanga mangrove cover and the changes that had taken place by the year 2003 and 2016 compared to the initial 1991 cover (data from the project team)

B.4 Drivers of degradation

Globally, major changes in mangrove coverage are a result of both climate change and anthropogenic stressors. The Western Indian Ocean region has witnessed increased frequency and intensity of weather events such as flooding and storm surges.4 Consequently, these have contributed to mangrove die-backs as a result of increased sedimentation and habitat degradation. The root causes of loss and degradation of mangrove forests in Kwale county have been identified during stakeholder analysis exercises (Figure 5).

Drivers of losses and degradation of mangroves in Vanga have been identified as population pressure, poverty and inequality, and poor governance. Poor governance manifests itself through illegal harvesting, forest encroachment and weak enforcement of existing laws. Social economic impacts of losses and degradation include loss of community livelihoods, declining fish stocks and shortage of harvestable wood products. Quantitative modelling of the drivers of mangrove loss across Kenya by the project team identify similar factors nation-wide.[5]

4 UNEP/Nairobi Convention Secretariat, 2009. Transboundary Diagnostic Analysis of Land-based Sources and Activities Affecting the Western Indian Ocean Coastal and Marine Environment, UNEP Nairobi, Kenya 378P.

5 Huxham M., Emerton L., Kairo J., Munyi F., Abdirizak H. and Muriuki T. (2015) Applying climate compatible development and economic valuation to coastal management: A case study of Kenya's mangrove forests. *Journal of Environmental Management*, 157, 168-181.

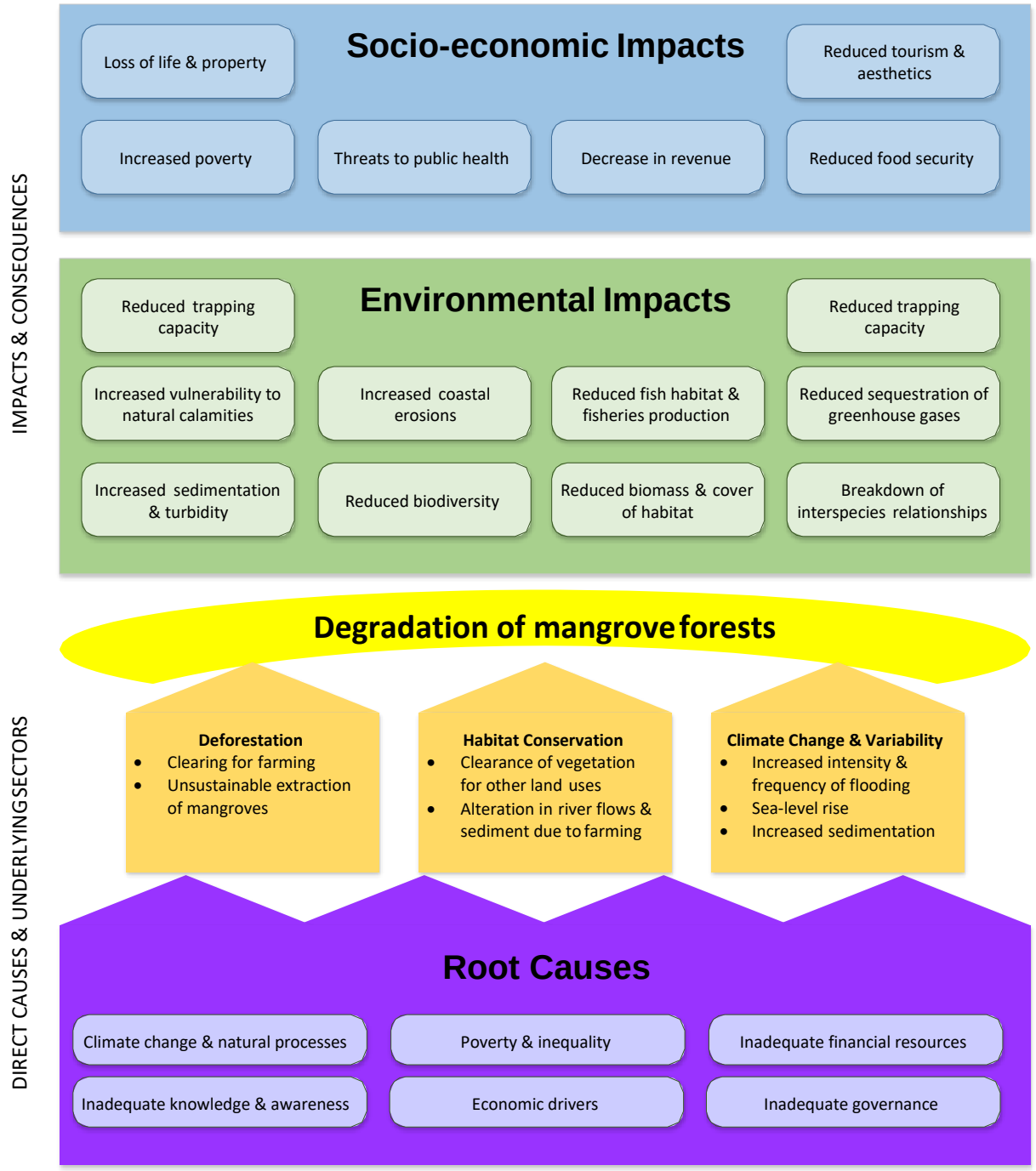


Figure 5: Problem tree of degradation of mangroves in Vanga (Source: Adapted from [4])

Part C: Community and Livelihoods Information

C.1 Participating communities/groups

Based on the 2017 census, the population in the project area is estimated to be 8,736 people, distributed across 974 households within Vanga, Jimbo and Kiwegu villages. The average members in each household is eight. Vanga has the biggest population of 7,018, followed by Kiwegu (1,037) and Jimbo (681) (Table 3). Overall, there are approximately 4,176 males and 4,560 females in the area. The population is mostly youthful, with 14.76 % and 4.03 % of the people falling below 5 and above 60 years respectively. The dominant ethnic groups are the Digos and Shirazi, accounting for 91 % of the population. Other ethnic groups in the project

area are Wakifundi, Durumas, Wagunya and Wapemba representing only 8 %. Islam is the dominant religion accounting for approximately 97 % of the population in the project area.

Table 3: Distribution of population and other demographic characteristics in the project area[9]

	Vanga		**Jimbo**		**Kiwegu**	
Total households	680		80		214	
Population distribution by Gender						
	Male	Female	Male	Female	Male	Female
Total Number	3,350	3,668	325	356	501	536
Proportion of education attainment by Gender (%)						
Without basic education	23	50	8	44	18	25
Incomplete primary	20	20	77	44	18	25
Complete Primary	40	30	15	12	41	50
Incomplete Secondary	7	0	0	0	5	0
Complete Secondary	8	0	0	0	13	0
Tertiary education	2	0	0	0	5	0
Proportion of age distribution by Village (%)						
<5yrs	14		19		14	
5>18yrs	32		34		49	
18>60yrs	49		45		34	
>60yrs	5		2		3	
Proportion of marital status of adults by Village (%)						
Married	82		67		74	
Widowed	7		17		10	
Divorced/Separated	6		6		16	
Single	5		10		0	

Compared to men, women have low representation in decision-making processes in Vanga. This attribute is common across Kenya, with men tending to predominate in leadership positions.[6] There are, however, positive changes in some community user groups in the project area whereby women are assuming leadership roles. The project will work to promote the role of women in leadership to meet the two-thirds gender rule enshrined in the national constitution (2010). Unemployment is high, with 30 % of youth in the population unemployed.[7] Generally, the education level is low with 39.07 % of the population having attained no formal education

6 Kiamba J.M. (2008) Women and leadership positions social and cultural barriers to success. Wagadu 6:7-26
7 KNBS (2013). Exploring Kenya's Inequality: Pulling Apart or Pooling Together? Kwale County report, KNBS and SID, Nairobi

(Table 3).

C.2 The socio-economic context

The major economic activity in Vanga is fishing, which accounts for about 80 % of the local economy.[8] Fishing is predominantly a male dominated activity; while women are involved in fish trading and selling food to fishermen. Nevertheless, some women, especially in female-headed households, engage in fishing activities to sustain their households. Other economic activities in the area include subsistence farming, small businesses and mangrove harvesting[9] (Figure 6). Lack of land ownership amongst farmers has contributed to low agricultural productivity in the area. Less than 25 % of farmers in the area have land title deeds thus limiting their capacity to use land for agriculture.[10]

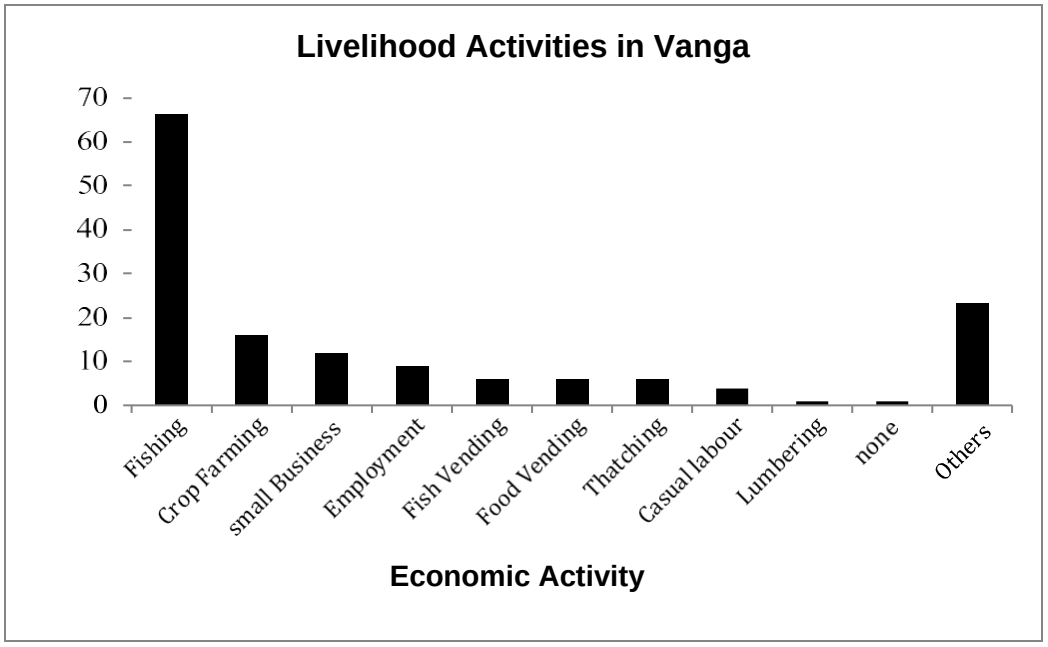


Figure 6: Main livelihood activities in the project area

Vanga project area has a poverty index of 0.25, which is slightly higher than the national average of 0.23. Household monthly income is estimated to range between KES 2,065-16,112 (US$ 20-156). This can be considered moderate when compared to the World Bank classification of a poverty line of KES 3,873 (US$ 37.50).[11] The total dependence ratio in the area is 90 %, which is among the highest in Kwale County.[12] This is attributed to the high unemployment rate, which is estimated at 30 % of the population.[13] Low economic status coupled with the high dependency ratio forces some of the residents to seek alternative sources of income, such as harvesting of mangrove wood products, in order to sustain their households. Continued removal of mangrove wood products is likely to result in continued forest degradation if no intervention is taken.

8 Omwenga, K. (2009). Transboundary socioeconomic monitoring report, KESCOM
9 Omondi M.A (2017). Analysis of local governance structures, attitudes and perceptions supporting mangrove management in Vanga, south coast, Kenya, *thesis unpublished*
10 KNBS (2013). Exploring Kenya's Inequality: Pulling Apart or Pooling Together? Kwale County Report, KNBS & SID, Nairobi
11 WorldBank (2013) WorldBank Annual report
12 KNBS (2013). Exploring Kenya's Inequality: Pulling Apart or Pooling Together? Kwale County Report, KNBS & SID, Nairobi
13 KNBS (2013). Exploring Kenya's Inequality: Pulling Apart or Pooling Together? Kwale County Report, KNBS & SID, Nairobi

The project area is poorly served by social amenities. There are 5 primary schools and 1 secondary school operating in Vanga, Jimbo and Kiwegu villages. The schools lack basic facilities, are understaffed and have no electricity. Access to Vanga is by a dirt road or by sea. However, during the rainy seasons, access is seriously affected by the Umba river that often bursts its banks and carries away bridges thus making the area inaccessible.

There is only one health facility located in Vanga village. Emergency cases are attended to by experienced members of the community through traditional knowledge. The level of sanitation in the area is generally poor, with about 87 % of the population using uncovered pit latrines or bushes. Further, the area lacks sanitary landfills for waste disposal. This leads to solid waste pollution and outbreaks of waterborne diseases such as typhoid and cholera during rainy seasons, and also poses a great threat to the adjacent marine environment. The reported cases of waterborne diseases in Vanga between 2015 and 2017 are shown in Table 4. The project will work with the CFA in addressing some of the health, education and environmental issues identified in Vanga.

Table 4: Cases of water borne diseases in Vanga pilot area from 2015-2017

Water borne diseases cases	2015	2016	2017*
Diarrhoea	2,645	1,164	319
Dysentery (Bloody Diarrhoea)	284	49	10
Typhoid fever	30	0	0
Bilharzia	92	48	13
Pneumonia	2,356	508	71
Respiratory problems	8,245	7,294	1,523
Sum of Water borne disease cases	13,661	9,063	1,936

*Source: Ministry of Health (MoH) Vanga - this is only part of the data generated by the MoH in Vanga.

C.3 Describe land tenure & ownership of carbonrights

Land in Kenya is classified as public, private, or community land and is governed by various legislations.[14] Forests can occur in any of the aforementioned land classes. All mangroves in Kenya are classified as National Forests. The management of these forests is vested with the Kenya Forest Service (KFS) either alone, or together with Kenya Wildlife Service (KWS) when they occur within the protected areas.

The Forest Conservation and Management Act (2016) of the Laws of Kenya promotes community participation in conservation and forest management. Co-management of National Forests with the community is facilitated through establishment of a Community Forest Association (CFA), development of Participatory Forest Management Plan (PFMP) of the area, and the signing of a Forest Management Agreement (FMA) between KFS and the CFA. Both

14 Government of Kenya (2010). The Constitution of Kenya. Nairobi

the PFMP and the FMA are reviewed every 5 years to establish their effectiveness in forest management and confirm the need for any revisions. KFS has approved a PFMP for Vanga project area (Annex 3); as such the community owns the carbon rights for the area.

Between 2010 to 2015, a number of civil society organizations initiated development of Community Conservation Areas (CCAs) in the Shimoni-Vanga area. The CCAs are set-aside areas previously used for fishing grounds for protection of local communities through consultations with the State department of Fisheries. However, the term CCA does not appear in Kenyan legislation and later, upon advice and direction from the state department of fisheries, the term co-management areas (CMAs) was adopted, which is the term used in BMU regulations, 2007. Hence in our activities, we aim to support the running of a CMA at Vanga focused on seagrass conservation.

Despite mangroves qualifying for REDD+, there are no plans yet to include the project area in the national REDD+ scheme for Kenya. Furthermore, although Kenya's 2020 Nationally Determined Contributions (NDC) submission included a commitment to "harness the mitigation benefits of the sustainable blue economy, including coastal carbon Payments for Ecosystem Services (PES)", there is no infringement of community rights to transact in ecosystem services; members of the project team were actively involved in the inclusion of 'blue carbon' into Kenya's NDC submission. . The project team are well connected with the relevant civil servants and departments and are working with them on the implications of NDCs for community projects.

Outside mangrove forests, VBF will establish woodlots of fast growing tree species (such as *Casuarina equisetifolia*) that will provide alternative sources of wood and energy to the community as part of the leakage mitigation strategy. The woodlots are not part of the carbon benefit activities and will not be used for issuing carbon certificates.

Part D: Project Interventions & Activities

D.1 Summarise of the project interventions

The VAJIKI community is committed to protecting and sustainably managing mangrove forests and seagrass beds for continued supplies of their goods and services in Vanga. The main interventions proposed in this PDD are: forest protection, forest restoration and conservation of seagrass beds. Proposed interventions eligible for generating tradable carbon include: avoided deforestation; natural regeneration; ecosystem rehabilitation and reforestation/revegetation. These are discussed in detail in Part G of the PDD. A number of additional, broader community interventions that are not eligible for offset carbon will also be implemented as follows:

- **Community woodlots and avoidance of leakage** – in order to provide alternative sustainable resources and avoid leakage, participating communities will be trained on the establishment of nurseries and plantations of fast-growing tree species, while energy-saving stoves will be promoted to enhance efficiency and reduce carbon emissions. In partnership with relevant agencies, we will also explore the promotion of sustainable agricultural activities in areas adjacent to mangroves, through the provision of training and extension services.

- **Economic empowerment** – to help promote alternative income generating activities, community organization and business training will be conducted to improve local capacity in forest management and nature-based enterprises such as beekeeping, ecotourism and agroforestry. The community will also be encouraged to initiate a microfinance credit scheme through which they can borrow small loans.

- **Socio-economic development** - as the local communities are largely dependent on fisheries, programmes aimed at sustainable fisheries, value addition, and marketing will be explored in collaboration with relevant agencies. Additionally, the fisher folk will be involved in mangrove conservation and restoration programmes outside the project area. The community will also receive direct benefits from conservation of the Vanga mangrove forest through job creation and enhancement of mangrove ecosystem services. In addition, money transferred into the community fund, generated by the sale of carbon credits, will be spent for community benefits. Specific projects supported through VBF will depend on democratic decisions taken by the community, but we anticipate that they may include access to clean water, establishment of an education bursary scheme, small business loans, improved health services and other community projects.

- **Seagrass conservation**: the Vanga seascape contains extensive yet vulnerable seagrass meadows, featuring four main species predominant in intertidal areas of Kenya. Human activities including fishing, particularly seine netting, damage and destroy seagrasses as evidenced on seagrass beds in Kenya (Harcourt et al., 2018). Establishment of a marine community conservation area (CCA) anticipated to cover 300 ha will ensure seagrass conservation and benefits to the community generated under a 'carbon plus' model where buyers of PVCs will have the option to pay an additional donation to fund the management of the meadows, which will be monitored using proxies of carbon specifically total seagrass area. The suggested donation will be based on carbon calculations assuming 1.38 tC/ha year^{-1} burial, based on the synthesis by Mcleod et al., (2011). However wider ecosystem services including coastal protection, fisheries enhancement and biodiversity will be emphasized to buyers. This additional income will be used for community benefit projects directed at the stakeholders affected by the seagrass management measures, primarily fishers.

D.2 Summary of the project activities for each intervention

VAJIKI will undertake activities geared towards the enhancement of carbon sequestration and overall reductions in GHG emissions, as presented in Table 5. The activities have been developed based on drivers and underlying root causes of mangrove degradation and deforestation in the project area.

Table 5: Project activities for each intervention

Intervention type		Activities	Target group	Eligible for PV accreditation?
Forest Protection	**Enhancement of carbon stock**	• Increased surveillance • Enhanced community education and awareness of the need for forest protection	**CFA, KFS, KMFRI**	**Yes**
	Avoided deforestation	• Clear demarcation of project area • Enforcement of forest laws and regulations • Involving local community in regular forest monitoring	**CFA, KFS**	**Yes**
Forest restoration	**Ecosystem rehabilitation**	• Initiate community based ecological mangrove restoration • Monitoring of natural regeneration	**CFA, KFS, KMFRI**	**Yes**
	Reforestation	• Protecting and monitoring of 10-year-old mangrove stands	**CFA, KFS**	**Yes**
Others	**Improved forest management and avoidance of leakage**	• Establishment of woodlots of fast growing species such as *Casuarina equisetifolia;* • Use of energy-saving stoves	**CFA, community farmers**	**No**
	Economic empowerment	• Promotion of alternative income generating activities, capacity-building and support to mangrove-based enterprises	**CFA, KMFRI**	**No**
	Socio-economic development	• Promote sustainable fishing activities and value addition • Support local development projects in education, water and sanitation and environmental conservation	**Community groups**	**No**
	Seagrass conservation	• Delineate seagrass protection areas within the Vanga seascape in a LMMA • support regulation of fishing activities • monitor seagrass coverage and quality	BMU, County Government of Kwale, KeFS, KMFRI	**No**

D.3 Effects of activities on biodiversity and the environment

In addition to offering crucial nursery habitat for marine life and protecting the coastline from storms and tsunami, mangroves provide consumptive and non-consumptive goods and services.[15] Mangrove forests are natural carbon sinks.[16] Through carbon capture and storage, mangroves help lessen the impacts of global warming. Unfortunately, in Kenya, mangrove forests have been abused, removed and degraded.[17] Through activities of the project, degraded mangroves in Vanga will be rehabilitated, thus increasing their resilience. Improved mangrove integrity will positively impact on other ecosystem services such as shoreline protection, biodiversity conservation and improved habitat for fisheries (Table 6). They will also function to prevent salt water intrusion into fresh water wells and enhance nutrient recycling.

Table 6: Key biodiversity groups in Vanga that are expected to flourish as a result of the project

Biodiversity group (flora/fauna)	**Species/Types**
Mangrove habitat	8 species dominated by: *Ceriops tagal*; *Rhizophora mucronata*; *Avicennia marina; and Sonneratia alba*
Seagrass habitat	12 species of seagrasses recorded e.g. *Thalassodendron ciliatum, Enhalus acoroides*, *Thalassia hemprichii*, *Syringodium isoetifolium*[18]
Mangrove fisheries	Common families include: Megalopidae; Chanidae; Clupeidae; Engraulidae; Arridae; Photosidae; Mugilidae; Centropomidae; Serranidae; Sillaganidae; Carangidae; Leiognathidae; and Lutjanidae etc.[19,20]
Seagrass fauna	Endangered dugong (*Dugong dugon*), rabbitfish, parrotfish, octopus, giant sea anemone, lobsters, long-spined sea urchins, sea cucumbers etc.[21]
Invertebrates	Prawns, crabs, molluscs
Marine turtles	Green turtles (*Chelonia mydas*), Hawksbill turtles (Eretmochelys imbricate) in IUCN red list[22]
Marine birds	40 species recorded e.g. Fork tailed drongo, Black kite, Grey heron, Palm nut vulture, Yellow billed Stork, Western reef heron, Egrets, Ibises.[23]

15 Field C., Osborn J., Hoffman L., Polsenberg J., Ackerly D., Berry J., Björkman O., Held A., Matson P., Mooney H. Mangrove Biodiversity and Ecosystem Function. *Global Ecology & Biogeography Letters*. 1998 Jan 1;7 (1):3-14

16 Donato D.K., Kauffman J.B., Murdiyarso D., Kurnianto S., Stidham M., Kanninen M. Mangroves among the most carbon-rich forests in the tropics. *Nature Geoscience*. 2011; 4 (5)

17 Kirui, B., Kairo, J.G., Bosire, J., Viergever, K. M., Rundra, S., Huxham, M., & Briers, R. (2012). Mapping of mangrove forest land cover change along the Kenya Coastline using Landsat imagery. *Ocean and Coastal Management*

18 KCDP, 2014. Kenya Coast Development Project, South Coast Ecosystem Monitoring and Health Assessment Report: Shimoni - Vanga-Funzi Bay Area. *Technical report.*

19 Huxham, M., Kimani, E., & Augley, J. (2004). Mangrove fish: a comparison of community structure between forested and cleared habitats. *Estuarine, Coastal and Shelf Science*, 60(4), 637–647.

20 Kimani, E. N., Mwatha, G. K., Wakwabi, E. O., Ntiba, J. M., & Okoth, B. K. (1996). Fishes of a shallow tropical mangrove estuary, Gazi, Kenya. *Marine and Freshwater Research*, 47(7), 857–868.

21 Government of Kenya (2009). State of the Coast report: Towards integrated management of coastal and marine resources in Kenya. Nation Environment Management Authority (NEMA), Nairobi, 88pp.

22 GVI Kenya. Conserving Kenya 2011. http://gvikenya.wildlifedirect.org/category/bird-surveys/

23 IPCC (2013) Coastal wetlands. In 2013 supplement to the 2006 IPCC guidelines for National Green House Gas inventories

Part E: Community participation

E.1 Participatory project design

A participatory approach has been used whereby the community (including women and youth) were involved in every step of the project design and planning. Technical support was provided by KMFRI through community training sessions on joint mangrove management approaches and the management of carbon offset projects in forestry. A total of four meetings were held during the preparation phase of the PDD. The inception meeting was provoked by the interest of the community in blue carbon projects. Afterwards, three consultative meetings were held to discuss the principles of blue carbon projects and associated opportunities and challenges. The community was also actively involved in the delineation of the area to be managed by VBF project (Annex 7: Community consultation meetings).

E.2 Community-led implementation

The project targets residents of Vanga, Jimbo and Kiwegu villages. VAJIKI CFA (Annex 8) is the vehicle through which the communities will co-manage the mangroves of Vanga with KFS. Development of the project was preceded by a series of consultative meetings and open forums with communities at Vanga, Jimbo and Kiwegu. Going forward, appraisal surveys will be used by members of the implementation committees from each village to rank priority community projects as well as identify risks. The project will be delivered by the Vanga Blue Forest (VBF) team, with a qualified Project Coordinator (PC) being recruited from the community for day-to-day running of the project in line with the work plan. The PC will be trained on coordination and monitoring procedures, and will be responsible for reporting of all the project activities and providing key technical data to ACES. Information on how much funding from carbon has been generated will flow from the coordinator to the committee and then on to the community members through the open village meetings (*barazas*), as well as being displayed on strategically located village notice boards.

E.3 Community-level project governance

Through consultative meetings, the VBF Committee will engage community members (from all three villages), in prioritising local development projects to be supported through sales of carbon credits. The carbon funds will be split into three portions, where each village will use its share to implement their own development projects. The consultation process will involve the PC and VBF team collecting information on priority projects and costings, before presenting them for consideration at *barazas*. The PC and the committee will ensure timely implementation of agreed work plans and that the allocated community funds are utilised for the intended purposes. Any grievances will be addressed by the VBF Committee in the first instance. If no resolution can be found, then respective village heads will be involved, following established practice, through the village *barazas* as stipulated in the VBF constitution; see a summary of the formal grievance process in Figure 7.

(Eds Alongi D., Karim A., Kennedy H., Chen G., Chmura G., Crooks S. et al).

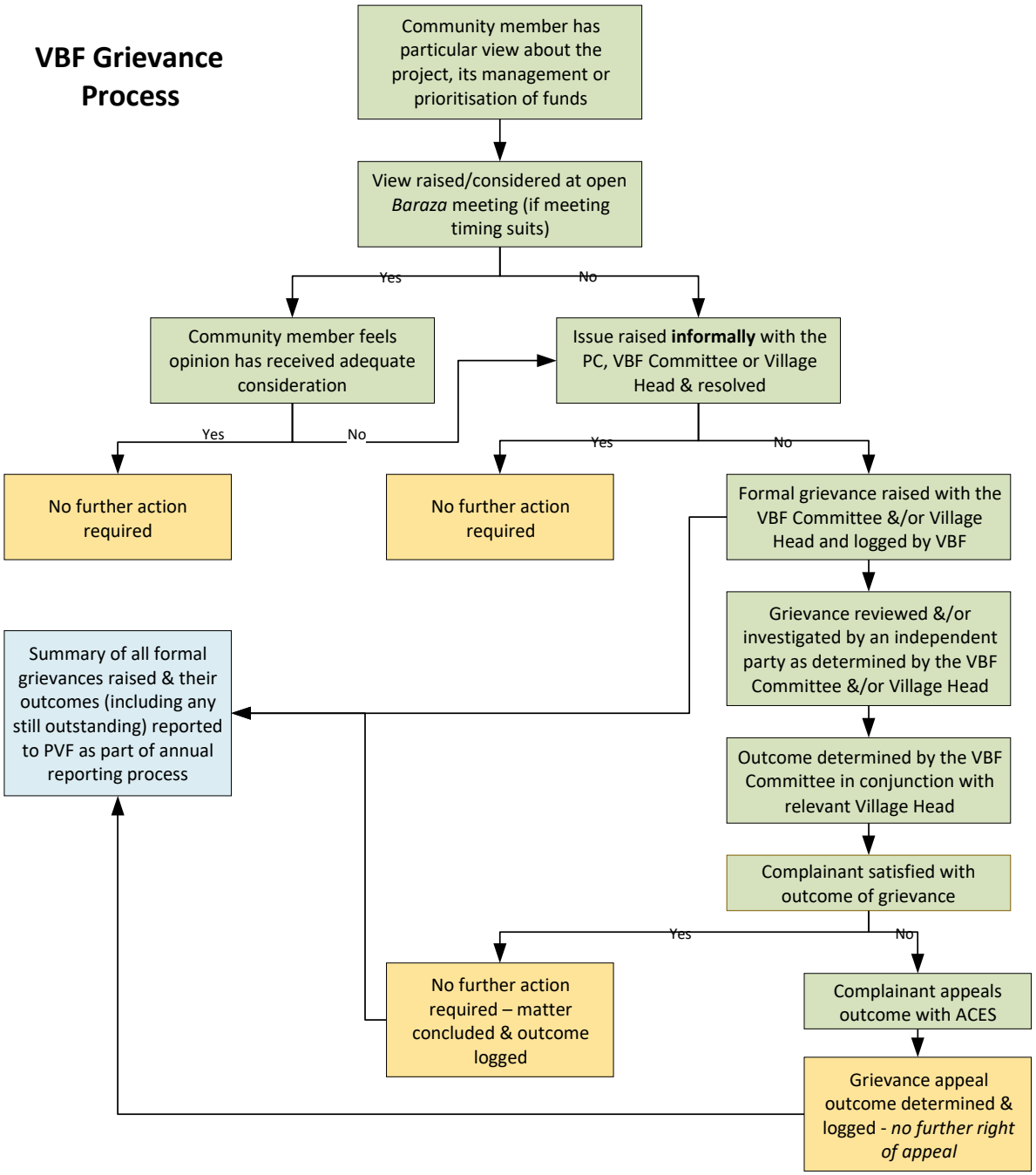


Figure 7: VBF Grievance Process

Part F: Ecosystem Services & Other Project Benefits

F.1 Carbon benefits

The VBF project will designate 460 ha from the total 4,428 ha of mangroves in Vanga. The project area will include 450 ha of avoided deforestation, 5.0 ha of established mangrove plantations and 0.25 ha of new plantations/recovered forest established per year for a period of 20 years. An analysis of Landsat imageries between 1991 and 2016 reveals an estimated

forest loss rate of 0.5 % per year for the entire 4,428 ha of mangrove cover in Vanga. The various project interventions are expected to improve the quality and restore the integrity of mangrove forests of Vanga, as well as slowing or stopping this loss. Using the IPCC methodology and guidelines (2003) in order to make predictions, the VBF project will have a net carbon benefit of 6,702 t CO_2e yr^{-1} before buffer reductions. After deducting a 20 % non-permanence and 5% leakage risk buffer, the net-emission reduction is 5,027 per year and over the 20 year-crediting period is estimated at 100,379 t CO_2e (Table 7). Full details of the calculations are provided in Part G and Table 10 of the technical specifications. **Important note**: Where possible (and as detailed in section G) an ex-post methodology will be applied, meaning we will only claim for those credits that have been verifiably achieved in the previous years, based on actual field data. Hence the figures presented here and in Table 10 are projections only and may differ once the project is running; because the ex-post approach is not vulnerable to mistakes in model projections it is more accurate and more conservative.

Table 7: Summarises the projected net carbon benefits per year from each project intervention[24,25]

Intervention type (Activities)	**Project Area (ha)**	**1. Baseline C uptake/ emissions i.e. without project** (t CO_2e yr^{-1})	**2. C benefits i.e. uptake/ emissions reductions with project** (t CO_2e yr^{-1})	**3. Expected losses from leakage** (t CO_2e yr^{-1})	**4. Deduction of risk buffer - 20 % of carbon benefits (2)** (t CO_2e yr^{-1})	**5. Net carbon benefit 5 = 2-(1+3+4)** (t CO_2e yr^{-1})
Avoided degradation Area 1 (Sii Island)[a]	200	0	1,721	86	344	1,291
Avoided degradation Area 2 (Mainland)	248	0	4,282	214	856	3,211
Avoided deforestation AGB area 1 (see table 13)	200	0	53	2.65	10.6	40
Avoided deforestation AGB area 2 (see table 13)	250	0	260	13	52	195
Avoided deforestation BG C (soil carbon) areas 1 and 2[b]	44	0	273	14	55	205
Reforestation (old stands in Jimbo)	5	0	102	5	20	77
Reforestation (new plantation)	0.25	0	11	1	2	8
TOTAL					**1,340**	**5,027**

[a] See Table 13 for calculations; [b] See Annex IX for soil carbon loss model

24 IPCC (2013) Coastal wetlands. In 2013 supplement to the 2006 IPCC guidelines for National Green House Gas inventories (Eds Alongi D., Karim A., Kennedy H., Chen G., Chmura G., Crooks S. et al)

25 Lang'at, J. K. S., Kairo, J. G., Mencuccini, M., Bouillon, S., Skov, M. W., Waldron, S., & Huxham, M. (2014). Rapid losses of surface elevation following tree girdling and cutting in tropical mangroves. *PLOS One*, 9(9), 1–8

F.2 Livelihoods benefits

The VBF will generate direct and indirect benefits to participating communities. The estimated US$ 35,133 generated from 5,019 t CO_2e yr^{-1} sale of carbon credits will be used to support community development projects in education, water and sanitation, and environmental conservation. Successful implementation of the project will generate benefits beyond carbon including: increased fishery and other biodiversity; shoreline protection; livelihood projects e.g. in bee-keeping; small-scale farming; and mangrove ecotourism (Table 8). Further, the project seeks to directly employ six local people and catalyse employment opportunities for at least another 100 people through project activities such as nursery establishment, reforestation and forest monitoring, and support for related enterprises. This project responds directly to the United Nations Sustainable Development Goals (SDGs), particularly SDG13 (climate action) and SDG 14 (life below water), as well as indirectly to: SDG 1 (no poverty); SDG 2 (zero hunger); SDG 4 (quality education); SDG 6 (clean water and sanitation); and SDG 8 (decent work and economic growth), as well as Aichi Biodiversity Target 15 on ecosystem resilience and biodiversity.

Some of the intended livelihood benefits are detailed in Table 8. The processes needed to achieve land tenure, improved access, woodlots and protection of non-timber ecosystem services and prevention of soil erosion are detailed in this PDD and are integral to the project. The processes for the other suggested livelihood benefits will be operated and controlled under the democratic structures of the VBF committee, hence cannot be prescribed here. However our experience with Mikoko Pamoja, the companion project, is that we will be able to leverage considerable co-funding and matching support from a large range of organisations once the project is fully operational. For example British Council funding combined with volunteer researchers from Edinburgh Napier and Nairobi Universities allowed for the design, piloting and implementation of fuel efficient wood stoves at the site; we anticipate running a similar and expanded project here. Provided sales of carbon credits meet expectations, there should be funding sufficient to meet our aspirations of micro-credit schemes (with assistance from economics researchers from Edinburgh Napier University) , fuel efficient stoves, bee keeping and more. It is important, however, to emphasise that the democratic principle of local control of project income is central to our philosophy, which is why specifying exactly how income will be spent in this PDD is not appropriate.

Table 8: Livelihood benefits

Food & agricultural production	**Financial assets & incomes**	**Environmental services (water, soil…etc.)**	**Energy**	**Timber & non-timber forest products (incl. forest food)**	**Land & tenure security**	**User rights to natural resources**	**Social and cultural assets**
Positive impacts on livelihoods and food security e.g. silvo-aquaculture, bee-keeping, ecotourism, animal production, kitchen-garden for vegetable production, protected seagrass securing fisheries habitat	Enhanced income via sale of carbon credits worth US$ 48,713 yr^{-1}. Funds to create (directly and indirectly) over 50 jobs and promote community enterprises	Project will minimise severe soil erosion and stabilized sediments in Vanga.	2.0 ha of alternative woodlots and use of clean energy stoves will meet community energy demands.	Enhanced timber and non-timber products through avoided deforestation (250 ha), reforestation (5.5 ha) and alternative woodlots.	Tenure rights and security for all community members via management agreement between CFA & KFS.	Community access to natural resources will be enhanced.	Improve community wellbeing (electricity, education, health & empowerment) and enhancing cultural ecosystem services (aesthetic & spiritual).

F.3 Ecosystem & biodiversity benefits

The project area harbours highly significant marine and coastal biodiversity, and has a rapidly growing human population dependent on marine and coastal resources for their livelihoods. Overfishing, destructive fishing practices, illegal logging and unsustainable resource-use patterns are major threats facing natural resources in the project area. Improved mangrove forest management activities will enhance ecosystem integrity and thereby enhance productivity and biodiversity in the area (Table 9). Mangroves restored through the project will also protect the shoreline from erosion and control sedimentation of the nearshore marine ecosystem. The management options in the seagrass CMA will determine which activities are allowed and which ones are not. Some of these options may include sustainable fisheries, banning of illegal fishing gears, closed seasons and others that may be proposed by the community. The overall impact will be restored seagrass areas, increased biodiversity including fish and crustaceans which can be exploited sustainably.

Table 9: Ecosystem Biodiversity benefits expected from successful implementation of the project activities

Intervention type (Technical specifications)	Biodiversity impacts	Water/watershed impacts	Soil productivity/ conservation impacts	Other impacts
Avoided degradation	Improved mangrove habitat quality for fish and other organisms	Improved mangrove habitat will protect shoreline from erosion/sedimentation thus controlling water quality	The protection will enhance sediment accretion and island stability	Reduced carbon loss and all other ecosystem services enhanced
Avoided deforestation (Protection of 450 ha of natural mangrove stand)	Improved mangrove habitat quality - a healthy mangrove forest provides habitat for fish and other wildlife and preserves the integrity of connected ecosystems such as seagrass and coral	Improved mangrove habitat will protect shoreline from erosion/sedimentation thus controlling water quality	Protection of 450 ha of mangroves will enhance coastal protection, sediment accretion and stability	Return of aesthetic and cultural values as well as proteomic species of crabs and gastropods
Reforestation (10 year old stand in Jimbo 5 ha)	Reforestation with suitable species enhances mangrove biodiversity and ecosystem functions. Over the last 10 years, 5.0 ha of degraded mangrove areas have been replanted in Vanga.	Replanted mangroves will serve to protect shoreline erosion/sedimentation, as such controlling water quality	Enhance coastal protection and sediment accretion and stability	None
Reforestation/ ecosystem restoration (new plantation 5 ha)	Over the 20 years period, the community will restore 0.25 ha per year. The restored forest will support fishery and other ecosystem services, including biodiversity in the area.	Replanted mangroves will serve to protect shoreline erosion/sedimentation, as such controlling water quality	Planting will help to reverse effects of coastal erosion and stabilise eroding shoreline	None
Seagrass conservation (300 ha CMA)	Conservation of a 300 ha area of seagrass will expand coverage and enhance quality for fish and other fauna	Seagrass helps to filter sediment and nutrients in seawater and enhances oxygenation	Seagrasses reduce wave heights and coastal erosion	Seagrass hold ~200 t C ha-1

Part G: Technical Specifications

GENERAL METHODOLOGICAL NOTE

In order to plan this project and meet the requirements for validation, we document reasonable assumptions based on IPCC methodologies, published research and project team data, which allows us to make the predictions detailed in Table 10. As we accrue site-specific data on forest growth and regeneration, we hope to use this (following the five year verification) to move to an *ex-post* methodology; claiming for credits that have been demonstrably achieved during each year. We anticipate that this will allow us to claim for more carbon benefits than indicated here, using conservative assumptions, which will operate for our first five years.

G.1 Project intervention and activities

Total mangrove coverage in the Vanga area is estimated at 4,428 ha, comprising mangroves of Vanga itself, Jimbo, Kiwegu, Majoreni and Sii Island (Figure 1). Unless where specifically mentioned, mangroves in Vanga, Jimbo, Kiwegu and Sii Island are referred to collectively here as Vanga mangroves. Landsat data from 1991-2016 indicates a 12 % reduction in mangrove coverage in Vanga, translating to a loss of 18 ha yr^{-1}. In order to reverse this trend, the project has designated ~460 ha of Vanga mangroves for expected climate benefits from forest restoration and protection. A suite of interventions and activities eligible for carbon benefits are proposed as follows (Table 10); note that areas given assume continued forest loss without the project which is reduced by 80% with project interventions, as detailed in Table 13.

Table 10: VBF project interventions and activities

Activity	**Forest type**	**Area** (ha)	**C benefits per hectare, per year** ($t\ CO_2\ ha^{-1}\ yr^{-1}$)	**Total annual C benefit for area** ($t\ CO_2\ yr^{-1}$)	**Income** (US$)[f]
1. Avoided degradation Area 1 (Sii Island)	Natural stand	199	8.65[a]	1,721.35	12,049
2. Avoided degradation Area 2 (Mainland)	Natural stand	247.5	17.3[a]	4,281.75	29,972
3. Avoided deforestation AGB[b] Area 2	Natural stand	0.94	275	256	2,119
4. Avoided deforestation AGB[b] Area 1 (Sii)	Natural stand	0.16	334	53	2,119
5. Avoided deforestation BGB C (soil carbon) Areas 1	Natural stand	1.10	248	273.32	1,913

and 2[c]					
6. Reforestation (Area 3)	10 yr old stands[d]	5	20.4	102.00	714
7. Reforestation (Area 4)	New plantation[e]	0.25	4	10.5	73.5
Total				6,698	46,885
Permanence risk buffer (20 %)				1,340	
Leakage buffer (5%)				334.896	
Average total sellable per year				5,023	35,164
Total sellable over 20 years				100,469	703,282

a Sequestration rate for avoided degradation is conservatively based on AGB and BGB emission rates estimated for dry tropical mangroves (IPCC, 2013), which is halved for Sii island given its higher standing stock **b** see Table 13 for explanation of area estimates and Table 14 for AGB values. **c** Carbon losses from sediment due to forest clearance are based on carbon flux experiment in mangrove forest in Gazi Bay that is adjacent to Vanga ecosystem, see Annex IX; **d** Area of degraded mangroves that has been rehabilitated by community at Jimbo in the last 10 years; **e** Sequestration rate for reforested mangrove stand is conservatively based on Kairo et al (2008) at Gazi bay. See Annex X for calculation of average benefit of 10.5 yr^{-1}; **f** Calculations assume conservative price of US$ 7.0 t CO_2e^{-1}.

1. **Enhancement of carbon stocks/avoided degradation (area 1)**: The restoration of the degraded forests of Vanga will play a critical role in restoring carbon profiles, protecting biodiversity and providing socioeconomic and other co-benefits. Site 1 designated for carbon enhancement under VBF is Sii Island, with a mangrove coverage of 200 ha. The forest provides protection to the nearby fringing reefs, which are major fishing grounds for fishermen from villages participating in the project. Vanga is the most important fishing ground in southern Kenya, with fish catches in long term decline, hence ensuring the protection and enhancement of fishing grounds and habitats is a priority. Currently the mangroves of Sii Island are less degraded than those on the mainland, with no evidence of clear cutting, fewer stumps and complete canopy closure in most of the forest. Baseline assessment of Sii Island mangroves, using standard approaches based on 10*10 m plots dominated by *Rhizophora mucronata* gives a standing stock biomass of 195 t ha^{-1} and a stump count of 243 ha^{-1}, with 30% of trees showing form 1 quality (the best quality). Hence whilst there is evidence of cutting and some human pressure, stocks are high and pressure is lower than on the mainland. However, the forest faces a growing threat from increasing demand for mangrove poles for construction and fuelwood on the mainland, leading to the potential for increased deforestation. We aim to curtail this threat and allow the forest to move towards a fully productive, pristine state. Carbon stock enhancement activities will include increased surveillance, on the ground and by satellite, in order to control illegal logging, and, crucially, clear education and communication with surrounding communities and fishers. The surveillance team will be equipped with tools and equipment such as GPS and modern communication gadgets. Here, for the purposes of illustrative prediction, we take the conservative Tier 1 recommendations from the IPCC wetland supplement for a

natural mangrove of 17.3 t CO_2 ha^{-1} yr^{-1} sequestration,[26] and note that this is less than we have recorded in our own research in neighbouring, recovering forest plots. Because Sii Island is less degraded than the mainland forest, we make a further conservative assumption and use 50 % (i.e. 8.65 t CO_2 ha^{-1} yr^{-1}) as the sequestration rate for Sii Island. The predicted emission reduction through avoided degradation in Sii Island will therefore be 1,721 t CO_2 yr^{-1} (Table 10). We will collect the following biannual data, which will inform our carbon calculations and claims for the revision of this PDD following 5 year verification:
a) field measurements of growth and recovery, i.e. growth increments translated into biomass, using our bespoke allometric equation[41], combined with appropriate threshold indicators for forest recovery as outlined in Table 19. Specifically this will involve using field measurements of ABG taken in our permanent monitoring plots, using a protocol that measures DBH of all trees and subsidiary branches and applies the allometric equation: ln dry biomass = -2.29711+ ($lnDBH^{2.54528}$) – a bespoke equation for the site developed by Cohen[41]- to calculate actual AGB at the plot level. This is conservative since we are not considering the BGB increment. These measurements are combined with stump counts, assessment of clear cutting and measures of regeneration (trees in three regeneration classes) to show appropriate evidence of plot recovery; stumps and clear cutting data are used to determine threshold levels of credits, as shown in Table 19.
b) 1.5 t C $ha^{-1}yr^{-1}$ for belowground carbon burial, contingent on meeting the green threshold indicators for tree stumps, forest clearance and forest recovery described in Table 19. This is a conservative estimate, below the global average burial rate for healthy/recovering mangrove forests of 1.74.[27]

2. **Avoided degradation/forest recovery (area 2):** 250 ha of mainland mangroves have been set aside for this activity. To achieve the activity's objective, several approaches will be employed including:

   i. **Zonation** and **clear demarcation** for the various user groups' activities in the forest. This will eliminate conflicts in the implementation of activities and enhance the enforcement of the regulations. Non-consumptive uses of mangroves such as bee-keeping and ecotourism will be allowed and encouraged in the delineated forest.

   ii. **Education** and **awareness** of the community on: causes and impacts of deforestation; forest conservation laws; and monitoring methodologies.

   iii. Engagement of the local community in **joint regular patrols** with KFS rangers and paid project scouts.

   iv. Creation of an **inventory database** and enhancement of **reporting**

   v. **Stricter enforcement** of the current environmental laws and regulations

   vi. Establishment of **physical** and **technical infrastructure** through construction of watch towers, and equipping community scouts and KFS with suitable monitoring tools and equipment, such as GPS and modern communication devices.

3. The carbon benefit through **avoided degradation,** coupled with recovery of 250 ha of mangrove forest in Vanga (area 2) is estimated at 4,281 t CO_2 yr^{-1} (Table 10) (assuming the

26 IPCC (2013) Coastal wetlands. In 2013 supplement to the 2006 IPCC guidelines for National Green House Gas inventories (Eds Alongi D., Karim A., Kennedy H., Chen G., Chmura G., Crooks S. et al).

27 Alongi, D. M. (2014). Carbon cycling and storage in mangrove forests. Annual Review of Marine Science, 6, 195–219.

IPCC Tier 1 value of 17.3 t CO_2 ha^{-1} yr^{-1}). Again, field data will be taken to calculate actual ex-post sequestration, for use in the next iteration of this PDD:

a) field measurements of growth and recovery, i.e. growth increments translated into biomass, using our bespoke allometric equation[41], combined with appropriate threshold indicators for forest recovery as outlined in Table 19

b) 1.5 t C $ha^{-1}yr^{-1}$ for belowground carbon burial, contingent on meeting the green threshold indicators for tree stumps, forest clearance and forest recovery described in Table 19.

4. **Avoided deforestation** in areas 1 and 2 will give us carbon benefits in addition to those from avoided degradation/forest recovery. These are calculated together as 309 t CO_2 yr^{-1} (Table 10), assuming different rates of forest removal based on satellite information, as explained in Table 13.

5. **Mangrove reforestation (area 3):** The local community in Jimbo has worked with partners KFS and KMFRI in replanting 5 ha of mangrove forest in Jimbo, but this voluntary plantation has no formal or informal protection. We will protect and monitor this area over the project timeframe. Assuming a conservative carbon sequestration potential of 20.4 t CO_2 ha^{-1} yr^{-1},[27,28] the activity is expected to accumulate 102 t CO_2 yr^{-1} (Table 10).

6. **Ecosystem rehabilitation (area 4)**: Some 5.0 ha of mangrove forest near Jimbo village were destroyed during a failed attempt to establish salt pans. We will restore this area using a combination of hydrological methods and artificial replantation, using locally sourced and nursery raised seedlings where necessary. We will achieve complete vegetation cover of the area within 20 years. We will report the objective progress towards this long-term goal every year. This will involve non-linear change, for example the breaching of dykes followed by recovery of edaphic conditions before natural re-growth, hence we are not setting regular yearly increments towards the target. This intervention will lead to an enhanced ecosystem integrity, biomass accumulation and increased sequestration of carbon by mangroves. Assuming a conservative carbon sequestration potential of 4.0 t CO_2 ha^{-1} yr^{-1},[28,29] the activity is expected to accumulate 1.0 t CO_2 yr^{-1} (Table 10); hence its contribution to our carbon budget is tiny, but we see multiple additional benefits from this ecosystem restoration.

Proposed activities that are not eligible for carbon payments include:

Improved forest management: An approved 5-year participatory forest management plan (PFMP) exists for the project area (Annex III). There has, however, been poor implementation of the plan mainly due to lack of resources and incentives. Activities proposed in the project will contribute to the revision and implementation of the plan for improved mangrove management. Community woodlots of *Casuarina equisetifolia* will be established in order to provide alternative sources of wood products and control leakage. Following practice in Mikoko Pamoja, wood products will be made available at below market price to local people as a way of generating income for the project. The details of how this

28 Kairo J.G., Lang'at J.K., Dahdouh-Guebas F., Bosire J., Karachi M. (2008) Structural development and productivity of replanted mangrove plantations in Kenya. *Forest Ecology and Management*. Apr 20;255(7):2670-2677.

29 Lang'at, J. K. S., Kairo, J. G., Mencuccini, M., Bouillon, S., Skov, M. W., Waldron, S., & Huxham, M. (2014). Rapid losses of surface elevation following tree girdling and cutting in tropical mangroves. *PLOS One*, 9(9), 1–8

is done will depend on full discussion and consent from the VBF committee, following practice in Mikoko Pamoja (where some wood has been sold to raise money for local schools and some has been provided free of charge). *Casuarina* is a naturalised tree species in Kenya that is commonly cultivated along the coastal area. Participating communities would be trained on nursery and plantations establishment of Casuarina sp. and other fast growing tree species. In addition, use of energy-saving stoves will be promoted to enhance efficiency and reduce carbon emissions.

Promotion of alternative income generating activities: The project will be used as a platform and catalyst for a range of other income generating activities. Community organisation and business training will be conducted to improve local capacity in forest management and mangrove-based enterprises such as beekeeping, ecotourism, crab farming, aquaculture and agroforestry. As part of capacity building and economic empowerment, the project will organise seminars through which the community will be trained in entrepreneurial skills. This will include making of business plans, gathering of market information and value addition in order to maximise their earnings from the forest-based enterprises. The project will support the youth and local schools in establishment of nurseries for fast growing trees such as *Casuarina spp* for sale. The community will be encouraged to initiate a microfinance credit scheme through which they can borrow small loans. As the local communities are largely dependent on fisheries, programmes aimed at sustainable fishing methods, improved catch and storage, value addition and marketing will be explored in collaboration with relevant agencies. Additionally, the fisher folk will be involved in the awareness and forest conservation programmes as beneficiaries of the mangrove forest.

Socio-economic development: The community will receive direct benefits from conservation of the Vanga mangrove forest including job creation, access to clean water, establishment of education bursary scheme, small business loans, improved health services and other community projects. The specific projects supported will depend on democratic decisions taken by the community at the beginning of every year.

Seagrass conservation: We will use a 'carbon plus' model to raise funds for the seagrass CMA; this is because measuring seagrass carbon to the precision required for formal accreditation is too expensive given current prices and total carbon stocks involved. Hence we will use a proxy measure (seagrass area and quality) that correlates with carbon, and invite buyers of our formal VBF credits to contribute additional sums if they wish to assist with seagrass conservation.

G.2 Additionality and environmental integrity

Together with the national constitution (2015), several sectoral laws and policies govern coastal and marine ecosystems in Kenya. The **Forest Conservation and Management Act** (2016) provides the legal framework for the management of forest resources in the country. The Act provides for the establishment, development, sustainable management, utilisation as well as conservation of forest resources using approved management plans and participation of stakeholders. This blue carbon project will empower communities in Vanga to successfully implement the approved Participatory Forest Management Plan (PFMP) of the area.

The **Fisheries Act (2012)** of the Laws of Kenya 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. Activities proposed in the current project would rehabilitate degraded mangrove areas and at the same time demarcate areas critical for fisheries and other wildlife, subsequently increasing food security and enhancing carbon capture and storage in the area.

Article 11(1) of **Land Act (2012**) of the Laws of Kenya mandates the National Land Commission to take appropriate action in maintaining public land that has endangered or endemic species, and critical habitats or protected areas. This project recognises the important role played by mangroves for fishery production, biodiversity conservation and shoreline protection; and the need to manage these in an integrated manner.

The project is also aligned with **Kenya's National Climate Change Response Strategy** (NCCRS), **National Climate Change Action Plan** (NCCAP) and the **National Mangrove Management Plan** (2017-2027). These documents advocate for GHG emissions reduction in the forest sector through afforestation, reforestation, avoided deforestation and sustainable land management activities that would be supported by the current project.

The **National REDD+ Strategy of Kenya** is aimed at controlling deforestation and forest degradation, enhancing carbon stocks, and promoting sustainable forest management and conservation. VBF seeks to generate benefits in the areas of climate, community and biodiversity; as such the project is aligned with National REDD+ activities.

In 2015, Kenya joined other parties of the United Nations Framework Convention on Climate Change (UNFCCC) in assenting to the **Paris Agreement on Climate Change.** Under this Agreement, countries are committed to lowering their GHG emissions levels, indeed Kenya aims to make a 30 % reduction in emissions by 2030 through its Nationally Determined Contributions (NDCs),, relative to a business-as-usual scenario of emitting 143 Mt CO_2e annually. Deforestation and forest degradation are responsible for more GHG emissions than most other sectors in Kenya.[30] Like other tropical countries, Kenya has not incorporated blue carbon ecosystems in its NDCs. Activities proposed by VBF seek to scale up and accelerate conservation of blue carbon ecosystems for the benefits of climate change mitigation, community livelihoods and biodiversity conservation. VBF aims to generate information that would be used to influence and ensure that mangroves become part of Kenya's NDCs in the future.

There is a hypothetical danger in forest conservation projects that people will intentionally clear areas prior to proposing them for PES benefits. No such clearance has occurred here. The national and international parties involved (KMFRI, KFS, ACES and Edinburgh Napier University) are government institutions, charities and conservation bodies; they would risk disgrace and litigation (for small rewards) if they engaged in such activity. Meanwhile the local people have neither the means nor the information to engage in such fraud.

30 Government of Kenya, 2012

Table 11: Project Barriers and Barrier Mitigation Actions

Type of Barrier	Description of Barrier	Overcoming Barrier
Legislative/governance barrier	Lack of enforcement of existing laws and regulations governing forest conservation and management in Kenya	Joint patrols between KFS and community scouts will be initiated to enhance forest surveillance and protection
Financial/Economic barriers	Lack of incentives to participate in mangrove restoration and protection activities; as well as lack of alternative livelihood	- Sale of mangrove carbon credits - Diversification of income generating activities such as beekeeping and ecotourism will be initiated
Technical barriers	There is inadequate capacity among communities for integrated mangrove management activities.	Partnerships will be sought from key institutions with expertise in mangrove management, including; KFS, KMFRI and NGO's, to support training and joint implementation of project activities.
Social barrier	The community involved in the project are drawn from three different villages and might disagree on the location of sites for different activities	The project will facilitate education and awareness in order to support the locals to adopt win-win approaches in the implementation of the proposed activities

Double counting

Vanga Blue Forest project is the only carbon-offset facility in the area, as such there is no risk of double accounting expected. Whilst most of the drivers of change are human mediated, there has been no deliberate degradation of the forest in order to meet the applicability conditions.

G.3 Project Period

The crediting period for the VBF project is 20 years (i.e. 2019-2039). This is the minimum permitted by the Plan Vivo Standard and corresponds to most estimates of the time taken for new mangrove forests to mature. For avoided deforestation, the proposed period is considered to be adequate for meaningful ecological impacts to be achieved in terms of mangrove biodiversity and ecosystem restoration, with experience at Mikoko Pamoja in Gazi Bay showing measurable changes in biomass and recruitment within 3-5 years, and changes in stump counts and signs of human intervention within one year. Annual monitoring will be conducted to assess the level of degradation while carbon sequestration rates will be assessed every

three years. The proposed period will also give adequate time to review, monitor and evaluate whether the project's overall economic impacts to the community have been achieved. We hope and anticipate that the project will extend beyond 20 years; achieving such an extension could form part of the five-yearly review cycle. However, formally committing to that at the moment implies further extrapolation of risk estimates and other uncertainties that we think is unjustified. Hence we are choosing 20 years for scientific and technical reasons, rather than in anticipation that the project stops or reverses after that.

G.4 Baseline scenario

Current conditions and trends:

Forest protection:

The dominant mangrove formations are mixed stands of *Rhizophora mucronata* that occupy 116.5 ha of forested area of the Island. This is followed by *Sonneratia-Rhizophora* and pure *Sonneratia alba* stands that fringe the Island (Figure 8).

Figure 8: Mangrove forests in the project area provide habitat for a variety of species

Mangroves in Sii Island are linked ecologically to the fringing reefs, which are major fishing grounds for fishermen from nearby villages. Landsat data for Sii Island from 1991 to 2016 indicate only 0.1 % loss in mangrove coverage. These forests are, however, under potential threats from increasing demands for mangrove wood products on the mainland. Without improved protection, Sii Island is likely to suffer increasing rates of forest loss and degradation in the near future. The project seeks to preserve this high-quality forest and to allow natural recovery of those areas that have suffered past impacts. Protection status of Sii Island as a seed source has been highlighted in the Kenya's National Mangrove Ecosystem Management Plan (2017).

Within the mainland, losses of mangroves over the 1991 to 2016 are estimated at 0.5 % area

per annum, equivalent to a loss of 18 ha yr^{-1} (Figure 4), which is slightly lower that the 0.7 % national average. Key drivers contributing to losses and degradation of mangroves in the mainland area include: illegal harvesting of mangrove wood for building poles and energy; land encroachment; and shoreline change. Without project interventions, these conditions are likely to continue and worsen. This prediction is made on the basis of detailed, published modelling conducted by members of the project team looking at mangrove dynamics across the south coast of Kenya.[31,32]

Forest restoration:

Carbon Pools:

The baseline includes three main carbon pools as follows: aboveground biomass (AGB -live and dead trees), belowground biomass (BGB - live and dead roots down to 60 cm belowground) and soil carbon down to 1 m (See Table 12).

Table 12: Main carbon pools accounted

Carbon pool	Accounted	Impact	Justification
AGB (live and dead trees)	Yes	High	• It is easy to quantify and monitor based on published and localised allometric equations for the area[33]
BGB (live and dead roots down to 60 cm below ground)	Yes	Moderate	• Estimated from established Shoot:Root ratio. Root biomass in the mangroves can be up to 50 % of the aboveground biomass.
Soil carbon down to 1 m	Yes	High	• Sediment constitutes the largest carbon pool in mangrove ecosystem; contributing up to 90 % of the total ecosystem carbon stock.[34,35] • Carbon losses from sediment due to small scale forest clearance are based on carbon flux experiments nearby the project area by Lang'at et al., (2014).[36]
Dead wood	No	Low	• Dead wood carbon is not accounted here as most of the fallen wood is collected for firewood by community
Litter	No	Low	• Litter carbon will not be included because it is removed by crabs or tides; and partly incorporated into the sediment carbon

***Baseline methodology*:**

Carbon stocks were measured using the approved VCS methodology, VM0033 Methodology

31 Kairo et al 2008 Kairo JG, Lang'at JK, Dahdouh-Guebas F, Bosire J, Karachi M. (2008) Structural development and productivity of replanted mangrove plantations in Kenya. Forest ecology and management. Apr 20;255(7):2670-2677

32 Rideout AJR, Joshi NP, Viergever KM, Huxham M, Briers RA. 2013 Making predictions of mangrove deforestation: a comparison of two methods in Kenya. Glob. Chang. Biol. 19, 3493 –501. (doi:10.1111/gcb.12176)

33 Kirui B. K, (2006). Allometric relations for estimating aboveground biomass of naturally growing mangroves, *Avicennia marina* (Forssk) Vierh and *Rhizophora mucronata* Lam. along the Kenyan coast- Unpublished Thesis.

34 Donato D.K., Kauffman J.B., Murdiyarso D., Kurnianto S., Stidham M., Kanninen M.Mangroves among the most carbon-rich forests in the tropics. *Nature Geoscience.* 2011; 4 (5).

35 Gress S. K., Huxham M., Kairo J. G., Mugi L. M. and Briers R. A. (2017) Evaluating, predicting and mapping belowground carbon stores in Kenyan mangroves. *Global Change Biology.* 23: 224–234.

36 Lang'at, J. K. S., Kairo, J. G., Mencuccini, M., Bouillon, S., Skov, M. W., Waldron, S., & Huxham, M. (2014). Rapid losses of surface elevation following tree girdling and cutting in tropical mangroves. *PLOS One*, 9(9), 1–8

for Tidal Wetlands and Seagrass Restoration, as well as the 2013 supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. We opted to use these approaches, as Plan Vivo doesn't have specific methodologies for carbon accounting. Additionally, our technical expert, Dr James Kairo, has been involved in the development of the methodologies referred to above, and therefore has strong experience implementing their procedures and adhering to each methodology's applicability conditions.

The project area comprises 250 ha of mangroves on the mainland plus 200 ha on Sii Island. An additional 0.25 ha of mangrove cover will be added through reforestation activities over the project lifetime (Table 10).

To accurately estimate biomass in the project area at reasonable cost, we used nested sampling designs of 10 m x 10 m. The general sampling framework is presented in Figure 9, as below:

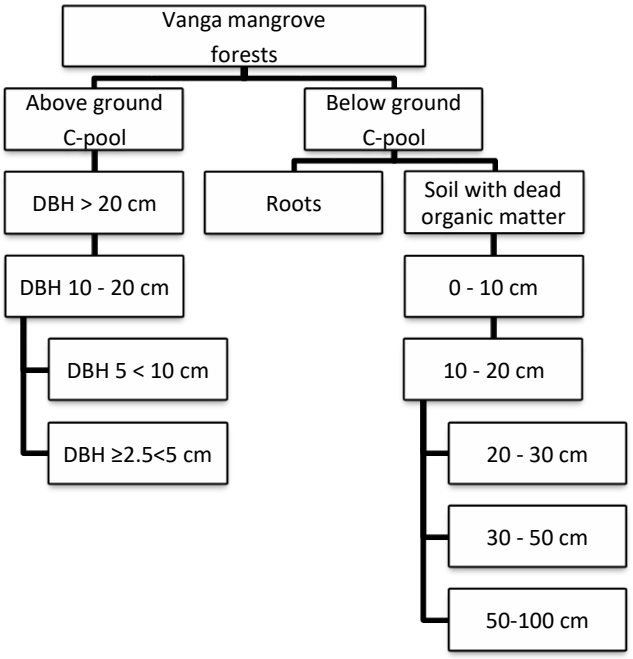


Figure 9: Forest components used for quantification of forest biomass and ecosystem carbon stocks in Vanga

- all trees with DBH > 5.0 cm were measured in the entire 10 m x 10 m plot,
- trees of DBH < 5.0 cm were sampled in sub-plots of 5 m x 5 m within the big quadrants

Generalised allometric equations for mangroves were used to convert height and diameter measurements into biomass.[37] Belowground root biomass was estimated using shoot: root

37 Komiyama A., Ong J. E., Poungparn S., 2008 Allometry, biomass, and productivity of mangrove forests: a review. Aquatic Botany 89:128-137.

ratio.[38] Soil was sampled down to a depth of 100 cm.[39]

Soil carbon pools were sampled at the centre of the 10 m x 10 m plots at 0, 20, 50 and 100 m depth using soil auger; and carrying up to 100 g of soils in each level for analysis. In the laboratory, the samples were weighed and oven-dried for 24 hours at 80 C, after which they were re-weighed to obtain the soil moisture content. About 25 grams of the dry soil sample was homogenized by grinding to a fine powder using a mortar and pestle and subjected to a series of sieves for grain size analysis. Five grams of the remaining sample were oxidized at 440 C in a furnace for 8 hrs until only inorganic ash was left. What was lost during the oxidation represents the soil organic matter (SOM). Based on the assumption that organic matter contains 58 % organic carbon,[40] a conversion factor of 1.724 was used to convert the organic matter to organic carbon. We hope to conduct similar procedures in subsequent monitoring of mangrove development in Vanga.

Carbon stocks in the mangroves of Vanga ranged from 174 - 904 Mg C ha^{-1} (mean: 469 + 176 Mg C ha^{-1}). Soil contributed the highest organic carbon (77 %), followed by above ground (16 %) and below ground root (7 %) components (Figure 10).

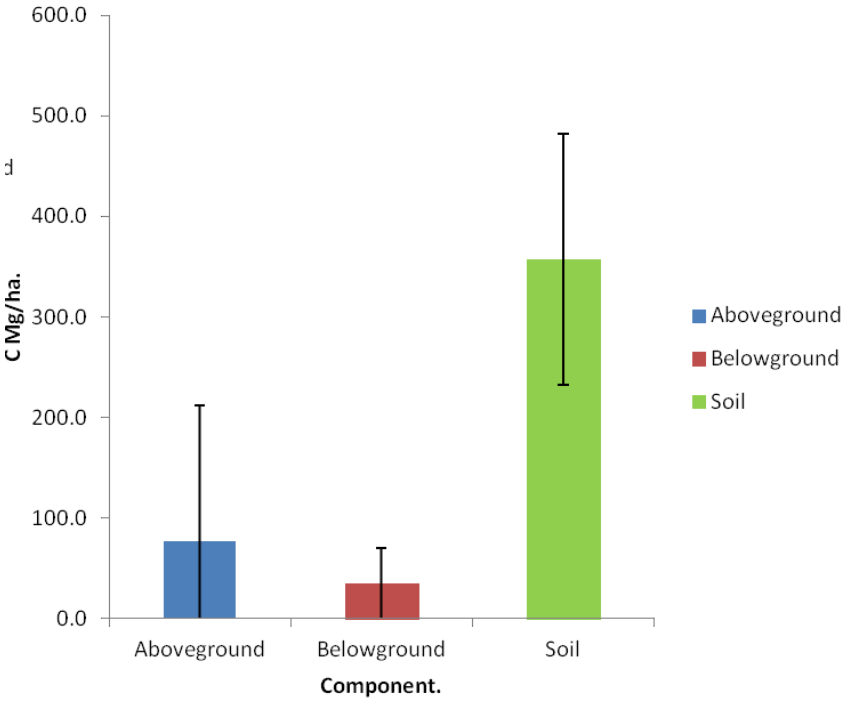


Figure 10: Carbon stocks in Vanga (original data from the project team)

38 Kairo J. G., Bosire J., Langat J., Kirui B., Koedam N., (2009) Allometry and biomass distribution in replanted mangrove plantations at Gazi Bay, Kenya. *Aquatic Conserv: Marine Freshwater Ecosystem* 19: S63–S69

39 Gress S. K., Huxham M., Kairo J. G., Mugi L. M. and Briers R. A. (2017) Evaluating, predicting and mapping belowground carbon stores in Kenyan mangroves. Global Change Biology 23: 224–234

40 Nelson, D.W. and Sommers, L.E. (1996) Total carbon, organic carbon, and organic matter. In Sparks, D.L., et al., Eds., Methods of Soil Analysis. Part 3, SSSA Book Series, Madison, 961-1010

Baseline emissions

The assumed baseline scenario for this project area, in the absence of intervention, is deforestation and forest degradation due to illegal logging and encroachment at the frontier of human expansion, as recorded at similar sites on the coast, and predicted using modelling approaches[31]. The project area has previously been used for commercial harvesting of mangroves for sale in the urban centres. A mangrove boardwalk was constructed for ecotourism purposes near Vanga village., but this activity failed due to reduced tourism in the area, which has led the community to a situation of financial crisis and unsustainability. The heavy losses, of food, houses and sometimes lives, due to recurrent floods have crippled community activities further.

Without the project, during the 20-year crediting period the total 450 ha designated for avoided deforestation would decrease to 424 ha, whereas with the project, the decrease would only be to 444 ha (assuming a conservative 80 % reduction in deforestation; Table 13). As a result, 22 ha would be saved from deforestation over the 20-year crediting period. The sequestration rate for avoided degradation on the mainland (area 2) is conservatively based on AGB and BGB emission rates estimated for tropical mangroves (IPCC, 2013) (but note that actual claimed benefits will be based on *ex-post* measurements). The estimates are based on the assumption that without the project interventions, mangroves will continue to be lost at the rate of 0.5 % per year in area 2 (mainland) and 0.1 % per year on Sii Island (area 1), and that the remaining forest will continue to be degraded. This would result in zero net sequestration in areas 1 (Sii Island) and 2 (mainland). These are conservative assumptions, using IPCC estimates that are considerably less than suggested by our own data from Gazi, as whilst there is no detailed sequence of stock estimates over time available for this site, there is good evidence that stocks per unit area have declined and that net sequestration under a no project scenario is likely to be negative:

- The neighbouring system of Gazi bay, which is much better known and studied (and is likely to enjoy better informal protection given its status as a study site for Kenya Marine and Fisheries Research Institute), has experienced a long-term decline in standing biomass per area because of degradation. An early published estimate of standing dry mass in the *Rhizophora mucronata* forest gave 250 t ha^{-1} from data taken before 1996.[41] A biomass of 103 t ha^{-1} was estimated some twenty years later,[42] although some of the discrepancy may be due to improved methods and inclusion of other species, this large reduction strongly suggests ongoing degradation, which is likely to be replicated at other sites such as Vanga.

- There are no pristine mangrove forests in East Africa that could be used as perfect 'controls' in establishing a baseline (indeed this is an important argument for our proposal to preserve Sii Island). The forests with least evidence and history of human impact in Kenya occur in the remote far north. Kiunga forest, north of Lamu, has AGB

41 Slim F, Gwada P, Kodjo M, Hemminga M. 1996 Biomass and litterfall of Ceriops tagal and Rhizophora mucronata in the mangrove forest of Gazi Bay, Kenya. Mar. Freshw. Res. 47, 999. (doi:10.1071/MF9960999)

42 Cohen R, Kaino J, Okello J a., Bosire JO, Kairo JG, Huxham M, Mencuccini M. 2013 Propagating uncertainty to estimates of above-ground biomass for Kenyan mangroves: A scaling procedure from tree to landscape level. For. Ecol. Manage. 310, 968–982. (doi:10.1016/j.foreco.2013.09.047)

of 200 t ha^{-1}, 54 % higher than the 130 t ha^{-1} estimated for Vanga in the same study by Cohen et al. Our estimate for AGB in area 2 is 75t C ha^{-1}, or 160 t dry mass ha^{-1}. An average for Indo-Pacific mangroves in general is 170 t ha^{-1},[43] hence Vanga biomass lies below what is recorded in similar forests within and outside Kenya, suggesting degradation and thus a considerable potential to increase sequestration accordingly.

- There are multiple other sources of evidence consistent with a scenario of increasing pressure and decreasing biomass in the Vanga forest. For example, forest structural surveys show far fewer straight poles than expected in un-cut forests and multiple direct signs of cutting, such as stumps.[44]

Under the scenarios of forest loss, we assume total loss of AGB and associated carbon. We also assume gradual loss of below ground carbon from sediment following forest clearance. Experimental work at nearby Gazi forest showed losses of 35 t CO_2 in the first year following small scale removal of forest in 12 m^2 plots[35]. We assume the same initial rate here, and apply an exponential model of the form:

$$\text{C loss (in year } t\text{)} = \text{Total eventual loss} * (1-\exp^{-kt})$$

We assume the total eventual loss is 50 % of the C content of the top 1 m of sediment, i.e. 180 t C ha^{-1}, a conservative assumption compared to the 60 % used by Siikamäki *et al.*[45] The project also proposes to reforest 0.25 ha of deforested land annually.

43 Donato DC, Kauffman JB, Murdiyarso D, Kurnianto S, Stidham M, Kanninen M. 2011 Mangroves among the most carbon-rich forests in the tropics. *Nat. Geosci.* **4**, 293–297. (doi:10.1038/ngeo1123)

44 Huxham M, Emerton L, Kairo J, Munyi F, Abdirizak H, Muriuki T, Nunan F, Briers R a. 2015 Applying Climate Compatible Development and economic valuation to coastal management: A case study of Kenya's mangrove forests. *J. Environ. Manage.* **157**, 168–181. (doi:10.1016/j.jenvman.2015.04.018)

45 Siikamäki, et al. 2012. Proceedings of the National Academy of Sciences 109 (36) 14369- 14374; DOI:10.1073/pnas.1200519109

Table 13: Comparison of deforestation rates with and without the project interventions at areas 1 and 2

	Area 2 (mainland)					Area 1 (Sii Island)				
	Without Project (Baseline/deforestation rate 0.5 %)		With Project (project deforestation rate 0.1%		Prevented Deforestation (ha)	Without Project (Baseline/ deforestation rate 0.1 %)		With Project (project deforestation rate 0.02 %)		Prevented Deforestation (ha)
Year	Forest cover (ha)	Deforestation (ha yr^{-1})	Forest cover (ha)	Deforestation (ha yr^{-1})		Forest cover (ha)	Deforestation (ha yr^{-1})	Forest cover (ha)	Deforestation (ha yr^{-1})	
0	250.000		250.000			200.000		200.000		
1	248.750	1.250	249.750	0.250	1.000	199.800	0.200	199.960	0.040	0.160
2	247.506	1.244	249.500	0.250	0.994	199.600	0.200	199.920	0.040	0.160
3	246.269	1.238	249.251	0.250	0.988	199.401	0.200	199.880	0.040	0.160
4	245.037	1.231	249.001	0.249	0.982	199.201	0.199	199.840	0.040	0.159
5	243.812	1.225	248.752	0.249	0.976	199.002	0.199	199.800	0.040	0.159
6	242.593	1.219	248.504	0.249	0.970	198.803	0.199	199.760	0.040	0.159
7	241.380	1.213	248.255	0.249	0.964	198.604	0.199	199.720	0.040	0.159
8	240.173	1.207	248.007	0.248	0.959	198.406	0.199	199.680	0.040	0.159
9	238.972	1.201	247.759	0.248	0.953	198.207	0.198	199.640	0.040	0.158
10	237.778	1.195	247.511	0.248	0.947	198.009	0.198	199.600	0.040	0.158
11	236.589	1.189	247.264	0.248	0.941	197.811	0.198	199.560	0.040	0.158
12	235.406	1.183	247.016	0.247	0.936	197.613	0.198	199.521	0.040	0.158
13	234.229	1.177	246.769	0.247	0.930	197.416	0.198	199.481	0.040	0.158
14	233.058	1.171	246.523	0.247	0.924	197.218	0.197	199.441	0.040	0.158
15	231.892	1.165	246.276	0.247	0.919	197.021	0.197	199.401	0.040	0.157
16	230.733	1.159	246.030	0.246	0.913	196.824	0.197	199.361	0.040	0.157
17	229.579	1.154	245.784	0.246	0.908	196.627	0.197	199.321	0.040	0.157
18	228.431	1.148	245.538	0.246	0.902	196.430	0.197	199.281	0.040	0.157
19	227.289	1.142	245.293	0.246	0.897	196.234	0.196	199.241	0.040	0.157
20	226.153	1.136	245.047	0.245	0.891	196.038	0.196	199.202	0.040	0.156
Total loss of forest area (ha, over 20 years)					**18.9**					**3.2**

Data Sources:

The total mangrove area designated for this project is 460 ha. To estimate the carbon emissions within the avoided deforestation site, we have used recommended IPPC sequestration rates for wet tropical mangroves.[46] The carbon losses from sediment due to forest clearance are based on carbon flux experiment in mangrove forest in Gazi Bay, an ecosystem adjacent to Vanga ecosystem.[47]

G.5 Ecosystem service benefits

The project expects to reduce mangrove deforestation by 22.1 ha over the 20 years' project period (Table 13). With project intervention, emissions will be reduced by 80 % assuming a non-permanence and leakage buffer of 25 % (Table 10). The average annual carbon benefits from the project eligible for crediting will be 5,023 t CO_2 yr^{-1}, while the total creditable carbon benefits expected over the 20 years' project period will be 100,469 t CO_2 (Table 10).

G.6 Leakage & Uncertainty

In order to mitigate carbon leakage, the project proposes to establish at least 2.0 ha of community woodlots as well as support community livelihood and income generating activities. The aim is to generate a sustainable supply of timber, fuelwood and income; thus removing the pressure on the mangrove forest. Our leakage calculations (focusing on dealing with firewood needs) are as follows. Average daily firewood use is estimated as 1.2 kg cap^{-1}, with 9.6 % provided by *Rhizophora mucronata.*[48] Given an estimated local population of 8,700, this implies a total local demand of 10,440 kg day^{-1}, 1,002 kg *Rhizophora mucronata* day^{-1} or 366 t mangrove firewood yr^{-1}. As firewood is extracted from the mainland forest (Sii Island is too remote for this use), we propose to protect 260 ha out of a total 4,428 ha i.e. 5.9 % of mainland forest. Assuming that the 366 t demand is currently met from this whole forest, protecting 5.9 % implies displacing 22 t yr^{-1}. One hectare of *Casuarina equisetifolia* woodlot produces > 120 t after 10 years,[49] or 12 t yr^{-1} interpolated production. We plan to establish 2 ha of woodlot, which should produce in excess of what is needed (including regular thinning). In addition, we will supply at least 150 improved cook stoves in the first 3 years, further reducing firewood need by an estimated 22 t yr^{-1} (assuming 33 % improvement in efficiency); these figures are based on the research in[48] along with our experience in Mikoko Pamoja; there is strong demand for the stoves with 100% uptake by those who request them. Community access to and use of woodlots will be determined by the VBF committee through consultation with local people and with the schools and youth groups who will be tasked with woodlot husbandry. So the final rules of wood use are yet to be determined (since doing so would be undemocratic). However based on experience with Mikoko Pamoja, we anticipate that firewood will be free to all locals to collect whilst timber will be divided between local needs (given or sold at below-market price) and sales to the market to raise

46 IPCC (2013) Coastal wetlands. In 2013 supplement to the 2006 IPCC guidelines for National Green House Gas inventories (Eds Alongi D., Karim A., Kennedy H., Chen g., Chmura G., Crooks S et al)

47 Lang'at, J. K. S., Kairo, J. G., Mencuccini, M., Bouillon, S., Skov, M. W., Waldron, S., & Huxham, M. (2014). Rapid losses of surface elevation following tree girdling and cutting in tropical mangroves. *PLoS ONE*, *9*(9), 1–8

48 Jung J. (2018) Firewood usage and indoor air pollution from traditional cooking fires and the possibility of introducing improved cookstoves in Gazi Bay, Kenya . *Edinburgh Napier University honours thesis*

49 Orwa C, A Mutua, Kindt R , Jamnadass R, S Anthony. 2009 Agroforestry Database: a tree reference and selection guide version 4.0 (http://www.worldagroforestry.org/sites/treedbs/treedatabases.asp)

money to compensate for the work involved in husbandry and planting. As an additional conservative assumption we have assumed a 5% leakage buffer for all our anticipated carbon benefits.

G.7 Summary of key parameters, equations and assumptions

The key parameters and equations used in estimating carbon benefits are given belowin Table 14, along with justifications for why the assumptions used are conservative.

Table 14: Summary of key parameters, figures and equations used for carbon benefits, with derivations and justifications

Description	Value or equation	Source	Notes and justification for conservative assumptions
Annual growth increment for tropical wet mangrove forest	9.9 t D.M. ha^{-1} yr^{-1}, equivalent to 17.3 t CO_2 $ha^{-1}yr^{-1}$	IPCC 2013, table 4.4[50]	*In situ* records of growth at similar Gazi plots exceed this value. But note that claims for credits will be based on *ex-post* real measurements in the field.
Annual sequestration of CO_2 in rehabilitated area (area 4)	4 t ha^{-1} yr^{-1}, derived from 8.9 t D.M. ha^{-1} yr^{-1} in Kairo et al. 2008[51]	Kairo et al., 2008	The value from Kairo et al 2008 is for above-ground biomass of a 12-yr old stand growing on productive land. It is equivalent to ~15 t CO_2 ha^{-1} yr^{-1}. Because we do not know the shape of the growth curve over 12 years (i.e. how fast growth might be in the initial few years compared to later ones) and because we are using a degraded site where growth may be slower, we have chosen a highly conservative value of less than 1/3rd of this growth rate and no belowground biomass. Projecting this across 20 years, and assuming recovery of all the 5 ha, gives an average annual carbon benefit
Annual sequestration of CO_2 in community planted area (area 3)	20.4 t CO_2 ha^{-1} yr^{-1}, from 11 t D.M. ha^{-1} yr^{-1}	Kairo et al., 2008	This value is for a 12-year old plantation (the Vanga plantation is 10 years old) in a similar setting, and includes below ground biomass. It is conservative since it incorporates all years between 0-12 years old i.e. early years when the trees are small. In VBF, the trees are already 10 years old.
Aboveground carbon benefits of avoided deforestation in area 2	0.94 ha forest saved from deforestation yr^{-1}, mean 75 t C in AGB gives 260 t CO_2 yr^{-1}	Rates of forest loss in Table 13, C values in Figure 10	Takes original field data from our site, so based on Tier 3 quality data. Does not assume any growth in average AGB during 20 yrs. so is conservative.
Aboveground carbon benefits of avoided deforestation in area 1	0.16 ha forest saved from deforestation yr^{-1}, mean 91 t C in AGB gives 53 t CO_2 yr^{-1}	Rates of forest loss in Table 13, C values of 195 t dry mass ha^{-1}	Takes original field data from our site, so based on Tier 3 quality data. Does not assume any growth in average AGB during 20 yrs. so is conservative.
Belowground carbon benefits of avoided deforestation in areas 1 & 2	273 t CO_2 yr^{-1} for all predicted avoided deforestation areas i.e. 22 ha over 20 years. Equation for C loss following clearing is C_{loss} = Total Loss * $(1-exp^{-kt})$, k is initial rate of loss, asymptote is 180 t ha^{-1}	Initial C loss following clearing Lang'at et al. 2014.[52] Exponential model in appendix IX, results table IXa	We have the world's only experiment on C loss following mangrove removal at Gazi, which showed 9.5 t C ha^{-1} after year 1. Losses will continue for an unknown period into the future. Work in the literature assumes that 60 % of all the C in the top 1 m will eventually be lost, following an exponential curve (Siikamäki, et al. 2012).[53] We make the conservative assumption that only 50 % will be lost (hence set an asymptote at 180 t loss), even though we know that effects are visible down to 1m after only the first year (Lang'at et al. 2014). The value of 273 is an integrated sum of C losses from all the gradually lost areas, losing C at rates dependent on their age; appendix IX shows the full workings.

50 IPCC (2013) Coastal wetlands. In 2013 supplement to the 2006 IPCC Guidelines for National Green House Gas Inventories (Eds Alongi D., Karim A., Kennedy H., Chen G., Chmura G., Crooks S. et al)
51 Kairo J.G., Lang'at J.K., Dahdouh-Guebas F., Bosire J., Karachi M. (2008) Structural development and productivity of replanted mangrove plantations in Kenya. *Forest Ecology and Management*. Apr 20;255(7):2670 -2677
52 Lang'at, J. K. S., Kairo, J. G., Mencuccini, M., Bouillon, S., Skov, M. W., Waldron, S., & Huxham, M. (2014). Rapid losses of surface elevation following tree girdling and cutting in tropical mangroves. *PLOS One*, 9(9), 1-8
53 Siikamäki, et al. 2012. Proceedings of the National Academy of Sciences 109 (36) 14369- 14374; DOI:10.1073/pnas.1200519109

Part H: Risk Management

H.1. Identification of risk areas

Six risk categories were identified in the project. Mitigation measures have been identified and are expected to lower the risk level (Table 15). The remaining risks were scored: i) impact – the proportion of reversed benefits; and ii) likelihood of the risk occurring. The scale used was: Very low = 0.05, Low = 0.1, Moderate = 0.25, High = 0.5, Very high = 0.75.

Table 15: Risk areas and mitigation

Risk	Management / mitigation measures	Impact	Likelihood
Administrative changes in the project	The community who have participated in all the stages of project development will be continuously advised on any changes in the project management including skill enhancement for coping with the changes. The community co-ordinator will be recruited from the community and be part of it, and will be the key player in instituting administrative changes	**Low**: administrative changes can affect the project negatively especially if the changes are not acceptable to the administrators and the community. However change is not a risk if managed well; rather inability to change and adapt is a more serious risk	**Medium:** there is a modest likelihood of changes because after every five years, a review will advise on the best way forward in the project and this may bring changes. New administrators may bring about change
Maintenance of community support is not sustained	Prioritised local development projects represent interests of all members of the community. A mechanism for resolution of conflicts and disputes will be put in place. The community *barazas* represent a tried and tested method of gauging local support and are well known to local people	**Medium:** a waning in community support could lead to some members withdrawing membership which will negatively impact project implementation	**Low:** This may arise especially when project activities fail to deliver expected livelihood benefits. However, the existence of similar successful projects nearby helps put expectations in perspective. The project team has an excellent track record in involving the community and avoiding elite capture, and will pursue site based research on benefit sharing to monitor and understand these risks.
Over reliance on external support to implement	Skill development for project coordinator. There will be continued training on PES as well as on forest carbon monitoring, reporting and verification. Project activities will be re-assessed annually throughout the crediting period. We have also	**Medium**: an unqualified PC lacking skills to run the project and a community without awareness and skills for management of carbon offset projects could lead to slowing down project activities	**Low**: the likelihood of this happening is low since a qualified PC will be recruited and awareness and capacity building on the project will be on going.

	secured funds for a full time PhD student to work at the site, studying forest productivity. She will be part of the project team and on-hand to assist in training and capacity building.	or neglect of some thus leading to reversal	
Inadequate management including poor organisation and mobilisation of the community	Capacity building for the project team and optimal communication and involvement of the community in every stage of project development and implementation. Clear governance structures and oversight by the VBF committee	**Medium:** this project relies heavily on the PC and VBF committee for implementation of the workplan; and if the community is isolated, the workplan may only be partly implemented	**Low:** this is because the community has been involved in the design and development of the project and will be involved in the implementation through their respective representatives. They have also visited Mikoko Pamoja and discussed the operation of that neighbouring project so understand how it works.
Extreme weather events/natural disaster	Restoration and protection of degraded areas as intended in this project will help increase the capacity of mangroves to withstand natural disasters as well as increase their resilience to cope with the disturbances. By using natural processes of regeneration (rather than relying heavily on planting) we are not vulnerable to the sudden catastrophic loss of nurseries. We also have more than one project site and will work in areas with mixed species, each with different vulnerabilities and hence with combined higher resilience	**Medium**: Extreme climate events (e.g. El Niño) have caused flooding and death of mangroves and sedimentation of seagrasses in Vanga in the past.	**Medium:** El Niño is cyclical and flooding events are becoming more common in Kenya than before. This means that they are likely to occur within the first five years of the project cycle. However the area naturally floods and ecosystems and people are resilient
Pests and diseases	A surveillance team will be formed and taught to identify signs of stress and pest infestations. Any evidence of pests and disease will be reported annually	**Medium**: Some mangrove species such as *Avicennia sp* are prone to defoliators. If the pests and diseases attack the saplings, it could lead to death and low recovery of the forest	**Low**: there has not been any reporting on pests or diseases on mangrove trees for the last five years. If attacked, mangroves tend to recover quickly without any interventions. Our experience with near-by nurseries is positive. We are also intending to use natural processes, if possible, for restoration, hence will not be heavily dependent on vulnerable nurseries.

Non adherence to management options in seagrass areas	The BMU with the assistance of the SDF&BE will work closely to ensure compliance. A surveillance team will be set up to ensure that only acceptable activities are undertaken. The BMU can take action against those not abiding by the management measures as stipulated in the BMU guidelines	**Medium** Seagrass conservation and return of ecosystem services will depend to a great extent on compliance with management options as suggested by the BMU. If BMU members do not comply, then it will not be possible to conserve the seagrass meadows in the CMA	**Low** The fishers of Vanga have a strong BMU and also the fisheries office is within the village and can be easily accessed by the fishers at any time. This ensures continued surveillance and quick reporting and action over any incidences of non-compliance

H.2: Risk buffer for non-permanence

The total buffer was quantified using the scale set out in section H.1, as per Table 16 below.

Table 16: Risk scores for non-permanence

Risk type	**Impact**	**Likelihood**	**Total**
Administrative changes in the project	10 %	0.25	2.5
Maintenance of community support is not sustained	25 %	0.1	2.5
Over reliance on external support to implement	25 %	0.1	2.5
Inadequate management including poor organisation and mobilisation of the community	25 %	0.1	2.5
Extreme weather events/ natural disaster	25 %	0.25	6.25
Pests and diseases	25 %	0.1	2.5
Total			18.75

The values for impact and likelihood are based on expert judgement derived from six years' experience of running a similar project at Gazi. Hence whilst they are inevitably subjective they are contextually relevant and are conservative, over-estimating the likelihood of these risks.

The risk buffer for the risks modelled with default parameters was rounded up to **20 %** to allow for additional uncertainties.

Part I: Project Coordination & Management

I.1 Project Organisational Structure

Vanga Blue Forest (VBF) project will be implemented by a registered community organisation with membership derived from VAJIKI CFA and shall receive technical support from KMFRI, KFS and other actors (Figure 10, Table 17). The Association for Coastal Ecosystems Services (ACES), a Scottish registered charity, will serve as the link between VBF and carbon markets. ACES has previously supported the successful implementation of its first pioneering mangrove carbon project, Mikoko Pamoja, that was set up by the communities of Gazi and Makongeni to conserve nearby mangrove forests.

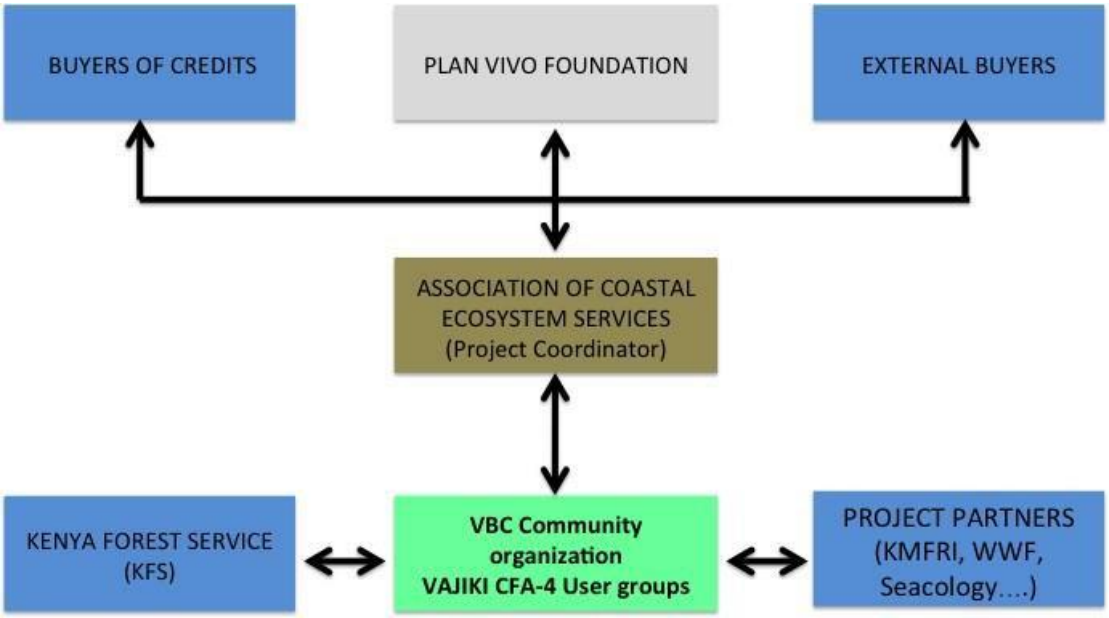


Figure 7: Vanga Blue Forest project organisational structure

Table 17: Key project partners and roles

Key functions	Organization	Type & Legal status	Brief description of activities
Project coordination	Association for Coastal Ecosystem Services (ACES)	Scottish Charity (non-profit organisation)	• Carbon sales, negotiations and promotion with buyers. • Managing PV payments to VBF based on annual monitoring. • Overseeing technical aspects and ensuring regular monitoring of project activities. • Coordinating annual reporting of project activities to the Plan Vivo foundation, the buyers and the partners. • Encouraging and supporting community decision making • Promoting VBF nationally and globally
Project technical operations	Kenya Marine and Fisheries Research institute (KMFRI)	Legally government agency	• Providing technical support to the project and community. • Overseeing project implementation and development. • Coordinating stakeholders' engagements and enhance capacity on PES schemes • Ensuring legal compliance by facilitating registration with the relevant government institutions, fair PES agreements and also transparent and due payments of carbon sales.
Project implementation	Vanga Blue Forest (VBF) community organization through VAJIKI CFA User groups: Jimbo Environmental Group, Magugu mariculture group, Mwambiweje Women Group, Vumilia Nguvu Kazi Group	A Community Forest Association registered in 2013. As an umbrella body, VAJIKI represents 4 user groups engaged in mangrove forest conservation and management of national forests in the project area including mangroves.	VAJIKI CFA represents the community and will be involved in; • Enlightening the community on the importance of mangroves and reducing their deforestation. • Working with KFS on the implementation of the PFMP of the area. • Conserving and protecting biodiversity and socio-cultural values of mangroves • Enhancing capacity building of the community through training • Organising regular (at least annual) community consultations through *baraza* and other means to facilitate benefit sharing • Managing the project co-ordinator and other paid and voluntary roles • Operating an efficient committee that abides by the constitution

I.2 Relationships to national organisations

The project implementer, Vanga Blue Forest (VBF) community organisation, comprises members from VAJIKI CFA, which is a registered community forest association (CFA) and is recognised by Forest Management and Conservation Act (2016) of the Laws of Kenya. VAJIKI, will work closely with KFS and other agencies in implementing the project activities in line with the approved participatory forest management plan (PFMP) of the area and the national mangrove ecosystem management plan. The project will complement and build upon the results of several ongoing initiatives:

FINNIDA is supporting KFS through the National Forest Programme (NFP) for forest sector reforms in Kenya. NFP is implementing Kenya's National Mangrove Ecosystem Management Plan (2017–2027), forming a base upon which the VBF project will build.

DFID, the Ecosystem Support for Poverty Alleviation (ESPA) and the Natural Environmental Research Council (NERC) supported the 'Coastal Ecosystem Services for East Africa' (CESEA) and the 'Sustainable Poverty Alleviation from Coastal Ecosystem Services' (SPACES) projects. Partners included researchers in UK, Sweden, Kenya, and Mozambique. These projects established the social, biodiversity and carbon baselines that were used in setting up VBF.

UNEP/GEF Blue Forest Project is implemented in Vanga with an overall objective to apply methodologies and approaches for carbon accounting and ecosystem service valuation in Blue Carbon Projects, so as to provide evidence-based experience that supports replication, up-scaling and adoption of Blue Forests concepts by the international community and the GEF. Lessons and experiences from this project will support the successful implementation of the proposed Vanga Blue Forest project.

Kenya Coastal Forest Conservation Forum (KCFCF) through Seacology is supporting ongoing conservation and management efforts of mangrove areas in Sii Island. Seacology, together with other stakeholders such as National Environmental Management Authority (NEMA), Kenya Marine and Fisheries Research Institute (KMFRI) and the Coastal Development Authority (CDA), are creating community awareness to enhance compliance with regulations on use of the mangrove forests.

I.3 Legal compliance

Some of the key legislations that the project will contribute to will include:

- The **Constitution of Kenya (2010)**, targeting a national forest cover of 10 %.
- **Forest Conservation and Management Act (2016)** providing for community participation in forest management, including mangroves. Participation of the community is further highlighted in the National Mangrove Ecosystem Management Plan (2017-2027).
- **Kenya National Biodiversity Strategy and Action Plan** (NBSAP, 2000), objectives 1, 3, 6 and 10, calling for capacity building, conservation, sustainable use of biodiversity and implementation of EIAs

- **Integrated Coastal Zone Management Policy and Action Plan (2010)**, calling for integrated coastal resource management
- **National Climate Change Response Strategy** (NCCRS) (2010) calling for low-carbon pathways in the national development and **National Climate Change Action plan** (NCCAP) promoting mangrove restoration activities
- **Environmental Management and Coordination Act** (2015), providing for EIAs and SEAs to be applied for all developments
- **Fisheries Management and Development Act** (2016) that recognizes mangroves as critical habitat for fisheries and other wildlife; and the need for their conservation.

Overall, the project will support Kenya's implementation of the **Sustainable Development Goals**, particularly; (SDG) 1 (poverty alleviation), 13 (climate action), 14 (life below water); as well as Kenya's commitments to **Aichi target** 15 and the **National Biodiversity Strategy and Action Plan**, objectives 1, 3, 6 and 10.
The project coordinator will adhere to the principles of fairness and gender rule in employment as stipulated in the Constitution of Kenya (2010). They will be guided by the VBF constitution as well as working closely with the executive committee in any employment process.

I.4 Project management

Dialogues for the implementation of VBF were initiated in December 2014. This was followed by surveys to establish ecological and sociological baselines (Table 18). A Project Idea Note (PIN) was developed in 2016. The PIN allowed feasibility assessment of a blue carbon project in Vanga. The project ideas were shared with the proponents who agreed to establish a VBF Committee to oversee project development and implementation. The Project Design Document (PDD) was initiated in Jan 2017 and submitted to Plan Vivo in 2018 for review and approval (Table 18).

The local implementation of VBF will primarily be driven by the Project Coordinator working with a democratically elected committee representing the villages comprising VAJIKI (Figure 10). In accordance with Plan Vivo guidelines, independent validation of the project will be undertaken every 5 years. The PC will be trained on the implementation of the work plan, monitoring and reporting, and with technical support from KFS and KMFRI, will develop a record keeping system which will document the following:

a) Minutes of the village *barazas* held
b) Financial income and expenditure
c) Environmental and socio-economic monitoring indicators
d) Reports from forest patrols and other project activities

Table 18: Timeline

Month and Year	Activity
December 2014	Project dialogue initiated
January to December 2015	Collection of Baseline data (Forest structure and socio-economic)
January to December 2016	PIN development
January to June 2017	Community consultations for PDD development
July to December 2017	Establishment of Vanga Blue Forest Committee
April to June 2018	Review of PDD and Stakeholders consultations
September 2018	Submission of PDD to Plan Vivo
March 2019	Third party Validation visit
July 2019	Official launch of Vanga Blue Forest project at Village level
November 2019	Recruitment of the Project coordinator
January 2020	Start of issuance period
March 2020	Community benefit consultation process
December 2020	Submission of first annual report to Plan Vivo
January 2021	Issuance and sale of 1st year carbon credits
September 2025	Project 5 year's validation
October-December 2025	Key project supporters, led by ACES and KMFRI, to review PDD on the basis of 5-year validation and own reflection on lessons learnt, to consider if it needs up-dating. Some changes will certainly be made, for example clarification of reforestation progress and indicators
December 2039	End of 20 year crediting period

I.5 Project financial management

The proposed VBF project will be managed and coordinated by ACES who will support in managing PV payments upon achievement of project targets. Income generated from sale of PVC will be utilised following close consultation with community to ensure fair and equitable benefit sharing and transparency. Funds channelled to support community development and payments to individual beneficiaries will be based on priorities determined by the local people

The prioritisation of the income will be as follows:

- 1st consultative community meeting in individual villages to suggest possible projects
- Committee to be to look into feasibility of the suggested projects
- 2nd consultative meeting where the community votes on the best projects to be implemented
- Funds to be allocated to individual projects as prioritised by the community

Vanga Blue Forest project anticipates allocating ~ 26 % of the income from sale of carbon credits directly to community projects (Figure 12). Some 36 % of the income will be spent on employing local work teams involved in nursery establishment, out-planting and surveillance (community scouts). Only ~6 % will be retained by ACES in order to support independent verifications every 5 years, as well as the fees from Markit and Plan Vivo. This financial structure aligns with the Plan Vivo requirements that require projects to allocate at least 60 % of sale proceeds directly to the community; note that ACES and VBF committee will be acting in voluntary (unpaid) capacities.

Start–up funding, essential costs and implications of poor sales

VBF has secured sufficient start-up funding to allow recruitment of key paid staff (especially project co-ordinator and forest scouts) for the first year of operation, along with funds to pay for an accreditation visit and Markit fees. Our economic projections are conservative, assuming a floor price for credits some US$ 4 below our best price achieved for the sister project Mikoko Pamoja, and assuming that we will sell only 50 % of credits in our first year (moving to 75 and then 100 % in the subsequent years). At 50 % sales, we can keep the project running and bring some small benefits to local people. We have been clear in all communication with the community that income is not guaranteed.

<table>
<tr><th colspan="2">TOTAL INCOME FROM CARBON CREDITS</th></tr>
<tr><td>AT LEAST 60% SENT TO VAJIKI CBO</td><td>UP TO 40% RETAINED BY ACES FOR COSTS</td></tr>
<tr><td>Including:
- 984,000 ksh for salaries (Coordinator, Assistant Coordinator and 2 x Forest Scouts);
- Approx. 400,000 ksh on conservation activities;
- Project administration costs (office costs, uniforms, travel, materials etc.) - variable depending on need;
- Community benefit projects—variable depending on projects</td><td>Including:
- Funds paid directly to Plan Vivo for annual administration (£1,700 / 270,000ksh);
- Funds set aside for 5-yearly verification visits (£2,300 / 350,000ksh);
- Costs of marketing and administration of credits (variable). This includes maintenance of website, negotiations with buyers, administration of carbon credits, annual reporting, representation on Plan Vivo boards (These activities take ~ 100 days per year to perform: currently done mostly by volunteers or through grant funding)
- ACES governance and charity reporting costs</td></tr>
<tr><td colspan="2">Note that many of the above figures can vary by year depending on actual costs and the price secured for carbon credits. If we are able to earn more money from sales, then we can allocate a larger proportion to community benefit.</td></tr>
</table>

Figure 8: Illustrative distribution of funds; exact percentages will depend on the balance of income to fixed expenses, such as fees

I.6 Marketing

ACES will support the project in promotional activities and advertise it to potential buyers. It will manage carbon sales and negotiations and promotion with buyers, both nationally and internationally. It will also help facilitate community engagement and decision making and ensure appropriate transfer of information to partners. ACES will manage the Markit account for carbon credits generated and use the ACES website, which already hosts and promotes Mikoko Pamoja. It will also encourage buyers to commit to 'carbon plus' contributions for seagrass conservation. Although ACES is a small charity without paid staff it has expertise developed over the past five years and is planning to meet the enhanced demands of this new project by looking at recruiting paid staff. It has an excellent track record in finding carbon buyers for Mikoko Pamoja.

I.7 Technical Support

KMFRI will provide continuous technical support to VBF organisation and work teams. Visiting scientists from all over the world frequent KMFRI, which will provide additional technical support. KMFRI also has links with local and international universities, providing training and research opportunities that could also serve as a valuable source of technical support.

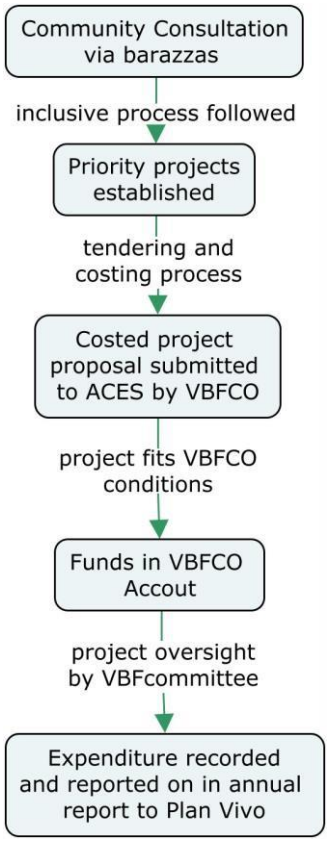
Technical support from KMFRI includes equipping the community and VBF organisation with mangrove management techniques (nursery establishment, planting and monitoring). KFS will also provide technical support towards implementing the PFMP with VAJIKI CFA.

Part J: Benefit sharing

J.1 PES agreements

Vanga Blue Forest project will use the existing CFA to facilitate integrated management of the mangrove forests. It will allow development of social structures that extend beyond single villages and facilitate benefit sharing among all participating communities. The seagrass conservation activity, anchored under VBF, will be overseen by a BMU subcommittee that will be elected to oversee the CMA; this will be guided by the BMU by laws on how to share benefits accrued from seagrass conservation activities.

J.2 Payments & benefit sharing



Funds/payments acquired through the sale of Plan Vivo certificates will be used on projects that have been prioritised by the community. To ensure equitability and transparency in distribution of funds, annual budget and work plans will be developed and reviewed by VBF to determine the expenditures of the funds generated. The benefit-sharing process together with any concerns or objections raised will be recorded for further reference.

VBF community organisation will operate their own bank account with three signatories. The process of applying for, receiving, disbursing and reporting on payments is outlined in Figure 12.

Payments will be dependent on the successful implementation of the annual work plan and the delivery of outputs agreed by the parties. Some or all payments shall be withheld if performance targets are not met.

Figure 9: Process of funds generation, disbursement and reporting

Part K: Monitoring

K.1 Ecosystem services benefits

The project has identified key indicators to monitor ecosystem benefits arising from project activities and interventions as summarised in Table 19. Monitoring parameters include; changes in forest cover, growth performance and natural regeneration. The growth performance for the alternative woodlots will also be assessed. An annual reporting system will be used to document the results of the monitoring in which KMFRI shall train community

members to take up a lead role in the monitoring process.

Table 19: Table identifying key indicators and monitoring of ecosystem services benefits and the threshold achievement for PES payment to the community. These thresholds will be used as a trigger for issuance of credits; if met, the carbon benefits issued are given in Table 10.

Project Intervention (activity) [weighting]	**Indicator**	**Green threshold** **PES: Full payment**	**Amber threshold** **PES: 20 % forfeit**	**Red threshold** **40% forfeit**	**Frequency**	**Who will monitor?**
Avoided deforestation/ degradation (Protection of 450ha) [90 % credit weighting, allocated proportionally to each of area 1 and area 2] 5 year thresholds: RED = project abandoned AMBER = new PDD required GREEN = project continued	Growth and Regeneration	Permanent plot AGB and regeneration measurements (regeneration classes (RCI, RCII, RCIII) show recovery and/or increasing biomass	Permanent plot AGB and regeneration measurements (regeneration classes (RCI, RCII, RCIII) show no change in recovery and/or biomass	Permanent plot AGB shows significant[a] drop in biomass	2 times per year	Community
		AND	AND	OR		
	Forest cover	Decrease in forest cover maintained within buffer (i.e. ≤20 % of initial rate of change).	Decrease in forest cover is 20 % - 50 % of initial rate of change.	Decrease in forest cover is >50 % of initial rate of change.	Remote sensing analysis every 5yrs. Field ass. 3 times yr^{-1}	KMFRI & community
		AND	AND	OR		
	Tree stumps	Forest surveys in 15 permanent plots. No significant increase in mean cut stumps. No evidence of clear felling.	Forest surveys in 15 permanent plots. Significant increase in cut stumps. No evidence of clear felling	Forest surveys in 15 permanent plots. Significant increase in cut stumps and evidence of clear felling	2 times per year	KMFRI & community

Reforestation (Reforestation of 5 ha) [5 % weighting] Threshold implications: Annual thresholds ≥ 1 RED = no credits 2 AMBER = 50 % credits 1 AMBER = 25 % credits	Planting & facilitated restoration	Clear and objective evidence of appropriate progress towards 20-year goal	Progress made but less than sufficient to achieve goal if repeated every year	No progress towards 20-year goal	Annually	Community
Alternative woodlot (Leakage control) [5 %] Threshold implications: RED = no credits AMBER = 50 % credits	Planting	Surveys of growth (DBH, height, % cover). Minimum of 2,000 trees planted	1,000- 2,000 trees planted	No tree planted	Every 3 years	Community

[a] 'Significance' in this table refers to statistical significance at α = 0.05

Notes on methods chosen for monitoring

Permanent Monitoring Plots

We will use 15 PMP to record forest change in the two protected areas. Using permanent plots like this is necessary to deal with the very large spatial variability typically experienced in mangrove forests; using a random design is likely to require at least three times the sample size to achieve the same statistical power, making it infeasible.

Using data from the Mikoko Pamoja plots at Gazi allows the following power calculation for detecting changes in numbers of stumps per plot using a paired design (Table 20):

Table 20: Stump count

Mean stumps per plot	15
SD of difference	14
Mean percentage change in stumps	100
Statistical power	0.9
Alpha	0.05
Sample size required	12

Hence, based on our field data, we will achieve a very high statistical power of 0.9 to detect a doubling in stump count if we have 12 plots; using 15 therefore exceeds this.

A similar, paired approach will be taken to detect changes in regeneration status (along with a qualitative comparison of frequency distributions of regeneration classes). We will use appropriate allometric equations, derived from work in Kenya with these species, to estimate biomass accretion based on measurements on all trees in the PMPs.

Activity outside of permanent plots

The PMPs will be used to accurately record stump counts, regeneration and forest biomass increments. In addition, we will monitor for activity outside of these plots using two approaches:

a) regular perimeter patrolling and observations of access points. The forest scouts will conduct this qualitative monitoring on a weekly basis and record any signs of change or incursions.

b) remote sensing for canopy change. We will use remote sensing to look for changes in total canopy cover; this will be done every five years, rather than annually, since it requires the technical support of KMFRI staff.

K.2 Socio-economic impacts

Monitoring of the socio-economic impacts of the VAJIKI Blue Carbon project will be reported annually and compared with the baseline (Table 21). During monitoring, input from the project will be assessed against output, outcome and impacts achieved in the preceding year. Results will be provided to all key stakeholders and interested parties using diverse media including reports, briefing papers and presentations. The results will be used to discuss the work plan for the coming year and the priority community projects to be supported by proceeds from sale of carbon credits, earned in line with the successful implementation of the previous year's work plan. The monitoring and evaluation will be based on the appropriate indicators identified below, but also depending on the democratic decisions during community consultations:

Table 21: Methods of measurement of expected socio-economic impacts of the project

Area of impact	**Baseline**	**Target**	**Method of measurement**	**Frequency**	**Suggested Tools**
Impacts of funded projects (water, education, health etc.)	zero	Number of schools, water points, health facilities, students supported etc.	Assessment of impacts of funded projects. Verification visits Survey data	Annually	Community group discussions Participatory wellbeing assessment Semi-structured interviews with target groups
Viability of mangrove-related local businesses	Number of existing mangrove related businesses e.g. beekeeping (to be verified later)	Increase in the number and viability of mangrove related businesses	Assessment of the viability of the businesses	Annually	Community group discussions Participatory wellbeing assessment Semi-structured interviews
Number of people employed in the project and associated projects	zero	The number of people employed	Assessment of number of persons employed by the project cash spent on employment	Annually	Community group discussions Semi-structured interviews with target groups

K3 Environmental and biodiversity impacts

As well as monitoring and assessing the changes in ecosystem services, other biodiversity impacts will also be monitored, as summarised in Table 22. New recruitments of mangroves and abundance and diversity of fauna such as fish, molluscs and gastropods will be monitored annually. Soil accretion and erosion rates will also be determined in both the avoided deforestation and reforestation activity areas. This is crucial to determine the recovery of mangrove ecosystem functioning and to assess whether project objectives are met. KMFRI will use its research capacity to train community members on participatory monitoring and reporting of environmental and biodiversity impacts. The results of the monitoring will be reported annually following Plan Vivo Guidelines.

Table 22: Methods of monitoring environmental impacts of proposed activities

Impacts	Baseline and indicators	Methods	Who will monitor?
Biodiversity impacts	Flora: number of new mangrove recruits/natural regeneration in the area.	Annual regeneration sampling of flora and faunal species in permanent monitoring plots in project area.	KMFRI, KFS, VAJIKI Community
	Fauna: recorded abundance and species diversity of molluscs and, if possible, crabs.		
Soil conservation impacts	Soil accretion and erosion rates	Annual monitoring of Soil accretion and erosion rates using Surface Elevation Tables (SETs) or cheaper alternatives.	KMFRI

K4 Seagrass

The voluntary seagrass management area (CMA) will be monitored according to the Seagrass Watch protocol, a global scientific, non-destructive, participatory seagrass assessment and monitoring program. Monitoring surveys will take place annually.

Monitoring data will be assessed by the project team to inform the inclusion of seagrass protection and monitoring in the technical specifications. ACES as project coordinators are actively engaged in exploring the potential to include seagrass in PES projects from a policy, financial and technical perspective and this initial inclusion will allow the project to explore the logistical and financial feasibility of including seagrass in a PES project with full accreditation for carbon or other benefits. If this initial implementation of seagrass protection is feasible and successful, future iterations of the technical specifications may incorporate seagrass in a more comprehensive way.

Table 23. Monitoring of impacts of seagrass management area

Impacts	Baseline	Measurements	Objectives
Seagrass coverage	The proposed conservation area will initially comprise 300 ha of intertidal seagrass beds in the north east of the bay	Following the Seagrass Watch protocol: annual percent cover estimations using quadrats. This will be supplemented by 5 yearly mapping of total coverage using freely available sentinel imagery.	No loss of seagrass cover
Biodiversity in seagrass meadow	Major groups of macrofauna as recorded in Githaiga, Frouws, Kairo, & Huxham, (2019)[1]	Survey of macrofauna (shellfish, sea cucumbers, fish etc.) – basic survey annually supplemented by detailed survey every 5 years	No significant decline in diversity or biomass
Stakeholder engagement and adherence	Initial engagement with all fishing stakeholders	Presence/absence of prohibited fishing activities within the protected area; verbal/written feedback to project team	No incursions or use of restricted fishing gears in area
Stakeholder benefits	None	Funds donated specifically to seagrass conservation activities (raised alongside sales of PVCs) and for benefits of beach management unit and other direct stakeholders	Support from key stakeholders translated into clear benefits and growing awareness

K5 Sharing monitoring results with the community and using them for adaptive management

[1] Githaiga, M.N., Frouws, A.M., Kairo, J.G., Huxham, M., 2019. Seagrass removal leads to rapid changes in Fauna and loss of carbon. Front. Ecol. Evol. 7, 1–12. https://doi.org/10.3389/fevo.2019.00062

Copies of all monitoring data will be kept centrally by the project co-ordinator in Vanga and will be open for anybody to inspect. Summaries of key monitoring results (particularly stump counts, coverage and biomass accumulation) will be displayed in permanent project display boards, and annual reports will be co-authored by and fully discussed with the VBF committee. Because targets for area 4 are left deliberately open, to allow for natural regeneration rather than artificial planting, monitoring here will be used to adapt this approach if restoration is not proceeding as planned (for example using nursery grown seedlings).

Part L: Annexes

Annex I. List of key people involved with contact information

- Professor Mark Huxham, ACES Director, m.huxham@napier.ac.uk
- Dr James Kairo, Head of Mangrove Ecosystems at KMFRI, gkairo@yahoo.com
- Simon Wahome, Head of Conservancy, Coast. Kenya Forest Service, hoccoast@kenyaforestservice.org
- Harith Mohammed, Chairman VAJIKI CFA, harithmohamed74@gmail.com

---

Annex II. Information about funding sources

Funding in kind comes from past and ongoing support from ACES, Edinburgh Napier University, KMFRI and KFS.

Grant funding to help with the production of this document, and in some cases with meeting costs for the first year of operations, comes from the Leonardo DiCaprio Foundation, Ecosystem Services for Poverty Alleviation, UNEP and GEF.

Annex III. Producer/Group Agreement Template

VANGA, JIMBO AND KIWEGU (VAJIKI) MANGROVE FOREST PARTICIPATORY MANAGEMENT PLAN

2018-2022




VAJIKI

K.M.F.R.I

KENYA
Forest Service

AnnexIV. Database template

MANGROVE INVENTORY: VEGETATION DATA

OBSERVERS…….

AREA…… SITE…… DATE…….

FOREST TYPE……. PLOT NO……..……. PLOT.SIZE……

INUNDATION CLASS…… COVER (%)……..... NO. OF CUT STUMPS…

GPS NO……... WAYPOINT…… PHOTO NO……....

EASTINGS:……. SOUTHINGS……

					Regeneration (Plot size.....)			
No	**Species**	**DBH (CM)**	**HT (M)**	**Quality classes (1, 2, 3)**	**Species**	**RC1**	**RCII**	**RCIII**

General observations.....

.....

.....

……...

Annex V. Example forest management plans/*Plan Vivos*

- Include real examples of *plan vivos* (PV requirement4.10)

We have a single agreement with the whole community hence no plan vivos with individual stakeholders – effectively the whole of this PDD with interventions described functions as this

AnnexVI. Permits and legal documentation

KENYA FOREST SERVICE

Telegrams:
Telephone: KWALE 020-2435999

When replying please quote
E-Mail zmkwale@kenyaforestservice.org

KENYA
Forest Service

ECOSYSTEM CONSERVATOR
KWALE
P.O. BOX 5,
KWALE

REF: KFS/KWL/F4/ (189)

Date: 7th September 2018

TO WHOM IT MAY CONCERN

Dear Sir,

RE: SUPPORT FOR VANGA BLUE FOREST PROJECT

This letter is to confirm that Kenya Forest Service (KFS) support the "**VANGA BLUE FOREST Project**" that is being executed by Vanga, Jimbo and Kiwegu communities in partnership with governmental and non-governmental organizations. The objective of the project is to establish a small scale carbon offset project in Vanga mangrove forest.

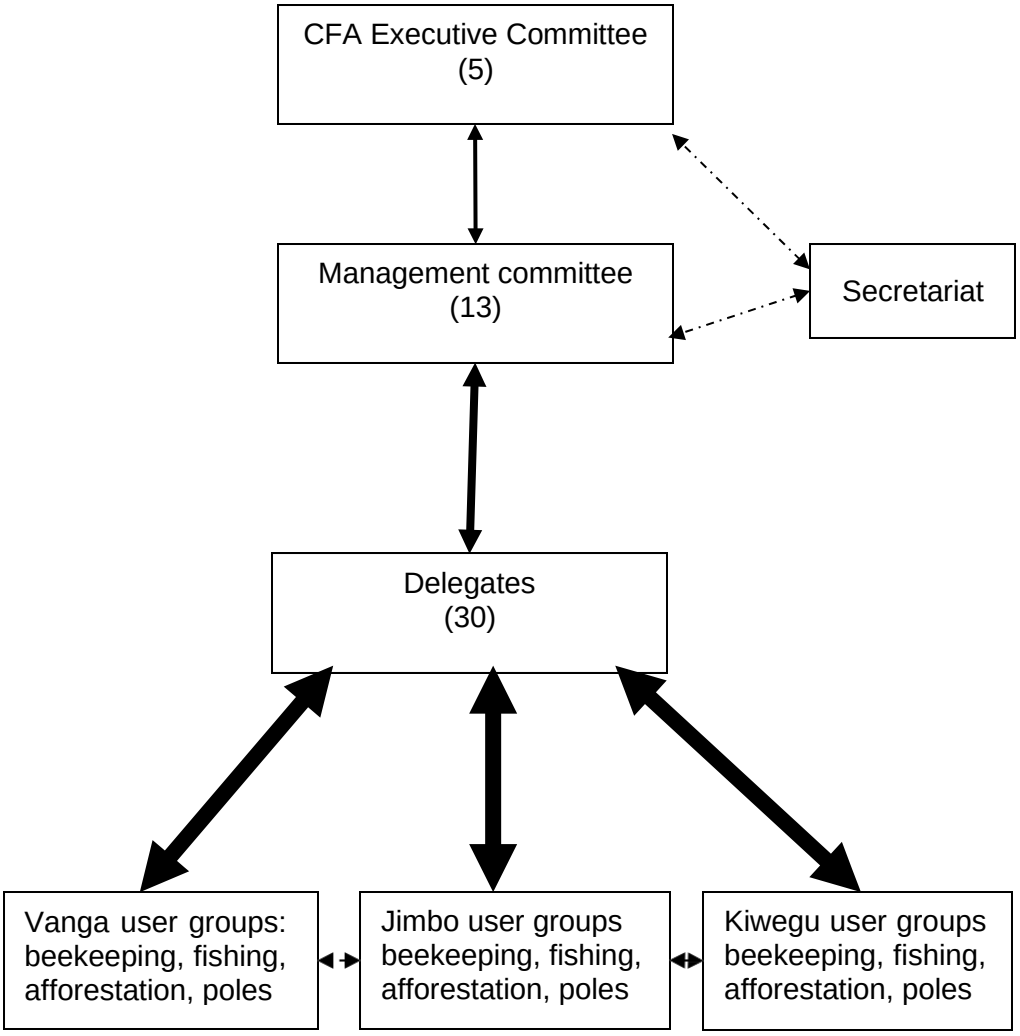
The project will be established in accordance with the Forest Management Agreement (FMA) between KFS and VAJIKI CFA where the parties agree to co-managing the forest and harnessing of non-consumptive benefits for conservation of the forest. The project is in line with KFS objectives of facilitating community based mangrove conservation.

With the approval of the project, KFS will sustain partnership in project execution and highlighting the project significance in conserving, protecting and managing mangrove forest.

GEORGE O. WARA
ECOSYSTEM CONSERVATOR
KWALE COUNTY

Annex VII. Evidence of community participation

Annex VIII. CFA organisation structure



Annex IX. Emissions of soil carbon following forest removal

Calculation of C loss after clearance, assumes exponential equation of the form:

C_{loss} = Total Loss * (1-exp^{-kt})

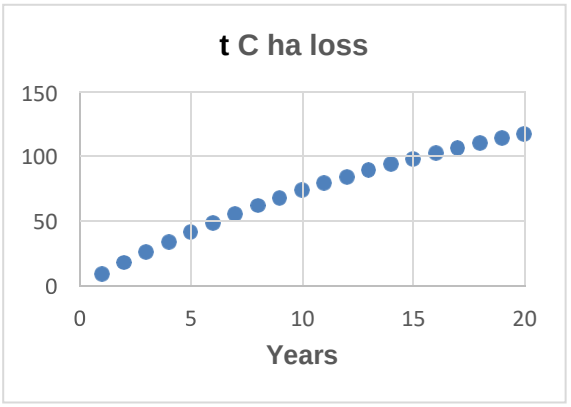
Where:

Total Loss = final amount lost
k = initial rate of loss (from Lang'at et al. 2014)[28]
t = time in years

NB Assumes 50 % of C in top M is eventually lost i.e. eventual asymptote is 180

Table 23: Carbon loss after clearance

Years	t C ha loss	Amount lost that year from a single ha
1	9.5	9.5
2	18.10356335	8.6
3	26.46065539	8.4
4	34.38635444	7.9
5	41.902929	7.5
6	49.03149809	7.1
7	55.79209052	6.8
8	62.20370126	6.4
9	68.28434473	6.1
10	74.05110546	5.8
11	79.52018607	5.5
12	84.70695281	5.2
13	89.62597872	4.9
14	94.29108457	4.7
15	98.71537771	4.4
16	102.9112889	4.2
17	106.8906072	4.0
18	110.6645131	3.8
19	114.2436101	3.6
20	117.6379541	3.4



Applying this per ha model to all the avoided deforestation areas in VBF, and summing the accumulated avoided emissions from belowground carbon over twenty years, gives the data presented in the Table 24 below:

Table 24: Avoided belowground emissions over 20 years

year	ha saved	yr 1	yr2	yr3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	TOTAL SAVED OVER 20 YEARS
0	0.000	9.500	8.604	8.357	7.926	7.517	7.129	6.761	6.412	6.081	5.767	5.469	5.187	4.919	4.67	4.42	4.2	3.98	3.77	3.58	3.39	
1	1.160	11.020	9.980	9.694	9.194	8.719	8.269	7.842	7.437	7.054	6.689	6.344	6.017	5.706	5.41	5.13	4.87	4.62	4.38	4.15		132.523
2	1.154	10.961	9.927	9.642	9.145	8.673	8.225	7.800	7.398	7.016	6.654	6.310	5.985	5.676	5.38	5.1	4.84	4.59	4.35			127.686
3	1.148	10.903	9.874	9.591	9.096	8.626	8.181	7.759	7.358	6.978	6.618	6.277	5.953	5.645	5.35	5.08	4.82	4.57				122.673
4	1.142	10.844	9.821	9.540	9.047	8.580	8.137	7.717	7.319	6.941	6.583	6.243	5.921	5.615	5.33	5.05	4.79					117.475
5	1.135	10.786	9.769	9.489	8.999	8.534	8.094	7.676	7.280	6.904	6.548	6.210	5.889	5.585	5.3	5.02						112.083
6	1.129	10.729	9.716	9.438	8.951	8.489	8.051	7.635	7.241	6.867	6.513	6.177	5.858	5.555	5.27							106.488
7	1.123	10.671	9.664	9.388	8.903	8.443	8.008	7.594	7.202	6.830	6.478	6.143	5.826	5.526								100.678
8	1.117	10.614	9.613	9.337	8.855	8.398	7.965	7.554	7.164	6.794	6.443	6.111	5.795									94.644
9	1.111	10.558	9.561	9.287	8.808	8.353	7.922	7.513	7.125	6.758	6.409	6.078										88.373
10	1.105	10.501	9.510	9.238	8.761	8.309	7.880	7.473	7.087	6.721	6.374											81.855
11	1.099	10.445	9.459	9.188	8.714	8.264	7.838	7.433	7.049	6.685												75.076
12	1.094	10.389	9.409	9.139	8.667	8.220	7.796	7.393	7.012													68.025
13	1.088	10.333	9.358	9.090	8.621	8.176	7.754	7.354														60.686
14	1.082	10.278	9.308	9.041	8.575	8.132	7.712															53.047
15	1.076	10.223	9.258	8.993	8.529	8.089																45.092
16	1.070	10.168	9.209	8.945	8.483																	36.805
17	1.065	10.114	9.159	8.897																		28.170
18	1.059	10.059	9.110																			19.169
19	1.053	10.005																				10.005
20	1.048	9.952																				9.952
																				TOTAL		1490.502
																				AV		**74.525**
																				Av CO2		273.284

The top grey line shows the C emissions from a single ha, cleared and then left for 20 years, based on the model above. These values are used to produce the appropriate emissions for each ha saved over the 20 years of the project. So the 1.16 ha saved in the first year will contribute 133 t C cumulatively, with 1.05 saved in the last year, only contributing 9.95.

Annex X Carbon calculations for Jimbo restoration site

Year	Ha restored	CO_2 captured	**Annual sequestration in Jimbo restored site** *Take the average tonnes yr^{-1} over 20 years, assuming 4 t CO_2 yr^{-1} ha^{-1}*
1	0.25	1	
2	0.5	2	
3	0.75	3	
4	1	4	
5	1.25	5	
6	1.5	6	
7	1.75	7	
8	2	8	
9	2.25	9	
10	2.5	10	
11	2.75	11	
12	3	12	
13	3.25	13	
14	3.5	14	
15	3.75	15	
16	4	16	
17	4.25	17	
18	4.5	18	
19	4.75	19	
20	5	20	
		10.5	