Blue Carbon and Fishery Potential in Kwale and Lamu Counties, Kenya

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This study summarizes the following technical reports that were produced through the assignment:

- Kairo, J. G., Mbatha, A.M, Njoroge G.W., Kiiru, B.G, Mburu, F.M, Kinya, G., and Kipkorir, J.S (2024). Blue Carbon Stocks in Kwale and Lamu Counties, Kenya. GIZ.
- Kilonzi, F. M; Hamza, A. J; Elm, A.-S.; Mary, K and Kairo, J. G. (2024). Economic and financial analysis of blue carbon projects in Kwale County, Kenya. GIZ.
- Wambua C, Kairo, J. G., Maingi L., and Kosgei G. (2024). Generating blue carbon credits in Kenya: Review of the enabling legal and policy environment. GIZ.
- Munga, C.N., Kamau, A.W. Osumba, M., Omingo, L. and Kairo, J. G. (2024). Estimation of income and costs of mangrove and seagrass fishery in Kwale County, Kenya. GIZ.

Annex ii provides a link to these underlying technical reports.

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Executive summary

The current study focuses on demonstrating to the financial sector the opportunities for investment in blue carbon and sustainable fisheries in Kenya. 'Blue carbon' is the term used to denote carbon captured by coastal wetlands, particularly mangroves, seagrasses, and salt marshes. Although these ecosystems occupy less than 1.0% of the ocean's surface, they contribute 50-70% of the oceanic carbonic sink. When degraded, these ecosystems not only halt taking up more carbon but also release the already stored carbon back to the atmosphere leading to global warming. Together with carbon storage, blue carbon ecosystems serve as habitats for fish and other wildlife, protect shorelines from erosion and support the livelihoods of millions of people along the coast. Unfortunately, around the world blue carbon ecosystems are being lost and degraded at alarming rates as a result of human and natural factors. Restoration and protection of blue carbon ecosystems is, therefore, recognized as priority actions for climate, community, and biodiversity benefits.

Mangroves and seagrasses are the major blue carbon ecosystems in Kenya, providing multiple benefits to nature and the society. These ecosystems are in different states of degradation along the coast due to overexploitation of resources, habitat conversion, pollution, and climate change. The current study focuses on blue carbon ecosystems in Lamu and Kwale Counties; that collectively constitute more than 70% of the country's mangroves and seagrass habitats.

Carbon densities of mangroves in Lamu and Kwale were estimated at 560.23 Mg C ha-1 and 526.34 Mg C ha-1, giving total ecosystem carbon of 20.0 and 3.8 million Mg C, respectively. In seagrasses, carbon densities were estimated at 171.65 Mg C ha-1 and 220.94 Mg C ha-1, amounting to total ecosystem carbon of 3.6 million Mg C and 2.2 million Mg C in Kwale and Lamu, respectively. Rates of decline of these blue carbon ecosystems vary across the country. Under the business as usual (BAU) scenario, mangroves in Lamu and Kwale counties will continue to decline by 0.16% yr-1 and 0.49% yr-1, leading to decrease in total ecosystem carbon to 19.02 Mg C (69.94 million tCO_2e) and 3.1 Mg C (11.40 million tCO_2e), respectively, over the next 30 years and relative to the 2020 baselines. At the same time, seagrasses in Lamu will decrease at 0.67% yr-1, emitting 5.21 million tCO_2e by 2050. With concerted efforts, emission reductions of 8.76 million tCO_2e and 5.12 million tCO_2e in mangroves and seagrasses, respectively, are expected over the 2020 - 2050 period in the two counties. Assuming a market price of US$20 per tCO_2e of high-quality blue carbon credits, the combined annual revenue from mangrove and seagrass carbon from Lamu and Kwale counties is projected at $3,589,750 yr-1 and $216,040 yr-1 respectively over the next 20 years.

To investigate the carbon credit potential in more detail, this study investigated the financial viability, including a cash-flow analysis, of a hypothetical avoided restoration (i.e. conservation) project. The results showed that there is a positive net present value (NPV) and an Internal Rate of Return (IRR) of 22%, demonstrating the high financial viability of mangrove conservation projects in Kwale or Lamu County. Also, a cash-flow analysis of a hypothetical carbon credit project in Kwale or Lamu County involving conservation of 90 ha and restoration of 10 ha of mangrove forests was conducted with results showing a highly positive NPV of around US$100,000 with an IRR of 20%, again demonstrating high financial viability.

Blue carbon ecosystems also serve as habitat for fish and other wildlife; with more than 80% of coastal fisheries depending in one way or another on these ecosystems. For example, considering demersal, prawn, crab and sea cucumber, the average annual fish landings in the past 17 years (2006 – 2022) period for Kwale was 2,354 Mt; with an average ex-vessel market value of KES 386,380,846 (US$ 2,972,160). This ex-vessel market value for each fish taxa is expected to increase with time due to better policy and institutional frameworks, improved fish handling and market infrastructure as well as increased demand for fish and fish products. Revenue and cost analysis of small-scale fisheries indicate relatively high annual profits realized in Kwale County. Profits from fisheries are likely to increase over time due to on-going local and national initiatives related to environmental, capacity building and institutional and legislative frameworks.

To demonstrate the various benefits of mangroves in economic terms, a cost-benefit analysis of mangrove conservation and restoration was conducted. The analysis underlines that the long-term benefits far exceed the costs, justifying the investment opportunity in these critical ecosystems. More specifically, the revealed benefit-cost ratio of 3.17 implies that for every dollar invested in mangrove conservation and restoration (incl. the sale of carbon credits), at least US$ 3.17 of socio-economic benefits are generated. Non-carbon benefits of the mangrove ecosystem considered in the analysis were ecotourism, fishery support, education and research, and shoreline protection.

Moreover, the study investigated the regulatory environment for blue carbon projects in Kenya. Kenya is well placed to benefit from investments in blue carbon projects for climate, community and biodiversity benefits. Whilst the national government has commendably developed legal and policy frameworks for carbon markets, these need to be operationalized now to unlock all these benefits. This endeavour will strengthen Kenya's position to trade in the blue carbon credits and at the same time ensure sustainable development.

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Abbreviations and acronyms

BAU	Business - as - Usual
BC	Blue Carbon
BCEs	Blue Carbon Ecosystems
BMU	Beach Management Unit
CAGR	Compound Annual Growth Rate
CO_2e	Carbon dioxide equivalent
COP	Conference of Parties
DNA	Designated National Authority
EEZ	Exclusive Economic Zone
FAO	Food and Agriculture Organization of the United Nations
FGD	Focus Group Discussion
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GWP	Global Warming Potential
Ha	Hectare
IPCC	Intergovernmental Panel on Climate Change
ITMOs	Internationally Transferred Mitigation Outcomes
KEFRI	Kenya Forestry Research Institute
KES	Kenya Shillings
KIIs	Key Informant Interviews
Km^2	Square kilometers
KFS	Kenya Forest Service
KMFRI	Kenya Marine and Fisheries Research Institute
KWFT	Kenya Women Finance Trust
MP	Mikoko Pamoja
MPA	Marine Protected Area
MRV	Measuring, Reporting and Verification
Mt	Metric ton
NbS	Nature-based Solutions
NBSAP	National Biodiversity Strategy and Action Plan
NDCs	Nationally Determined Contributions
NGO	Non-governmental Organization
NPV	Net Present Value
PES	Payment for Ecosystem Services
REDD+	Reducing Emissions from Deforestation and Forest Degradation
SOC	Soil Organic Carbon
tCO_2e	tons of carbon dioxide equivalent
TEC	Total Ecosystem Carbon
TUM	Technical University of Mombasa
UNFCCC	United Nations Framework Convention on Climate Change
VBF	Vanga Blue Forest
VCM	Voluntary Carbon Market
VSLA	Village Savings and Loan Association
WIO	Western Indian Ocean
Yr	Year

Conversion table

Value (grams)	Unit	Name
10^3	Kg	Kilogram
10^6	Mg	Megagram (tonne)
10^9	Gg	Gigagram
10^{12}	Tg	Teragram
10^{15}	Pg	Petagram

1 million ton = 1 Gigagram

1 Gigaton = 1000 Tera-grams

1 hectare (ha) = 10,000 m^2

1 Carbon credit = 1 CO_2e

1 tonne (t) = 1 metric ton = 1 Megagram (Mg) = 1,000 kg

The abbreviation Mt refers to Megaton (1 million tons)

Glossary

Adaptation	An adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects that moderate, harm, or exploit beneficial opportunities.
Beach Management Unit	Legally recognized community organization that brings together all community members who traditionally depend on fisheries activities for their livelihoods.
Carbon credit	A carbon credit is a generic term for any tradable certificate or permit representing the right to emit one tonne of carbon dioxide or the mass of another greenhouse gas with a carbon dioxide (tCO_2e) equivalent to one tonne of carbon dioxide.
Carbon dioxide equivalent	A metric measure used to compare the emissions from various greenhouse gases based on their Global Warming Potential (GWP). It converts amounts of other gases to the equivalent amount of carbon dioxide with the same GWP.
Carbon stock	Quantity of organic carbon in a given pool(s) per unit area.
Mitigation	Mitigation in the context of climate change refers to actions or activities that limit emissions of Greenhouse Gases (GHGs) from entering the atmosphere and/or reduce their levels in the atmosphere (IPCC).
Nationally Determined Contributions (NDCs)	A national plan to reduce emissions and adapt to climate change. Parties under the Paris Agreement submit an NDC every five years.
Nature-based Solutions (NbS)	Actions to protect, conserve, restore, sustainably use and manage natural or modified terrestrial, freshwater, coastal and marine ecosystems which address social, economic and environmental challenges effectively and adaptively, while simultaneously providing human well-being, ecosystem services, resilience and biodiversity benefits.
Soil Organic Carbon	Refers to the carbon component of soil organic matter. The amount of soil organic carbon depends on soil texture, climate, vegetation, and historical and current land use/management.
tCO_2e	Tonne of CO_2 equivalent. Standardised unit for greenhouse gases that expresses all emissions in terms of the amount of CO_2 with equivalent global warming potential.
Voluntary Carbon Market	Systems and associated standards that enable the generation, buying, and selling of carbon credits on a voluntary basis. These markets function outside the compliance markets and enable companies and individuals to purchase carbon offsets voluntarily.

1 Background information

The triple planetary crisis facing humanity is that of climate change, biodiversity loss, and pollution (UNEP, 2021). It impacts ecosystems, human health, and the global economy while worsening inequalities. Restoration and sustainable management of the planet's natural capital such as blue carbon ecosystems (BCEs) can be an effective means to address environmental and societal challenges facing humanity (Erftermeijer et al., 2022).

'Blue carbon' is the term used to denote carbon captured and stored by coastal wetlands, particularly mangroves, seagrasses, and salt marshes (Nellenman et al., 2009; Duarte et al., 2013). Although they occupy less than 1.0% of the ocean's surface, blue carbon ecosystems account for 50-70% of oceanic carbon sinks (Mcleod et al., 2011) and their conservation and sustainable management could deliver up to 21% of global emission reductions required by 2050 in order to keep the temperature rise below the 1.5 °C (Hoegh-Guldberg et al., 2019).

However, blue carbon ecosystems are being lost and degraded globally at an alarming rate of 1-7% per year (Pendleton et al., 2012). When these ecosystems are degraded, they not only halt to take in more carbon, but also release the already stored carbon back into the atmosphere, exacerbating global warming (Nellenman et al., 2009; Siikamäki et al., 2012). The "carbon sink" service is one of the numerous important benefits these ecosystems provide to human well-being, along with food security, water quality improvement, raw materials, and shoreline protection among others (Nagelkerken et al., 2008; Lee et al., 2014).

Mangroves and seagrasses are the major blue carbon ecosystems in Kenya. Despite the numerous benefits these ecosystems offer to society, they continue to be lost and degraded due to a combination of both natural and human activities. Past studies, particularly by the Kenya Marine and Fisheries Research Institute (KMFRI), have demonstrated that Kenya is losing 0.7% of its mangrove forests annually. Available data suggest that currently, 16% of the Kenyan coastline is at higher levels of exposure to coastal hazards but this could increase to 41% if coastal ecosystems (mangroves, corals, and seagrasses) are lost leading to increased loss of fisheries resources (Hamza et al., 2022).

Backed by UK partners and local communities the Kenya Marine and Fisheries Research Institute developed Mikoko Pamoja (Box 1). Located at Gazi bay of Kwale county, Mikoko Pamoja is a carbon offset project using mangroves as the domain (Kairo et al., 2009). Mikoko Pamoja is verified by Plan Vivo systems and standards to trade ca. 3000 tCO_2e annually into voluntary carbon markets for a crediting period of 20 years, since 2014. Success of Mikoko Pamoja enabled replication of project activities in Vanga Blue Forest (VBF) in 2019. Both Mikoko Pamoja and VBF projects demonstrate scalable best practices in mangrove conservation for nature and community benefits.

Box 1. Demonstrable Blue Carbon Projects in Kenya

MIKOKO PAMOJA is the first community-type project in the world to restore and protect mangrove forests through sales of carbon credits. The project aims to protect 117 ha of mangroves with an additional annual planting of 4000 trees in degraded areas of Gazi bay. The resulting avoided deforestation along with the newly planted trees generate eligible carbon credits tradable in the voluntary carbon market. Mikoko Pamoja is certified by Plan Vivo systems and standards to trade ca. 3000 tCO_2e annually over a crediting period of 20 years since 2014. The generated annual revenue of about US$ 25,000 from the sale carbon credits are used to support community development projects in water and sanitation, education, health, and environmental management.

VANGA BLUE FOREST (VBF) also in Kwale County is a replica of Mikoko Pamoja. The project protects 460 ha of mangroves in Vanga Bay with an additional annual planting of 4000 trees. VBF was launched in 2019 and generates about 5500 tCO_2e yr-1 worth over US$55,000 yr-1. The project aims to conserve mangroves while providing benefits such as fish habitat, shoreline protection, and sustainable livelihood opportunities for approximately 9000 community members living in Vanga, Jimbo and Kiwegu villages.

Both Mikoko Pamoja and VBF are excellent examples of triple win projects with climate, community and biodiversity benefits. The projects are run and managed by community groups in Gazi and Vanga using an approved Participatory Forest Management Plans (PFMP). Through the signing of Forest Management Agreements (FMAs) with the government the participating communities have rights to manage designated mangrove forest areas.

Billions of people worldwide depend on marine and coastal ecosystems for their livelihoods; with ocean-based sectors estimated to contribute more than US$1.5 trillion to the global economy (Sumaila et al., 2020). In Kenya, marine-based small-scale fishing activities occur in near shore environments supported by both mangrove and seagrass ecosystems. Catches from this sub-sector have been increasing over the years. Total catches in 2021 were recorded at 25,380 tons and valued at KES 5.4 billion. In 2022, catches increased to 35,596 tons valued at KES 8.7 billion (Government of Kenya, 2022). Small scale fishery in Kenya directly supports over 14,000 artisanal fishers and multitude other players along the value chain. Unfortunately, several stressors including anthropogenic activities are threatening the supporting ecosystems with direct and negative impacts on coastal and marine fisheries.

Kenya aims to achieve its development blueprint, Vision 2030, through a low carbon climate resilient development pathway. Harnessing the mitigation benefits of sustainable blue economy, including blue carbon Payments for Ecosystem Services (PES), are among ambitious ocean climate actions incorporated into Kenya's updated Nationally Determined Contributions (or NDCs) to the Paris Agreement. Ocean accounting, which considers the complex nature of sustainability by offering information on the "triple bottom line" (social, economic, and environmental circumstances) guarantees that decisions are supported by facts and that the costs and benefits to society and the environment have been fairly balanced.

1.1. Study objectives

The study focused on demonstrating to the financial sector the opportunities for investment in blue carbon and sustainable fisheries in Kenya. This was motivated by the fact that mangroves and seagrasses are carbon-rich ecosystems, providing multiple benefits to nature and society; including support to fisheries and shoreline protections. Through the project, the following activities were undertaken:

i. Quantitative estimation of carbon stock and carbon credit potential of mangrove and seagrass conservation and restoration for the next 20 years at the Kenya coast. This included:
    a. Assessments of mangroves and seagrass carbon stocks in Kwale County using tools and methodology appropriate for Voluntary Carbon Market (VCM);
    b. Estimation of carbon credit potential for mangrove and seagrass conservation and reforestation over the next 20 years in Kwale County based on the carbon stock estimated in (1);
    c. Estimation of carbon credit potential for mangrove conservation as well as reforestation over the next 20 years in Lamu County, Kenya;

ii. Cost estimation of mangrove conservation and reforestation for the next 20 years as well as rough cost estimation for the blue carbon credit validation, verification, and registration process using industry best standards;

iii. Detailed estimation of income and costs of sustainable fishery that benefits from mangrove and seagrass presence for Kwale County for the next 20 years;

iv. Cost-benefit analyses of mangrove conservation and restoration, including a cash flow analysis of a hypothetical small-scale carbon credit project;

v. Analysis of (i) national carbon credit regulations in Kenya, (ii) strong initiatives/institutions that could act as borrower or carbon credit issuer locally, and (iii) risks and potential safeguards when scaling up conservation and reforestation efforts for carbon credits.

2 Study approach and methodology

2.1. Description of the project area

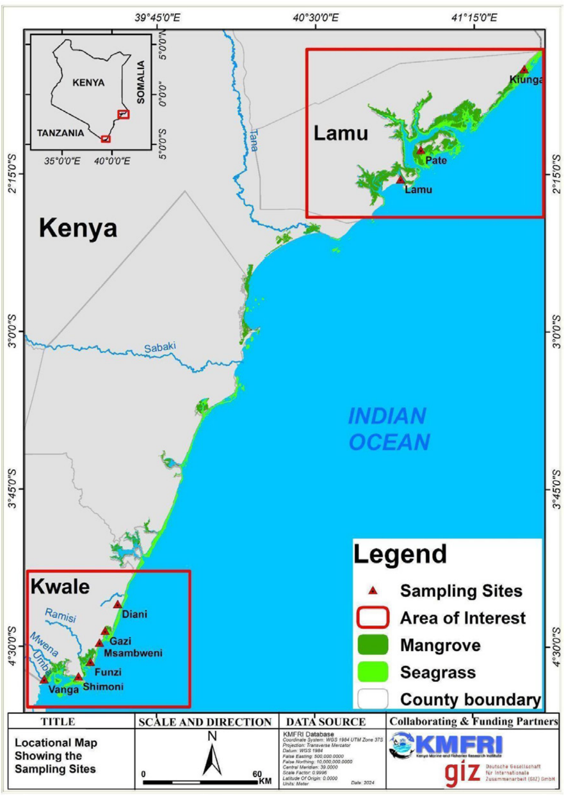
Kenya has a coastline of about 640 km and an Exclusive Economic Zone (EEZ) of 142,400 km^2. The country has also laid claim to an extended EEZ of 150 nm reaching 350 nm with an extra area of approximately 103,320 km^2 (Figure 1). This coastal area is endowed with rich natural resources including marine fisheries, coral reefs, seagrass beds, mangrove forests and diverse cultural heritage. According to the national mangrove ecosystem management plan (2017-2027), there are 61,271 ha of mangroves in Kenya, distributed across Kwale, Mombasa, Kilifi, Tana River, and Lamu counties (GoK, 2017). This is in addition to 33,600 ha of seagrasses that occur in creeks and subtidal areas along the coast (UNEP, 2009). The current study focused on blue carbon ecosystems and the opportunities arising from their conservation and restoration in Kwale and Lamu counties which constitutes more than 70% of mangroves and seagrasses in Kenya.

2.2. Scope of work

Multiple approaches were used in achieving project objectives as outlined below:

1. Project Meetings: Virtual meetings were held with the Client to validate the proposed actions and work plan. These were supplemented with in-house meetings by the consulting team to validate data sources, analysis and reporting.

Figure 1: Map of Kenya coast showing location of the study sites



2. System literature review: A desktop review was performed to collate and collect data relevant for the study. This included archived data and information on blue carbon and coastal fisheries; as well as published scientific publications sourced from Web of Science; Science Direct, Google Scholar as well as technical reports on fisheries, ecosystem services valuation, sustainable blue economy, livelihoods, blue carbon stocks, mangroves and seagrasses in Kenya. Analysis was performed on the data and information gathered to assess status, conditions and trends.

3. Carbon stock assessment: Our scope of inference was defined as all above-ground carbon pools plus below-ground organic carbon, up to a maximum depth of 1.0 m in mangroves and 50 cm in seagrasses. Carbon stocks were estimated from data derived from existing information (peer-reviewed, technical reports and KMFRI database). This was supplemented by primary data generated from two field campaigns in Lamu and Kwale counties using Kauffman and Donato (2012) protocol; whose application can be found in Kairo et al. (2021). Carbon sequestration by the blue carbon ecosystem was estimated using appropriate tiers in IPCC (2014) supplemented by global average values published by Fourqurean et al., (2012). Carbon emissions of both mangroves and seagrasses were estimated using existing local estimates for Kenya (Lang'at et al., 2014; Githaiga et al., 2019). Detailed methodologies for quantification of carbon stocks, sequestration, emissions, as well as Remote Sensing are provided in Annex 1

4. **Interviews:** In order to appraise the role of different stakeholders in blue carbon and fishery sectors, key informant interviews (KIIs) were held with Kenya Forest Service (KFS), Ministry of Tourism in Kwale County, Mikoko Pamoja, Gazi Women Mangrove Boardwalk, Wasini Women group, Mwakamba Jitegemee Youth Group and Kenya Marine and Fisheries Research Institute (KMFRI). Focus group discussions (FDGs) were also administered in 3 Beach Management Units (BMUs) which included Mkunguni, Shimoni and Vanga BMUs in Kwale County. Target respondents including fishers and fish traders/dealers were questioned on fishing gear types, revenues and costs of fishing and access to finance. Tools used to carry out the interviews and surveys are included in the thematic reports.
5. **Policy and legal framework analysis:** Involved identifying and reviewing key laws and policies at the national, regional and international levels on fisheries, livelihood, blue carbon, and carbon markets
6. **Data quality control, analysis, and reporting:** At least three expert workshops were held in the course of the study to consolidate and validate various data sources and perform gap analysis. Appropriate tools and social survey software were used to analyse the data thus allowing reporting.

Team collecting soil carbon samples in mangroves and validating degraded seagrass hotspots in Kwale County.

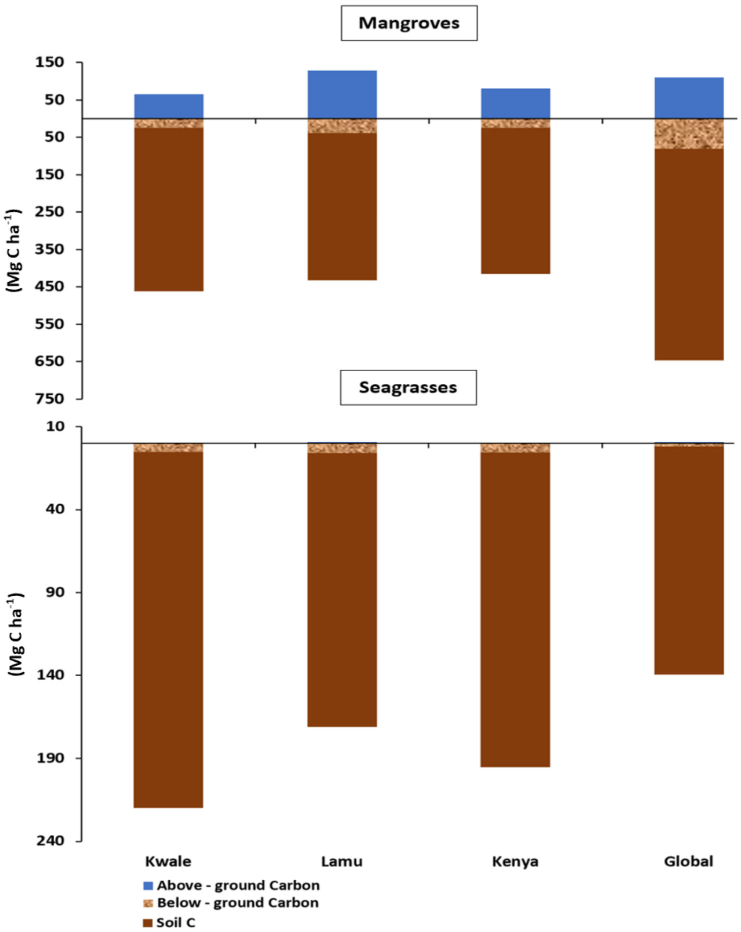
3 Key findings and discussion

3.1. Carbon stocks and carbon credit potential in Kwale and Lamu counties

Carbon densities of mangroves in Lamu and Kwale Counties were estimated at 560.23 Mg C ha-1 and 526.34 Mg C ha-1, respectively. As expected, most of this carbon is stored in the sediment (Figure 2). This is consistent with other mangrove blue carbon studies in Kenya (Gress et al., 2017; Kairo et al., 2021), and elsewhere that indicate more than 70% of mangrove carbon as being stored in the sediment (Hamilton & Friess, 2018).

In seagrasses, carbon densities in Lamu (171.65 Mg C ha-1) and Kwale (220.94 MgC ha-1) are higher than the country's average (140.21 Mg C ha-1) but consistent with the global averages (195.98 Mg C ha-1). At least 97% of carbon stocks in seagrasses is represented in sediment while the rest is in vegetation carbon (Figure 2). This is consistent with global estimates where more than 90% of seagrass carbon is captured in seagrass sediment while the rest is stored in above- and below-ground biomass carbon pools (Fourqurean et al., 2012; Githaiga, 2017).

Figure 2: Comparison of blue carbon stocks (Mg C ha-1) in Kwale and Lamu Counties with national and global estimates. Only the top metre of soil is included in the soil carbon estimates



The total ecosystem carbon of mangroves in Lamu and Kwale Counties is estimated at 20.0 million Mg C (or 73.35 million tCO_2e) and 3.8 million Mg C (or 13.22 million tCO_2e), respectively. Considering that mangroves in Lamu and Kwale are declining at 0.16% yr-1 and 0.49% yr-1, under business-as-usual (BAU) scenario, total ecosystem carbon is expected to decrease to 19.02 Mg C (69.94 million tCO_2e) and 3.1 Mg C (11.40 million tCO_2e), respectively, between 2020 and 2050. However, some management interventions (including conservation and restoration; adopted from the national mangrove ecosystem management plan 2017-2027) are likely to abate carbon emissions of about 1.38 and 7.38 million tCO_2e in Kwale and Lamu, respectively, over the same period (Table 1).

In seagrasses, total ecosystem carbon is estimated at 3.6 million Mg C (17.08 million tCO_2e) in Lamu and 2.2 million Mg C (8.04 million tCO_2e) in Kwale. Seagrasses in Lamu were found to be declining at 0.67% yr-1. Under the BAU scenario, carbon emissions from loss and degradation of seagrasses in Lamu are projected at 6.38 million tCO_2e by 2050. **With concerted intervention efforts, emission reductions of 5.12 million tCO_2e** compared to the BAU scenario **from seagrasses in Lamu are projected by 2050 (Table 1).**

Table 1: Mangroves and seagrass carbon dynamics in Kwale and Lamu counties over a 30-year projection (2020 – 2050)

Mangroves				
County	Component	2020	2050	
		Baseline	BAU	Interventions
Kwale	Cover (ha)	7,220	6,224.98	7,687.85
	Total Ecosystem C storage (Million tCO_2e)	13.22	11.4	14.08
	Sequestered C (Million tCO_2e)	0.12	3.6	3.86
	C emissions (Million tCO_2e)	0.13	4.43	2.48
	Net C (Million tCO_2e)	-0.01	-0.83	1.38
	Net C (tCO_2e/ha/yr)		-4.44	5.98
Lamu	Cover (ha)	35,678.00	34,018.54	37,400.84
	Total Ecosystem C storage (Million tCO_2e)	73.35	69.94	76.90
	Sequestered C (Million tCO_2e)	0.62	18.69	19.52
	C emissions (Million tCO_2e)	0.5	18.96	12.14
	Net C (Million tCO_2e)	0.02	-0.28	7.38
	Net C (tCO_2e/ha/yr)		-0.27	6.58

Seagrass				
County	Component	2020	2050	
		Baseline	BAU	Interventions
Kwale	Cover (ha)	9,920.00	10,861.56	10,864.36
	Total Ecosystem C storage (Million tCO_2e)	8.04	8.81	8.81
	Sequestered C (Million tCO_2e)	0.01	0.64	0.64
	C emissions (Million tCO_2e)	0.05	0.51	0.51
	Net C (Million tCO_2e)	-0.05	0.13	0.13
Lamu	Cover (ha)	21,067.00	17,212.76	20,784.60
	Total Ecosystem C storage (Million tCO_2e)	17.08	13.96	16.85
	Sequestered C (Million tCO_2e)	0.04	1.17	1.28
	C emissions (Million tCO_2e)	0.11	6.38	1.26
	Net C (Million tCO_2e)	-0.07	-5.21	0.02

BAU = business as usual scenarios, Interventions = with project interventions. Sequestered C = cumulative carbon sequestration over 30 years and C emissions = cumulative carbon emissions over 30 years

Please refer to Annex II for additional information on Blue Carbon Stocks in Kwale and Lamu Counties.

3.1.1. Carbon credit potential of seagrass and mangroves conservation and reforestation over 20 years period in Kwale and Lamu Counties

Restoration and protection of degraded blue carbon ecosystems offers relatively low-cost natural climate solutions and other benefits. Incentive based schemes associated with blue carbon credits present a potential revenue stream to compensate those involved in mangrove and seagrass conservation activities. Assuming a value of US$20/t$CO_2$e for high quality blue carbon credits, the estimated benefit from avoided deforestation and restoration activities mangroves and seagrasses in Lamu and Kwale Counties over the next 30 years is estimated at US$ 114,173,700 (Table 2). This is in addition to the value of blue carbon ecosystems to shoreline protection, biodiversity conservation, livelihood support among others (Kilonzi et al., 2024).

Table 2: Carbon credit investment opportunity and projected income from blue carbon ecosystems in Kwale and Lamu Counties, Kenya

Investment opportunity	County	Intervention area (ha)[a]	Carbon sequestration (tCO_2e $ha^{-1}yr^{-1}$)[b]	Potential returns per year (US$$yr^{-1}$)@$20/ tCO_2e[c]	Potential returns between 2020 and 2050 (US$)[(c x 30)]	Risks
Mangrove carbon credits	Kwale	2661	17.3[a]	920,706	27,621,180; **24,859,062	Market volatility, regulatory changes, land use changes, etc.
	Lamu	7714	17.3[a]	2,669,044	80,071,320; **72,064,188	
Seagrass carbon credits*	Lamu	2700.5	4[b]	216,040	6,481,200; **5,833,080	
Total					114,173,700 **102,756,330	

a = IPCC (2014), b= Murray et al., (2012). 1 Carbon credit = 1 CO_2e. *Only data on Lamu is used here as this is where loss on cover was observed. **Adjusted returns after risk deduction (% buffer): Verified Carbon Standard (VCS) provides a Carbon buffer percentage of 10-20% to cover unforeseen losses and ensure credit integrity. In the present study, we used a 10% buffer.

3.2. Financial analysis of small-scale carbon credit projects in Kenya

3.2.1. Costs accruing for blue carbon projects

This section provides an overview of the results of costs associated with blue carbon projects (Table 3). More information on each cost type is provided in the underlying technical study "Economic and financial analysis of blue carbon projects in Kwale County" in annex 2.

Data on **conservation and restoration costs** was obtained by taking the average costs incurred by Mikoko Pamoja (MP) and Vanga Blue Forest (VBF) projects in Kwale County. The average annual costs per hectare for mangrove conservation is estimated at US$79.62ha/yr. This includes labour, staff and office costs as well as expenditures in community development projects. If the cost of planting materials such as seedlings for restoration activities (estimated at US$500/ha/yr) is included, the operational costs for conservation and restoration activities becomes US$ 580/ha/yr.

Moreover, there are costs associated with validation, verification, and registration of carbon projects. Cost for **blue carbon validation, verification and registration under Plan Vivo** were estimated also using MP and VBF as case studies. Validation costs include expert fees negotiated for individual projects. According to Plan Vivo guidelines, independent verification of a project is to be conducted every 5 years. Each year, the two projects in Kwale set aside part of funds generated from sales of carbon credits to cater for verification costs. Assuming a hypothetical small-scale blue carbon project size of 100 ha, the estimated validation costs amount to US$150/ha, while project verification costs amount to US$1.29/ha/yr. In addition, **Kenya's Climate Change (amendment) Act (2024) has introduced costs for registering and operating carbon projects in the country,** differing between citizen and non-citizen run projects as well as the size of a project. These include the carbon project application fee, the carbon project design fee, the administrative fee upon approval of the project design document, an administrative fee upon issuance, and corresponding adjustment fees for Internationally Transferred Mitigation Outcome.

The **further initial costs for the establishment of carbon projects** involve a feasibility assessment of the project (site selections; analysis of, historical land use, land cover changes, agents and drivers of deforestation); a carbon assessment, stakeholder's consultations, as well as development of Project Idea Note (PIN), and Project Design Document (PDD). Based on the costs occurred for MK and VBF, one can assume an average cost per hectare for these further initial investment costs required when developing a blue carbon credit project of US$581.61/ha.

Please note that no costs for acquisition of land was considered here, as the assumption was based on the two community projects MP and VBF, which are established on public land. However, for all projects on public land, benefit sharing is a requirement by Kenya's law (see chapter 3.5.1.7). The existing blue carbon projects in the country, Mikoko Pamoja and Vanga Blue Forest currently provide communities with a 60% share of revenues, well above the floor of 40% prescribed in Kenya's laws.

Table 3: Assumed costs (per hectare) for setting up and operating a blue carbon project

Initial investment		Operational expenses	
Type	**2024 US$/ha**	**Type**	**2024 US$/ha/yr**
Preliminary assessment (site selection, historical land use and land cover changes, analysis of agents & drivers of deforestation)	111.28	Verification under Plan Vivo (assuming small-scale project) **	1.06
Carbon assessment (carbon density measurements)	164.82	Administrative fee upon issuance (assuming issuance for < 15000 tCO2e / yr) **	1.77
Project Idea Note (PIN), Project Design Document (PDD)	305.51	Corresponding adjustment fees for Internationally Transferred Mitigation Outcome (assuming 50% transfer) **	35.38
Validation under Plan Vivo (assuming small-scale project) **	150.00	Restoration (seedlings)	500.00
Carbon project application fee (Kenyan citizen) *, **	0.77	Operational expenses associated with conservation & restoration (labour/staff salary, office costs, community development projects)	79.62
Carbon project design document fee (Kenyan citizen) *, **	7.70		
Administrative fee upon approval of the project design document (project with issuance of < 15000 carbon credits/yr) **	11.54		
Total	**752**	**Total**	**618**

* Average carbon project application fee for non-citizens would be US$7.7/ha, while the PDD fee US$15.04/ha. ** Please note that for calculating fixed costs that are the same for all small-scale carbon projects, the per hectare costs were received by assuming a project with size of 100 hectares and associated carbon credits obtained.

3.2.2. Benefits accruing from blue carbon projects

To obtain the climate benefits associated with blue carbon projects, this study estimated the average revenue generated per unit area per year using (a) the case of Mikoko Pamoja, (b) the case of Vanga Blue Forest, (c) the carbon sequestration values based on stock data, and (d) the carbon sequestration values based on net carbon in Kwale and Lamu County. Part (e) provides an overview of the four different results and outlines the assumptions made in the economic report of this study (Table 4). More information is provided in the underlying technical study "Economic and financial analysis of blue carbon projects in Kwale County" in annex 2.

a. Mikoko Pamoja

Mikoko Pamoja is involved with restoration and protection of 117 ha of mangrove forests in Kwale County (Box 1). Since 2014, Mikoko Pamoja has generated carbon credits that are then sold into the international voluntary carbon markets. Revenue generated from sales of carbon credits is used to support local development projects and in mangrove conservation. By 2023 Mikoko Pamoja had sold 18,006 tCO_2e, earning the community a total of US$239,000. This is equivalent to 204 US$/ha/yr.

b. Vanga Blue Forest

Vanga Blue Forest (Box 1) is a replica of Mikoko Pamoja and protects 460ha of mangroves Vanga, Jimbo and Kiwegu (VAJIKI) villages of Vanga Bay. By 2023, VBF had sold 16,046 tCO_2e earning the community US$171,234; translating to 124 US$/ha/yr.

c. Carbon sequestration-based stocks data

To value benefits associated with carbon sequestration by mangroves, this study took into consideration the total carbon stocks in Lamu and Kwale Counties as 73.35 and 13.22 million tCO_2 (as obtained in this study), and based on the assumption by Donato et al., (2011) and Alongi (2012), mangroves sequester 1-3% of their carbon stocks. On this basis, mangroves in Lamu and Kwale counties will sequester an average of 2% of their total carbon stocks, which translates to 1.7314 million tCO_2. To get the sequestration rate per hectare, this value was divided by the total coverage of 42,898 ha in both Lamu and Kwale under the baseline scenario, giving a per unit sequestration rate of 40.36 tCO_2/ha/yr (Kilonzi et al. 2024).

d. Carbon sequestration based on net mangrove carbon in Lamu and Kwale counties

The study used the estimated carbon sequestration with and without project interventions for both mangroves in Lamu and Kwale Counties (see Table 1). Taking the average of the carbon sequestration based on net carbon per hectare in Kwale County and net carbon per hectare in Lamu County, this study assumes an average carbon sequestration of 6.28 tCO_2e/ha/yr. Using the assumed carbon credit price of US$20, this results in estimated revenue of US$125.6/ha/yr.

e. Benefits summary

Table 4 below gives an overview of the results, outlining the benefits associated with mangrove conservation and restoration projects in terms of potential carbon credits obtained / possible to obtain. It, therefore, considers the two-case studies MP and VBF as well as the two scientific approaches (c. and d.).

Using the average annual carbon credit potential per hectare of 17.69 tCO_2e/ha/yr, assuming a carbon credit price of US$20 and a buffer of 10%, the average revenues that could be generated from the sale of carbon credits amounts to US$318/ha/yr.

Table 4: Summary of benefits associated with a mangrove carbon credit project

Method	Carbon credit potential (tCO_2e/ha/yr)
Based on Mikoko Pamoja	15.39
Based on Vanga Blue Forest	8.72
Carbon sequestration based on carbon stock in Kwale and Lamu County (approximation)	40.36
Carbon sequestration based on net carbon in Kwale & Lamu County	6.28
Total	**17.69**

3.2.3. Cash-flow analysis

This chapter outlines the results of the financial analysis including the cash-flow analysis of two hypothetical blue carbon projects of 100 hectares: (i) a pure conservation/avoided deforestation project and (ii) a conservation and restoration project. The study uses average costs and benefits outlined in Sections 3.2.1 and 3.2.2. All assumptions and respective results are outlined below.

I. Avoided deforestation

Based on the costs and benefits derived in the previous chapters, this study investigated the financial viability, including a cash-flow analysis, of a hypothetical avoided restoration (i.e. conservation) project in Kwale or Lamu County. Table 5 shows the assumptions and results.

The results show that there is a highly positive NPV and an IRR of 22%, demonstrating the high financial viability of a conservation project in Kwale or Lamu County. Even until a discount rate of 22%, the NPV would remain positive. Nevertheless, the results are quite sensitive to the carbon credit price assumed: a minimum of US$ 16 is necessary to result in a positive NPV. Assuming the annual revenues from the issuance of carbon credits start to accrue from year 1 onwards (as it is a conservation project) in a constant manner (conservative approach), the cash-flow is positive from year 1 onwards and breaks even after 4 years.

Table 5: Financial viability of a blue carbon project (conservation intervention)

Method	
Size of proposed intervention (in ha)	100
Initial project investment costs in US$ / ha (see chapter 3.2.1)	752
Annual operational expenses (opex) in US$ / ha (see chapter 3.2.1, excluding seedling costs here)	118
Annual increase in opex (in %)	5
Carbon credits possible to issue per hectare in tCO_2e/ha/yr (see chapter 3.2.2 e.)	17.69
Price per carbon credit sold in US$	20
Potential revenues per hectare measured in US$/ha/yr (based on the carbon credits per hectare possible to issue of 17.69, a carbon credit price of 20 US$ and a 10% buffer)	318
Discount rate (in %)	5
Time horizon (in years)	20
Results	
Net Present Value (NPV) in US$	**97,189**
Internal Rate of Return (IRR) in %	**22**

II. Conservation and restoration intervention

In addition, the financial viability including the cash-flows of a hypothetical conservation and restoration project in Kwale or Lamu County has been investigated. Table 6 shows the assumptions and results.

The results show that there is a positive NPV and an IRR of 20%, demonstrating the financial viability of a conservation and restoration project in Kwale or Lamu County. Until a discount rate of 20%, the NPV would remain positive. Nevertheless, the results are quite sensitive to the carbon credit price assumed: a minimum of 15 US$ is necessary to receive a positive NPV.

It is interesting to note that the NPV and IRR both get less attractive the more hectares are restored and the fewer hectares are purely conserved. This can be explained by the fact that the same number of credits can be issued per year as for conservation activities, but in the case of restoration the issuing of the credits is delayed and higher annual costs incurred due to the required seedlings.

The detailed cash-flow analysis over the 20-year project period can be provided upon request. It is assumed that the restoration activities take place over the first 5 years (2 hectares per year) and afterwards these hectares restored will be conserved in addition to the other 90 hectares. Revenues associated with conservation start to accrue in year 1, those associated with restoration start to accrue 3 years after the restoration took place. All revenues accrue annually, and no carbon credit price increase is assumed over time (conservative approach). The cash-flow is positive from year 1 onwards and breaks even in year 5.

Table 6: Financial viability of a blue carbon project (conservation & restoration intervention).

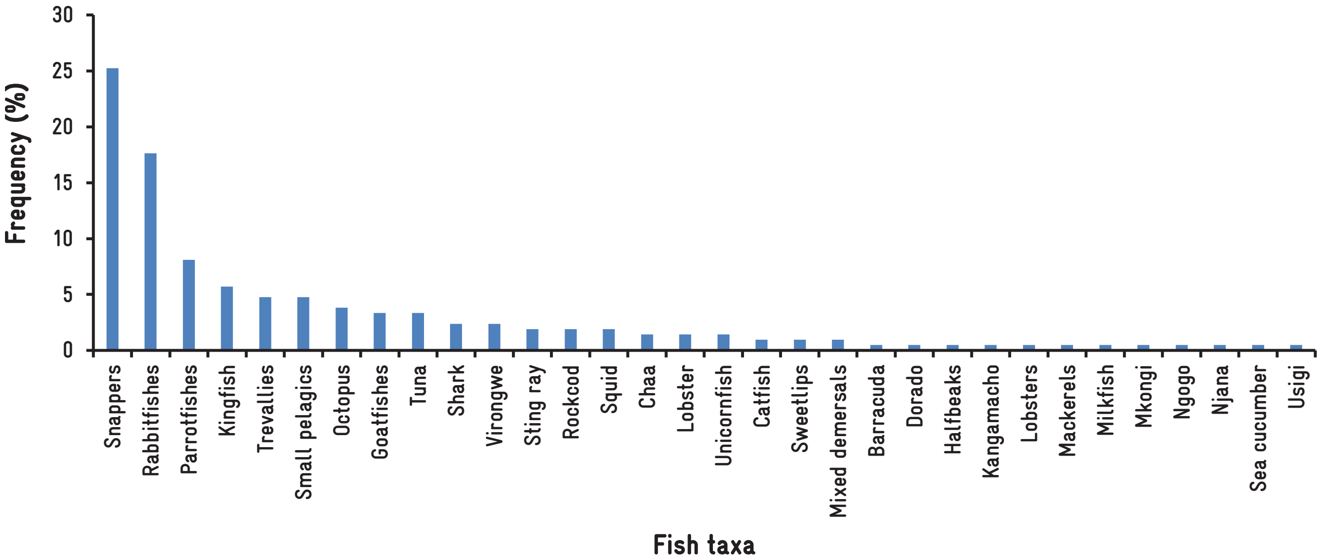
Method	
Size of proposed intervention (in ha) - restoration	10
Size of proposed intervention (in ha) - conservation	90
Initial project investment costs / ha (US$)	752
Annual opex in US$ / ha (see chapter 3.2.1) for conservation	118
Annual increase in operational cost (in %)	5
Additional annual restoration costs (seedlings + staff/labor etc.) in US$/ha/yr (relevant for the first 5 years, assuming 2 hectares per year restored)	618
Carbon credits possible to issue per hectare in tCO_2e/ha/yr (see chapter 3.2.2 e.)	17.69
Price per carbon credit sold in US$	20
Potential revenues per hectare measured in US$/ha/yr (based on the carbon credits per hectare possible to issue of 17.69, a carbon credit price of 20 US$ and a 10% buffer)	388
For restoration: first carbon credits are issued x years after plantation	3
Discount rate (in %)	5
Time horizon (in years)	20
Results	
Net Present Value (NPV) in US$	**100,082**
Internal Rate of Return (IRR) in %	**20**

3.3. Income and costs of sustainable mangrove fishery

The study also investigated the fisheries market in Kwale County, as this is a major income source for local communities and is highly dependent on healthy mangrove ecosystems. This should facilitate the identification of how fishermen can be supported in scaling-up their engagement in sustainable fishing practices and mangrove conservation, thus indirectly increasing their sources of income from fishing. Therefore, the study identified the preferred fish taxa in the County, looked at the current and potential future market value of these, analysed the stability of costs and revenues and lastly looked into the market value associated with healthy mangrove systems.

A total of 32 fish taxa were found to be preferred by the fishers in Kwale County (Figure 3). The most preferred fish taxa are snappers (Lutjanidae), rabbitfishes (Siganidae) and parrotfishes (Scaridae) which are all demersal fisheries resources (Munga et al., 2024). Demersal fishery species such as prawns and crabs are mostly associated with mangrove ecosystems, while sea cucumbers are mostly affiliated to seagrass beds (Floren et al., 2021).

Figure 3: Overall frequency of preferred fish taxa by fishers surveyed in BMUs of Mkunguni, Shimoni and Vanga in south coast Kenya



3.3.1. Current market value of mangrove fishery and the magnitude of the potential market value

Considering demersal, prawn, crab and sea cucumber, the average annual fish landings in the past 17 years (2006 – 2022) period for Kwale was 2,354 Mt; with an average ex-vessel market value of KES 386,380,846 (US$ 2,972,160). Over the same period, Lamu County recorded an average annual fish landing of 3,188 Mt at an ex-vessel market value of KES 373,717,361 (US$ 2,874,748). Average annual landings of each fish taxa as well as their average annual ex-vessel market value are provided in Table 7. The ex-vessel market value was the actual prevailing market value under the period of investigation. This ex-vessel market value for each fish taxa is expected to increase with time due to better policy and institutional frameworks, improved fish handling and market infrastructure as well as increased demand for fish and fish products.

Table 7: Current catch and market value of different fish taxa for the past 17 years (2006 – 2022) for Kwale and Lamu (figures in brackets is US$ based on exchange rate of KES 130). Data source, Fisheries Statistical Bulletin 2006 - 2022

Fish Taxa	Kwale County		Lamu County	
	Average annual landings (Mt)	Average annual ex-vessel market value (KES)	Average annual landings (Mt)	Average annual ex-vessel market value (KES)
Demersal	2,068	286,317,139 (2,202,439.5)	3,131	277,689,350 (2,136,071.9)
Prawn	129	50,132,861 (385,637.4)	32	12,318,779 (94,759.8)
Crab	102	30,940,129 (238,000.9)	12	58,962,630 (453,558.7)
Sea Cucumber	55	18,990,717 (146,082.4)	13	24,746,602 (190,358.5)
Total	**2,354**	**386,380,846 (2,972,160.2)**	**3,188**	**373,717,361 (2,874,748.9)**

3.3.2. Stability of revenues/costs

Mkunguni, Shimoni and Vanga Beach Management Units (BMUs) were selected for investigation of stability of revenues and costs. Mkunguni BMU has a total of 213 and 41 registered fishers and fish traders, respectively; Shimoni BMU a total of 964 and 110 registered fishers and fish traders, respectively; and Vanga BMU a total of 600 and 120 registered fishers and fish traders, respectively.

Tables 8 and 9 are a summary of the total annual revenues and costs for the respective Beach Management Units (BMUs), and the selected gear-based fishery types that target demersal fishery resources in Kwale County. BMU revenues included landing fee, anchorage fee, membership fee among other revenue streams, whereas their respective costs were spent on salaries, electricity and water bills, travelling and conducting BMU assembly meetings. With respect to gear-based fishery type, respective revenue is generated from data on proportion of fish catch by gear type from Fisheries Statistical Bulletin of 2022, Marine Fisheries Frame Survey data (2004 – 2022) whereas operations costs included boat fuels and baits, alongside maintenance costs obtained from our recent BMU field survey conducted in June 2024.

Tables 8 and 9 are a summary of the total annual revenues and costs for the respective Beach Management Units (BMUs), and the selected gear-based fishery types that target demersal fishery resources in Kwale County. BMU revenues included landing fee, anchorage fee, membership fee among other revenue streams, whereas their respective costs were spent on salaries, electricity and water bills, travelling and conducting BMU assembly meetings.

With respect to gear-based fishery type, respective revenue is generated from data on proportion of fish catch by gear type from Fisheries Statistical Bulletin of 2022, Marine Fisheries Frame Survey data (2004 – 2022) whereas operations costs included boat fuels and baits, alongside maintenance costs obtained from our recent BMU field survey conducted in June 2024.

Table 8: Annual financial status for selected Beach Management Units in Kwale County based on 2024 field survey

BMU	Total Annual Revenue (KES)	Total Cost (KES)	Annual Profit (KES)
Mkunguni	453,400 (US$ 3487.7)	215,000 (US$1,653.8)	238,400 (US$1,833.9)
Shimoni	1,056,840 (US$ 8129.5)	285,000 (US$ 2,192)	771,840 (US$5,937)
Vanga	1,083,000 (US$ 8330.8)	867,000 (US$6,669.3)	216,000 (US$1,661.5)

Table 9: Annual financial status for selected gear-based fishery types in Kwale County based on Marine frame survey report 2022. (figures in brackets is US$ based on exchange rate of KES 130)

Fishery type	Mean Number	Catch by gear type (kg)	Average selling price (KES)	Annual revenue (KES)	Annual costs (KES)	Annual income (KES)
Gillnet	828	580	300	174,000 (US$ 1,338.5)	128,400 (US$ 989.7)	45,600 (US$ 350.8)
Basket trap	1322	871	300	261,300 (US$ 2,010)	13,000 (US$ 100)	248,300 (US$ 1,910)
Handline	1856	672	300	201,600 (US$ 1550.7)	9,800 (US$ 75.4)	191,800 (US$ 1475.4)

Current and future revenues and costs for both BMUs and fishers in both Kwale and Lamu Counties are likely to be influenced by several factors (Table 10). These factors were categorised as environmental, climatic, socio-economic, and institutional and legislative frameworks. However, income and market value are expected to rise over time in the two counties. This is attributed to the on-going initiatives promoting ecosystem approach to fisheries management.

Table 10: Factors influencing stability of fishery revenues and costs based on recent 2024 survey in Kwale County

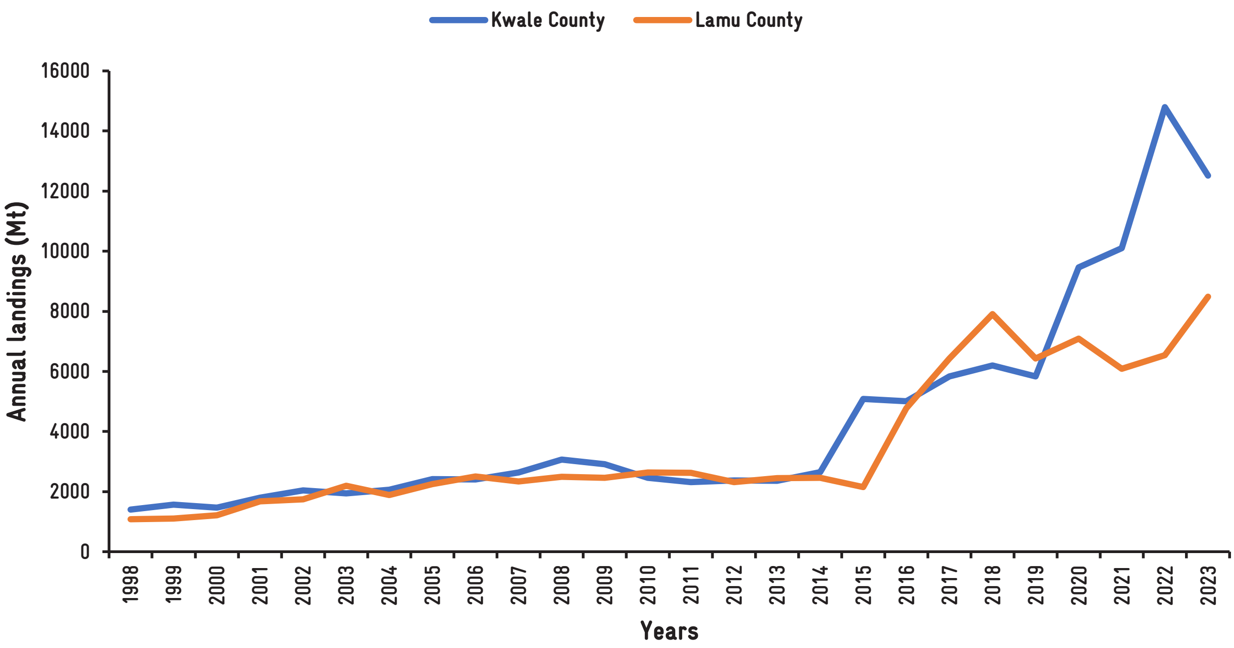
Category	Impact on fisheries
Environmental factors	
Pollution, pest and diseases, sedimentation	Under BAU scenarios, 13.8% of mangroves in Kwale County are likely to be lost over the next 30 years, relative to the 2020 baselines. This loss is likely to affect adjacent fish habitats and seagrass through sedimentation. Additionally, upcoming and ongoing mega projects in Kwale County such as the Mwache Dam and KISCOL sugar company are also envisioned to have environmental impacts that may increase sedimentation. The development of the Shimoni Port may likely increase pollution through possible dredging and dumping operations, as well as the risk of oil spills from the dredging vessel. Outbreaks of pests and diseases may lead to a decline in the health of mangrove and seagrass ecosystems, reducing their ability to support fisheries. A study on insect infestation found that in Gazi, Bottegia rubra attacked small and young mangrove trees within the plantation, thereby posing a challenge to restoration initiatives. Restoration and protection efforts can, however, enhance fish habitats, leading to increased fish populations and improved sustainability of local fisheries. In Kwale County, several conservation initiatives are being carried out by government institutions, NGOs, and the existing community groups.
Climatic factors	
Sea level rise, temperature, rainfall, and storm surges	Climatic changes such as sea level rise, increased sea surface temperature, erratic weather patterns, and more frequent storms significantly impact fisheries. Sea level rise disrupts traditional fishing grounds, whereas higher temperatures degrade coral reefs and influence fish breeding and migration patterns. Unpredictable weather disrupts mangroves by altering freshwater flows, while stronger storms physically damage mangroves, seagrass beds, and fishing equipment. These impacts have an influence on fish catches, which in turn may affect fishers' income and revenues.
Socio-economics factors	
Population increase	The Kwale County population projections for 2022 to 2027 shows a 7.74% increase in population (KNBS 2019). This population growth will exert more pressure on mangrove and seagrass ecosystems due to overfishing and land use changes, leading to habitat degradation and reduced fish stocks.
Fisher Co-operatives	BMUs in coastal Kenya have been sensitized on the need to form co-operatives. Formation of cooperatives will be beneficial to fishers through: receiving professional training, services like insurance, loans as well as grants offered by state and non-state actors as well as receiving benefits such as cooperative subsidies and incentives. Cooperatives will therefore help BMUs and fishers attain higher fishing returns and promote economic growth.
Infrastructure development	The development of the Shimoni Port which will be equipped with a warehouse, a fish processing plant, cold storage, an ice-making plant, a port access road, and a commercial port gate, hence promoting fishery in Kwale County. The facility will enable fishers to preserve their catches for longer periods, reducing spoilage and ensuring that fish retain freshness and therefore minimal post-harvest losses.
Institutional and legislative framework	
	Kenya is implementing the ecosystem approach to fisheries management which advocates for development of fisheries management plans resulting in improvement on sustainable management of fisheries resources. Reviewed strategies include the Tuna Fishery Development Strategy, Small and Medium Pelagic Fishery Strategy, Prawn Fishery Management Plan. Some of the local, national, regional, international developments and policies include; Climate change policies, community-based natural resource management (CBNRM), 30*30 CBD Global Biodiversity Framework, UNEP's Sustainable Blue Economy initiative. In keeping with the above policies and frameworks, Kenya has started implementing some of the frameworks by developing several fisheries Joint/Co-management Areas (J/CMAs) along the Kenya coast. The creation of J/CMAs can safeguard critical habitats, allowing fish populations to recover and replenish. In Kwale County, the KEMSFED -led project established two CMAs and three JCMAs respectively. These include Mwakamba and Mwaepe CMA, Chale-Gazi, Mwandamu-Funzi, and Shimoni-Vanga JCMAs.

3.3.3. Estimating effects of mangrove cover and cover change on fishery market value chains

Existing decadal mangrove cover changes for Lamu and Kwale counties indicate an overall increase in mangrove cover in the 2020s. These increased trends in fish landings with corresponding increase in mangrove cover are depicted in both Kwale and Lamu counties (Figure 4). Such an increase in fish landings has a direct positive impact on the market value of the fish if all other factors remain the same (i.e. no inflation/deflation or other price-influencing developments).

The value of mangrove to fisheries was determined by analysing the collective catches of mangrove-dependent fauna, including prawns, sea cucumbers, demersal fishes, and crabs (see chapter 3.3.1). With an overall total catch of 2,354 metric tons at an overall market value of US$ 2,972,160 (Table 7), a mangrove area of 8,354 hectares, and an assumed mangrove area – fishery correlation of around 70% (Carrasquilla-Henao, 2017), the value of mangrove to fisheries in Kwale County is estimated to account for US$ 249/ha/yr.

Figure 4: Trend of low annual landings coinciding with the mangrove degradation period between 2000 and 2010 compared with improved landings and increased mangrove cover change in the 2020s in Kwale & Lamu County

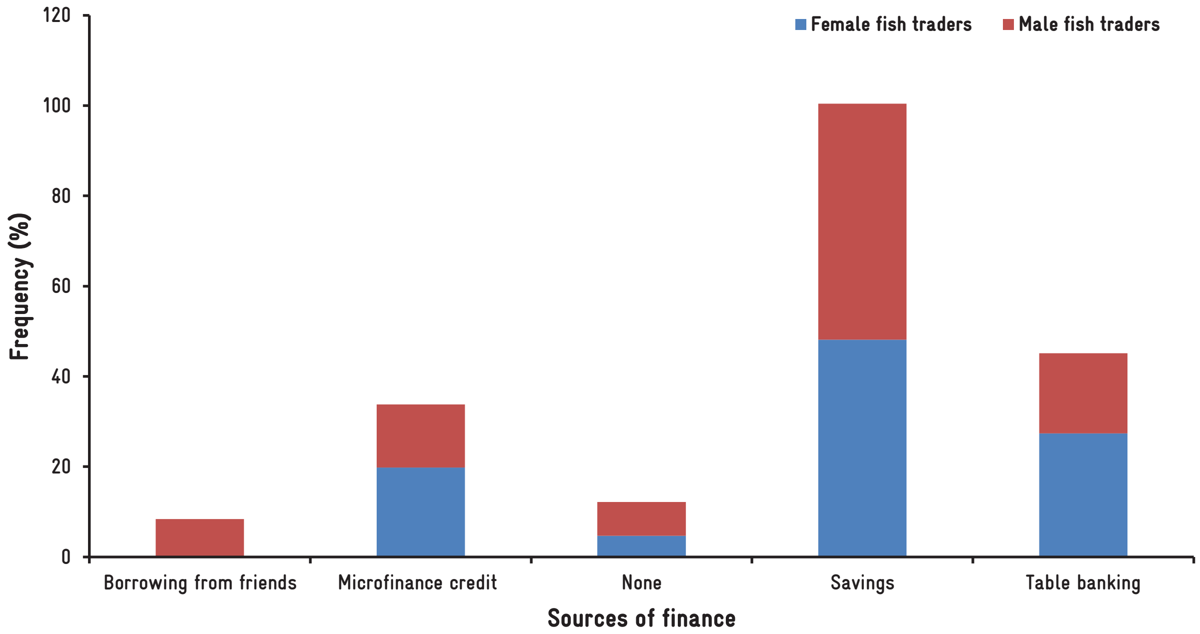


3.3.4. Status of access to finance for fishermen/women

Results from FGDs among the fishers in Mkunguni, Shimoni and Vanga identified various financing schemes, including: Banks (Equity Bank); Micro-finance institutions (Yehu microfinance and Kenya Women Finance Trust), informal banking (Table banking, merry-go-round, Village Savings and Loan Associations (VSLA) and Personal savings), M-Shwari mobile loan as well as borrowing from friends/employers (Figure 5).

Access to finance for fish traders in Kwale County is mainly limited to personal savings, table banking, microfinance credit, and borrowing from friends. Highest preference for personal savings (50%) was observed, followed by table banking (23%) and microfinance credit (17%). By gender, female fish traders dominated in terms of preference for table banking (27%) and microfinance credit (20%). The preference for borrowing from friends as a source of finance was reserved for male fish traders (8%). Savings as a source of finance was more equally preferred by both genders, 48% for females against 52% for male fish traders. Most of the banking services in Kwale County are distributed within major towns (Ukunda and Kwale) thus limiting banking and financial services access to the majority of the businesses and residents of

Figure 5: Frequency of preferred sources of finance by fish traders in South Coast Kenya



Kinango, Lunga-Lunga and Msambweni sub-counties. Majority of the residents and women do not have tangible collateral to support borrowing from commercial banks. However, the prevalence of informal table and village banking (VSLA), Merry-go-rounds, Chamas and the innovative agency banking offered by commercial banks and microfinance are playing pivotal roles in championing financial empowerment and inclusion for all. Banking agencies such as Co-op Kwa Jirani, KCB Mtaani, and Equity Bank agents also provide banking services in rural areas where there are no mainstream banks.

Access of fish traders to finance was hindered by several barrier types. Low literacy level (33%), inadequate savings (21%) and unreliable fish catches (15%) recorded the highest frequency. Low literacy levels made fish traders unaware of potential sources of finance. Inadequate savings mostly attributed to unreliable fish catches hindered fish traders from engaging in microfinance credit services such as Yehu microfinance, KWFT and bank loans. Respondents decried the minimum savings required by lenders in order to guarantee them access to loans. Finance access for exclusively female fish traders was affected by inactive membership to microfinance organisations and loan defaulting. Lack of access to finance was also attributed due to unreliable fish catches mostly for male fish traders. Islamic religion bars fish traders in accessing finance due to the fact that Islam prohibits loan interest associated with most credit services. This study recommends the following:

- Invest on conservation of mangroves and seagrasses to maintain the functional ecology of the associated fishing grounds
- Invest on capacity building of small-scale fishers on financial knowledge and management, and marketing
- Invest on strengthening fisheries co-management to encourage sustainable management of fisheries resources
- Invest on infrastructure and knowledge on fish post-harvest losses to maximize on production and profit.

3.4. Cost-benefit analysis of mangrove conservation and restoration in Kwale county

Table 11 provides an overview of the different costs and benefits associated with the conservation and restoration of mangroves in Kwale County. The costs are outlined in Chapter 3.2.1, whereas the carbon sequestration benefits are elaborated in Chapter 3.2.2 and the fishery functions in Chapter 3.3. To value contributions of mangrove ecosystems to research and education, the average of the budget available for research and education activities at (i) Kenya Marine and Fisheries Research Institute (KMFRI), (ii) Gazi Women Boardwalk and (iii) Mikoko Pamoja was considered. The value of mangroves to ecotourism in Kwale County was derived from the average income generated through ecotourism activities of three projects (Gazi Bay, Mwakamba Jitegemee youth group at Diani, and Wasini). Lastly, estimating the value of mangroves to shoreline protection, the study used the avoided damage approach as well as the replacement cost method. More information can be found in the underlying technical study "Economic and financial analysis of blue carbon projects in Kwale County" in annex 2.

Table 11: Summary of cost and benefits associated with mangroves conservation and restoration in Kwale County.

Costs	Amount in US$	Benefits	Amount in US$
Initial investment costs (see chapter 3.2.1)	752/ha	Carbon sequestration (through the sale of carbon credits incl. a 10% buffer; see chapter 3.2.2)	318/ha/yr
Operational expenses (see chapter 3.2.1)	618/ha/yr	Fisheries functions	US$249/ha/yr
		Education and research	19.45/ha/yr
		Ecotourism	138.38/ha/yr
		Shoreline protection	1356.4/ha/yr
Total (per ha, over 20 years)	13,112	Total (per ha, over 20 years)	41,624
Benefit-Cost Ratio:	**3.17**		

As shown in Table 11, a cost-benefit ratio of 3.17 over a 20-year period was obtained. **This means, for every dollar invested in mangrove conservation and restoration at least US$ 3.17 of socio-economic benefits are generated.**

3.5. Review of carbon credit regulations and frameworks

3.5.1. National carbon credit regulation

An analysis of key documents, including the National Oceans and Fisheries Policy (GoK, 2008), the National Forest Policy (GoK, 2014), and the National Land Use Policy (GoK, 2017), indicates that the country's policies simply provided general guidance on actions necessary to protect, conserve and sustainably manage blue carbon ecosystems. Nevertheless, over the last years Kenya has made significant strides in developing comprehensive policy and legal frameworks to enhance, protect, and manage blue carbon ecosystems.

Kenya's updated Nationally Determined Contribution (NDC) submitted to the UNFCCC in 2020 proposes implementation of projects, measures, and activities focused on coastal resources and promote nature-based solutions such as seaweed farming and sustainable mangrove management. A mitigation priority under the updated NDC is to harness the mitigation benefits of the sustainable blue economy, including the creation of coastal carbon Payment for Ecosystem Services (PES) (GoK, 2020). Further, the National Mangrove Ecosystem Management Plan provides key actions aimed towards the sustainable management and conservation of mangroves (GoK, 2017), while the National Climate Change Action Plan (NCCAP III) is the first policy document calling for the conservation of seagrasses (GoK, 2023).

Laws, including the Forest Conservation and Management Act, 2016 (FCMA), Wildlife Conservation and Management Act, 2013 (WCMA), and the Environmental Management and Co-ordination Act, 1999 (EMCA) are also critical for the sustainable management of blue carbon ecosystems. The FCMA calls for the sustainable management of forests, including mangroves; whereas the WCMA supports the preservation of blue carbon ecosystems by protecting associated wildlife and establishing marine protected areas (MPAs) that include mangrove environments. EMCA, sets out the framework for environmental conservation and calls for the sustainable management of wetlands.

Kenya has also made notable progress in establishing a legal framework for engaging in both voluntary and compliance carbon markets; in line with Article 6 of Paris Agreement. The country enacted the Climate Change Act in 2016, however the Act lacked specific provision for carbon markets and was therefore amended in 2023 to cover carbon markets. This amendment, effective from September 15, 2023, was followed by the Climate Change (Carbon Markets) Regulations, 2024 (Regulations), gazetted on May 17, 2024. The Regulations provide a regulatory framework for Kenya's engagement in global carbon markets and are pivotal for the development and management of blue carbon projects as well as the generation of blue carbon credits.

3.5.1.1. Designation of blue carbon projects in Kenya

Neither the Act nor the Regulations explicitly mention "coastal and blue carbon forest projects". They, however, provide for carbon projects, categorising them as either land-based or non-land-based. Land-based carbon projects are defined in the Regulations to involve activities related to land use, management, and ecosystem conservation to reduce greenhouse gas emissions or enhance carbon sequestration (Carbon Market Regulations 2024, r 2). Blue carbon ecosystems fall under land-based carbon projects, as they are included in the Regulations' broad definition of land-based projects.

3.5.1.2. Governance Framework for the development and management of blue carbon projects

The Act and Regulations establish a governance framework for carbon projects, assigning specific roles to various entities. Some of the entities set out include the Cabinet Secretary who appoints members to the multi-sectoral committee, sector registrars, and is charged with developing regulations on carbon trading, registries and non-market approaches, which may impact blue carbon projects.

The Designated National Authority (DNA), who has by Gazette Notice been designated as National Environment Management Authority (NEMA), oversees carbon project approvals, monitors registered projects, and provides guidance on Article 6 of the Paris Agreement. The DNA also maintains and updates a list of recognized carbon standards and appoints ad hoc committees for project reviews. The Multi-sectoral Technical Committee, comprising experts from various sectors, advises the DNA, while county governments are responsible for issuing project proponents with letters of support, and overseeing the negotiation and implementation of Community Development Agreements entered into by project proponents and communities on public and community land. The Climate Change Directorate (CCD) supports these efforts by coordinating stakeholders, facilitating public awareness, and conducting research on carbon markets, providing essential information for the effective implementation of blue carbon projects.

3.5.1.3. Technical infrastructure

The Act establishes the National Carbon Registry ("Registry") to be headed by the DNA. The Registry which is yet to be established is to contain registers on the amount of carbon credits issued or transferred by Kenya, carbon credit projects and programmes implemented within the country, a record of corresponding adjustments, amongst others. The establishment of the Registry is fundamental for providing guidance on tracking and transfers of carbon credits which is currently lacking in the country. The Registry also provides a mechanism for ensuring that the carbon sequestration contributions of blue carbon projects are accurately tracked, verified, and recognized and double counting is avoided.

3.5.1.4 Approval process for blue carbon projects

To register a blue carbon project in Kenya, a project proponent must first apply to the DNA using the Form PCN set out in the First Schedule to the Regulations. The DNA will review the application and, if complete and compliant, issue a letter of no objection within 14 days. If the application is declined, the DNA will notify the proponent in writing, explaining the reasons. Upon receiving the no-objection letter, the proponent has 12 months to develop and submit a Project Design Document (PDD) to the DNA, including all required approvals and reports. The DNA will then forward the PDD to an ad-hoc committee for review. Based on the committee's recommendations, the DNA, with the Cabinet Secretary's concurrence, will approve or reject the project. Once approved, the proponent must begin implementing the project within 12 months or request an extension and failure to do so may result in project cancellation.

3.5.1.5. Specific requirements related to Letters of Authorization

Blue carbon project proponents in Kenya may request authorization for International Transfer of Mitigation Outcomes (ITMOs) from the Designated National Authority (DNA). The request for authorization form additionally clarifies that authorized credits from Kenya could be used towards the achievement of another country's NDC, for CORSIA, or for other international mitigation purposes. Upon receiving the request, the DNA, with Cabinet Secretary approval, may issue a Letter of Authorization (LoA), specifying the authorized use of the carbon credits and amount of ITMOs allowed for transfer. The LoA includes a government declaration to prevent double claiming and counting, ensuring that emission reductions authorised as ITMOs will not be used to meet Kenya's NDC and will be accounted for with corresponding adjustments under the Paris Agreement. Additionally, the LoA may require projects to allocate a portion of carbon credits for Kenya's NDC and global emission reduction contributions, though specific contributions will be determined on a case-by-case basis pending further DNA guidelines.

3.5.1.6. Environmental and social safeguards

The Act and Regulations emphasize the importance of environmental and social safeguards in carbon projects to maximize benefits and prevent harm. At the approval stage, projects must demonstrate environmental integrity in their concept notes and Project Design Documents (PDDs) and undergo an Environmental and Social Impact Assessment (ESIA) as required by EMCA. Adherence to sector-specific standards and safeguards is mandatory, with REDD+ projects needing a specific safeguards assessment, though the process is yet to be clarified. Free, Prior, and Informed Consent (FPIC) is required for all land-based projects on community land, and failure to comply with these safeguards can result in project cancellation or liability for environmental or human harm.

3.5.1.7. Benefit sharing

Blue carbon projects on public and community land must make an annual social contribution to communities. The annual social contribution is defined as the sharing of annual benefits accruing from carbon projects (Carbon Market Regulations 2024, r 2), and is the mechanism under which communities receive benefits. In the case of projects on public and community land, contributions must be included, managed and disbursed under the Community Development Agreement (CDA) as outlined in the Fourth Schedule, and must be at least 40% of the aggregate earnings from the previous year, minus the cost of doing business (Carbon Market Regulations 2024, r 29). The existing blue carbon projects in the country, Mikoko Pamoja and Vanga Blue Forest currently provide communities with a 60% share of revenues, well above the floor of 40% prescribed in Kenya's laws. Private carbon projects on private land are however not required to disburse the annual social contributions in the manner prescribed in the Act.

3.5.1.8. Fees and costs

Blue carbon project proponents in Kenya are required to pay some fees at different stages of the carbon project approval process. The fees for a Letter of No Objection and a Letter of Approval vary depending on whether the project is classified as a "citizen" or "non-citizen" project, with citizen projects benefiting from reduced rates. Further administrative fees are payable to the DNA in two stages, and depend on the quantity of carbon credits projected to be issued/ issued to a carbon project. These fees are set out in greater detail in chapter 3.2.1 and in the underlying technical study "Economic and financial analysis of blue carbon projects in Kwale County" in annex 2.

3.5.1.9. Dispute resolution

Disputes arising under land-based projects must first be resolved through the dispute resolution mechanism outlined in the CDA within 30 days. If unresolved, the dispute is referred to the National Environmental Tribunal (NET), with any further appeals directed to the Environment and Land Court (Climate Change Act 2016, s 23H)

3.5.1.10. Transition

The Act provided a one-year transition period for existing blue carbon projects, allowing them until September 14, 2024, to comply with its provisions. The Regulations require ongoing carbon projects to complete an environmental audit within six months of the Regulations' commencement, translating to November 16, 2024, for blue carbon projects. Blue carbon project proponents must ensure compliance with all provisions of the Regulations within two years, and as such by May 16, 2026. Compliance with these transition requirements is essential for the legal operation of blue carbon projects in Kenya.

3.5.2. Institutions that could be involved in blue carbon projects locally

The institutions and entities involved in developing blue carbon projects and generating blue carbon credits in Kenya operate under the authority and mandates provided by the country's existing laws and regulations governing coastal and blue carbon ecosystems. These stakeholders include public and private sector entities, as well as non-governmental organisations and local communities. The Constitution mandates that every individual must cooperate with State organs and other entities to protect and conserve the environment, ensuring ecologically sustainable development and responsible use of natural resources. This includes an obligation to protect, conserve and restore mangroves, seagrasses and all other coastal resources in Kenya.

An analysis of the policy and legislative framework reveals that various bodies are responsible for managing blue carbon ecosystems, as well as in the generation and sale of blue carbon credits. Key institutions include public institutions at both the national and county levels, local communities, academia, Non-Governmental Organisations (NGOs), Civil Society Organizations (CSOs), project developers, financiers, and investors. Each of these groups play a distinct and crucial role in the development and management of blue carbon projects.

Blue carbon and coastal ecosystems are constitutionally recognized as public land vested in and held by the national government in trust for the people of Kenya. As such, the Kenya Forest Service (KFS) which under the Forest Conservation and Management Act (FCMA), has the duty of conserving, protecting and managing all public forests, would be the public entity granting any authorizations for forest conservation and a project proponent would need to demonstrate consent of the KFS for the development and implementation of the carbon project. The approval of other government entities may be necessary dispensing on the project area. For example, Kenya Wildlife Service has a role to play in protecting wildlife protected areas where a blue carbon project may be situated, and in this case has an overlapping mandate with KFS in such areas.

Under the FCMA, private entities may also be involved in the management of public forests through concessions and joint management agreements. Local communities can be involved in blue carbon projects as Kenya's forestry laws recognize participatory forest management, and allow the establishment of Community Forest Associations (CFAs). CFAs enter into Joint Management Agreements with KFS setting out the communities' obligations to manage and conserve the public forest in question, and setting out forest user rights and community benefits. This enables local coastal communities to undertake blue carbon projects with the technical support of research institutions, NGOs, financiers and investors.

3.5.3. Risks and potential safeguards

Carbon projects for coastal and blue carbon ecosystems have significant benefits for both people and the planet. However, scaling up conservation and reforestation efforts for carbon credits has attendant risks that must be carefully understood, minimised and mitigated wherever possible. Table 12 summarises various risks and potential safeguards against them.

Table 12: Risks and potential safeguards of carbon projects in Kenya

S/N	Risk	Safeguard
1.	Double counting	To mitigate double counting in blue carbon projects, proponents must determine if their project will contribute to Kenya's Nationally Determined Contribution (NDC) or to other purposes, such as another State's NDC or CORSIA. If the emission reductions from the project are to be transferred out of Kenya and not used to meet Kenya's NDC, proponents must request Letters of Authorization and Kenya will apply corresponding adjustments. Additionally, Kenya plans to establish a National Carbon Registry to track all carbon credits, transfers, and adjustments for both compliance and voluntary markets. Through robust oversight and maintaining accurate records, double counting risks can be minimized.
2.	Over-crediting	Over-crediting affects a project's environmental integrity and is caused by using unrealistic baseline assumptions or employing data with large uncertainties. Robust project design carefully utilizing blue carbon methodologies from recognized standard bodies and application of appropriate MRV systems is critical for blue carbon projects to mitigate these measurement risks. Maintaining a carbon credit buffer to ensure a backup pool or reserve of carbon credits exists is also important to act as a safeguard that ensures these carbon credits are set aside to be relied on where a project faces carbon credit over-issuance.
3.	Additionality, non-permanence and leakage	Careful selection of the blue carbon project area and thorough analysis of its additionality is necessary to prevent the risk of non-additionality. To mitigate the risk of non-permanence, blue carbon projects should be sited where land tenure, tree and carbon rights have been clarified, and external insurance is available where the trees are destroyed. To mitigate against leakage, alternative livelihood activities, such as the promotion of sustainable fishery, can be established for local communities to reduce pressures on forests elsewhere. Project proponents must also ensure that the PDD includes strategies to monitor and manage potential leakage effects.
4.	Human rights violation risk	To avoid human rights violation risks, blue carbon projects must ensure public participation, and most importantly obtain Free Prior and Informed Consent as the counting of their emission credits depends on this. In their engagement with communities, blue carbon projects must also ensure that they comply with the benefit-sharing and grievance recourse mechanisms set out in law. It is also fundamental that project proponents comply with the requirements to undertake environmental impact study assessments and environmental audits in the Act and Regulations. Measures that clarify land tenure and land use must also be put in place.
5.	Legal risk	As a safeguard to the risk of lack of legal clarity, blue carbon project proponents must seek legal advice as they develop their projects and keep abreast with all legal developments in the country. These developments will include regulations to be made by the Cabinet Secretary as mandated by the Act, as well as guidance from the DNA on the rules, modalities and procedures of Article 6.4 and 6.2 of the Paris Agreement on cooperative approaches.
6.	Market risks	To address market risks, it is crucial that blue carbon projects adhere to rigorous and internationally recognized standards for their carbon accounting and verification. The projects must ensure that their carbon credits meet the high integrity thresholds by using well-established methodologies, obtaining third-party certifications, implementing transparent reporting practices, and adhering to environmental and social safeguards. By actively demonstrating a commitment to high-quality carbon credits, blue carbon projects can bolster their credibility and enter into contracts with buyers on the future sale of carbon credits for a secured carbon credit price mitigating market risk.
7	Natural disaster risks	To mitigate natural disaster risks, project proponents may implement comprehensive insurance coverage to protect against financial losses from such events and maintain carbon credit buffer pools that can be relied on to address risks of non-delivery that arise when natural disasters are experienced. Innovative contracting is also crucial, with force majeure clauses defining natural disaster scenarios and outlining responsibilities, alongside contingency plans for recovery and performance bonds to ensure financial stability. Additionally, incorporating resilience measures such as fire-resistant practices, emergency response plans, and regular monitoring can help manage and reduce vulnerabilities.

4 Conclusion and recommendations

Blue carbon ecosystems in Kenya are represented by mangrove forests and seagrass beds. These coastal wetlands capture and store huge carbon stocks; in addition to providing habitat for fish and other wildlife, protecting shoreline, and supporting community livelihood. Unfortunately, along the Kenyan coast, blue carbon ecosystems continue to be lost and degraded as a result of overexploitation of resources, habitat conversions, pollution and climate change. Losses of blue carbon ecosystems have undesirable effects to fisheries, shoreline stability, and resource sustainability. This study focused on demonstrating to the financial sectors the opportunities for investment in mangrove and seagrass conservation and restoration arising from 1) the carbon market and 2) sustainable fisheries in Kenya.

Under the business as usual (BAU) scenario, mangroves in Lamu and Kwale counties will continue to decline by 0.16% yr-1 and 0.49% yr-1, leading to emissions of 514.01 and 482.92 Mg CO_2e ha-1, respectively, over the next 30 years and relative to the 2020 baselines. At the same time, seagrasses in Lamu will decrease at 0.67% yr-1, emitting 5.21 million tCO_2e by 2050. With concerted efforts, emission reductions of 8.57 million tCO_2e and 5.12 million tCO_2e in mangroves and seagrasses, respectively, are expected over the 2020-2050 period in the two Counties. Assuming a crediting price of US$20/t$CO_2$e for high quality blue carbon credits, the estimated benefit from avoided deforestation and restoration activities for mangroves and seagrasses in Lamu and Kwale Counties over the next 30 years is estimated at US$ 114,173,700.

Further, the study investigated the financial viability, including a cash-flow analysis, of a hypothetical avoided restoration (i.e. conservation) project in Kwale or Lamu County. The results showed that there is a highly positive NPV and an IRR of 22%, demonstrating the high financial viability of a conservation project in Kwale or Lamu County. Also, the cash-flow analysis of a hypothetical carbon credit project in Kwale or Lamu County that involves conservation (90 hectares) and restoration (10 hectares) interventions were also conducted with results showing a highly positive NPV of around US$100,000 with an IRR of 20%, again demonstrating high financial viability.

Mangroves and seagrasses are also vital habitats in supporting coastal fisheries with more than 70% of small-scale fisheries estimated to depend one way or another on these blue carbon ecosystems. Income from small-scale coastal fishery indicates relatively increasing trends in Kwale and Lamu Counties. The profits are likely to be stable over time due to on-going local and national initiatives related to environmental, capacity building, and institutional and legislative frameworks.

The economic analysis of mangrove conservation and restoration revealed that the long-term benefits in terms of carbon sequestration, fishery support, education and research, ecotourism, and shoreline protection far exceed the costs, justifying the investment opportunity in these critical ecosystems. To be specific, the cost-benefit analysis revealed a benefit-cost ratio of 3.17, implying that for every dollar invested in mangrove conservation and restoration (incl. carbon offsetting), US$ 3.17 of socio-economic benefits are generated.

Kenya is well placed to benefit from investments in blue carbon projects for climate, community and biodiversity benefits. The path to unlocking this potential lies in the concerted efforts of different actors in both the public and private sectors, to realise the opportunities available. Whilst the national government has commendably developed legal and policy frameworks for carbon markets, these need to be operationalized with the requisite technical and institutional infrastructure set up. This includes the establishment of the National Carbon Registry and supporting regulations, as well as guidelines on Article 6 implementation. County governments such as those of Lamu and Kwale who are required by the Carbon Market regulations to issue carbon project proponents operating in their counties with letters of support need to coordinate seamless processes and procedures for the acquisition of this supporting documentation, to enable these blue carbon projects to operate in the country.

International Development Organizations such as GIZ have a critical role to play in providing technical support for the development of the requisite carbon market infrastructure and capacity building at the national and sub-national level. This will ensure national policymakers as well as county governments and local communities implement the legal and a regulatory requirement in a manner that minimises carbon market risks and enhances benefits. International and local financial institutions should prioritise ensuring carbon project developers access finance to develop blue carbon projects structuring localised financial instruments that address the needs of both sellers and buyers, and local NGOs and communities have a role to play in advocating for high integrity blue carbon projects and creating knowledge and awareness about the role of blue carbon, the benefits of blue carbon projects and the roles and responsibilities of different entities involved in these projects as set out in Kenya's nascent legal and regulatory framework.

Following these recommendations will strengthen Kenya's position to trade in the blue carbon markets, and at the same time ensure sustainable development is realized.

References

Bosire, J. O., Mangora, M. M., Bandeira, S. O., Rajkaran, A., Ratsimbazafy, R., Appadoo, C., & Kairo, J. G. (2016). *Mangroves of the Western Indian Ocean: status and management.* WIOMSA, Zanzibar Town, 1-161.

Carrasquilla-Henao, M. and Juanes, F. (2017). *Mangroves enhance local fisheries catches: a global meta-analysis.* Fish and Fisheries, 18, 79-93.

County Government of Kwale (2013). *First County Integrated Development Plan. County Government of Kwale.*

Duarte, C. M., Losada, I. J., Hendriks, I. E., Mazarrasa, I., & Marbà, N. (2013). *The role of coastal plant communities for climate change mitigation and adaptation.* Nature climate change, 3(11), 961-968.

Eklöf, J. S., De la Torre-Castro, M., Gullström, M., Uku, J., Muthiga, N., Lyimo, T., & Bandeira, S. O. (2008). *Sea urchin overgrazing of seagrasses: a review of current knowledge on causes, consequences, and management.* Estuarine, Coastal and Shelf Science, 79(4), 569-580.

Erftermeijer, P., de Boer, M., Hilarides, L. (2022). *Status of mangroves in the Western Indian Ocean Region.* Wetlands International, 1-67.

Githaiga, M. N., Kairo, J. G., Gilpin, L., & Huxham, M. (2017). *Carbon storage in the seagrass meadows of Gazi Bay, Kenya.* PloS one, 12(5), e0177001.

GoK (2024), *Climate Change (Carbon Markets) Regulations.*

GoK. (2017). *National mangrove ecosystem management plan.* Kenya Forest Service: Nairobi, Kenya.

GoK. (2020). *Nationally Determined Contributions.* Ministry of Environment, Climate change and Forestry.

GoK. (2023). *Ministry of Environment Climate Change and Forestry, National Climate Change Action Plan III 2023-2027.*

Hamza, A. J., Esteves, L. S., & Cvitanović, M. (2022). *Changes in mangrove cover and exposure to coastal hazards in Kenya. Land, 11(10), 1714.*

Hamza, A. J., Esteves, L. S., Cvitanovic, M., & Kairo, J. (2020). *Past and present utilization of mangrove resources in Eastern Africa and drivers of change.* Journal of Coastal Research, 95(SI), 39-44.

Harcourt, W. D., Briers, R. A., & Huxham, M. (2018). *The thin (ning) green line? Investigating changes in Kenya's seagrass coverage.* Biology letters, 14(11), 20180227.

Hoegh-Guldberg, O., Northrop, E., & Lubchenco, J. (2019). *The ocean is key to achieving climate and societal goals.* Science, 365(6460), 1372-1374.

Hamilton, S. E., & Friess, D. A. (2018). *Global carbon stocks and potential emissions due to mangrove deforestation from 2000 to 2012.* Nature Climate Change, 8(3), 240-244.

IPCC. (2019). *2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.* Recuperado de: https://www.ipcc-nggip.iges.or.jp/public/2019rf/index.html

Kairo, J. G., Wanjiru, C., & Ochiewo, J. (2009). *Net pay: economic analysis of a replanted mangrove plantation in Kenya.* Journal of Sustainable Forestry, 28(3-5), 395-414.

Kairo, J. G., Dahdouh-Guebas, F., Bosire, J., & Koedam, N. (2001). *Restoration and management of mangrove systems—a lesson for and from the East African region.* South African Journal of Botany, 67(3), 383-389.

Kilonzi, F; Hamza, A. J; Mary, K and Kairo, J. G. (2024). *Cost–Benefit Analysis of Mangrove Conservation in Kwale County.* GIZ Nairobi (Unpublished).

KWS. (2013). *Coral reefs and seagrass ecosystems conservation strategy 2014- 2018.* P 8-21, Nairobi, Kenya.

Langa't et al., (2024). *Delivering the ocean climate actions: Building a robust information base to facilitate and enhance the incorporation of blue carbon solutions into Kenya's climate commitments.* In Press

Lee, S. Y., Primavera, J. H., Dahdouh-Guebas, F., McKee, K., Bosire, J. O., Cannicci, S., ... & Record, S. (2014). *Ecological role and services of tropical mangrove ecosystems: a reassessment.* Global Ecology and Biogeography, 23, 726-743.

Macreadie, P. I., Costa, M. D., Atwood, T. B., Friess, D. A., Kelleway, J. J., Kennedy, H., Lovelock, C. E., Serrano, O., & Duarte, C. M. (2021). *Blue carbon as a natural climate solution.* Nature Reviews Earth & Environment, 2(12), 826-839. https://doi.org/10.1038/s43017-021-00224-1

Mcleod, E., Chmura, G. L., Bouillon, S., Salm, R., Björk, M., Duarte, C. M., ... & Silliman, B. R. (2011). *A blueprint for blue carbon: toward an improved understanding of the role of vegetated coastal habitats in sequestering CO2.* Frontiers in Ecology and the Environment, 9(10), 552-560.

Nagelkerken, I. S. J. M., Blaber, S. J. M., Bouillon, S., Green, P., Haywood, M., Kirton, L. G., & Somerfield, P. J. (2008). *The habitat function of mangroves for terrestrial and marine fauna: a review.* Aquatic botany, 89(2), 155-185.

Nellenmann, B (2009). T*he Role of Healthy Oceans in Binding Carbon: A Rapid Response Assessment.* GRID-Arendal, Arendal, [Norway], 9, 819-828.

Ochieng, C. A., & Erftemeijer, P. L. (2003). Kenya and Tanzania. In Green E., and Short F. (Ed.). T*he seagrasses of Kenya and Tanzania, World Atlas of Seagrasses World Conservation Monitoring Centre (Vol. 7, pp. 82–92).* University of California Press, PP 83-100.

Pendleton, L., Donato, D. C., Murray, B. C., Crooks, S., Jenkins, W. A., Sifleet, S., ... & Baldera, A. (2012). *Estimating global "blue carbon" emissions from conversion and degradation of vegetated coastal ecosystems.* PLoS ONE, 7(9), e43542.

Sumaila, U. R., Walsh, M., Hoareau, K., Cox, A., Abdallah, P., Akpalu, W., ... & Sack, K. (2020). *Ocean finance: Financing the transition to a sustainable ocean economy.* World Resources Institute.

Uku, J., Daudi, L., Alati, V., Nzioka, A., & Muthama, C. (2021). *The status of seagrass beds in the coastal county of Lamu, Kenya.* Aquatic Ecosystem Health & Management, 24(1), 35-42

United Nations Environment Programme (2021). *Making Peace with Nature: A scientific blueprint to tackle the climate, biodiversity and pollution emergencies.* Nairobi. https://www.unep.org/resources/making-peace-nature

UNEP. (2009). *The Natural Fix? The role of Ecosystems in climate mitigation, A UNEP Rapid Response Assessment-United Nations Environment Programme, UNEP-WCMC, Cambridge, UK.*

Wambua C, Kairo, J. G., Maingi L., And Kosgei G. (2024). *Generating Blue Carbon Credits in Kenya: Review of the Enabling Legal and Policy Environment.* Giz Nairobi (Unpublished).

List of annexes

Annex i: Protocols (follow the links)

- Protocol for mangrove carbon assessment and emissions
- Protocol for seagrass carbon assessment and emissions
- Protocol for mangrove and seagrass mapping
- Protocol for desktop review of existing data and information on status, conditions and trends of Blue Carbon in Kenya
- Protocol for mangrove and seagrass cumulative carbon stocks, sequestration rates, and emission projections

Annex ii: Reports

https://drive.google.com/drive/folders/1eT8S-wQ_uIhnPmImSeQwJjBO7cshhWbB?usp=drive_link

Annex iii. Maps

https://drive.google.com/drive/folders/1rzwnq5KUjkd35iZ1_nfNI_9MN0b7wXu-?usp=drive_link

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