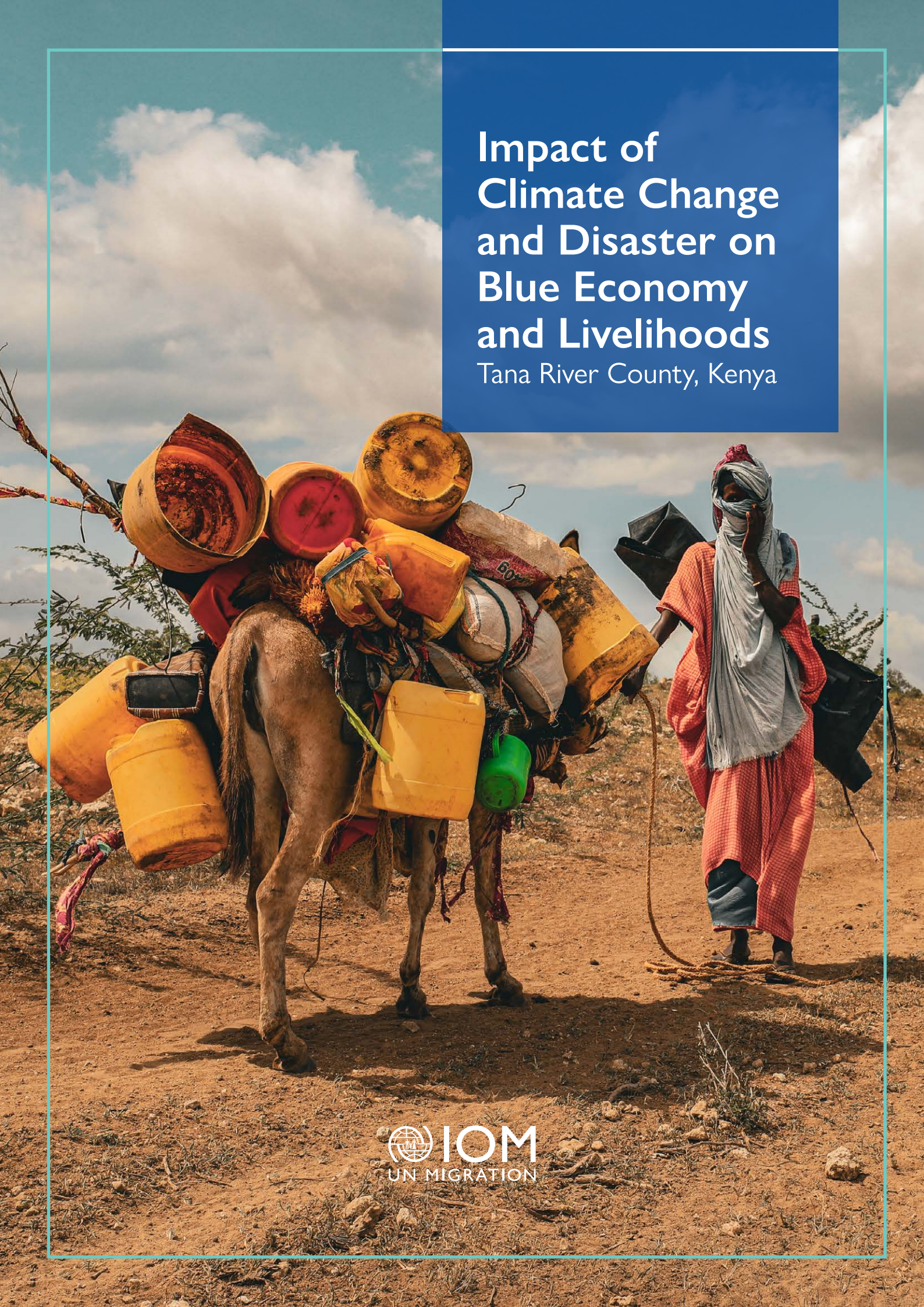
Impact of Climate Change and Disaster on Blue Economy and Livelihoods

Tana River County, Kenya



IOM
UN MIGRATION

This report was prepared within the framework of the project "Kenya: Engaging Migrants and Diaspora Communities for an Inclusive and Climate Resilient Blue Economy" funded by the IOM Development Fund. The opinions expressed herein are those of the author and do not necessarily reflect the views of IOM.

Publisher: International Organization for Migration
Kenya Country Office
Sri Aurobindo Avenue, Off Mzima Spring Road
Lavington, Nairobi,
Kenya
Tel: +254.20.422.1000
Fax: +254.20.444.957717
E-mail: IOMKECountryOffice@iom.int
Website: http://www.iom.int

This publication was issued without formal editing by IOM.
This publication was issued without IOM Publications Unit (PUB) approval.
This publication was issued without IOM Research Unit (RES) approval.

Required citation: International Organization for Migration Kenya Country Office, 2022. Impacts of Climate Change and Disasters on Blue Economy Livelihoods in Tana River County, Kenya. IOM, Kenya.

Impact of Climate Change and Disaster on Blue Economy and Livelihoods

Tana River County, Kenya

IOM
UN MIGRATION

CONTENTS

EXECUTIVE SUMMARY

The blue economy underpins our life on earth. Oceans produce half of the world's oxygen, absorb carbon dioxide, and are essential in the provision of food, transport, and recreational and tourism activities. However, blue economy livelihoods and industries are threatened by climate change and disasters. For instance, climate change is altering ocean climate, sea level, acidity, water circulation, and ice distribution. These system changes are impacting on coastal ecosystems and species that underpin coastal economic benefits. Therefore, long-term blue economy management plans will need to take account of the potential impacts of climate change and disasters on blue economy livelihoods and businesses. This is essential because climate projections indicate that even if global warming is limited to 2oC, oceans will warm by 2 to 4 times by 2100, and 5 to 7 times under higher emission scenario in comparison to 1970–2017 levels.

Therefore, this research study examined the impacts of climate change and climatic disasters on blue economy livelihoods in Tana River County, one of the most vulnerable coastal counties to the effects of climate change and disasters in Kenya. The data collection was conducted through extensive literature review, questionnaire, key informant interviews and focus group discussions. The identified blue economy livelihoods include fishing, fish farming, coastal tourism, farming, and pastoralism. Although agriculture is not primarily considered a blue economy livelihood, much of crop farming and pastoralism are enabled by the Tana Delta, a blue economy resource, in Tana Delta Sub-County, Tana River County.

The blue economy has a potential to contribute USD 4.8 billion to the Kenyan economy between 2020-2030. The study ascertained that there is a high-level political will to promote sustainable blue economy in Kenya. For instance, the blue economy is one of the priority sectors in the Third Term Medium Plan (MTP III) (2018-2022). In 2016, the State Department for Fisheries, Aquaculture and the Blue Economy was established under the Ministry of Agriculture, Livestock and Fisheries. Also, Kenya is one of the 14 member countries of the High-Level Panel for a Sustainable Ocean Economy. These countries envision ocean solutions that benefit local people, nature, and the economy and have committed to sustainably manage 100 per cent of the ocean area under their national jurisdiction by 2025.

The study found out that droughts pose serious and/or severe risks to crop farmers and pastoralists. However, only nearly a third of the respondents perceived flood risk to be serious. Resource-based conflicts were perceived to be more severe among the pastoralists (94%). The research further explored how climate patterns have changed in the last 20 years. The respondents highlighted that the dry periods occur more frequently and for a prolonged period. About 95 per cent of the farmers also illustrated that rainy seasons have shifted and are more unpredictable due to climate change. Majority of the fishers (70%) highlighted that the surface ocean temperature has increased compared to 2000. Also, over 80 per cent of the fishers perceived sea level to have risen within the last two decades.

Climate change and disasters have impacted negatively on investigated blue economy livelihoods. For instance, at least two-thirds of the farmers have experienced crop failure and reduced harvests due to prolonged droughts and erratic rainfall. About three-quarters of the pastoralists have lost their livestock because of prolonged droughts. Droughts cause a reduction of water levels in lakes and rivers. Furthermore, over 95 per cent of fishers argued that the fish catch potential, and the composition of harvested fish species have decreased or significantly decreased in the last twenty years. Nearly three-quarters of the fishers attributed this reduction to changing ocean climate.

Planting drought-resistant crops was the most prevalent climate change adaptation strategy by nearly three-quarters of the farmers. Four predominant adaptation strategies by over 80 per cent of the pastoralists include diversification of livelihoods through crop farming, buying animal fodder, reducing the number of livestock, and migration to the Tana Delta region.

Livelihood diversification through crop farming was the main adaptation measure by nearly half of the fishers. Several constraints have hampered the adoption of effective climate change adaptation strategies. Farmers cited financial constraints as the main stumbling block towards the transition to climate smart agriculture. Similarly, 88 per cent of the fishers alluded that financial challenges have impeded the acquisition of modern fishing vessels and gears to enable offshore and deep-sea fishing. On the other hand, dwindling grazeland and prolonged droughts are threatening pastoralism. Farmland expansion and increasing wildlife conservancies were cited as the major drivers for shrinking grazeland.

ABBREVIATIONS

BMU	Beach Management Unit
EbA	Ecosystem-based Adaptation
Eco-DRR	Ecosystem-based Disaster Risk Reduction
DRR	Disaster Risk Reduction
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Product
IOM	International Organization for Migration
IPCC	Intergovernmental Panel on Climate Change
KCSAS	Kenya Climate Smart Agriculture Strategy
KeFS	Kenya Fisheries Service
KEMFRI	Kenya Marine and Fisheries Research Institute
KES	Kenya Shilling
KFS	Kenya Forest Service
KNSL	Kenya National Shipping Line
KWS	Kenya Wildlife Service
MCS	Monitoring, Control and Surveillance
MECC	Migration, Environment and Climate Change Unit
MTP III	Third Medium Term Plan
NDC	Nationally Determined Contributions
NDMA	National Drought Management Authority
NEMA	National Environment Management Authority
NGO	Non-Governmental Organization
PPP	Public Private Partnership
REDD+	Reducing emissions from deforestation and forest degradation, and the role of conservation, sustainable management of forests, and enhancement of forest carbon stocks in developing countries
SBEC	Sustainable Blue Economy Conference
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Programme

Due to the impending drought, a number of wells and dams have dried up in Tana River County, which has forced people to move to find pastures and water sources elsewhere. Photo: © Moses Otunga/IOM 2022

Drought-affected pastoralists have migrated in search of water and pasture for their livestock in Tana River County, Kenya. Communities in the Tana River are facing the threat of starvation due to the continued drought conditions. Photo:© Angela Njuguna/IOM 2022

1. BACKGROUND

1.1 INTRODUCTION

The blue economy is viewed as a blueprint for promoting economic development through sustainable use and conservation of oceanic and inland water resources. The scientists and policymakers are now cognizant of the role of the blue economy in enhancing socio-economic development and environmental sustainability (Okafor-Yarwood et al., 2020). It is estimated that the blue economy accounts for about 3.5 per cent to 7 per cent of the global GDP (UNCTAD, 2020), and 1 per cent of the global workforce. In addition, the ocean fisheries sector provides livelihoods to approximately 8 per cent of the world's population, either directly or indirectly (Sarker et al., 2019). Also, global marine and coastal tourism generate about USD 161 billion in revenues annually (FAO, 2016).

However, climate change and disasters pose an imminent threat to the blue economy mainly through disruption of ocean-based businesses/livelihoods and degradation of water-related ecosystems and biodiversity (Karanja and Saito, 2018). Climate change is altering ocean climate, sea level, acidity, water circulation, and ice distribution. These system changes have direct impacts on coastal ecosystems and species that underpin coastal economic benefits (Gaines et al., 2019; Obura et al., 2017a; IPCC, 2019).

Furthermore, coastal hazards such as tsunami, floods, and earthquakes undermine the resilience and sustainability of the blue economy (IPCC, 2019; Karanja and Saito, 2018). Climate change is expected to increase the frequency and intensity of hydrological, meteorological, and climatological disasters such as floods, tropical cyclones, and drought (IPCC, 2019). Additionally, the COVID-19 pandemic has severely affected coastal tourism, fisheries and seafood production, and maritime transport globally (UNCTAD, 2020).

Kenya is susceptible to prolonged droughts and intense flooding. In 2020, blue economy-based livelihoods were severely affected by ravaging floods in the coastal region and rising water levels in Rift Valley lakes. For instance, rising water levels submerged businesses and displaced nearly 25,000 and 5,000 people living on the shores of Lake Turkana and Lake Baringo, respectively (Kakai, 2020; Wambua-Soi, 2020). In the coastal region, floods displaced at least 48,000 people in Tana River County in May 2020 (Njoka, 2020). Between 2017 and 2019, floods severely affected coastal communities of Kenya because of heavy rains (Blaskovic, 2017; Feingold and Thornton, 2018; Maranga, 2019; Okaka and Odhiambo, 2019).

Furthermore, the blue economy sector is highly vulnerable to climate change in most African countries (Barange et al., 2018). For instance, the fisheries sector in Africa is mainly composed of artisanal and small-scale fishers largely characterized by basic fishing gears and vessels and inshore fishing (Obura et al., 2017b). As ocean surface warms and fish stocks shift to cooler climate such as the deep sea, the livelihoods of artisanal and small-scale fishers will be severely threatened. Therefore, there is an urgent need to increase the resilience of emerging blue economy sector in Africa.

Although there is a consensus that climate change and disasters are a threat to blue economy-based livelihoods (IPCC, 2019), there are limited studies that have examined the impacts of climatic disasters on blue economy-based livelihoods/businesses particularly in East Africa (Gaines et al., 2019). Furthermore, the few available studies have largely examined the impacts of sudden-onset disasters namely earthquakes, floods, and tsunamis on ocean-based businesses (Karanja and Saito; 2018; Okaka and Odhiambo, 2019). However, how slow-onset disasters such as droughts and human-induced disasters such as conflicts influence the blue economy is rarely investigated. Therefore, this study aims to holistically examine the impacts of

climate change and disasters on blue economy livelihoods in Tana River County, Kenya. Recommendations from this study are expected to contribute to developing programmes to strengthen the resilience of blue economy livelihoods to climate change and coastal disasters.

1.2 SPECIFIC OBJECTIVES

i. To assess the impacts of sudden/slow-onset disasters such as floods and drought and human-induced disasters, including resource-based conflicts on migration and blue economy livelihoods in Tana River County.

ii. To examine the impacts of climate change on blue economy livelihoods in Tana River County.

iii. To examine adopted disaster risk reduction and climate change adaptation strategies in coastal region of Tana River County.

iv. To assess climate change adaptive capacity and conduct needs assessment to enhance the resilience of blue economy-dependent communities.

v. To examine blue economy and climate change institutional and policy frameworks.

vi. To map out public-private partnerships in the blue economy sector in Kenya; and,

vii. To suggest pilot projects to enhance blue economy resilience in Tana River County.

Climate change has caused drought and water scarcity exposing women and girls in Tana River to new vulnerabilities like abuse, rape and Gender Based Violence as they walk long distances to search for water for their households. Photo:© Moses Otunga/IOM 2022

2. LITERATURE REVIEW

INTRODUCTION

The blue economy underpins life on our planet. Oceans produce half of the world's oxygen, absorb carbon dioxide, and are essential in the provision of food, transport, and recreational and tourism activities. Long-term blue economy management plans will need to take account of the potential impacts of climate change on blue economy livelihoods/businesses. The desktop review, therefore, examines the impacts of climate change and climatic disasters on the blue economy. Since the overall study focuses on coastal Kenya, most of the statistics and analysis focus on the Western Indian Ocean. The review also explores how the blue economy could strengthen adaptive capacity and resilience to climate change and coastal disasters. Lastly, the review critically examines the policies and strategies adopted by the Kenyan Government to strengthen climate change resilience, disaster risk reduction, and a sustainable blue economy. Interviews were also conducted with officials from the State Department of Fisheries, Aquaculture, and the Blue Economy to understand level of private sectors engagement in sustainable blue economy development. The review aims to provide support to policymakers and stakeholders in the quest for a healthy, sustainable, and resilient blue economy. It also provides mechanisms on how the country can harness diaspora resources and skills to promote sustainable blue economy.

The study defines the blue economy as sustainable use of aquatic, coastal and marine resources including oceans, seas, coasts, lakes, rivers, underground water, and wetlands. In Kenya, the blue economy is centred on fisheries and aquaculture, coastal and cruise tourism, maritime transport, ocean renewable energy, offshore oil and gas exploration, deep and short sea shipping, blue biotechnology, extractives, and marine aquatic products.

2.1 IMPACTS OF CLIMATE CHANGE AND DISASTERS ON THE BLUE ECONOMY

Climate change is unequivocal (IPCC, 2014). This section illustrates how climate change has affected physical and coastal ecosystems that enable the blue economy. Climate drivers on marine and coastal ecosystems include warming ocean, sea level rise, acidification, deoxygenation, storm characteristics, runoff, and changes in wind and precipitation patterns (Nicholls et al., 2010; IPCC, 2019) as summarized in Table 2.1.

2.1.1 WARMING OCEAN

There is a high certainty that global warming has reached 1oC above pre-industrial levels (IPCC, 2014). According to the Intergovernmental Panel on Climate Change (IPCC) Special Report on the Ocean and Cryosphere in a Changing Climate, there are compelling evidence that oceans are warmer, more acidic, and less productive (IPCC, 2019). Ocean warming reduces the supply of oxygen and nutrients necessary to support aquatic life (Nicholls et al., 2010; Barange et al., 2018).

Table 2.1 Climate drivers and their impacts on physical and coastal ecosystems

Climate Drivers (Trend)		Main physical and ecosystem effects on coastal systems
CO2 concentration ⇧		Increased CO2 fertilization: decreased seawater pH (ocean acidification) negatively impacting coral reefs and other pH-sensitive organisms
Sea surface temperature ⇧		Increased stratification/changed circulation; reduced incidence of sea ice at higher latitudes; increased coral bleaching and mortality; pole ward species migration; increased algal blooms.
Seal level rise ⇧		Inundation, flood, and storm damages; erosion, saltwater intrusion; rising water tables (impede drainage): wetland loss/change.
Storm	Intensity ⇧	Increased extreme water levels and wave heights; increased episodic erosion, storm damage, risk of flooding, and defence failure.
	Frequency (?)	Altered surges and storm waves and hence risk of storm damage and flooding
Wave Climate (?)		Altered wave condition, including swell; altered patterns of social erosion and accretion; re-orientation of beach orientation
Runoff		Altered flood risk in coastal lowlands; altered water quality/salinity: altered fluvial sediment supply: altered circulation and nutrient supply.

Key: ⇧ = increase:? = uncertain

Source: Nicholls et al., 2010; IPCC, 2019

It is estimated that oceans absorb 93 per cent of the excess heat in the climate system (IPCC, 2014; Barange et al., 2018). Every year from 2005 to 2017, the ocean warmed at a rate of 5.31 ± 0.38 ZJ from 0-700 m depth and at 4.02 ± 0.97 ZJ from 700-2000 m. It is also likely the ocean warming has continued in the abyssal and deep ocean below 2000 m of the southern hemisphere and the Southern Ocean. From 1993 to 2017, ocean warming increased by two-fold, and is expected to continue increasing (IPCC, 2019). In the Western Indian Ocean, sea surface temperature increased by about 0.6oC from 1950 to 2009, with some spatial variability (Barange et al., 2018; Moustahfid et al., 2018).

Climate projections indicate that even if global warming is limited to 2oC, oceans will warm by 2 to 4 times by 2100 and 5 to 7 times under higher emission scenario in comparison to 1970–2017 levels. From 2017 to 2100, the 0-2000 m layer of the ocean is projected to warm by 900 ZJ and 2,150 ZJ under low and higher emission scenarios, respectively. The overall warming of the ocean is expected to continue even after radioactive forcing and mean surface temperature stabilize (IPCC, 2019).

Warmer oceans are projected to trigger frequent storms and spatial distribution of marine species including fishes, hence significantly affecting livelihoods of coastal communities as discussed in subsequent sections.

2.1.2 SEA LEVEL RISE

Melting glaciers and ice sheets are causing sea level rise, and coastal extreme events are becoming more severe (Bosello and De Cian, 2014; Barange et al., 2018; IPCC, 2019). During the 20th century, sea level rose globally by about 15 cm. In the 21st century, however, it is rising at 0.36 cm annually and accelerating. Because of already accumulated greenhouse gases, the sea level rise could reach about 29-59 cm by 2100

even if global warming is limited below 2oC. Under high greenhouse gas emissions scenario, the sea level is projected to rise by about 61-110 cm (IPCC, 2019). Future sea level rise shall be triggered by thermal expansion, melting of glaciers and ice sheets, and land water storage changes. These factors are dependent on levels of greenhouse gas emission pathways (IPCC, 2014; IPCC, 2019).

Sea level rise will lead to serious ramifications on low-lying coastal communities as the frequency of sea level events will increase, such as high tides and intense storms (IPCC, 2019). Sea level rise interacts with mid-latitude storms and tropical cyclones, aggravating water level increases, waves, shore erosion, and the risk of flood and defence failures (Bosello and De Cian, 2014). Tropical cyclone winds and rainfall, which are on the rise, are exacerbating extreme sea level events and coastal hazards. Coastal communities and cities will be exposed to escalating flood risks. By 2050, many low-lying cities and small islands will experience extreme sea level events annually. This is likely to make small island nations uninhabitable, although habitability thresholds remain extremely difficult to assess (IPCC, 2014; IPCC, 2019).

Sea level rise and associated impacts such as inundation, flood, storms, wetland losses, erosion, saltwater intrusion, rising water tables, and disrupted drainage severely affect the blue economy sectors and resources such as tourism, fishery, agriculture, biodiversity, freshwater, and coastal infrastructure (Nicholls et al., 2010). Research indicates that with continuous trends in coastal development, intense and frequent extreme sea level events will increase annual flood damages by 2-3 orders of magnitude by 2100 (IPCC, 2019). Also, other risks associated with sea level rise such as erosion, flooding and salinization are expected to significantly increase by the end of the 21st century (Nicholls et al., 2010).

In Kenya, it is projected that a sea level rise of 30 cm is likely to inundate 17 per cent of Mombasa County (Awuor et al., 2008). This could disrupt Mombasa port operations that serve not only Kenya but also other land-locked countries including Uganda, Rwanda, Burundi, South Sudan, the Democratic Republic of Congo (DRC) as well as northern Tanzania. This could lead to severe economic impacts as 80-90 per cent of Kenya's exports and imports depend on maritime transport and by extension Mombasa port, the largest port in eastern Africa (Awuor et al., 2008; The Presidency, 2019).

Also, the coastal region is one of the most popular tourist destinations in Kenya (Met Office, 2011). Therefore, such inundation will severely affect the coastal tourism sector. In addition, the inundation will destabilize coastal ecosystem functions, disrupt economic activities, displace people, damage property (including cultural sites such as Fort Jesus), contaminate water, and trigger water-borne diseases (Awuor, 2008). It will also make agriculture unsuitable due to increased salt stress thus contributing to food and nutrition insecurity (Awuor, 2008; Karanja and Saito, 2018).

Adaptation responses to sea level rise will raise equity concerns about marginalization of the most vulnerable communities and could spark potential and compound social and nature resources-based conflicts (Karanja and Zakaria, 2018; IPCC, 2019) such as those witnessed in Tana River Counties recently (Karanja and Saito, 2018; Karanja et al., 2018). Limited resources, complex trade-offs between safety conservation and economic development, power relations, conflicting interests of coastal stakeholders, and multiple ways to frame the 'sea level rise' problem shall impede the selection of feasible response strategies (IPCC, 2019). Therefore, countries should prioritize disentangling this complex web based on their localized needs and priorities.

2.1.3 CLIMATIC COASTAL HAZARDS

Climate change is increasing the frequency and intensity of extreme weather events such as heat waves, droughts, floods, and tropical cyclones (Barange et al., 2018; IPCC, 2019). Increasing ocean warming is expected to increase the intensity of tropical storms (Bosello and De Cian, 2014). Extreme climate events

that occurred once in a century are now projected to occur annually by 2050. This will cause devastating impacts in coastal areas to both human and coastal ecosystems and biodiversity. It is projected that without major investments in climate change adaptation and resilience, the current flood losses in large coastal cities could increase from USD 6 billion to USD 1 trillion by 2050 (IPCC, 2019).

Due to warming ocean waters, marine heat waves' frequency doubled since 1982, and the intensity is increasing. Their frequency, duration, extent, and intensity are projected to increase with increasing greenhouse gas emissions. For instance, comparable to pre-industrial levels, the heat waves' frequency will be up to 20 times higher if global warming is limited at 2oC, and 50 times more if emissions continue to increase strongly (IPCC, 2019).

The IPCC (2019) report also revealed that mountainous people and those living in downstream areas are increasingly exposed to water hazards due to the melting of mountain glaciers. Eastern Africa is projected to lose about 80 per cent of the current ice mass under high emission scenario by 2100. As a result, downstream communities such as those living in further downstream of Tana River (Tana Delta) are likely to experience intense flooding because of melting glaciers in Mt. Kenya and Aberdare ranges, the water catchments for Tana River (Karanja and Saito, 2018). Therefore, there is a need to employ integrated water resources management and trans-county collaboration to address this menace.

Coastal disasters damage coastal infrastructure and resources that underpin blue economy livelihoods and businesses. Increasing frequency and intensity of floods, tropical cyclones and droughts are expected to aggravate water management problems, reduce agricultural production and food security, increase health risks, damage critical infrastructure, and disrupt the provision of essential services such as water and sanitation, education, energy, and transport (Awuor, 2008; Karanja and Zakaria, 2018; IPCC, 2019).

In Kenya, climate change has increased the frequency and severity of floods and droughts (Awuor, 2008; Met Office, 2011). Karanja and Zakaria (2018) also revealed that resource-based conflicts are on the rise because of climate change. Droughts, flood-induced agricultural damages, and reduced agricultural production due to conflicts will threaten food security as well as intensify pressure on fishery resources due to overfishing.

2.1.4 OCEAN ACIDIFICATION AND DEOXYGENATION

Oceans are crucial carbon sinks. Since the 1980s, oceans have absorbed 20-30 per cent of the emitted anthropogenic carbon dioxide, causing ocean acidification and deoxygenation (IPCC, 2014; IPCC, 2019). It is estimated that water acidity has increased by 26 per cent since the industrial revolution and is expected to continue increasing especially in warmer low and mid latitudes (Barange et al., 2018). Since the late 1980s, the open ocean alkalinity declined by a range of 0.017-0.027 pH units per decade (IPCC, 2019). In the Western Indian Ocean, surface ocean pH decreased by 0.1 pH units (Moustahfid et al., 2018). Ocean acidification has reduced the stability of mineral forms of calcium carbonate due to a lowering of carbonate ion concentrations affecting shell-forming aquatic life (Barange et al., 2018; IPCC, 2019).

By 2081 to 2100, the surface ocean pH is projected to decline by a rate of 0.036-0.042 or 0.287-0.29 pH units under low and high emission scenarios, respectively. The latter will make oceans more corrosive for the major mineral forms of calcium carbonate (IPCC, 2019). In the Western Indian Ocean, it is projected that ocean surface pH will decrease by 0.1 pH units under low emission scenario (Moustahfid et al., 2018).

It is estimated that the open ocean lost 0.5-3.3 per cent of the oxygen between 1970-2010 (IPCC, 2019). Within the last five decades, dissolved oxygen in the Western Indian Ocean decreased at a rate of 20 to 30mol/m2, accounting for 5 per cent of the global decrease (Moustahfid et al., 2018). As dissolved oxygen levels decrease with increased temperature (Barange et al., 2018), it is projected to increase by 25 mmol/

m3 by the end of the twenty-first century in the Western Indian Ocean, under low emission scenario (Moustahfid et al., 2018). Globally, by 2081 to 2100, the oxygen content in the ocean is anticipated to decline by 1.6-2.0 per cent or 3.2-3.7 per cent under low and high emission scenarios, respectively, relative to 2006 to 2015 levels (IPCC, 2019). However, subsurface (200-600 m depth) dissolved oxygen is expected to increase under the low emission scenario towards the end of the century (Moustahfid et al., 2018).

In addition, warming ocean, sea level rise, and enhanced loads of nutrients and sediments in deltas have led to salinization and deoxygenation of estuaries leading to upstream redistribution of benthic and pelagic species based on their tolerance limits (IPCC, 2019). Since the early 1980s, ocean warming, deoxygenation and eutrophication have triggered the occurrence of harmful algal blooms and pathogenic organisms. This has negatively affected food provision, tourism, fisheries and human health (Barange et al., 2018; IPCC, 2019).

2.1.5 CHANGING MARINE ECOSYSTEMS AND BIODIVERSITY

Coastal and marine ecosystems and biodiversity are the cornerstones of the blue economy. Global warming is altering ocean climate, acidity, hence threatening coastal and marine ecosystems and species that underpin coastal economic benefits (Gaines et al., 2019; IPCC, 2019). Increasing temperature, changing rainfall and climatic patterns, and the melting of snow and ice affect the quality, quantity, and seasonality of water resources, causing inevitable changes in aquatic ecosystems (IPCC, 2019; European Commission, 2020).

The IPCC (2019) report revealed that coastal ecosystems are under stress from ocean warming and sea level rise, and further exacerbated by human-induced non-climatic pressures such as ocean pollution, plastic waste, and overfishing (European Commission, 2020). For instance, warming ocean, sea level rise, extreme climate events, and other human activities have led to decline of global wetland by about 50 per cent relative to the pre-industrial level. In the last 50 years, warming induced mangrove encroachment into subtropical salt marshes have been witnessed (IPCC, 2019).

The fifth IPCC assessment report affirmed that many marine and freshwater species have shifted their geographic ranges, seasonal activities, migration patterns, abundances, and species interactions in response to changing climate (IPCC, 2014). There is also high scientific confidence that warming ocean has contributed to observed changes in biogeography of organisms ranging from phytoplankton to marine, consequently changing community composition, and in some cases, altering interactions between organisms (IPCC, 2019).

Climate models project that nets primary productivity in the ocean will highly decline by 4 to 11 per cent by 2081-2100 under high emission scenario. Since the 1970s, increased nutrient and organic matter loads in estuaries have aggravated the effects of warming in bacterial respiration and eutrophication, leading to expansion of hypoxic areas. Under high emission scenario, nitrate concentrations in the upper 100 m are expected to decline by 9 to 14 per cent by 2081-2100, relative to 2006-2015. The total mass of marine animals is expected to decline by 15 per cent by 2100 (IPCC, 2019).

Furthermore, inland shifts in plant species distributions attributable to inundation, coastline erosion and salinization have been observed, and have been accelerating in the last decades. Warming has also led to contraction of sea grass meadows and kelp forests (IPCC 2014; IPCC, 2019).

Ocean warming has increased the frequency of large-scale coral bleaching events (IPCC, 2014; Obura et al., 2017a). It is estimated that nearly all coral reefs will be degraded from their current state even if global warming is limited below 2oC. Also, species composition and diversity of remaining shallow coral reef communities is expected to change (IPCC, 2019).

In the tropical Indian Ocean, acidification and bleach of coral reefs are the major impacts experienced (Table 2.1). In 1998, one of the hottest years and the strongest El Nino recorded, Kenya experienced a coral mortality of 90 per cent. Since then, corals have recovered slowly. Kenya's second severe coral bleaching was recorded in 2016. Less than 10 per cent of coral reefs showed high or extreme bleaching and about 10 per cent experienced moderate morality (of 10-50%) (Obura et al., 2017a). Continuous bleaching of coral reefs will disrupt the flow of ecosystem services they provide such as tourism and recreation, coastal protection, seafood production that are estimated at USD 18.1 billion annually (Obura et al., 2017b; Conservation International, 2018).

The projected impacts of sea level rise on coastal ecosystems during the twenty-first century include habitat contraction, loss of functionality and biodiversity, and lateral and inland migration. The impacts will be exacerbated in cases of land reclamation and where anthropogenic barriers prevent inland migration of marshes and mangroves and limit the availability and relocation of sediments. Marshes and mangroves tend to keep up with sea level rise of below 10 mm per year; however, their capacity is dependent on factors such wave exposure of the location, tidal range, sediment trapping, overall sediment availability and coastal squeeze (IPCC, 2019).

Climate change impacts on coastal ecosystems and biodiversity not only diminish crucial ecosystem services they provide, but also threaten fundamental cultural dimensions of lives and livelihoods among coastal indigenous peoples and local communities. For instance, there is a risk of erosion of indigenous and local knowledge of ocean and coastal ecosystems, reduced access to traditional/indigenous food, and loss of indigenous cultures and cultural ecosystem services such as aesthetic, spiritual appreciation, and marine recreational activities (IPCC, 2019; Karanja et al., 2018).

Climate change and changes in marine and coastal species and ecosystems will severely affect coastal tourism, a crucial blue economy sector. Under lower emission scenario, coastal tourism is projected to lose up to USD 3 billion annually due to the loss of coral reefs caused by marine heat waves and acidification. The loss is projected to be up to USD 5.8 billion per year under high emission scenario (IPCC, 2019).

2.1.5 FISHERIES SECTOR

Changes in primary production and ocean warming have negatively affected the productivity of many fish stocks (Table 2.1). Also, shifts in the distribution of fish populations have reduced the global catch potential. Tropical oceans are expected to witness a further decline. During the twentieth century, fish stocks declined by about 3 per cent per decade in population replenishment and 4.1 per cent in maximum catch potential. Since the 1970s, the composition of fisheries catches is dominated by warm water species (IPCC, 2019). In the Western Indian Ocean, climate change is causing tuna species to shift in spatial distributions and range (Moustahfid et al., 2018). Reduced catch potential will induce strong socio-economic impacts and threaten food and nutrition security among communities highly dependent on seafood.

By 2050, the maximum fish catch potential in the world's exclusive economic zones is projected to decline by 2.8-5.3 per cent or 7.0-12.1 per cent under lower and higher emission scenarios, respectively. By 2095, it is projected to decrease by 16.2-25.2 per cent under high emission scenario (Barange et al., 2018). Fish catches are dependent on ocean productivity capacity as well as the management decisions espoused to address ocean productivity capacity. Therefore, countries should strive to sustainably manage their fishery sector.

In Kenya, the marine fish landed declined by 0.45 per cent from 9,136 metric tonnes in 2013 to 9,096 metric tonnes in 2016. During the same period, the total fish production declined by 21.3 per cent from 163,389 metric tonnes to 128,645 metric tonnes. The decline is attributed to climate change, excessive and

unregulated fishing, and use of inappropriate fishing gears and methods (The National Treasury and Planning, 2018).

Climate change-induced changes in spatial distribution and abundance of fish stocks are challenging the management of fisheries and accrued economic benefits. Shifting distributions of fish stocks could escalate jurisdictional conflicts (IPCC, 2019). Decreased fish productivity is predicted to occur at low/mid latitudes (Barange et al., 2018; IPCC, 2019). Reduction in global marine biomass and fish catch potential could intensify the risk of impacts on income, livelihood, and food security of the dependent coastal communities. The revenue potential in the fishing industry is projected to decline by about 10 per cent globally by 2050 (IPCC, 2019).

In Africa, the fisheries sector is largely composed of artisanal fishers (Obura et al., 2017b). How will shifts in the distribution of fish affect their income, fish prices, and food and nutrition security? This a major concern since Barange et al. (2018) noted that small-scale fishers and fish farmers are highly vulnerable to climate change. Interviews with the State Department of Fisheries, Aquaculture and the Blue Economy revealed that most Kenyan fishers are artisanal. Due to the limited capacity and usage of basic fishing vessels, their fishing activities are concentrated near the shoreline leading to overfishing. As ocean surface warms and fish stocks shift to cooler climate such as the deep sea, the livelihoods of artisanal fishers will be severely threatened. Therefore, there is a need to empower artisanal fishers to conduct offshore and deep-sea fishing and/or provide them with alternative livelihoods such as aquaculture and seaweed farming.

Table 2.2 Impacts of climate change on the tropical Indian Ocean

Ocean Attributes	Parameters	Tropical Indian Ocean	
Green house	Physical Changes	Temperature	**
		Oxygen	*
		Ocean pH	***
		Sea ice extent	No assessment
		Seal level	**
Climate change	Ecosystems	Upper water column	*
		Coral	***
		Coastal wetlands	**
		Kelp forest	No assessment
		Rocky shores	No assessment
		Deep sea	No assessment
		Polar benthos	No assessment
		Sea ice-associated	No assessment
	Human systems & ecosystem services	Fisheries	*
		Tourism	No assessment
		Habitat services	**
		Transportation/shipping	No assessment
		Cultural services	No assessment
		Coastal carbon sequestration	**

Source: IPCC, 2019

Legend

Physical changes	
	Increase
	Decrease

Attribution Confidence	
***	High
**	Medium
*	Low

There is also a strong correlation between coral reef bleaching and fish production. Wilson et al. (2016) noted that a loss of 10 per cent coral cover resulted in a 62 per cent reduction of fish species abundance. Kenya is classified as the most vulnerable country in the Western Indian Ocean to the impacts of coral bleaching on fisheries (Moustahfid et al., 2018). This further reinforces the need to increase the resilience and adaptive capacity of fishing communities, as climate change will significantly affect coral reef fisheries hence severely affecting the livelihoods of coastal communities. Large pelagic fish such as tuna and billfish are projected to change their movement patterns and to dwell more in deeper layers, hence reducing the effectiveness of surface gears (Moustahfid et al., 2018; IPCC, 2019). As a result, locally operated artisanal or semi-industrial fishing fleets will be significantly affected unless they develop innovative and adaptive gears to the changing habitat conditions (Moustahfid et al., 2018).

It should be noted that oxygen levels are projected to increase at depth in the Western Indian Ocean. This could become a new ecological niche for deep-dwelling tunas, thus offering opportunities for deep fishing

(Moustahfid et al., 2018). This reinforces on the urgent need to increase deep fishing capacity for small-scale reef fisheries across the Western Indian Ocean as they have been cited as highly vulnerable to climate change (Moustahfid et al., 2018).

2.2 ROLE OF THE BLUE ECONOMY IN ENHANCING RESILIENCE TO CLIMATE CHANGE AND DISASTERS

It should be noted that oxygen levels are projected to increase at depth in the Western Indian Ocean. This could become a new ecological niche for deep-dwelling tunas, thus offering opportunities for deep fishing (Moustahfid et al., 2018). This reinforces on the urgent need to increase deep fishing capacity for small-scale reef fisheries across the Western Indian Ocean as they have been cited as highly vulnerable to climate change (Moustahfid et al., 2018).

A healthy and sustainable blue economy contributes to climate change mitigation and strengthens climate change adaptation and disaster risk reduction (DRR) through ecosystem based-adaptation (EbA) and ecosystem-based disaster risk reduction (Eco-DRR) approaches (Renaud et al., 2013; Karanja and Saito, 2018). EbA and Eco-DRR are cost-effective coastal protection tools that provide multiple socio-ecological benefits (Renaud et al., 2013).

2.2.1 CLIMATE CHANGE MITIGATION

Coastal blue carbon ecosystems (such as ocean, mangroves, salt marshes and seagrass) can help mitigate carbon emissions. Coastal and marine ecosystems absorb about 30 per cent of anthropogenic carbon dioxide (Basu and Mackey, 2018). Vegetated marine habitats can store up to 1000 tC per ha, much higher than most terrestrial ecosystems (IPCC, 2019). Since the 1980s, oceans have absorbed more than 90 per cent of the excess heat in the atmosphere and sequestrated about 20-30 per cent of the anthropogenic carbon dioxide (IPCC, 2019). The carbon sequestration value of salt marshes and mangroves is estimated to be USD 30/ha/yr and USD 30.50/ha/yr, respectively (Barbier, 2011).

Marine renewable energy also offers an opportunity to reduce greenhouse gas emissions. Marine renewable energy includes ocean energy, floating solar energy and offshore hydrogen generation. By 2050, the European Union envisions producing about 35 per cent of its electricity from offshore sources (European Commission, 2020). During the Sustainable Blue Economy Conference (SBEC), Toyota Tsusho pledged to invest in renewable energy in Africa including generation of energy from waste in Mombasa, Kenya (SBEC Review Committee, 2018a).

The concept of "green ports" has emerged to help reduce the ecological footprint of port operations. Also, stakeholders are increasingly interested in transforming maritime transport towards less carbon-intensive energy sources. For instance, the European Union aims to cut 50 per cent of shipping's carbon emissions by 2050. In Europe, the shipping industry currently accounts for 3-4 per cent of carbon emissions and could reach 10 per cent by 2050 under the business-as-usual scenario (European Commission, 2020). Also, coastal regions should strive to make coastal tourism more sustainable to reduce tourists' ecological footprint.

In summary, ocean-based mitigation solutions are estimated to close the current emission gap by 21 per cent and 25 per cent in limiting global warming to 1.5oC and 2.0oC, respectively, by 2050. Under business-as-usual scenario, ocean-based solutions are expected to reduce greenhouse gas emissions by nearly 4 billion metric tonnes of carbon dioxide by 2030, and more than 11 billion tonnes by 2050 (Hoegh-Guldberg et al., 2019).

2.2.2 CLIMATE CHANGE ADAPTATION AND DISASTER RISK REDUCTION

Blue economy-dependent communities are exposed and challenged to adapt to changes in the ocean and cryosphere even if current and future climate change mitigation efforts limit global warming below 2oC (IPCC, 2019). Therefore, there is an urgent need to roll out effective climate change adaptation strategies. Coastal ecosystems could supplement climate change adaptation and DRR strategies in three ways. First, healthy coastal ecosystems can help mitigate increasing coastal hazards. For instance, healthy and well-managed mangrove forests act as a buffer against floods, storms, and tsunami. Costanza et al. (2008) estimated that mangroves provide an economic value of USD 126/ha/yr to USD 586,845/ha/yr in hurricane protection. Mangrove ecosystems also provide a value of USD 4,679ha/yr in erosion control (Barbier, 2011). In Kenya, mangroves are estimated to provide a value of USD 2,903/ha/yr in shoreline protection (Kairo et al., 2010) and a net value of USD 238/ha/yr to USD 311/ha/yr in flood risk reduction (Karanja and Saito, 2018). Also, coastal ecosystems, including mangroves, saltmarshes, vegetated dunes, and sandy beaches, can build vertically and expand laterally in response to sea level rise (IPCC, 2019).

Second, healthy coastal ecosystems provide a continuous flow of ecosystem services (blue economy) to the coastal communities that ultimately increase their adaptive capacity and reduce vulnerability to climatic hazards and risks (Renaud et al., 2013; Karanja and Saito, 2018). In other words, the blue economy builds on the adaptive capacity of coastal communities through the provision of economic power. Ocean-based businesses are estimated to contribute more than USD 500 billion to the world's economy. It is estimated that the blue economy accounts for about 3.5 per cent to 7 per cent of the global GDP (UNCTAD, 2020), and 1 per cent of the global workforce. Also, global marine and coastal tourism generate about USD 161 billion in revenues annually (FAO, 2016). In Kenya, the marine fisheries sector had employed 27,000 fishers by 2016 (UNDP, 2018).

Besides, coastal ecosystems are essential in ensuring food and nutrition security, a key adaptation option against droughts and other disasters impacting agricultural productivity. The ocean fisheries sector provides livelihoods to approximately 8 per cent of the world's population, either directly or indirectly (Sarker et al., 2019). Marine fisheries provide 80Mt of protein, about 16 per cent of consumed animal protein (European Commission, 2020).

Coastal ecosystems are also key enablers of marine fisheries and by extension food and nutrition security. The value of mangroves as a breeding ground for fish was estimated to range between USD 708/ha and USD 987/ha (Barbier, 2007). World's coral reefs are estimated to contribute USD 5.7 billion to fisheries (Conservation International, 2008). The fisheries sector generates 9 per cent of the gross marine product in the Western Indian Ocean region (Moustahfid et al., 2018). The fisheries and aquaculture sector are expected to play a crucial role in feeding an increasing population projected to reach 9.6 billion by 2050. The sector has also been cited as essential in curbing hunger and poverty and promoting health, as fish is highly nutritious (UNDP, 2018).

Furthermore, new sustainable blue economy industries, such as sustainable fisheries and aquaculture, sustainable tourism, blue carbon, marine renewable energy, and marine biotechnology, offer opportunities to generate new sources of jobs and growth, diversify the economy and livelihoods, enhance climate resilience, and strengthen food and nutrition security (UNDP, 2018). In Kenya, the blue economy supports approximately two million people either directly or indirectly (Setlur, 2020). It is estimated that Kenya's blue economy could be worth approximately USD 4.8 billion, accounting for about 5 per cent of the GDP (UNDP, 2018; The Presidency, 2019).

Third, healthy coastal ecosystems provide essential resources during the disaster recovery phase. For instance, they act as an alternative source of food, fuel, shelter, and medicine. They also provide rebuilding materials for damaged infrastructures (Renaud et al., 2013; Karanja and Saito, 2018).

However, sea level rise and extreme events alongside other drivers are expected to contribute to biophysical limits of EbA and Eco-DRR. For instance, ocean acidification and ocean warming could limit corals replenish during this century (IPCC 2019; Karanja and Saito, 2018). Also, pollution and infrastructure development could constrain tidal wetlands as they limit their inland migration (IPCC, 2019). As a result, EbA and Eco-DRR should not be viewed as panacea, but as supplementary and supportive strategies. Literature indicates that profound economic, institutional and governance transformations are needed to achieve a climate-resilient and sustainable blue economy (IPCC, 2019). IPCC (2019) recommends that adaptation decisions should be taken based on decision analysis methods to address uncertainties about post-2050 sea level rise and extreme events. These methods call for flexible responses and periodically adjustable decisions and use of robustness criteria such as effectiveness across a range of circumstances for evaluating alternative responses instead of standard expected utility criteria. Also, integrated coastal and marine protected areas have been cited as important adaptation governance responses.

2.3 CLIMATE CHANGE LEGISLATIVE FRAMEWORK IN KENYA

However, sea level rise and extreme events alongside other drivers are expected to contribute to biophysical limits of EbA and Eco-DRR. For instance, ocean acidification and ocean warming could limit corals replenish during this century (IPCC 2019; Karanja and Saito, 2018). Also, pollution and infrastructure development could constrain tidal wetlands as they limit their inland migration (IPCC, 2019). As a result, EbA and Eco-DRR should not be viewed as panacea, but as supplementary and supportive strategies. Literature indicates that profound economic, institutional and governance transformations are needed to achieve a climate-resilient and sustainable blue economy (IPCC, 2019). IPCC (2019) recommends that adaptation decisions should be taken based on decision analysis methods to address uncertainties about post-2050 sea level rise and extreme events. These methods call for flexible responses and periodically adjustable decisions and use of robustness criteria such as effectiveness across a range of circumstances for evaluating alternative responses instead of standard expected utility criteria. Also, integrated coastal and marine protected areas have been cited as important adaptation governance responses.

2.3.1 VISION 2030

Kenya's Vision 2030 aims to transform the country into a new industrializing middle-income country providing high quality of life to its citizens by 2030 in a safe and secure environment. Vision 2030 is implemented through five years term development plans. The Third Medium Term Plan (MTP III) (2018-2022) of the Vision 2030 identified climate change and disaster risk management as key thematic areas to be addressed. The MTP III aims to address the negative effects of climate change through promotion of a low carbon climate resilient and green growth development. This shall be achieved through strengthening climate change governance and coordination, climate change monitoring, reporting and verification, capacity building and public awareness, and formulation and implementation of the Green Economy Strategy and the National Climate Change Action Plan (The National Treasury and Planning, 2018).

2.3.2 CLIMATE CHANGE ACT (2016)

The Climate change Act (2016) aims to: (i) mainstream climate change responses into development planning, decision-making and implementation; (ii) build resilience and enhance adaptive capacity to the impacts of climate change; (iii) formulate programmes and plans to enhance the resilience and adaptive capacity of human and ecological systems to the impacts of climate change; (iv) mainstream and reinforce climate change and disaster risk reduction into strategies and actions of public and private entities. It further aims to: (viii) facilitate capacity development for public participation in climate change responses through awareness creation, consultation, representation and access to information; (ix) mobilize and transparently manage public and other financial resources for climate change response; (x) provide mechanisms for, and facilitate

climate change research and development, training and capacity building; (xi) mainstream the principle of sustainable development into the planning for and decision making on climate change response; and (xii) integrate climate change into the exercise of power and functions of all levels of governance, and to enhance cooperative climate change governance between the national government and county governments.

The Act established the Climate Change Directorate under the Ministry of Environment and Forestry as the lead agency in the implementation and coordination of national climate change plans and actions. The Act established the National Climate Change Council as the overarching national climate change coordination mechanism. The National Environment Management Authority (NEMA) regulates, enforces, and monitors compliance on greenhouse gas emission levels (Climate Change Act, 2016).

The Climate Change Act (2016) calls on county governments to integrate and mainstream climate change mitigation and adaptation measures into county integrated development plan and county sector plans while considering national and county priorities and needs. This is expected to localize climate change adaptation strategies. Each county government is expected to designate a County Executive Committee Member responsible for the coordination of climate change affairs (Climate Change Act, 2016). The Kenya Institute of Curriculum Development is also expected to integrate climate change into various disciplines and subjects of the national education curricula at all levels to promote climate change education and awareness creation. The Act further calls upon NEMA to integrate climate risk and vulnerability assessment into all forms of environmental assessment (Climate Change Act, 2016). Academic studies are required to understand to what extent climate change has been mainstreamed into school curricula, county government development plans and environmental impacts assessments.

One key principle of the Climate Change Act (2016) is ensuring active participation and consultation of key stakeholders including local citizens and private stakeholders. For instance, the National Climate Change Council membership must include among others, representatives from private sector, civil society, and a marginalized community (Climate Change Act, 2016).

The Act also recognizes the role of the private sector in enabling climate change mitigation and adaptation. Article 16 of the Act empowers the National Climate Change Council to impose climate change obligations on private entities as well as stipulates investigation, monitoring and enforcement powers. Furthermore, the Act authorizes the Council to assign duties relating to climate change and implementation of the Climate Change Action Plan to both public and private entities (Climate Change Act, 2016).

The Climate Change Act (2016) established Climate Change Fund, a financing mechanism for priority climate change actions and interventions approved by the National Climate Change Council. The Fund is meant to: (i) provide grants for climate change research and innovation; (ii) provide grants and loans to businesses, industries, civil society, academia, and other stakeholders for development of innovative actions that benefit climate change responses in Kenya; (iii) finance the implementation of climate change adaptation and mitigation actions; and (iv) provide technical assistance to county governments.

2.3.3 NATIONAL CLIMATE CHANGE RESPONSE STRATEGY (2010)

The Strategy was the first national policy document on climate change. It sought to advance the integration of climate change mitigation and adaptation into all government planning, budgeting, and development objectives. It also desired to assess the evidence and impacts of climate change in Kenya, recommend robust and feasible adaptation and mitigation measures as well as develop a conducive and enabling policy, legal and institutional framework to combat and adapt to climate change.

2.3.4 NATIONAL CLIMATE CHANGE ACTION PLAN (2018-2022)

To operationalize the Response Strategy, the first National Climate Change Action Plan (2013-2017) was established. The Action Plan established Kenya's baseline emissions projections up to 2030 and developed a low carbon climate resilient development pathway through outlining priority adaptation and mitigation actions.

The second National Climate Change Action Plan (2018-2022) strives to strengthen Kenya's path towards a sustainable and low carbon climate-resilient society. The priorities of the Climate Change Action Plan (2018-2022) are summarized in Table 2.3.

Table 2.3 National Climate Change Action Plan (2018-2022) priority

Priorities	Objectives
Disaster risk (floods & drought management	Reduce risks to communities and infrastructure resulting from climate-related disasters such as droughts and floods
Food and nutrition security	Increase food and nutrition security through enhanced productivity and resilience of the agricultural sector in as low-carbon manner as possible
Water and the blue economy	Enhance the resilience of the blue economy and water sector by ensuring access to and efficient use of water for agriculture, manufacturing, domestic, wildlife and other uses
Forestry, wildlife, and tourism	Increase forest cover to 10 per cent per cent of total land area, rehabilitate degraded lands, and increase the resilience of the wildlife and tourism sector
Health, sanitation, and human settlements	Mainstream climate change adaptation into the health sector, and increase the resilience of human settlements including improved solid waste management in urban areas and climate resilient buildings
Manufacturing	Improve energy and resource efficiency in the manufacturing sector
Energy and Transport	Climate-proof energy and transport infrastructure, encourage electricity supply based on renewable energy, encourage the transition to clean cooking, and develop sustainable transport systems

2.3.5 KENYA NATIONAL ADAPTATION PLAN (2015-2030)

The National Adaptation Plan endeavours for an enhanced climate change resilience towards the attainment of Kenya's Vision 2030 and beyond. It builds on the foundation laid by the National Climate Change Response Strategy and the first National Climate Change Action Plan (2013-2017). The objectives of the National Adaptation Plan include to: (i) highlight the importance of adaptation and resilience building actions in development; (ii) integrate climate change adaptation into national and county level development planning and budgeting processes; (iii) enhance the resilience of public and private sector investment in the national transformation, economic, and social pillars of the Vision 2030 to climate shocks; (iv) enhance synergies between adaptation and mitigation actions in order to attain a low carbon climate resilient economy; and (v) enhance the resilience of vulnerable populations to climate shocks through adaptation and disaster risk reduction strategies.

2.3.6 NATIONAL CLIMATE CHANGE FRAMEWORK POLICY (SESSIONAL PAPER NO. 3 OF 2016)

The Framework Policy strives to enhance adaptive capacity and resilience to climate change and to promote low carbon development for sustainable development. Specifically, the Policy aims to: (i) establish and maintain an effective and efficient institutional framework to mainstream climate change responses across relevant sectors and into integrated planning, budgeting, decision-making and implementation at national and county levels; (ii) reduce vulnerability to the impacts of climate change by building adaptive capacity, enhance climate change resilience and strengthen capacities for disaster risk reduction; (iii) catalyse Kenya's transition to cleaner, lower emission and less carbon intensive development; (iv) incentivise private sector involvement in building climate change resilience and engaging in low carbon development opportunities; (v) facilitate widespread public awareness, participation, ownership and oversight of Kenya's climate change response efforts, actions and plans; (vi) provide a framework to mobilise resources for Kenya's climate change response and ensure effective and transparent utilisation of the resources; (vii) adopt intergenerational, special needs, and gender mainstreaming approaches across all aspects of Kenya's climate change response; (viii) provide the policy framework to facilitate effective implementation of regularly updated and scientifically informed climate change action plans; and (ix) enhance research and use of science and technology in policy decisions and sustainable management of resources.

2.3.7 NATIONALLY DETERMINED CONTRIBUTIONS (2015 AND 2020)

Kenya submitted its nationally determined contributions (NDC) under the Paris Agreement in 2015. Kenya revised its NDC in 2020. The NDCs are implemented through the national climate change action plans. Kenya committed to reduce national greenhouse gas emissions by 32 per cent by 2030, relative to the business-as-usual scenario of 143 MtCO2eq. In terms of climate change adaptation, the country committed to ensuring enhanced resilience to climate change towards the attainment of Vision 2030, by mainstreaming climate change into MTPs, and implementing adaptation actions (Ministry of Environment and Forestry, 2020a).

2.3.8 NATIONAL POLICY ON CLIMATE FINANCE (2016)

The National Policy on Climate Finance provides a guiding framework to enhance national financial systems and institutional capacity to effectively access, disburse, absorb, manage, monitor, and report on climate finance in a transparent and accountable manner. Identified avenues to mobilize climate change finance include the established Climate Change Fund by the Climate Change Act of 2016. Other sources of funding include the Green Climate Fund, Global Environment Facility, Special Climate Change Fund, Least Developed Countries Fund, nationally appropriate mitigation actions, and market-based approaches such as REDD+. The National Treasury is the national designated authority for the Green Climate Fund, while as NEMA is the national implementing entity for the Green Climate Fund and Global Environment Facility funding (The National Treasury, 2016).

The Policy also underscored that climate finance has the potential to support other sectors to transform Kenya into a low carbon climate resilient country. Some of the sectors stressed include agriculture (promotion of climate smart agriculture), forestry (reduction of deforestation and forest degradation, and sustainable conservation of forests), energy (promotion of energy efficiency and renewable energy), transport (adopting low emitting clean energy sources), trade (promotion of low-carbon and green products), tourism (promoting Kenya as a low carbon footprint destination), manufacturing (promotion of clean technologies and energy efficiency in industries), and, water and sanitation (promotion of water efficiency and water towers conservation) (The National Treasury, 2016).

2.3.9 GREEN ECONOMY STRATEGY AND IMPLEMENTATION PLAN (2016-2030)

The MTP II (2013-2017) identified the development of a national green economy strategy as a priority for the achievement of Vision 2030. The Green Economy Strategy supports Kenya towards sustainable pathways through five thematic areas: sustainable infrastructure, building resilience, sustainable management of natural resources, resource efficiency, and social inclusion and sustainable livelihood (Ministry of Environment and Natural Resources, 2016).

In sustainable infrastructure thematic area, the Green Strategy aims to (i) reduce vehicular emissions through legal and fiscal measures; (ii) incorporate climate proofing into infrastructural design, construction and maintenance; (iii) promote use of eco-toilets in urban and rural areas; (iv) increase the share of renewable energy (geothermal, wind and solar) in the national grid to at least 70 per cent; (v) promote use of bio-energy at household, public institutions and commercial enterprises; (vi) ensure 75 per cent of new and renovated public (national and county) and private large scale buildings are green by 2030; (vii) capacity build architects, engineers, contractors and other stakeholders on integrated green technologies in design and construction; (viii) develop and implement certification standards for green buildings; and (ix) mobilize financial resources from capital markets and other financial instruments for green investments (Ministry of Environment and Natural Resources, 2016).

Under the building resilience thematic area, the Green Strategy strives to (i) promote livelihood diversification for vulnerable communities; (ii) mainstream climate change and disaster risk management in sectoral development strategies; (iii) strengthen coordination mechanisms for disaster risk management; and (iv) promote sustainable management of natural ecosystems (Ministry of Environment and Natural Resources, 2016).

Sustainable natural resource management thematic area aims to: (i) promote application of market-based instruments and entrepreneurship in natural resources management such as payment for ecosystem services; (ii) attain at least 10 per cent forest cover; (iii) increase per capita water availability; (iv) invest in conservation of marine and aquatic resources while advancing benefits of the blue economy; (v) promote sustainable extractive industry; and (vi) promote sustainable land management (Ministry of Environment and Natural Resources, 2016).

Resource efficiency thematic area aims to increase energy and water efficiency and manage waste as a resource. Lastly, the social inclusion and sustainable livelihoods thematic area plans to: (i) mainstream green economy into all forms of education and training; (ii) accelerate creation of green jobs; (iii) promote green innovation and technology development particularly through green small and medium enterprises; and (iv) reduce environmental health risks (Ministry of Environment and Natural Resources, 2016).

2.3.10 NATIONAL ENVIRONMENT POLICY (2013)

The Policy strives to provide a framework for an integrated approach to the sustainable management of the environment and natural resources. The Policy calls for action to promote climate change resilience and adaptation, as follows: (i) develop a comprehensive climate change policy; (ii) strengthen capacity for national and county level institutions for climate resilience and low carbon development; (iii) develop and implement awareness and capacities to implement the climate change action plan; (iv) strengthen research capacity; (v) develop a climate financing mechanism; (vi) establish a national carbon trading platform; and (vii) promote public and community participation in mitigation and adaptation. As highlighted by the above climate change policy documents, the first three objectives have largely been achieved.

2.3.11 KENYA CLIMATE SMART AGRICULTURE STRATEGY (KCSAS) (2017-2026)

The Policy strives to provide a framework for an integrated approach to the sustainable management of the environment and natural resources. The Policy calls for action to promote climate change resilience and adaptation, as follows: (i) develop a comprehensive climate change policy; (ii) strengthen capacity for national and county level institutions for climate resilience and low carbon development; (iii) develop and implement awareness and capacities to implement the climate change action plan; (iv) strengthen research capacity; (v) develop a climate financing mechanism; (vi) establish a national carbon trading platform; and (vii) promote public and community participation in mitigation and adaptation. As highlighted by the above climate change policy documents, the first three objectives have largely been achieved.

2.3.12 ENERGY ACT (2019)

The Energy Act stimulates climate change mitigation through the promotion of energy efficiency and renewable energy investments. It empowers the Energy and Petroleum Regulatory Authority to produce, supply and market renewable energy. It also established Rural Electrification and Renewable Energy Corporation to: (i) oversee the implementation of rural electrification programmes; (ii) develop and update the renewable energy master plan; (iii) develop, promote and manage in collaboration with other agencies, the use of renewable energy and technologies; and (iv) harness opportunities offered under the clean development mechanisms such as carbon credit trading (Energy Act, 2019).

2.3.13 CLIMATE RISK MANAGEMENT FRAMEWORK FOR KENYA (2016)

The Framework outlines how the government plans to harmonize its climate change and disaster risk policies at national and county levels. The Framework identifies ten overlapping priority area that ought be harmonized: (i) harmonize programmes and projects and create a coordination mechanism among the national government (institutional framework); (ii) create an enabling policy and legal framework for integrated climate risk management (policy framework); (iii) build capacity at national and county levels for integrated climate risk management (capacity building); (iv) analyse the level of exposure, vulnerability to disasters, and capacity at the local scale (exposure, vulnerability, capacity); (v) involve communities at risk, and consider gender and marginalized groups (gender mainstreaming); (vi) mobilize financial resources for climate risk management (resource mobilization); (vii) mainstream climate risk management into sector programmes, plans and activities (mainstreaming climate risk management); (viii) design and implement pilot projects for climate risk management at national and county levels; (ix) enhance research and dissemination of information about climate risk management (training, research, and outreach); and (x) create platforms for sharing lessons and good practices on integrated climate risk management (learning).

2.4 DISASTER RISK MANAGEMENT LEGISLATIVE FRAMEWORK IN KENYA

2.4.1 VISION 2030

Kenya's Vision 2030 aims to enhance disaster preparedness in all disaster-prone areas and improve the adaptive capacity to global climate change. It also strives to reduce conflicts, enhance food security, curb poverty and hunger, empower vulnerable groups, and improve water security and sanitation.

As earlier indicated, the MTP III (2018-2022) of the Vision 2030 identified disaster risk management as a key thematic area to be addressed. The MTP III endeavours to establish an integrated disaster risk management

system to mitigate and reduce the risk of disasters, enhance disaster preparedness, and ensure a rapid and effective response to disasters and post-disaster recovery. The "Big Four Agenda" that is anchored in the MTP III, strives to end drought emergencies and food insecurity. The MTP III also plans to establish a disaster risk management centre of excellence and to finalize on national disaster risk management policy and bill (The National Treasury and Planning, 2018).

2.4.2 NATIONAL DISASTER RISK MANAGEMENT POLICY (2018)

The National Disaster Risk Management Policy was approved in 2018. It aims to: (i) establish a legal and institutional framework for the management of disasters; (ii) create synergy in coordination of disasters; (iii) mainstream disasters into development plans; (iv) reduce disaster impacts and losses; (v) strengthen adaptive capacity and resilience to disasters and climate change; (vi) promote disaster awareness and research; and (vii) facilitate the implementation of the Sendai Framework for Disaster Risk Reduction (2015-2030).

2.4.3 NATIONAL DISASTER MANAGEMENT AUTHORITY BILL (2019)

The Bill was enacted in March 2019. The Bill calls for the establishment of the National Disaster Management Authority. However, the Authority was yet to be established as of July 2021. When functional, the Authority is expected to: (i) coordinate and control disaster response and management; (ii) build capacity in disaster response and disaster resilience at both levels of government; (iii) serve as the command centre for all communication and information relating to response operations; (iv) coordinate disaster management efforts between various government agencies to ensure there is a seamless response to disasters; (v) undertake public awareness on disaster preparedness and response; (vi) establish and operate an effective and efficient national early warning disaster monitoring information system; (vii) facilitate disaster management contingency processes that will result in the formulation of contingency plans to be updated regularly; (viii) document, publish and disseminate all relevant disaster management data and information to all stakeholders; and (ix) operate a functional and effective monitoring and evaluation system for programming and management of activities in disaster management.

2.4.5 NATIONAL DISASTER RISK REDUCTION STRATEGY FOR KENYA (2006-2016)

The DRR Strategy was established to enhance DRR efforts and guide the implementation of the Hyogo Framework for Action (2005-2015). Literature is missing on the effectiveness of the DRR Strategy in enhancing the achievement of the Hyogo Framework priority action areas.

2.4.6 NATIONAL DISASTER RESPONSE PLAN (2009)

The defunct Ministry of State for Special Programmes and the National Disaster Operation Centre drafted the National Disaster Response Plan in 2009. The Plan aimed at establishing a coordination structure and operating procedures for addressing all aspects of disaster preparedness and responses in Kenya. The Plan also developed disaster response management, standard operating procedures for disaster response, and humanitarian services committee to enhance coordination. In 2014, the Disaster Management Unit established National Emergency Plan, Basic Incident Management Guidelines, and Standards Operating Procedures to ensure coordinated disaster response.

2.4.7 NATIONAL ENVIRONMENT POLICY (2013)

The National Environment Policy (2013) recognizes the environment and disasters nexus. It highlighted those disasters pose significant environmental challenges. Increasing frequency and intensity of disasters such as droughts, floods and landslides affect terrestrial ecosystems, disrupt water supply, and often lead to environmental losses and/or degradation. On the other hand, sustainable management of natural resources minimizes disaster and environmental risks.

The National Environment Policy aims to: (i) establish an institutional, policy and legal framework to effectively manage disaster risks; (ii) strengthen and enhance early warning and response systems for DRR; (iii) promote good soil management practices to avert landslides, mudslides, floods, and other preventable disasters; (iv) collaborate with international institutions on emergency and disaster response; and (v) involve and empower communities in DRR.

2.4.8 ENERGY ACT (2019)

The Energy Act calls for the establishment of Consolidated Energy Fund to address energy sector disaster mitigation response and hydro risk mitigation. Also, county governments through county energy planning are expected to develop and implement disaster management plans (Energy Act, 2019).

2.4.9 FRAGMENTATION IN DISASTER MANAGEMENT

It is not explicitly clear whether disaster management is a national or a devolved function. The Constitution of Kenya (2010) designates disaster management as a function of the national government. It also assigns the role of firefighting services and disaster management to the county governments. In practice, the national government takes the lead in disaster emergencies such as droughts, floods, conflicts, and locusts' outbreak. However, this has been impeded by the lack of a dedicated disaster risk management agency.

At the national level, disasters are managed across different line ministries and departments. For instance, the Directorate of Special Programmes under the Ministry of Devolution and Planning coordinates disaster risk management while the Disaster Management Unit under the Ministry of Interior and Coordination of the National Government also coordinates disaster and emergency response. The National Disaster Operation Centre was established in 1998 as the national focal point for coordinating disaster response. It acts as the command centre for all communications and information relating to response operations. The National Drought Management Authority implements and coordinates drought emergencies.

Although the Directorate of Special Programmes in principle oversees disaster risk management, it primarily focuses on humanitarian assistance and food relief. It is hoped that the proposed National Disaster Management Authority will holistically address disasters through pre, during and post disaster resilience efforts.

2.5 BLUE ECONOMY INSTITUTIONAL FRAMEWORK

2.5.1 POLITICAL WILL

There is remarkably high political will to promote a sustainable blue economy in Kenya, which is affirmed by recent incentives since 2016. The MTP III (2018-2022) identified the blue economy as a priority sector for the achievement of Kenya's Vision 2030 (The National Treasury and Planning, 2018). This is expected to

significantly transform the blue economy that has the potential to contribute USD 4.8 billion to the Kenyan economy (The Presidency, 2019).

Indeed, Kenya has also emerged as a leading country in Africa in promoting sustainable blue economy development. In November 2018, it hosted the first global conference on sustainable blue economy (SBEC Review Committee, 2018b). During the Conference, the President of Kenya pledged to: (i) adopt appropriate policies, strategies and mechanisms to harness the blue economy so as to create job opportunities; (ii) tackle waste management and plastic pollution; (iii) ensure responsible and sustainable fishing; (iv) ensure maritime safety and security; (v) establish a blue economy bank to support its growth and development; (vi) revive maritime transport; and (vii) establish an African blue economy innovation and research centre (SBEC Review Committee, 2018a).

In June 2020, Portugal and Kenya planned to co-host the UN Ocean Conference in Lisbon, Portugal. The Conference was postponed due to the outbreak of the COVID-19 pandemic. It was held in June 2022. The theme of the conference was "Scaling up ocean action based on science and innovation for the implementation of Goal 14: Stocktaking, partnerships and solutions" (United Nations, 2020). Delegates adopted a Declaration titled "Our Ocean, Our Future, Our Responsibility" where they agreed to commit to take science-based and innovative actions towards a sustainable ocean-based economy and to achieving Goal 14 (United Nations, 2022).

Kenya is one of the 50 countries that have committed to protect at least 30 per cent of the globe's land and ocean by 2030 (High Ambition Coalition for Nature and People, 2021). The country is one of the 14 member countries of the High-Level Panel for a Sustainable Ocean Economy. These countries envision ocean solutions that benefit local people, nature, and the economy. These countries have committed to sustainably manage 100 per cent of the ocean area under their national jurisdiction by 2025, guided by the Sustainable Ocean Plans. They have also urged all coastal and ocean states to join this commitment to ensure that all ocean areas under national jurisdiction are sustainably managed by 2030 (Ocean Panel Secretariat, 2018).

2.5.2 INSTITUTIONAL FRAMEWORK

Kenya has institutional reforms to transform the blue economy sector. Recognizing the importance of the blue economy in fostering economic development, Kenya established the State Department for Fisheries, Aquaculture, and the Blue Economy through the enactment of Executive Order No. 1/2016. The State Department is under the Ministry of Agriculture, Livestock and Fisheries and coordinates the development of policy, legal, regulatory, and institutional framework for the fisheries industry and the blue economy (The Presidency, 2016). In practice, the State Department focuses on fisheries resources and aquaculture, and partly maritime security and safety. Other segments of the blue economy are dealt with by respective line ministries or agencies, for instance, coastal tourism (Kenya Tourism Board), maritime transport and port development (Ministry of Transport and Infrastructure), maritime renewable energy (Ministry of Energy), and ocean mining (Ministry of Petroleum and Mining).

In 2016, four institutions were established under the State Department for Fisheries, Aquaculture, and the Blue Economy through the enactment of the Fisheries Management and Development Act (2016). These institutions were established to strengthen governance of the fisheries and aquaculture, and to enable investments along the fishery value chains to maximize socio-economic benefits. These include Kenya Fisheries Service (KeFS), Kenya Fisheries Advisory Council, the Fish Marketing Authority, and Fish Levy Trust Fund (Fisheries Management and Development Act, 2016). In subsequent years, Kenya Coast Guard Service (2018) and Kenya Industries Fishing Corporation (2019) were established. Also, the Kenya Marine

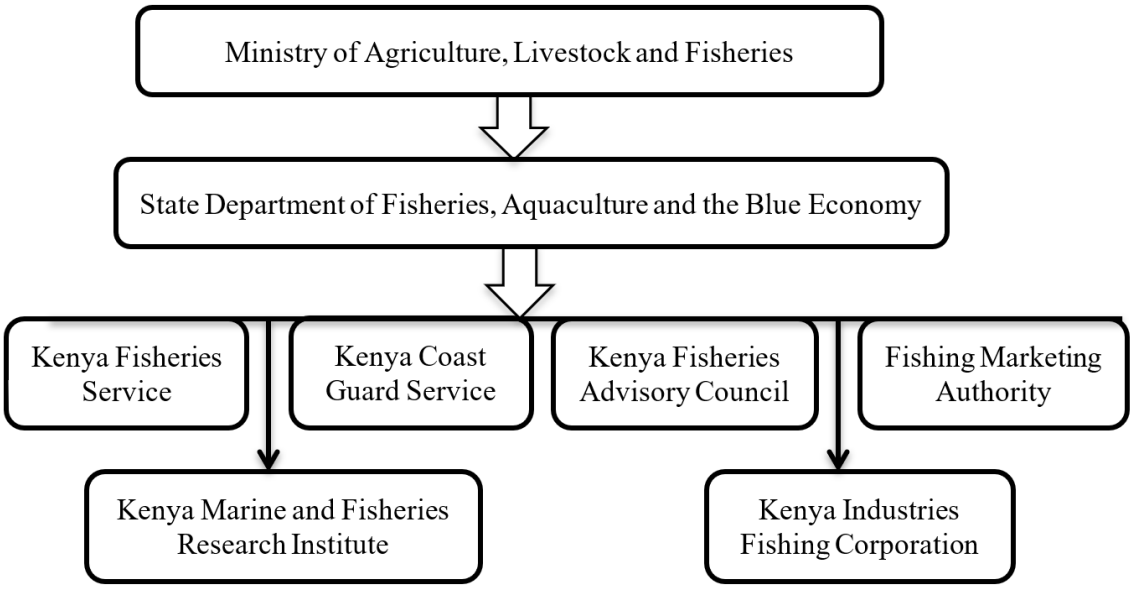
and Fisheries Research Institute (KEMFRI) established in 1979 is under the State Department (Figure 2.1).

The KeFS is the primary agency responsible for the conservation, management, and development of fisheries resources. It is also expected to develop standards and guidelines for fisheries and aquaculture development as well as control and regulate fishing safety and quality in accordance with the Public Health Act and the Food, Drugs and Substance Act. The Act also established the Monitoring, Control and Surveillance Unit (MCS Unit) within the KeFS and a vessel monitoring system was installed (Fisheries Management and Development Act, 2016; The National Treasury and Planning, 2018). During the MTP II (2013-2017), Kenya also procured an offshore patrol vessel (PV Doria) for surveillance of deep-sea fishing on the coast, and two patrol boats stationed at Lake Victoria and Lake Turkana (The National Treasury and Planning, 2018).

2.5.2 INSTITUTIONAL FRAMEWORK

Kenya has institutional reforms to transform the blue economy sector. Recognizing the importance of the blue economy in fostering economic development, Kenya established the State Department for Fisheries, Aquaculture, and the Blue Economy through the enactment of Executive Order No. 1/2016. The State Department is under the Ministry of Agriculture, Livestock and Fisheries and coordinates the development of policy, legal, regulatory, and institutional framework for the fisheries industry and the blue economy (The Presidency, 2016). In practice, the State Department focuses on fisheries resources and aquaculture, and partly maritime security and safety. Other segments of the blue economy are dealt with by respective line ministries or agencies, for instance, coastal tourism (Kenya Tourism Board), maritime transport and port development (Ministry of Transport and Infrastructure), maritime renewable energy (Ministry of Energy), and ocean mining (Ministry of Petroleum and Mining).

Figure 2.1 The blue economy organization structure



The Kenya Fisheries Advisory Council is composed of relevant cabinet secretaries. fisheries stakeholders and experts. The primary function of the Council is to advise the national government on fisheries related policies development and coordination (Fisheries Management and Development Act, 2016).

The Fish Marketing Authority was established to market fish and fisheries products from Kenya and is

expected to: (i) develop, implement and coordinate a national fish marketing strategy; (ii) ensure that fish and fishery products from Kenya enjoy market access to local, national, regional and international levels as premier products; (iii) promote the sustainable use of fish by preventing, deterring and eliminating trade in illegal, unreported and unregulated fishing; (iv) enforce national and international fisheries trade laws; (v) identify fish market needs and trends and advise fisheries stakeholders accordingly; (vi) organize stakeholders to ensure smooth marketing of fish and fishery products; and (vii) collaborate with national and international trade related bodies.

The Fisheries Research and Development Fund is meant to supplement fisheries research funding. The Fish Levy Trust Fund was established to fund activities geared towards management, development and capacity building, awards, and urgent mitigation to ensure the sustainability of the fisheries resources (Fisheries Management and Development Act, 2016).

The Kenya Coast Guard Service was established in 2018 to enforce maritime security and safety, enforce pollution control, provide port and coastal security, and ensure protection of maritime resources including fisheries (Kenya Coast Guard Service Act, 2018). The Service conducts daily patrols in the Kenya's waters to curb illegal, unregulated, and unreported fishing, provide safety to seafarers, and prevent drug smuggling and illegal movement of people and goods (The Presidency, 2019).

KEMFRI was established in 1979 through enactment of the Science and Technology (Amendment) Act (1979). It is mandated to conduct research and recommend effective management plans and strategies on the national exploitation of living and non-living aquatic resources in the ocean and freshwater (KEMFRI, 2017).

The Fisheries Management and Development Act (2016) also recognizes the role of county governments in promoting sustainable fisheries. It empowers the county governments to develop fisheries management measures and plans for fisheries resources within their respective jurisdiction in accordance with the Fisheries Act. The KeFS is expected to inform and consult county governments in the management and conservation of fisheries resources.

In 1990, the Coast Development Authority was established to provide integrated development planning, coordination, and implementation of projects and programmes within the coast region (Coast Development Authority Act, 1990).

The Kenya Ports Authority is the primary agency mandated to maintain, operate, and regulate the ports (Kenya Ports Authority Act, 2018). On the other hand, Kenya Maritime Authority was established to monitor, regulate, and coordinate activities in the maritime industry. The Kenya Maritime Authority is responsible for the administration and enforcement of the Merchant Shipping Act of 2009 (Kenya Maritime Authority (Amendment) Act, 2012).

To enhance maritime transport, His Excellency President Uhuru Kenyatta also announced the revival of the Kenya National Shipping Line (KNSL). As a start, the KNSL, Kenya Ports Authority and the Mediterranean Shipping Company signed a new shareholding agreement in 2019 with an aim of transforming KNSL into a world class shipping line in the next 10 years (The Presidency, 2019).

The KNSL was initially established in 1987 as a national carrier for containerized export and import freight cargo. However, due to poor management, it failed to reach desired status (The Presidency, 2019). For instance, in 2016/2017 financial year, it reported a loss of KES 46.16 million (KNSL, 2017). Nevertheless, with about 80-90 per cent of Kenya's foreign trade dependent on maritime transport, the KNSL has the potential to benefit from the regional and global maritime transport value chain (The Presidency, 2019).

On 21 December 2016, President Kenyatta established the Blue Economy Committee. On 29 June 2018, the Committee was renamed the Blue Economy Implementation Standing Committee. The Committee is expected to coordinate and oversee the implementation of prioritized programmes and prepare and submit monthly reports to the President about the progress of implementation. General Samson Mwathethe, Chief of Defence Forces, heads the Committee. Other members include the Attorney General; principal secretaries of: (a) the State Department of Fisheries, Aquaculture, and the Blue Economy, (b) the State Department of Maritime and Shipping Affairs, (c) the National Treasury, and (d) the State Department for Transport; Deputy Chief of Staff (Policy and Strategy) and Economic Advisor both from the Executive Office of the President; and Secretary to the Kenya International Boundaries Office (Republic of Kenya, 2018).

The Committee does not represent all segments of the blue economy. Therefore, it could include KEMFRI (as the lead research organization in marine and fisheries), Principal Secretary of Tourism (as coastal tourism is a key sector of the blue economy), Director General of Kenya Wildlife Service (KWS) (KWS is in charge of management of marine protected areas, wetlands and Ramsar sites such as Tana Delta), Principal Secretary of State Department of Energy (as Kenya is in the process of developing nuclear energy in Tana River County as well as exploring maritime renewable energy), Principal Secretary of Mining (due to offshore and deep-sea mining), and Principal Secretary of the Environment (to ensure conservation and protection of marine and coastal ecosystems). This will also facilitate effective collaboration and coordination of blue economy-related programmes.

In 2019, President Uhuru Kenyatta commissioned Bandari Maritime Academy, previously known as Bandari College, to equip youth with technical skills and create employment opportunities in the vast blue economy sector. The blue economy sector is projected to create over 52,000 jobs by 2029. The Academy also aspires to increase opportunities for women in the maritime industry who only accounts for 2 per cent of the total workforce in the industry. According to the President, "The Academy is expected to become a top supplier of world class seafarers for shipping lines all over the world" (The Presidency, 2019).

2.5.3 FRAGMENTATION IN THE MANAGEMENT OF THE BLUE ECONOMY

Kenya has established a relatively strong institutional framework to drive the blue economy. However, one of the challenges is fragmentation in the management of the blue economy leading to duplication of duties and redundancy. For instance, there are overlapping mandates between the MCS unit of the KeFS and the Kenya Coast Guard Service. Both agencies are mandated to conduct patrols in the ocean to prevent illegal and unregulated fishing as well as apprehend and prosecute culprits in a court of law (Fisheries Management and Development Act, 2016; Kenya Coast Guard Service Act, 2018). However, the Fisheries Management and Development Act (2016) permits the cabinet secretary in charge of fisheries to make regulations establishing and assigning functions to an inter-agency MCS Unit. This could pave way for coordinated monitoring and surveillance.

There is also fragmentation in the management of coastal and marine resources. Currently, there is no single ministry or agency dedicated to managing coastal and marine resources. Most of the institutions with a stake in coastal ecosystems management fall under different ministries or sectorial disciplines including environment, fisheries, water, transport, regional development, wildlife, and energy. For example, KWS manages marine national parks, marine national reserves, Ramsar sites (such as Tana Delta), and established coastal conservancies. On the other hand, Kenya Forest Service (KFS) is mandated to manage all forest resources including coastal forests, which could be classified as marine national parks/reserve or a Ramsar site. Therefore, adequate synergy is essential to effectively coordinate management of coastal and marine resources (Japp, 2011).

Apart from lack of synergy, the blue economy sector is also constrained by limited financial and technical resources. It is hoped that prevailing political will lead to increased budget allocation and attracts investments.

2.5.4 PRIVATE STAKEHOLDER PARTICIPATION

Kenya utilizes public private partnership (PPP) to organize fishing communities for effective management of fisheries resources. The fisheries law encourages private stakeholders in the fisheries sector to organize into associations and form national coordinating mechanisms to ensure efficient marketing systems that adhere to sanitary and phytosanitary requirements. As a result, beach management units (BMUs) were initiated in 2006. BMU is a fishing community management unit designed to manage marine resources in collaboration with the State Department for Fisheries, Aquaculture and the Blue Economy and respective county governments. The members of a BMU include fishing crew, boat owners, fish traders and boat builders and repairers.

The marine fisheries sector is managed and governed under the BMUs. The County Executive Committee Member facilitates the establishment of BMUs in each designated fish landing station. BMUs aims to: (i) strengthen the management of fish-land stations, fishery resources and the aquatic environment; (ii) support the sustainable development of the fisheries sector; (iii) help to alleviate poverty and improve the health, welfare and livelihoods of the members through improved planning and resource management, good governance, democratic participation and self-reliance; (iv) ensure production of safe and quality fish and fishery products; (v) build capacity of the members for the effective co-management of fisheries in collaboration with other stakeholders; (vi) prevent, reduce and resolve conflicts in the fisheries sector; and (vii) strengthen co-management through formation of BMU networks (Fisheries Beach Management Units Regulations, 2019).

BMUs have been cited as an effective strategy for the co-management of fisheries resources in Kenya. They help limit access as fishing rights are only granted to BMU members. BMUs also supplement in monitoring, control, and surveillance to curb illegal, unreported, and unregulated fishing in their jurisdiction. They are also expected to maintain hygiene and sanitation at the beach to ensure fish safety standards are maintained. BMUs help in developing fisheries inventory data as they record daily landed fish. As a result, it is easier to examine fish abundance and diversity trends. Furthermore, since fishing communities are in organized groups, it becomes easier to mobilize and conduct awareness campaigns on sustainable fisheries (Kanyange, 2012; Indian Ocean Commission, 2014).

Kenya is also engaging private stakeholders to promote offshore fishing. As noted above, most of the fishers in Kenya are artisanal. Since they operate with small boats and have limited capacity, fishing is conducted near the shore leading to over-exploitation in the area. The KeFS is engaging both local and foreign private investors to invest in fishing vessels that can harvest in open waters within Kenya's territorial waters. This is meant to reduce pressure around the shoreline and diversify fish species harvested. Interviews with the KeFS revealed that due to PPP, there are six deep-sea fishing vessels licensed to harvest in Kenya's territorial waters. The foreign vessels may export either raw or processed fish, but at least 30 per cent of the harvest must be landed in the country to ensure continuous food supply and create employment for fish traders.

2.5.5 ROLE OF DIASPORA

Diaspora community could enable sustainable blue economy through blue economy business development and investments, knowledge and skills creation and sharing. The diaspora is expected to drive innovations in the blue economy sector such as offshore renewable energy generation, desalination, and integrated waste management. As highlighted in the previous section, there are limited deep-fishing freight vessels in Kenya, due to their financial muscle; this could be an entry point for the diaspora interested in investing in the blue economy.

2.6 BLUE ECONOMY-RELATED POLICIES

The blue economy has been regarded as the new frontier for economic growth in Kenya. Although Kenya has yet to develop a blue economy specific policy, there are several policy directives and strategies promoting the blue economy sector as a key enabler of Kenya's Vision 2030 development blueprint.

2.6.1 VISION 2030

The blue economy is anchored in the MTP III (2018-2022) of the Vision 2030 as one of the eight priority sectors to drive economic growth. Specifically, the MTP III calls for the development of an integrated and holistic master plan for the blue economy to enhance sustainable utilization of marine resources. It further calls for the establishment of a national fishing fleet and fishing ports. The development of fisheries and marine infrastructure in the coastal region is expected to create 12,000 jobs and inject KES 20 billion into the GDP by 2022. The MTP III also aims to create other blue economy related jobs through initiatives such as Vijana Baharini Programme to produce 1,250 workforces annually and ship building and repairs industry that has the potential to create 1,000 jobs annually. According to the MTP III, the fish production shall increase by 136 per cent from 128,649 metric tonnes in 2016 to 304,000 metric tonnes annually (The National Treasury and Planning, 2018).

The blue economy contributes on food security and nutrition (Setlur, 2020), which is a key goal under the "Big Four Agenda" initiative (2018-2022) of the current government. To enhance food production, the MTP III aims to develop 1.2 million acres of commercial irrigated production (The National Treasury and Planning, 2018).

The MTP III highlights two challenges facing the blue economy in Kenya. First, the lack of adequate policy, legal, and institutional framework for coastline security and management of blue economy resources. Second, there are inadequate technical skills to advance the blue economy sector. Recognizing the blue economy as an emerging field, the MTP III calls on universities and technical and vocational education and training (TVET) institutions to develop technical courses related to the blue economy.

2.6.2 ENVIRONMENTAL MANAGEMENT AND COORDINATION (AMENDMENT) ACT (2015)

The Act provides regulations for the management of rivers, lakes, wetlands, and coastal zones. The cabinet secretary in charge of environmental matters can declare a lake basin, wetland, coastal zone, or river basin as a protected area to protect it from degradation. The Act prohibits water pollution. Therefore, the discharge of waste into the aquatic environment is punishable in a court of law.

2.6.3 NATIONAL ENVIRONMENTAL POLICY (2013)

The National Environment Policy aims to: (i) promote sustainable use of marine resources and the conservation of vulnerable coastal ecosystems; (ii) ensure the development and implementation of a harmonized integrated coastal zone management policy and integrated ocean management policy, strategy and action plan; (iii) undertake and support research and training in the conservation and management of coastal and marine ecosystems and resources; (iv) promote closer regional and international cooperation in the conservation and management of marine migratory species; (v) harmonise and coordinate the roles of various regulatory agencies charged with the management of coastal and marine resources; and (vi) involve and empower communities in the management of coastal and marine ecosystems.

To promote sustainable fisheries, the policy aims to: (i) promote sustainable management and utilization of fishery resources; (ii) strengthen capacity to carry out fisheries monitoring, control and surveillance; (iii) promote sustainable aquaculture development; (iv) strengthen community participation in fisheries resources management, value addition and marketing; and (v) protect fish breeding grounds and implement closed seasons regulations where necessary (National Environment Policy, 2013).

The policy also strives to promote sustainable tourism: Specifically, it aims to: (i) provide incentives to encourage eco-tourism industry initiatives aimed at protecting the environment; (ii) improve policy implementation and strictly enforce environmental regulation; (iii) set up a framework for information exchange and for environmental awareness creation of all stakeholders in the tourism industry; (iv) market "green" tourism products; (v) encourage the promotion of investment in sustainable tourism, including eco-tourism and cultural tourism; and (vi) encourage community participation in the tourism industry (National Environment Policy, 2013).

Solid waste and wastewater effluents are threats to the blue economy. Wastewater often cause increased nutrient levels leading to algal blooms and depleted dissolved oxygen, hence affecting aquatic habitats and species. Also, oil spillage can devastate coastal and marine ecosystems. To address these issues, the policy calls for the development of an integrated national waste management strategy to promote cleaner production, waste recovery, recycling, and re-use (National Environment Policy, 2013).

Kenya plans to establish a nuclear power plant in Tana River County, worth KES 540 billion with an initial production capacity of 1,000 megawatts. The plan is set to be operational in 2027 (Ngugi, 2020). As a result, radioactive waste management could be a huge challenge for the County Government of Tana River and the Nuclear Power and Energy Agency. The National Environment Policy (2013) aims to: (i) maintain an inventory of sources, types, and quantities of radioactive materials, periodically monitor status and trends, and enhance protection measures; (ii) strengthen capacities for handling and management of radioactive waste and ionizing agents; and (iii) ensure telecommunication equipment and structures conform to the international radiation standards.

2.6.4 FISHERIES MANAGEMENT AND DEVELOPMENT ACT (2016)

Kenya enacted the Fisheries Management and Development Act (2016) to promote sustainable management of fisheries resources. The law aims to protect, manage, use, and develop aquatic resources sustainably to uplift the living standards of the fishing communities. It also aims to introduce fishing to traditionally non-fishing communities to enhance food and nutrition security (Fisheries Management and Development Act, 2016).

The fisheries law also acknowledges the need for structured community participation in fisheries management. It mandates the cabinet secretary to make regulations setting out standards for the management of BMUs established by the county governments. The standards may include protection of vulnerable groups, especially youth and women. The law also prohibits deprivation of community from traditional access to fisheries due to aquaculture development (Fisheries Management and Development Act, 2016).

To protect marine resources, the Act mandates the cabinet secretary to establish marine protected areas. He or she may declare any species of fish to be endangered or threatened with extinction and such fish may not be caught or processed. The cabinet secretary may also establish fish landing stations, designated fishing ports, and protected fish breeding grounds. Fishing for marine mammals is prohibited. The law also prohibits pollution in fishery waters. The law also sets guidelines and standards for the development of aquaculture in Kenya (Fisheries Management and Development Act, 2016).

2.6.5 THE NATIONAL WILDLIFE CONSERVATION AND MANAGEMENT POLICY (2017) AND WILDLIFE CONSERVATION AND MANAGEMENT ACT (2013)

The policy aspires to develop a marine protected area strategy in line with the national and international integrated coastal zone management strategy. It also aims to develop coastal and marine related disaster action plans. It further aims to protect and manage essential ecosystems that provide wildlife habitats and an array of goods and services including coastal mangroves, marshes, estuaries, coral reefs, and sea grass (National Wildlife Conservation and Management Policy, 2017).

The Wildlife Conservation and Management Act (2013) mandates the cabinet secretary in charge of wildlife management through recommendation by the KWS and in consultation with the National Land Commission, to gazette protected wetland that is an important habitat or ecosystem for wildlife conservation, and a marine conservation area or marine protected where there is rich biodiversity or critical habitats for a variety of marine resources and/or threatened marine species.

2.6.6 NATIONAL TOURISM BLUEPRINT 2030

In 2017, the Government of Kenya established the National Tourism Blueprint 2030, a tourism strategy. It aims to set policies and identify programmes that will make tourism a catalyst for sustainable national development, an engine in protecting the environment and preservation of cultural heritage, creating shared value of tourism to surrounding communities and enhancing gender equality. It also aims to spell out national goals, targets, and indicators for sustainable tourism development. It also strives to reposition and brand the Kenyan coastal destination through development of beach nodes and cruise tourism strategy (National Tourism Board, 2017).

Although the national policy advocates for spatial distribution of tourists, tourism marketing largely focuses on the traditional attractions leading to concentration. Crowded attractions are detrimental for the environment. For instance, heavy concentration has polluted beaches and affected coral reefs, marine species, and coastal ecosystems (National Environment Policy, 2013). Therefore, there is a need to strengthen the enforcement of environmental regulations to reduce environmental damages. Also, considering coastal tourists mainly visit Mombasa, other coastal county governments in partnership with the Kenya Tourism Board could develop and market attractive tourism packages to distribute tourists across the coastal region.

2.6.7 MARINE POLLUTION CONTROL DIRECTIVES

To partly curb marine pollution, in 2017, Kenya banned single use of plastic bags through the Gazette Notice No. 2356. It is estimated that Kenya has recorded about 80 per cent success in ban enforcement. Polythene bags collected along the coastal area have reduced. However, the country has been engulfed with the challenge of enforcement due to the illegal importation of polythene bags from neighbouring countries (Ministry of Environment and Forestry, 2020b). There is a need for behaviour change among Kenyans as well as synchronize plastic pollution control policies within the East African Community to enhance enforcement.

In 2020, the Kenyan Government banned single use of plastics in protected areas. The listed protected areas include national parks, national reserves and wildlife sanctuaries, national monuments, biosphere reserves, world heritage sites, Ramsar sites, beaches, and protected forests. The ban came into effect on 5 June 2020, (Ministry of Environment and Forestry, 2020b). Therefore, visitors will not be permitted to carry water bottles, cups, disposable plates, cutlery, and straws into these protected areas.

2.6.8 OTHERS RELATED STRATEGIES

The blue economy master plan is in the process of development. Kenya is also committed to promoting sustainable aquaculture development. There are plans to develop aquaculture master plan, review aquaculture policy, and develop aquaculture guidelines and standards. The National Treasury allocated KES 1.8 billion for the aquaculture business development project during 2020/21 financial budget (The National Treasury, 2020).

2.7 CONCLUSION

The review revealed that oceans are warmer, more acidic, and less productive. This is impacting on nutrient and carbon cycling, ocean productivity, marine habitats, ecosystem structure, marine organisms at multiple trophic levels, and fisheries with implications on food and nutrition security and livelihoods for coastal communities. By 2090, significant and widespread changes in the ocean state are projected under high emission scenario, thus undermining the blue economy potential. The impacts include warming ocean, sea level rise, coastal disasters, ocean acidification, decreased stability of mineral forms of calcite, oxygen loss, reduced near-surface nutrients, decreased net primary productivity, reduced fish production, and loss of key ecosystems services that are essential for human well-being and sustainable blue economy.

Therefore, there is an urgent need to reduce greenhouse gas emissions to limit the scale of ocean and cryosphere changes as well as ensure that ecosystems and the livelihoods dependent on them are preserved. Climate change adaptation depends on individuals' and communities' capacities and resources available to them. Increasing Kenya's adaptive capacity and resilience to climate change and prevalent disasters as well as promoting low carbon sustainable development are expected to advance the Vision 2030.

Kenya has developed elaborate policies to enhance climate change adaptation and resilience and endeavours to further mainstream these policies into sectoral and development planning. However, lack of effective disaster risk management legislative and institutional framework has impeded effective disaster risk reduction. There is also high political will to promote the blue economy in Kenya. Prevailing political will is expected to significantly transform the blue economy, particularly during the 2020s decade.

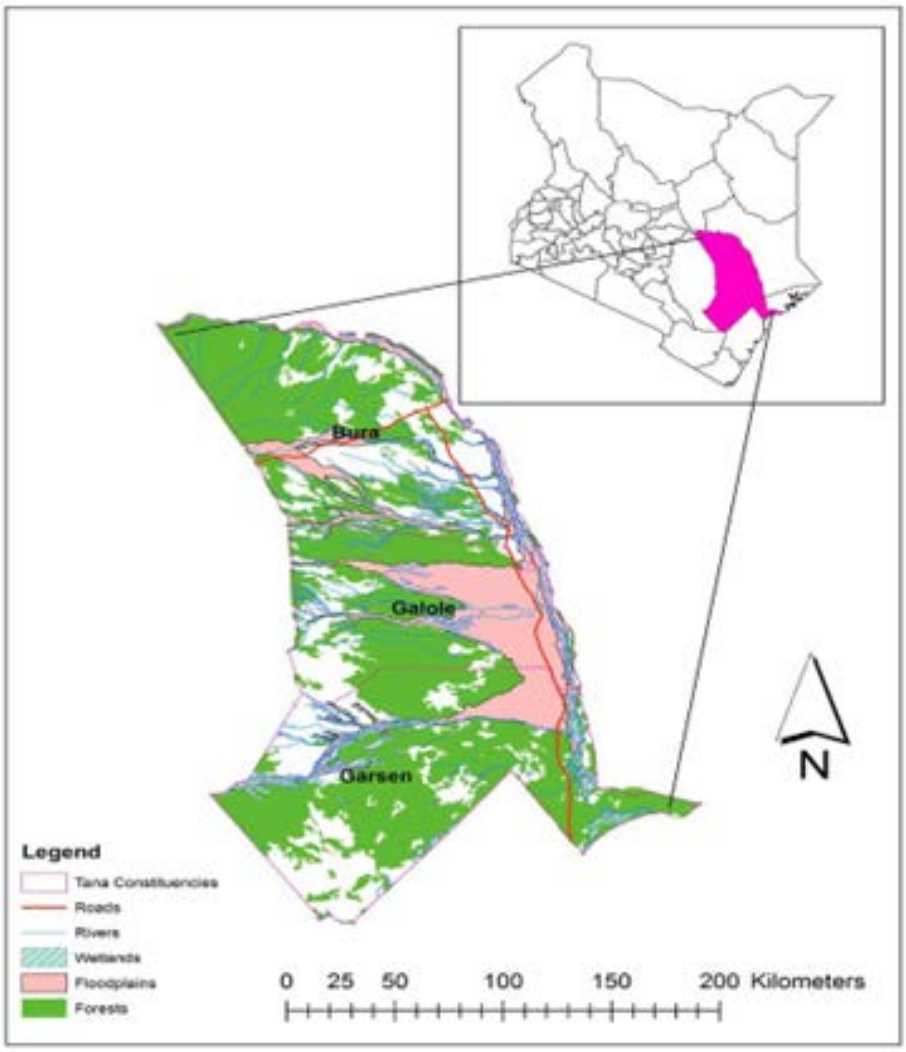
In Tana River, adverse effects of climate change has increased workload of women and girls to collect water and firewood as well as food and nutrition insecurity due to water scarcity. Photo:© Angela Njuguna/IOM 2022

3. METHODOLOGY

3.1 STUDY AREA

The study was conducted in Tana River County (Figure 3.1). Tana River County covers a surface area of 38,437 km2 (about 6.61 per cent of Kenya's landmass) with about 76 km of the coastal strip (Commission of Revenue Allocation, 2020). According to the 2019 census, the County has a population of 315,943 people, with approximately 68,242 households (KNBS, 2019). The County is home to three predominant ethnic tribes: Pokomo (largely farmers), Orma, and Warder (nomadic pastoralists). Tana River County has three administrative sub-counties: Tana North (Bura Constituency), Tana River (Galole Constituency), and Tana Delta (Garsen Constituency) (Commission of Revenue Allocation, 2020).

Figure 3.1 Tana River County



Climatic condition, geographical location, and vulnerability levels were the major determinants used in selecting the study area (Table 3.1). Tana River County is classified as a semi-arid area with annual rainfall and temperature ranging between 400 mm and 750 mm, 30oC and 33oC, respectively (Commission on Revenue Allocation, 2020). Despite relatively low rainfall, the County is highly vulnerable to riverine floods largely due to heavy rainfall in upstream areas of the river Tana. Also, erratic rains during March-May and October-December rainy seasons partly contribute to flooding (Commission of Revenue Allocation, 2020; Karanja and Saito, 2018).

The County also experiences recurrent droughts (Karanja and Saito, 2018). Climate change projections indicate that the frequency and magnitude of droughts will increase in Tana River County (Ngaina et al., 2014). This is likely to further intensify resources-based conflicts experienced in the County (Karanja et al., 2018).

Table 3.1 Selection criteria for the study area

Determinants	Tana River County
Diversity of blue economy resources	• Coastal strip of 76 km • Tana River • Tana Delta ecosystem • Lakes (Shaka Bado, Bilisa & Mpwonge)
Climate condition	• Arid and semi-arid (prone to resources-based conflicts and droughts)
Disaster vulnerability	• Floods • Droughts • Conflicts
Blue economy-based economic activities	• Fishing (marine & riverine) • Aquaculture • Coastal tourism • Agriculture

Most of blue economy resources are found in Tana Delta Sub-County (Figure 3.1). Therefore, much of data collection was concentrated in the Sub-County. Within Tana River County, Tana Delta is the most vulnerable to floods and less susceptible to droughts in comparison to the other two sub-counties. Tana Delta Sub-County is also prone to resource-based conflicts (Karanja et al., 2018).

Crop farming and nomadic pastoralism are the major economic activities practiced in the Tana River County. Only about 4 per cent of the County land is classified as arable land. The Tana Delta provides grazing land during the dry season. Farmers also utilize the Tana River to irrigate their crops such as rice, banana, maize, mangoes, and soya beans (Commission of Revenue Allocation, 2020; Karanja and Saito, 2018). Other economic activities yet to be fully exploited include fishing, aquaculture, and tourism (Karanja and Saito, 2018).

3.2 DATA COLLECTION

A preliminary field visit was conducted in January 2021 to familiarize with the field and meet critical stakeholders from both national and county governments. This was followed by the data collection exercise in the month of March 2021. The study adopted a mixed-method approach to collect data comprehensively. First, a comprehensive literature review was conducted to preliminary understand the impacts of climate change and disasters on the blue economy. The review clarified initiated policies and strategies in Kenya aimed at strengthening climate change resilience, climate change adaptation, and DRR to ensure a sustainable and resilient blue economy. Policy gaps and mismatches were identified as explicated in Chapter 2.

Second, three sets of questionnaires (based on practiced blue economy livelihoods) were electronically administered to the residents of Tana Delta Sub-County using the Kobo Collect application. Questionnaires were developed in XLSForm using excel (Annexes 1-3) and then uploaded to the dedicated IOM KoboToolbox server. The layout designs of the questionnaires are presented in Appendices 1-3. Three pairs of enumerators (a total of six) were recruited to assist in data collection. Each pair worked on a specific set of a questionnaire to ensure consistency in data collection. In total, 252 questionnaires were administered, 84 questionnaires per pair. Collected data are organized in data sets in Annexes 4.

The first set of the questionnaire was administered to crop farmers as farming is enabled by the Tana Delta. The questionnaire assessed: (i) crops planted; (ii) farmers' perceptions about climate change and disasters; (iii) impacts of climate change and disasters on crop farming; and (iv) climate change coping strategies adopted by farmers.

The second set of the questionnaire targeted pastoralists. Although pastoralism in traditional sense is not a blue economy livelihood, it is highly practiced in the delta region, as a blue economy resource especially in dry seasons. The questionnaire assessed: (i) agro/pastoralists' perceptions about climate change and disasters; (ii) impacts of climate change and disasters on pastoralism; (iii) adaptation measures adopted by pastoralists; and (iv) effectiveness of pastoralism as an adaptation strategy.

The last set of the questionnaire targeted fisherpersons and assessed: (i) fishing gears fishers and vessels utilized; (ii) fishes caught; (iii) fishers' perceptions about climate change; (ii) the impacts of climate change and disasters on fisheries; and (iii) adaptation and coping strategies adopted by fishers.

Third, key informant interviews were conducted with key stakeholders to understand and validate the impacts of climate change and disasters on blue economy livelihoods practiced in Tana River County. The interviews also explored ongoing and stalled blue economy-related projects. Table 3.2 summarizes key stakeholders that will be targeted for interviews.

Table 3.2 Stakeholders for key informant interviews

No	Organizations	Key Stakeholders
1.	County Government of Tana River County	• County Executive Committee Members in charge of fisheries and aquaculture, agriculture, natural resources and environment, and tourism (Hola) • Tana Delta Sub-County Administrator (Garsen)
2.	National Government	• Deputy County Commissioner (Garsen) • National Drought Management Authority (Hola) • Kenya Fisheries Service (Nairobi & Mombasa) • Kenya Marine and Fisheries Research Institute (Mombasa)
3.	NGOs/CBOs	• Kenya Red Cross • Nature Kenya (Garsen)

Lastly, focus group discussions (FGDs) were held with key stakeholders to further understand the impacts of climate change and disasters on the blue economy livelihoods. The FGDs also explored feasible inventions to enhance the resilience of blue economy dependent communities. Three FGDs were organized in Hola and Garsen towns. The first FGD was held in Hola town with the Tana River County Steering Committee that is composed of officials from the County Government, National Government and NGOs operating

in the Tana River County. The meeting was set up by the Office of the County Commissioner. . The second FGD was held in Minjala town with Tana Delta Sub-County Steering Committee, organized by the Deputy County Commissioner (Garsen) and the NDMA. The third FGD was held in Garsen town with the following representatives from Kipini region: Assistant County Commissioner in Kipini, Kipini East Ward Administrator, four village elders, representatives from at least two BMUs, two representatives from two local community-based organizations (Kipini Conservation Management Forum-KCMF and Kipini Integrated Community Enterprises-KICE), and two tourism operators.

Figure 3.2 Data collection pictures

Interview with a female fisher in Lake Shakabado

Interview with a farmer in Kipini East Ward

Discussion with pastoralists in Konani Cluster

Interview with a pastoralist in Tana Delta

Interview with a farmer in Kipini East Ward

Interview with a fisher in Kipini Beach

Furthermore, the lead researcher alongside with IOM officials visited several villages and had informal discussions with local communities in Konani Cluster, Odha village, Minjala town and Hola town as well as members of Tawfiq Girls Champion Self-Help.

3.3 VALIDATION OF RESEARCH FINDINGS

A validation session of research findings was organized with the Technical Working Group of the project that consisted of Migration, Environment and Climate Change (MECC) unit of IOM; Directorate of Diaspora Affairs from the Ministry of Foreign Affairs; the State Department for Fisheries, Aquaculture and the Blue Economy in the Ministry of Agriculture, Livestock and Fisheries, and National Diaspora Council of Kenya. The research validation session extended invitation to the County Government of Tana River (to the directors in charge of fisheries, water, and natural resources as well as Tana Delta Sub-County Administrator), the Office of County Commissioner in Tana River County, the National Drought Management Authority in Tana River County, and Kenya Red Cross Society in Tana River County. Due to the challenges posed by the COVID-19 pandemic that restricted physical meetings, the validation session was held online on 11 May 2021.

The Minjila water pan in Tana River county is rapidly drying up. In the area, both pastoralists and farmers rely only on this dam, which causes tensions, as both are predominantly dependent on it.
Photo:© Angela Njuguna/IOM 2022

4. FINDINGS AND DISCUSSION

4.1 SOCIO-DEMOGRAPHIC FEATURES

Table 4.1 summarizes the socio-demographic features of the respondents based on targeted blue economy livelihoods in Tana River County. There was no significant gender disparity among farmers. In the pastoralism sector, female respondents accounted for 63 per cent. This is partly because men were in the rangeland looking after the livestock. In the fisheries sector, there was significant gender disparity where female respondents only accounted for 4 per cent of the total fishers. All the female fishers fished at Lake Shakabado. Although this is the case, a lot of women are involved in the fish trade business.

The education status of the respondents was relatively low. Overall, at least 59 per cent of the respondents had attained primary level education. However, there were noted differences across livelihood types. For instance, about two-thirds of the pastoralists had no formal education, with fishers and farmers accounting for 40 per cent and 17 per cent, respectively. Farmers had a higher education level with about 83 per cent having attained at least primary education and 22 per cent at least secondary education.

In terms of income, fishers were doing better with an average daily income of at least KES 800, earning about eight times higher than the farmers and about three times higher compared to the pastoralists.

Table 4.1 Respondents' socio-demographic features

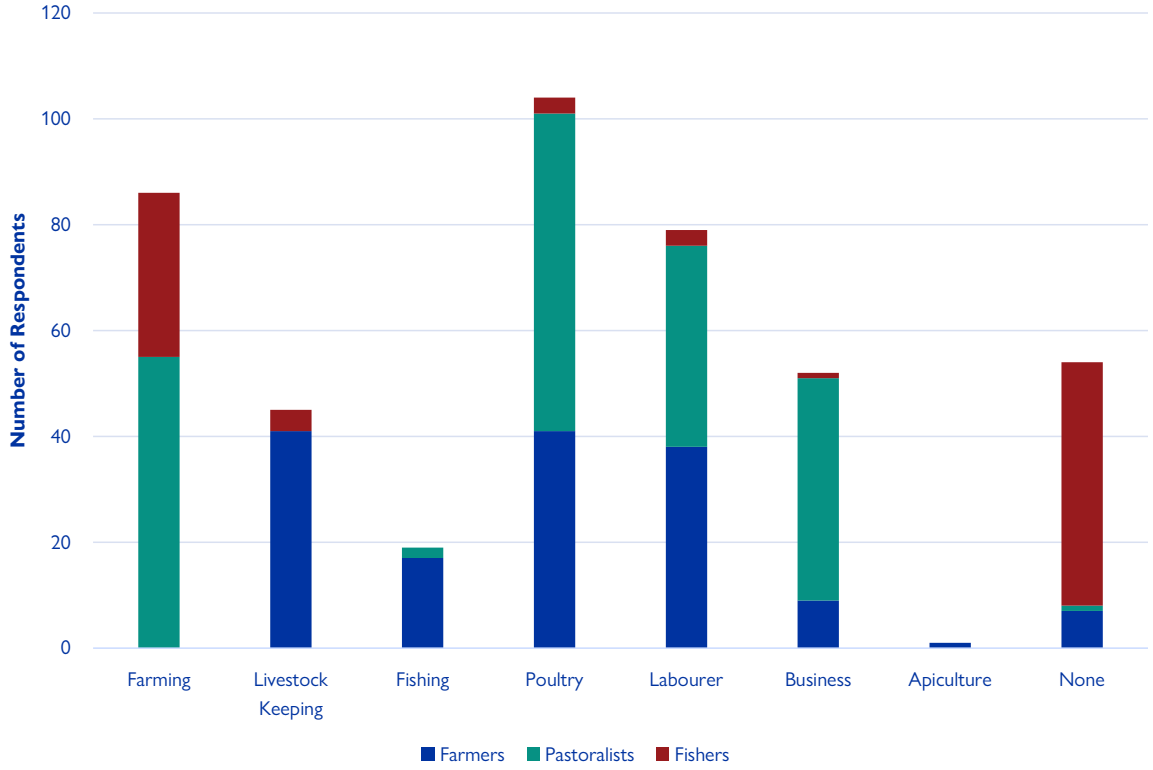
Category	Variables	Farmers	Pastoralists	Fishers	Total
Gender	Male	47 (56%)	31 (37%)	81 (96%)	159 (63%)
	Female	37 (44%)	53 (63%)	3 (4%)	93 (37%)
Education level	No basic education	14 (17%)	56 (67%)	34 (40%)	104 (41%)
	Primary level	51 (61%)	27 (32%)	42 (50%)	120 (48%)
	Secondary level	17 (20%)	1 (1%)	7 (8%)	25 (10%)
	Post-secondary	2 (2%)	0	1 (1%)	3 (1%)
Age	Average age	44	42	46	44
Household size	Average hh size	7.2	7.4	5.6	6.7
Income (KES)	Annual average	34,946	96,571	307,584	146,367
Average years of experience in:	Farming	19.5	-	-	21.1
	Livestock keeping	-	26.2	-	
	Fishing	-	-	17.5	

n=252

The study targeted respondents who were at least thirty years old to capture respondents' perceptions about climate change in comparison to the last twenty years (2000-2020). The total average age for the respondents was forty-four years and the total average working experience in the target livelihoods was about 21 years. This meant that the respondents had sufficient experience to provide valid perceptions about climate change and climate variability, at least for the last 20 years.

Nearly all pastoralists (99%) and farmers (92%) had alternative sources of livelihood (Figure 4.1). Only 45 per cent of fisherpersons had alternative sources of livelihood. Poultry (71%), crop farming (65%) and business (50%) were the main alternative livelihoods practiced by pastoralists. Farmers depended on poultry (48%), livestock keeping (48%), and working as labourers as alternative livelihoods. The fisherpersons (36%) practiced crop farming as an alternative livelihood. As later elaborated in section 4.14.2, pastoralists were very particular on the type of alternative livelihoods they were interested in while farmers were more flexible. On the other hand, majority of fishers were not enthusiastic about practising alternative livelihoods

Figure 4.1. Alternative livelihoods practiced by respondents



4.2 BACKGROUND: AGRICULTURE SECTOR

Most of the farmers (88%) practiced rain-fed agriculture (Table 4.2). Therefore, they are more susceptible to climate variability that has manifested in terms of prolonged dry periods, shifting rainy seasons and floods as discussed in the climate change section. The top three planted crops were maize (89%), green grams (54%) and sesame (31%) (Table 4.3).

Pastoralists practiced nomadic pastoralism with migration concentrated within Tana River County and occasionally to neighbouring Lamu, Kilifi, and Garissa counties. During prolonged dry periods, migration is concentrated in Tana Delta Sub-County, Tana River County that tends to be green. Cattle (96%), goats (87%) and poultry (86%) were the main livestock kept (Table 4.4).

Table 4.2 Type of farming practiced

Farming type	Frequency	Percentage (%)
Rain-fed only	74	88%
Rain-fed and irrigation	10	12%

n=84

Table 4.3 Main crops planted

Crops	Frequency	Percentage (%)
Maize	75	89%
Green grams	45	54%
Sesame (simsim)	26	31%
Banana	22	26%
Cotton	13	15%
Mangoes	11	13%
Cassava	9	11%
Cashew nuts	8	10%
Lemons	7	8%
Beans	6	7%
Sugarcane	6	7%
Rice	4	5%
Tomatoes	4	5%
Pawpaw	3	4%
Coconut	2	2%
Cowpeas	2	2%
Kales	2	2%
Bixa (Achiote)	1	1%
Casuarina tree	1	1%
Eggplant (Brinjals)	1	1%
Groundnuts	1	1%
Onions	1	1%
Pepper	1	1%
Sorghum	1	1%

n=84

Table 4.4 Type of livestock kept

Herd species	Frequency	Percentage (%)
Cattle	81	96%
Goats	73	87%
Poultry	72	86%
Donkey	7	8%
Ducks	2	2%
Sheep	1	1%

4.3 BACKGROUND: FISHERIES SECTOR

Interviewed fishers were predominantly practicing marine fishing with Kipini serving as the main landing site. About a quarter of the fishers were practising river fishing with more than half of them also practising marine river fishing. About 14 per cent of the fishers were practising lake fishing and a quarter of them were women (Table 4.5). The boat was the main fishing vessel utilized (Table 4.6). Due to limited fishing capacity, most of the fishing activities (81%) were conducted around the shore and/or offshore (Table 4.7).

On average, fishers take about four hours to get to the fishing ground and about 7 hours for fishing (Table 4.8). Much of the marine fishing activities are conducted at night.

Table 4.5 Type of fishing practiced

Fishing type	Frequency	Percentage (%)
Marine fishing	71	85%
River fishing	23	27%
Lake fishing	12	14%

n=84

Table 4.6 Fishing vessels utilized

Fishing vessels	Frequency	Percentage (%)
Boat	69	82%
Canoe	11	13%
Swimming	4	5%

n=84

Table 4.7 Where do fishing activities happen?

Areas	Frequency	Percentage (%)
Both inshore and offshore	60	71%
Deep sea	16	19%
Mainly inshore	5	6%
Mainly offshore	3	4%

n=84

Table 4.8 Time taken to fish and quantity of fish harvested

Fishing Activities	Average	Standard deviation
Average time taken to get to fishing ground	4.4 hours	2.97
Average fishing duration per day	7.2 hours	2.57
Daily harvested fish	88 Kgs	61.33

Hook and line were the most utilized (by 44 per cent of fishers) fishing gear. However, about 20 per cent of the fishers were using illegal fishing gears with monofilament gill net being the most common (Table 4.9). There is a need to build the capacity of fishers and beach management units (BMUs) to ensure only legal fishing gears are used to minimize degradation of marine ecosystem and species. Capacity building initiatives could be in form of supporting fishers with modern and eco-friendly fishing gears supplemented by training on modern fishing techniques, sustainable use of fisheries resources as well as enhancing the capacity of BMUs to effectively conduct fisheries monitoring, control, and surveillance in their jurisdictions. There are three BMUs along the coastal strip of Tana River County: Kipini, Ozi and Chara BMUs.

Respondents were also asked to list the top three main fish species caught. Tuna (55%), octopus (26%), shark (21%), and red snapper (20%) were the most common fish species harvested (Table 4.10).

Table 4.9 Common fishing gears

Fishing gear	Frequency	Percentage	Legal status
Handlining/ Hook & Line) (Mshipi)	37	44%	Legal
Monofilament gill net (Nyavu ya mkano)	9	11%	Illegal
Gill Net-Drifting (Jarife-Nyavu ya kuogelesha)	8	10%	Legal
Gill Net-Stationary (Jarife-Nyavu ya kutega)	5	6%	Legal
Beach seine/Reef seine net (Juya/Nyavu ya kukokota)	5	6%	Illegal
Ring Net (Nyavu ya kufunga)	5	6%	Under review
Trolling (Mship wa kurambaza)	5	6%	Legal
Scoop net/hand net (kimia)	4	5%	
Fence trap (uzio/zonga/rakasa/ wando/ tando)	2	2%	Legal
Mosquito net (uduvi/tandilo)	2	2%	Illegal
Longline (Zulumati)	1	1%	Legal
Spear and Harpoon (Mkuki/ Njoro na Shomo/ Mkondzo	1	1%	Illegal

n=84

Table 4.10 Main fish species caught

Fish species	Frequency	Percentage (%)
Tuna (jodari)	46	54.8%
Octopus (pweza)	22	26.2%
Shark (papa)	18	21.4%
Red snapper (shogo)	17	20.2%
Kingfish (nguru)	12	14.3%
Sailfish (suli suli)	12	14.3%
Lobsters/prawns (kamba)	11	13.1%
Silverfish	10	12.0%
Clarias (tonzi)	9	10.7%
Marbled lungfish (kamongo)	8	9.5%
Pawazi	8	9.5%
Saresare	8	9.5%
Para para fish	7	8.3%
Ray fish (kipungu)	6	7.1%
Delagoa threadfin bream (koana)	5	6.0%
Ngonda	5	6.0%
Tilapia	5	6.0%
Barracuda	4	4.8%
Catfish (fumi)	4	4.8%
Hammerhead shark (papa mbingusi)	4	4.8%
Milkfish (Mborode)	4	4.8%

Fish species	Frequency	Percentage (%)
Large–eye bream (Tangu)	4	4.8%
White snapper	4	4.8%
Grouper (chewa)	3	3.6%
Jumbo	3	3.6%
Rabbitfish (tasi/tafi)	3	3.6%
Starfish (samaki wa nyota)	3	3.6%
Otomerbora mullet (mbinini)	2	2.4%
Bull ray/spotted eagle ray (shepwa)	1	1.2%
Dunje	1	1.2%
Little Mackerel (una)	1	1.2%
Punga fish	1	1.2%
Pungwe chiselmouth	1	1.2%
Shrimp scad (kambisi)	1	1.2%
Tank goby (jumburu)	1	1.2%

4.4 FOOD INSECURITY

The respondents were asked whether their household had run out of food for the last five years. Pastoralists and farmers were more vulnerable to food insecurity compared to fishers. This is probably because fishers' average income was much higher than farmers and pastoralists as elaborated by Table 4.1. At least three-quarters of interviewed farmers and pastoralists had run out of food within the last five years (Table 4.11). Only about a third (36%) of fishers experienced a similar predicament.

Table 4.11 Has your household run out food for the last five years?

Respondents	Yes	No
Farmers	63 (75%)	21 (25%)
Pastoralists	70 (83%)	14 (17%)
Fishers	30 (36%)	54 (64%)
Total	163 (65%)	89 (35%)

n=252

About 62 per cent of farmers and 59 per cent of pastoralists that had run out of food, attributed the food shortage to prolonged droughts. Other reasons illustrated by farmers include crop destruction by wildlife and livestock leading to human-wildlife conflicts and disputes with pastoralists. Other factors causing food shortage among pastoralists include lack of employment opportunities and floods.

About 80 per cent of the fishers that had run out of food attributed the food shortage to low fish catch. The low fish catch was attributed to strong winds. The lake fisherpersons attributed low catch to prolonged drought that led to drying of Lake Shakabado. Other reasons included inadequate fishing gears to enable offshore fishing.

The main factors contributing to food insecurity could be attributed to changing climatic conditions. For instance, prolonged droughts as highlighted by the farmers and pastoralists as well as low fish catch attributed to changing ocean climate (more details in climate change section), strong winds and droughts for inland fishers. Resource-based conflicts were somewhat contributing to food insecurity. Karanja and Abdul-Razak

(2018) discovered that climate change tended to increase resource-based conflicts among pastoralists in arid and semi-arid regions of Kenya.

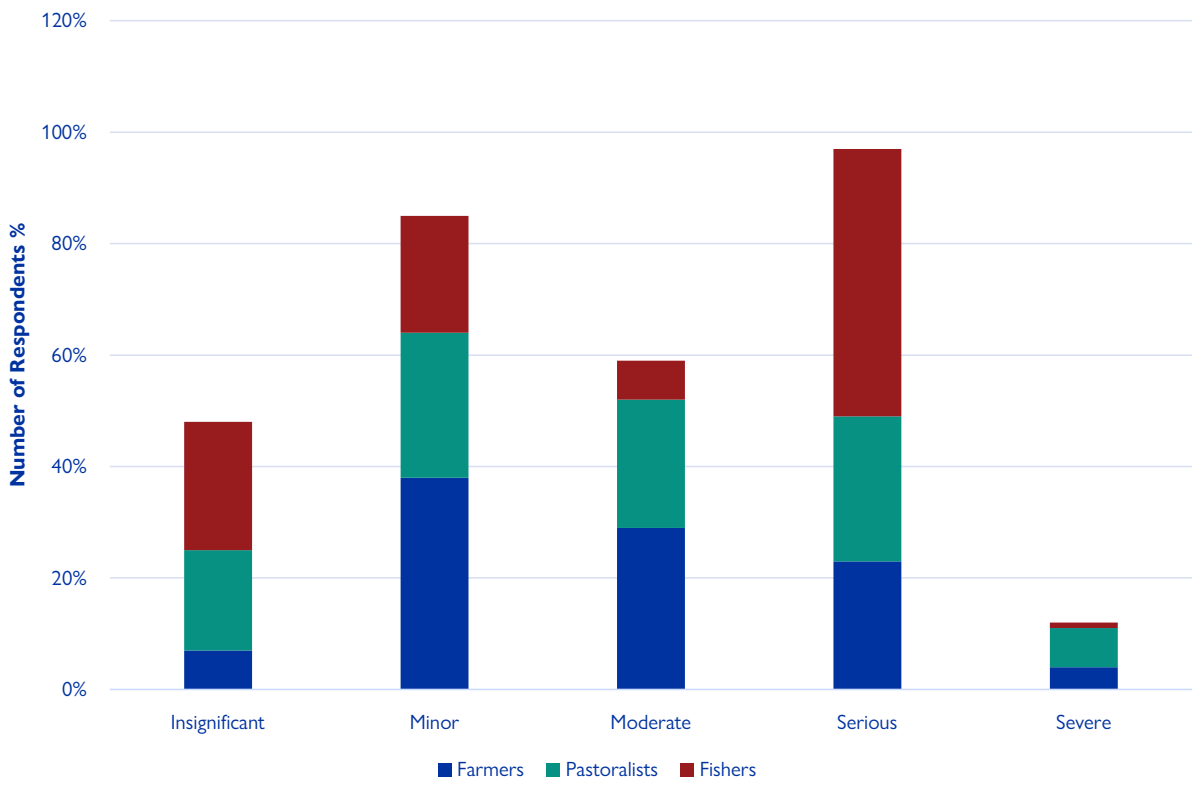
4.5 DISASTER RISK ASSESSMENT

4.5.1 FLOOD RISK

A third (32%) of the respondents perceived flood risk to be serious, the majority of whom (49%) were fishers. Two-thirds of the farmers (67%) and nearly half of the pastoralists (49%) perceived flood risk to be either minor or moderate (Figure 4.2).

The research also examined how the frequency of flood disasters has changed within the last five years (2015-2020). Most of the respondents (59%) illustrated that flood frequency has been declining (Table 4.12). Floods in Tana River County are caused by heavy precipitation and the sudden release of water held upstream in hydro dams. The respondents revealed that the dry periods have prolonged, and this could be attributed to the declining floods' frequency. Also, key interviewers with humanitarian actors revealed that the floods are occurring less frequently compared to the last 10 years. However, floods are still causing devasting impacts particularly in Tana Delta Sub-County as elaborated in section 4.6 and as earlier revealed by Karanja and Saito (2018).

Figure 4.2 Flood risk assessment



Although majority of the respondents stated that floods are occurring less frequently, it is important to note that about 30 per cent of the farmers and pastoralists perceived floods to be more frequent (Table 4.12).

Table 4.12 Flood frequency (2015-2020)

Floods' frequency	Farmers	Pastoralists	Fishers	Total
No change	13 (15%)	14 (17%)	24 (29%)	51 (20%)
Less frequent (fewer incidents)	45 (54%)	45 (54%)	58 (69%)	148 (59%)
More frequent (increased incidents)	26 (31%)	25 (30%)	2 (2%)	53 (21%)

n=252

4.5.2 DROUGHTS

There was a consensus, particularly among farmers and pastoralists, that droughts pose a serious or severe risk to communities. Overall, 83 per cent of the respondents classified drought as a serious or severe risk (Figure 4.3). Similarly, about 86 per cent of the respondents exemplified that the frequency of drought disasters has been increasing (Table 4.13). This was particularly pronounced among the farmers (99%) and pastoralists (96%) due to the direct and immediate impacts of droughts on their livelihoods as opposed to the fishers. Rain-fed farming and livestock production are entirely dependent on rainfall.

Figure 4.3 Drought risk assessment

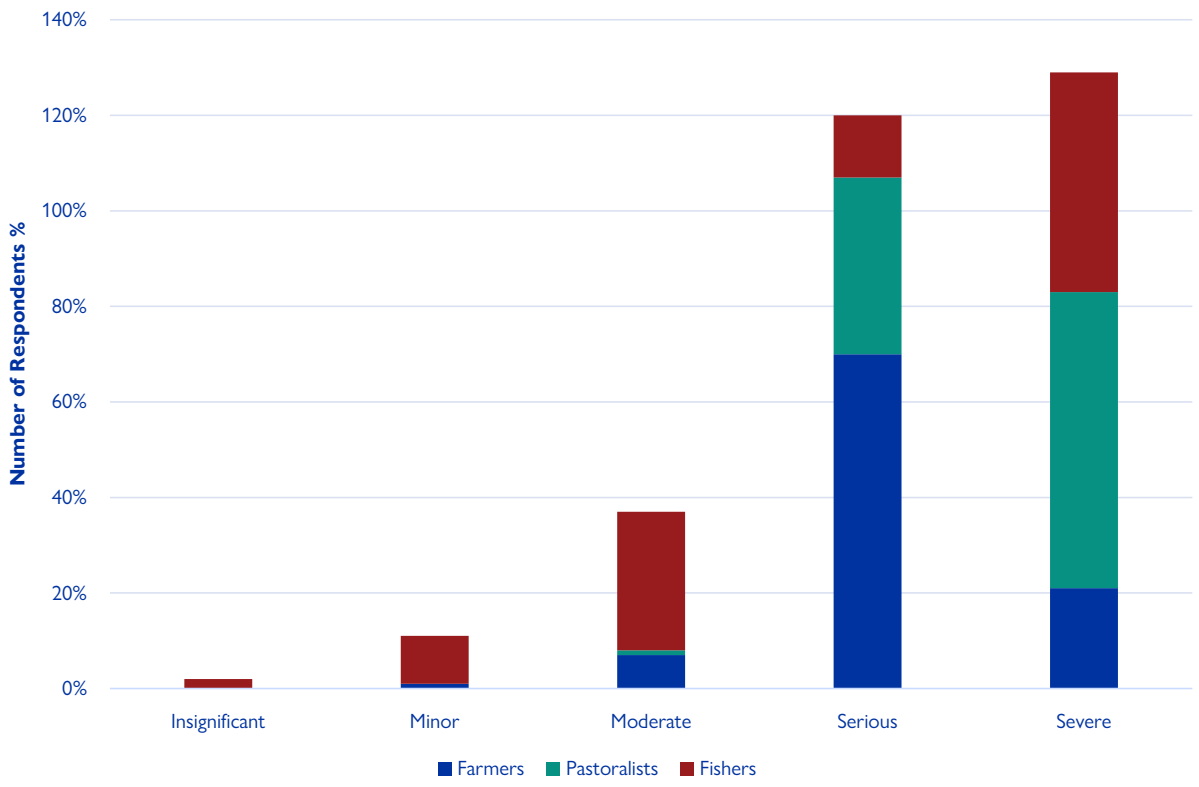


Table 4.13 Drought frequency (2015-2020)

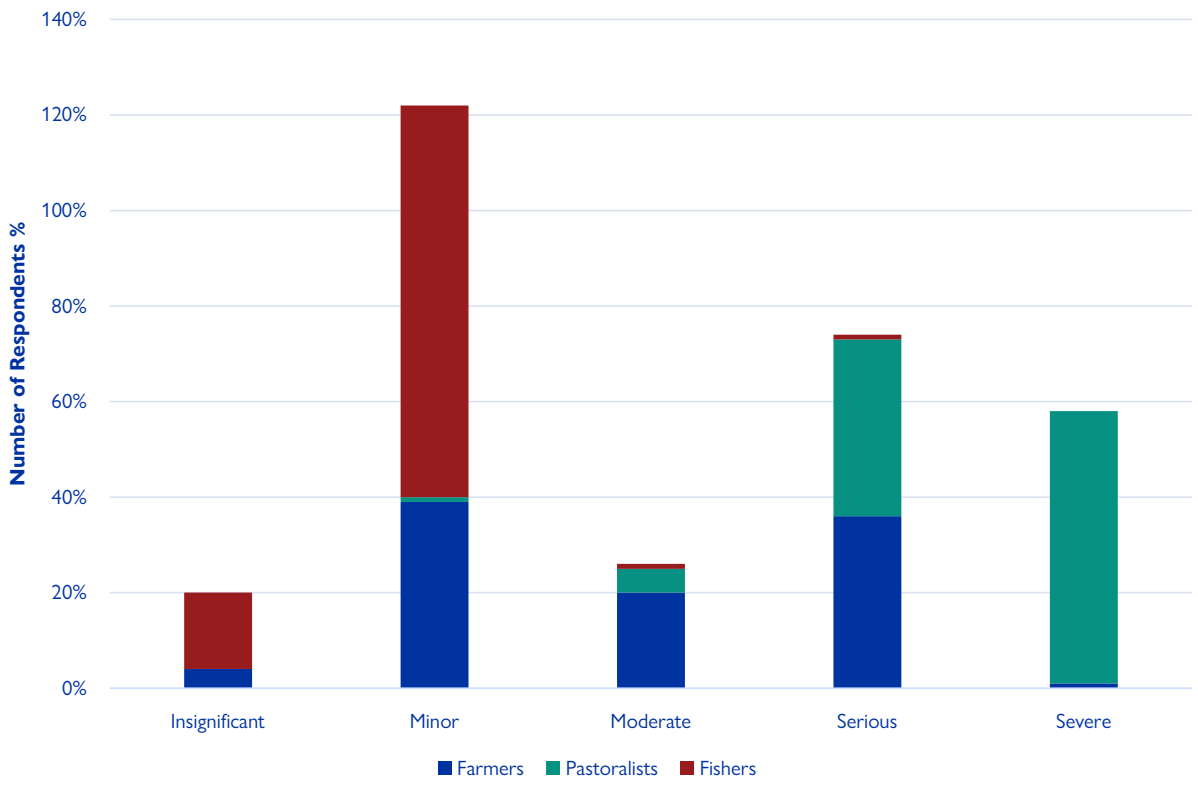
Droughts' frequency	Farmers	Pastoralists	Fishers	Total
No change	0	0	9 (11%)	9 (4%)
Less frequent (fewer incidents)	1 (1%)	3 (4%)	21 (25%)	25 (10%)
More frequent (increased incidents)	83 (99%)	81 (96%)	54 (64%)	218 (86%)

n=252

4.5.3 RESOURCE-BASED CONFLICTS

Resource-based conflicts were perceived to be more serious and severe among the pastoralists (94%) (Figure 4.4). Only about 37 per cent of the farmers perceived resource-based conflicts to be serious and/or severe, whilst 98 per cent of the fishers regarded these conflicts as insignificant and minor. This disparity could be attributed to the types of conflicts each group experiences. Pastoralist's experience three types of conflicts with the farmers over grazing areas; ii). clan conflicts due to competition over rangeland resources and political reasons.; iii) T human-wildlife conflicts. These findings have also been confirmed by several studies (Adey, 2015; Kipkemoi et al., 2017).

Figure 4.4 Risk assessment of resource-based conflicts



Farmers on the other hand, experience conflicts with pastoralists when livestock encroach their farmland. This type of conflict has been highlighted by Adey, 2015; Karanja et al., 2018; and Kipkemoi et al., 2017. Farmers also reported increasing incidents of wildlife invasion. Furthermore, lack of security of tenure for

their farmland breeds land conflicts. The fisher experience conflicts associated with the management of their BMUs.

About 92 per cent of the pastoralists also lamented that the incidents of resource-based conflicts have been increasing in the last five years (2015-2020). However, 57 per cent of the farmers and 70 per cent of fishers stated that the conflict incidents have reduced (Table 4.14). The difference could also be associated with the different nature of conflicts experienced by each group.

Table 4.14. Frequency of resource-based conflicts

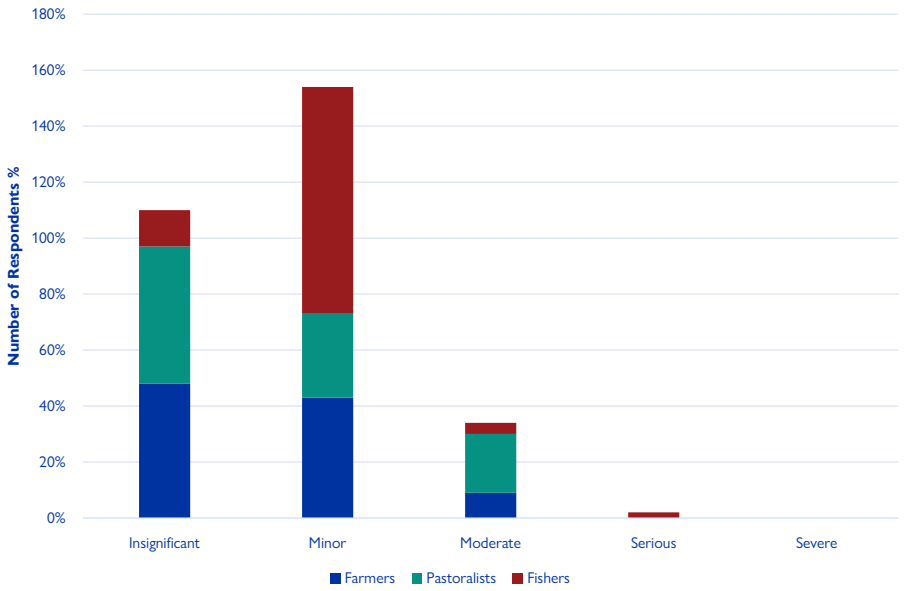
Conflicts' frequency	Farmers	Pastoralists	Fishers	Total
No change	6 (7%)	0	24 (29%)	30 (12%)
Less frequent (fewer incidents)	49 (58%)	7 (8%)	59 (70%)	115 (46%)
More frequent (increased incidents)	29 (35%)	77 (92%)	1 (1%)	107 (42%)

n=252

4.5.4 COASTLINE POLLUTION

Considering coastal pollution is a serious threat to marine ecosystems and blue economy livelihoods (such as fisheries and tourism), the study assessed the severity of coastline pollution along Kipini beach. About 88 per cent of the respondents perceived coastline pollution as an insignificant and a minor risk (Figure 4.5). However, the respondents reiterated that coastal pollution might intensify with a slowly increasing population. Therefore, there is need to establish an effective waste management strategy for Kipini town and other towns located along River Tana as well as create awareness on proper waste disposal.

Figure 4.5 Risk assessment of coastal pollution



In Tana River County, solid waste management is not only a concern for coastal towns but also, a threat to

emerging inland towns, particularly Hola town, the headquarters of Tana River County. Hola is urbanizing at a moderate rate. However, the town has no designated waste dumping site. Most of the waste is dumped in downtown of Hola town about 100 metres from River Tana (Figure 4.6). The solid wastes are clogging drainage system and could trigger flash floods in the future. Also, the dumped solid and effluent waste (largely from domestic waste) is also likely to find its way to the Tana River, which will lead to river and coastal pollution as well as cause health problems since Tana River is the main water source for most Hola residents. The challenge of waste management in Hola town was also highlighted by a local newspaper, Daily Nations (Oduor, 2021). Therefore, an integrated solid waste management plan could be explored to ensure proper waste disposal and curb river pollution within the Tana River basin.

Figure 4.6 Pictures of disposed waste in Hola

4.5.5 STRONG WINDS

About 56 per cent of the respondents considered strong winds as insignificant and minor risk, the majority of whom were pastoralists (Figure 4.7). Majority of the fishers and 19 per cent of farmers perceived strong winds a serious risk. The fishers lamented that they are unable to conduct offshore fishing during intense winds.

Furthermore, about 97 per cent of pastoralists and 80 per cent of the farmers described the frequency of strong winds to either have declined or remained the same for the last five years (2015-2020). However, half of the fishers illuminated the increasing frequency of strong winds (Table 4.15). Small-scale fishing activities are influenced by winds and storms, and this could explain why fishers were likely to perceive winds' frequency to be increasing. Their daily fishing decisions are determined by the nature and strength of winds and storms.

Figure 4.7 Risk assessment of strong winds

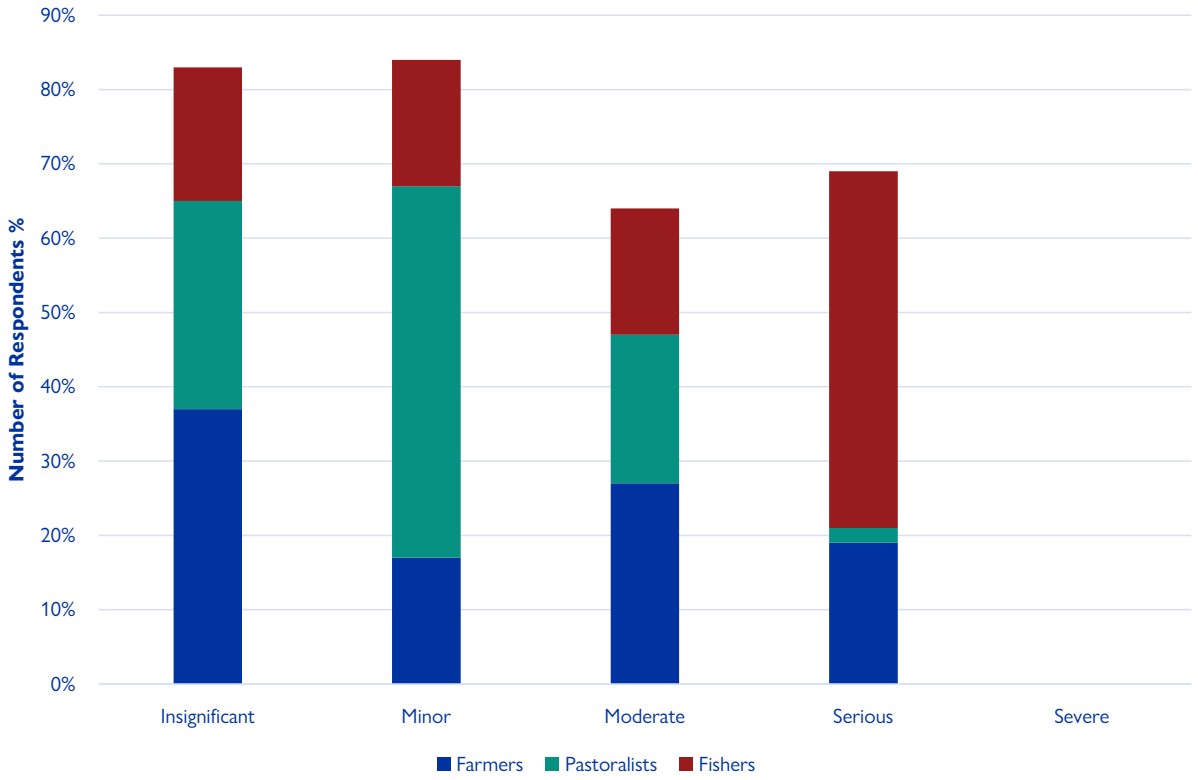


Table 4.15 Frequency of strong winds

Strong wind frequency	Farmers	Pastoralists	Fishers	Total
No change	29 (35%)	25 (30%)	14 (17%)	68 (27%)
Less frequent (fewer incidents)	38 (45%)	56 (67%)	27 (32%)	121 (48%)
More frequent (increased incidents)	17 (20%)	3 (4%)	43 (51%)	63 (25%)

n=252

4.5.6 SALTWATER INTRUSION

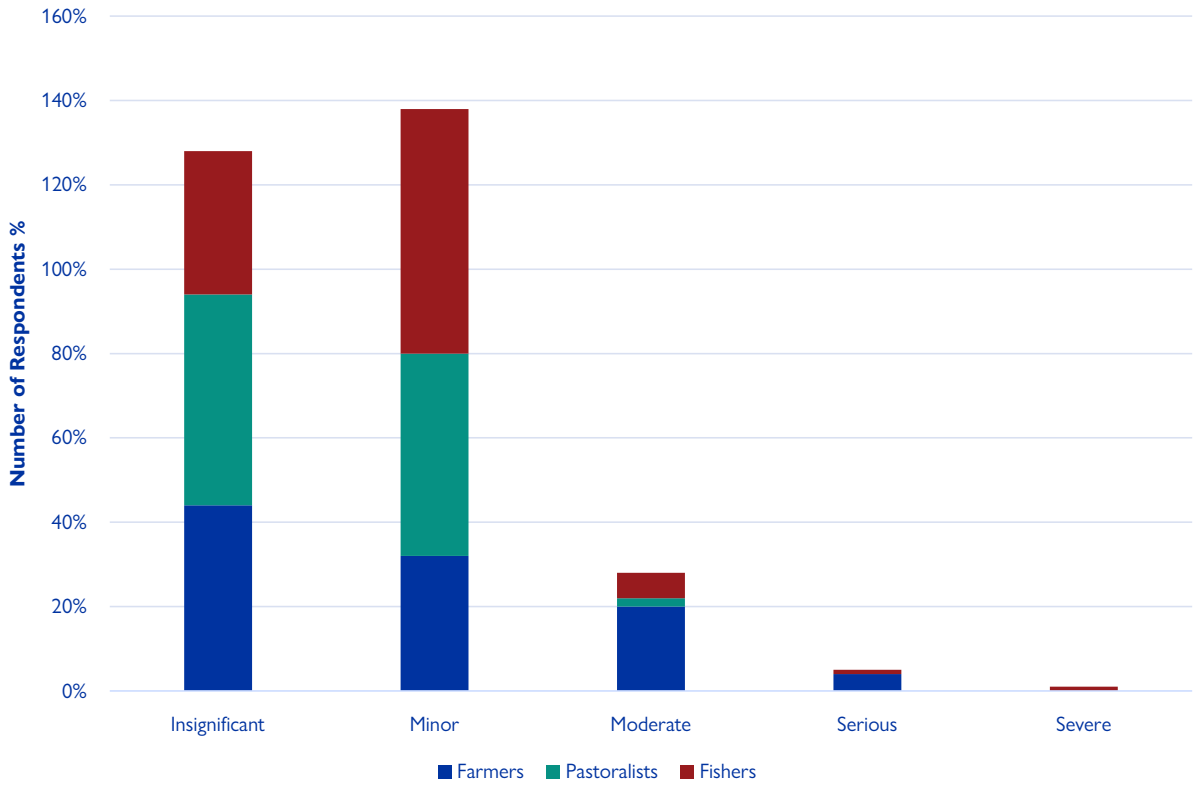
Approximately 88 per cent of the respondents classified saltwater intrusion as an insignificant and minor risk (Figure 4.8). Since farmers are the ones impacted by saltwater intrusion, the research assessed coastal farmers' observations about the frequency of saltwater intrusion. According to the experience of 56 per cent of the farmers, the frequency of saltwater intrusion has remained the same for the last five years (2015-2020), and about 36 per cent of the farmers noted they have experienced fewer incidents of saltwater intrusion (Table 4.16). Furthermore, 93 per cent of the farmers confirmed that the impacts of saltwater intrusion are less severe.

Table 4.16 Frequency about saltwater intrusion

Frequency	Farmers
No change	47 (56%)
Less frequent (fewer incidents)	30 (36%)
More frequent (increased incidents)	7 (8%)

n=84

Figure 4.8 Risk assessment of saltwater intrusion



4.6 IMPACTS OF CLIMATE CHANGE

4.6.1 FLOODS

This study primarily focused on the impacts of disasters (including floods) on crop farming, pastoralism, and fisheries sectors. Floods experienced in Tana River County often led to the displacement of people, destruction of property and infrastructure as well as disruption of transport services making crucial institutions and services inaccessible such as schools, hospitals, and markets. Floods also trigger an outbreak of water-borne diseases such as cholera and malaria. Karanja and Saito (2018) estimated annual flood damage and losses to range from USD 84.32 to USD 1,233.52 per household in the lower Tana Delta.

4.6.1.1 Crop farming

Two-thirds (68%) of the farmers had experienced crop failure and reduced harvests due to prolonged droughts, reduced precipitation, and erratic rainfall. Shifting rainy seasons has also affected the planting time. The farmers indicated because of rains' unpredictability, it has been challenging to correctly time ploughing and planting seasons. Incorrect timing often results to crop failure and increases the cost of farming as the farmers are sometimes forced to plant at least twice within a crop calendar.

About three-quarters of the farmers elucidated that they have experienced waterlogging in their farmland causing stunted crop growth and reduced crop yield. Waterlogging increases soil salinity thus reducing soil productivity. Nearly a third (32 per cent) of the farmers reiterated that floods often damage and sweep away crops. The reduced crop yield and crop damages engender reduced incomes for farmers, increasing their vulnerability to other disasters and shocks. Farmers also recapped that flood often precipitate aflatoxins, which are harmful to humans and livestock.

4.6.1.2 Pastoralism

About 65 per cent of pastoralists illustrated that they have not been severely affected by floods. About 20 per cent of pastoralists encapsulated that animal diseases including mastitis, anthrax, blackleg, and foot rot increase during the flooding season. These diseases are compounded by limited vaccines and veterinarians leading to increased loss of livestock. Floods also cause inundation of pastureland due to overgrazing in unsubmerged areas, inducing migration of livestock somewhat triggering conflicts due to competition over resources.

4.6.1.3 Fisheries

About 56 per cent of fishers affirmed that floods do not have significant impacts on their fishing activities as majority spend on marine fishing. Nevertheless, floods usually disrupt river and lake fishing activities. About 21 per cent of the fishers highlighted that flood leads to reduced fish catch in the rivers because they are unable to access the river. For lake fishers, they stated that floods lead to flocking of hippopotamus and crocodiles making fishing risky. They affirmed that few fishers have either been injured and killed by these animals.

4.6.2 DROUGHTS

4.6.2.1 Crop farming

As earlier highlighted, 88 per cent of the farmers practice rain-fed agriculture (Table 4.2), as such they are highly vulnerable to droughts. About 95 per cent of the farmers lamented that a drought often leads to crop failure due to a shortage of rains. The farmers also emphasized that droughts, coupled with increased temperatures, contribute to pest outbreaks that affect crops and forage leading to reduced crop yield. The farmers gave an example of desert locusts that severely affected their cropland. Furthermore, the farmers illustrated that they end up investing in pesticides and insecticides to control pests and insects. This often increases the cost of production thus reducing their competitive advantage.

The farmers also elucidated that a drought often triggers farmers-pastoralists conflicts as livestock encroach crop farms due to loss of pasture. The respondents noted that these conflicts have been on the rise. Also, wildlife are increasingly invading croplands, particularly during dry seasons thus contributing to crops damage and reduced yield. Farmers are rarely compensated for the damages caused by wildlife.

4.6.2.2 Pastoralism

Prolonged droughts lead to reduced pastureland causing the death of livestock. About three-quarters (76 per cent) of the pastoralists indicated that prolonged droughts and limited rainfall shrunk grassland and caused the death of livestock. Nealy all pastoralists lose livestock due to droughts. This significantly affects their livelihoods. There are rarely markets for malnourished livestock and if available, livestock are bought at a throw away price. Due to limited markets and low market values, many livestock end up dying due to hunger. Herders also lamented that milk production declines during the drought seasons leading to reduced income. Also, watering points often dry up because of shrinking pastureland and water points; pastoralists are forced to migrate towards the Tana Delta region in search of pasture and water. Thereby, creating pressure on Delta resources and often triggering conflicts with farmers. This also begets perennial farmers-pastoralists conflicts as livestock invade farmlands.

About 39 per cent of the pastoralists also argued that climate change has triggered deforestation. During the drought season, people result to charcoal burning to feed their families. This usually leads to the degradation of terrestrial ecosystems that browsers depend on for feeding.

4.6.2.3 Fisheries

Fishing activities increase during drought seasons thus creating pressure, particularly on inshore resources. It was not clear the type of fishing gears seasonal fishers utilize. For the lake and river fishers, prolonged drought was the main factor that leads to a reduction in fish catch potential. The fishers in Lake Shakabado revealed that prolonged droughts usually cause the lake to dry forcing lake fishers to look for an alternative source of livelihood. Droughts also led to a reduction in river water levels due to reduced inflow, high evaporation rate and increased consumption.

4.6.3 RESOURCE-BASED CONFLICTS

4.6.3.1 Farmers

Conflicts between farmers and pastoralists with livestock grazing crops and conflicts between farmers and wildlife were expressed from farmers. About 36 per cent and 30 per cent of the farmers said that their crops had been damaged by livestock and wildlife, respectively. This leads to low production. Destruction of crops by livestock and wildlife demotivates farmers from practising large-scale production. The farmers also illustrated that there are no compensations provided by the KWS for damages caused by wildlife.

Farmers also demonstrated that conflicts related to farmland rights have been on the rise, largely attributed to the insecurity of tenure that characterizes many farmlands. These conflicts are also triggering a reduction in crop production.

4.6.3.2 Pastoralists

Pastoralists claimed that conflicts usually emerge during dry periods mainly with farmers largely due to shrinking grazeland because of agricultural expansion. Sometimes these conflicts escalate to tribal conflicts causing death and loss of property. Peace building initiatives have been rolled out by the County Government of Tana River and the Ministry of Interior and Coordination of National Government (through the Office of the County Commissioner and the Kenya Police Service) to promote co-existence. There are also grassroots peace initiatives rolled out by local communities and supported by national and county governments as well as by development and humanitarian organizations.

Pastoralists also acknowledged that there are conflicts among themselves and with wildlife (mainly crocodiles) due to competition of watering points during dry periods. They complained they are rarely compensated in case livestock are killed or injured by wildlife. They also lamented that increasing wildlife conservancies and protected areas within Tana Delta Sub-County have contributed to the reduction of grazeland.

4.6.3.3 Fishers

Fishers acknowledged they experienced few conflict incidents that are related to mismanagement of BMUs and influx of foreign fishers (mainly from Tanzania) to the Kipini coastal area.

4.6.4 STRONG WINDS

4.6.4.1 Farmers

About 55 per cent of the farmers exemplified that strong winds often damage and uproot crops leading to decreased harvest. Few farmers, however, acknowledged that normal winds are essential for crop pollination.

4.6.4.2 Pastoralists

Pastoralists indicated that winds have insignificant impacts on livestock.

4.6.4.3 Fishers

According to 5 per cent of the fishers, strong winds have also contributed to low fish catch potential as they make it difficult and risky to conduct offshore fishing. It is extremely difficult to navigate canoes and boats during periods of strong winds. It was noted that some fishers have lost their lives due to strong winds and storms as their canoe and boats sunk. Lack of marine rescue operations has also contributed to the loss of lives for the fishers. Fishers explicated that they usually practice inshore fishing during strong winds period. As a result, strong winds lead to low fish catch and create pressure on inshore fishery resources.

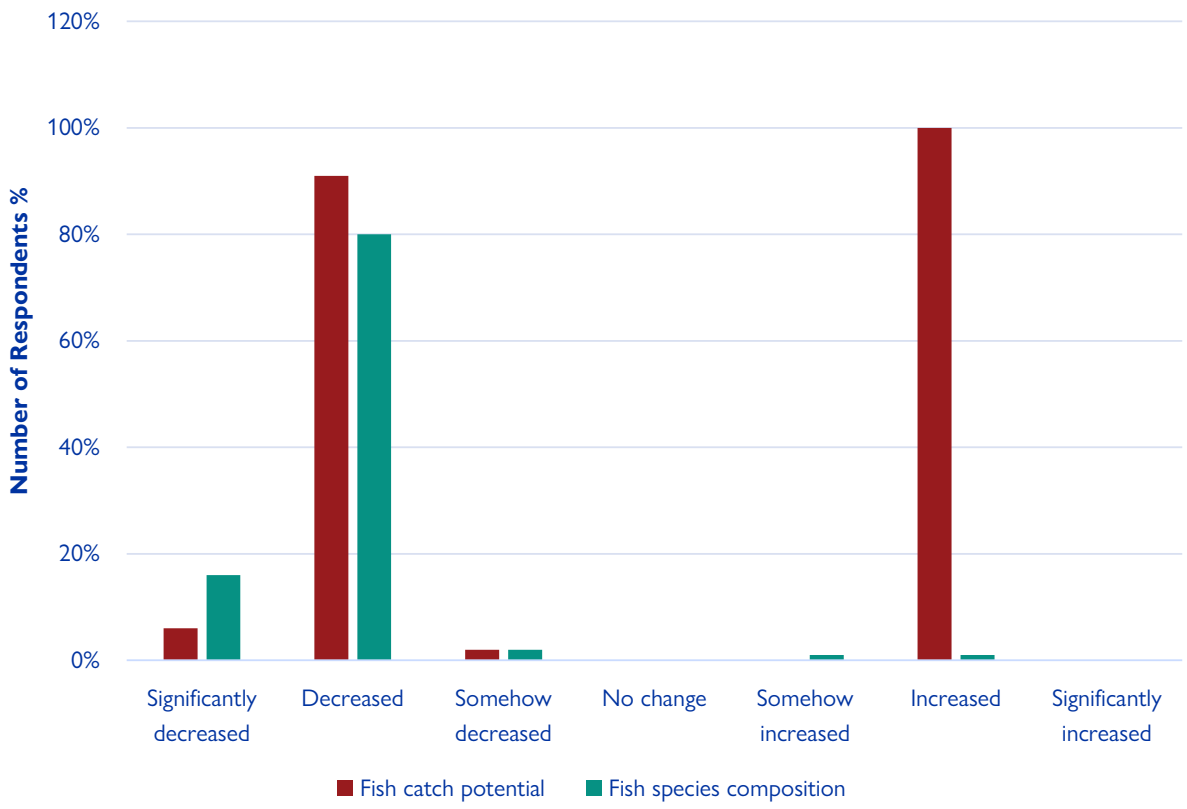
4.6.5 Saltwater Intrusion

Sea level rise has partly contributed to saltwater intrusion. The focus group discussion (FGD) with key stakeholders from Kipini Division revealed that saltwater intrusion largely triggered by high tides has been a predicament for coastal farmers. The intrusion leads to soil salinization, making the soil less productive for agriculture. According to coastal farmers, saltwater intrusion to farmland causes crop failure leading to reduced harvest and triggering food insecurity. Farmers revealed some crops such as mangoes, maize, and bananas have started drying due to increased salt levels. Soil experiments are needed to examine soil salinization levels to determine potential salt-tolerant crop varieties that could be adopted by farmers.

4.6.6 Sea level rise

We also wanted to know how the fish catch potential/fish abundance and composition of harvested fish species have changed in the last 20 years. 97 per cent) of the fishers argued that fish catch potential/fish abundance has either decreased or significantly decreased (Figure 4.17). Equally, 96 per cent of the fishers stated that the composition of harvested fish species has either decreased or significantly decreased in the 20 years. The IPCC (2019) indicated that reduced productivity and shifts in the distribution of fish populations led to a decline of 4.1 per cent of fish catch potential and 3 per cent of fish stock per decade in the twentieth century. Even with the low emission scenario, the fish catch potential is projected to decline by 2.8-5.3 per cent by 2050 (IPCC, 2020).

Figure 4.17 Perceptions about change in fish catch potential and composition of fish species



74 per cent of the fishers attributed the reduction in fish catch potential and change in the composition of fish species harvested to climate change (Table 4.17). Climate change referred to increasing ocean temperature and partly to sea level rise. 20 per cent of the fishers attributed this reduction to the migration of fish to deep sea. Increasing surface ocean temperature could have triggered this migration. According to the IPCC (2019), the composition of fish catches has been dominated by warm water species for the last five decades.

Table 4.18 Factors attributed to reduction in fish catch potential

Causes	Values (per cent)
Climate change	62 (74 per cent)
Migration of fish to deep sea	17 (20 per cent)
Prolonged drought causing lakes to dry & river water levels to decline	9 (11 per cent)
Influx of non-local fishers largely from Pemba Island in Tanzania	6 (per cent)
Bad fishing habits and destructive fishing gears	5 (6 per cent)
Strong wind	4 (5 per cent)

Apart from climate change, other factors have contributed to the reduction in fish catch potential (Table 4.18). The fishing along the coastline of Tana Delta Sub-County is under-utilized. This was reinforced by interviews with the Director and Chief Officer of Fisheries of Tana River County Government. This has led to an influx of non-local fishers especially in Kipini beach. About 7 per cent of fishers argued that the influx of non-local fishers has led to a reduction of fish catch potentials. Fishers come from as far as Pemba Island in Tanzania. According to FGD with key stakeholders from Kipini Division, there are only five motorized

boats owned by local people in Kipini due to limited capacity. Non-locals' own majority of the boats in Kipini. Therefore, there is an urgent need to enhance the capacity of local fishers to sustainably utilize resources in their localities to empower themselves.

Additionally, the local beach management units should be empowered to effectively conduct fisheries monitoring, control and surveillance as mandated by the Kenya Fisheries Management and Development Act of (2016).

Reduction in fish catch potential has had significant impacts on fishers' livelihoods and income. About 96 per cent of the fishers stated that reduction in fish catch potential consequently resulted in low income. Due to low income, some of the fishers indicated that were unable to fully cater for their family needs and to buy modern fishing gears and equipment.

4.7 STRATEGIES ADOPTED TO COPE WITH CLIMATE CHANGE IMPACTS

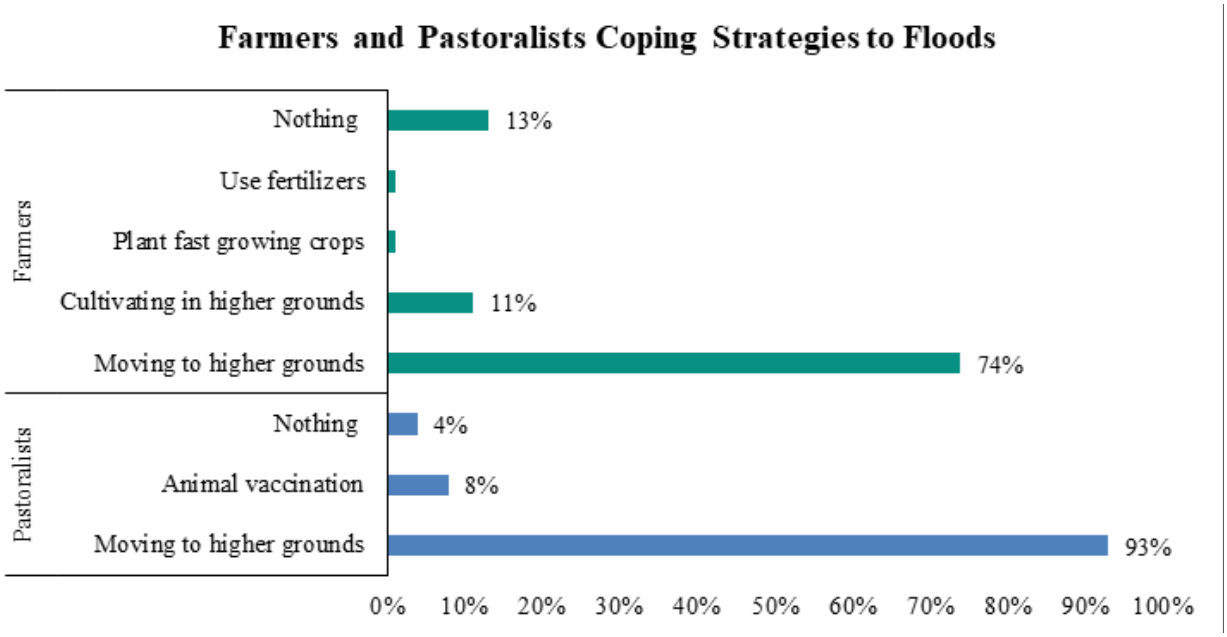
4.7.1 FLOODS

As earlier observed, floods have minimal impacts on marine fisheries, therefore, no notable coping strategy has been initiated by fishers. However, farmers and pastoralists have instituted several strategies to cope with flood disasters. Moving to higher grounds is the most common coping strategy practiced by farmers (74 per cent) and pastoralists (93 per cent) (Figure 4.9). To mitigate the perennial loss of lives and property due to floods, the County Government of Tana River initiated a village programme, a resettlement plan for residents living in flood-prone areas. Currently, fourteen clusters are being piloted and are facing challenges such as water insecurity and substandard housing. For farmers, most of their farmlands are still situated in flood-prone areas.

Therefore, there is need to build the capacity of village cluster dwellers to practice irrigation farming around the newly settled areas. This will minimize flood damage on cropland, reduce the cost of transport for farm produce and boost food security as illustrated by the farmers in the Garsen-Minjala cluster, commonly known as Konani cluster by the local dwellers.

About 8 per cent of the pastoralists conduct pre-flood vaccination of livestock to avoid water-borne diseases such as blackleg, anthrax, foot rot and mastitis. The vaccination exercise is often hampered by inadequate supply of vaccines and limited veterinarians. The pastoralists narrated that sometimes they walk for over 20 kilometres to buy livestock vaccines. Well-equipped veterinary stores are found in major towns such as Hola, Bura, Garsen, Minjala and Kipini.

Figure 4.9 Flood coping strategies adopted by farmers and pastoralists



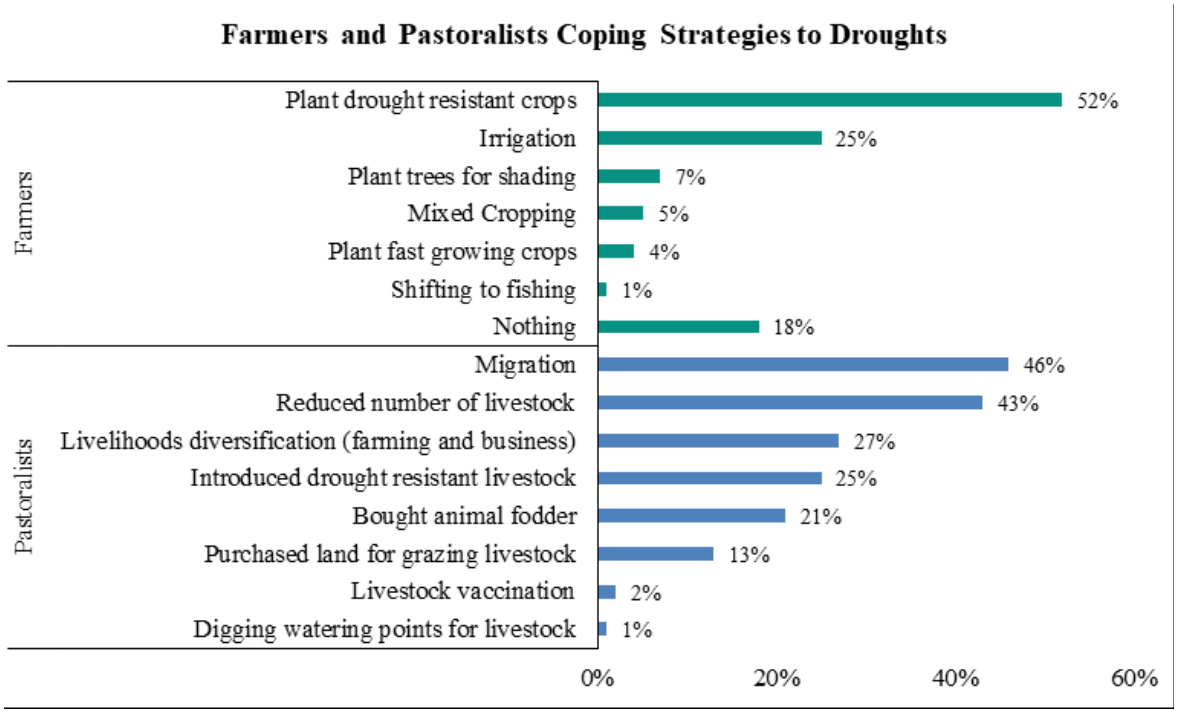
4.7.2 DROUGHTS

Both farmers and pastoralists have adopted various measures to cope with the effects of drought (Figure 4.10). Planting drought-tolerant crops such as green grams, sesame, cotton, bixa, cow peas, and sorghum was the main coping strategy adopted by more than half of the farmers. or instance, at least 54 per cent of the farmers were planting green grams and 31 per cent sesame (Table 4.3). Most of the farmers acknowledged that they shifted to drought-tolerant crops through the intervention of development partners. However, more capacity building on climate smart agricultural practices, post-harvest handling and value addition is needed to boost food security as well as enhance farmers' adaptation to prolonged droughts.

Irrigation is also practiced by 25 per cent of the farmers particularly those close to the Tana River and the Indian Ocean. The coastal farmers are also experiencing a challenge of saltwater intrusion. Therefore, there is a need to educate farmers on salt-resistant crops.

It should be noted that a fifth of the farmers were not practising any coping strategy to mitigate and reduce the impacts of droughts These farmers are likely to be severely affected by droughts. There is a need to explore cost-effective coping strategies applicable to coastal small-scale farmers. For instance, only 4 per cent of the farmers were planting fast-growing crops, which could be an effective strategy.

Figure 4.10 Drought coping strategies adopted by farmers and pastoralists



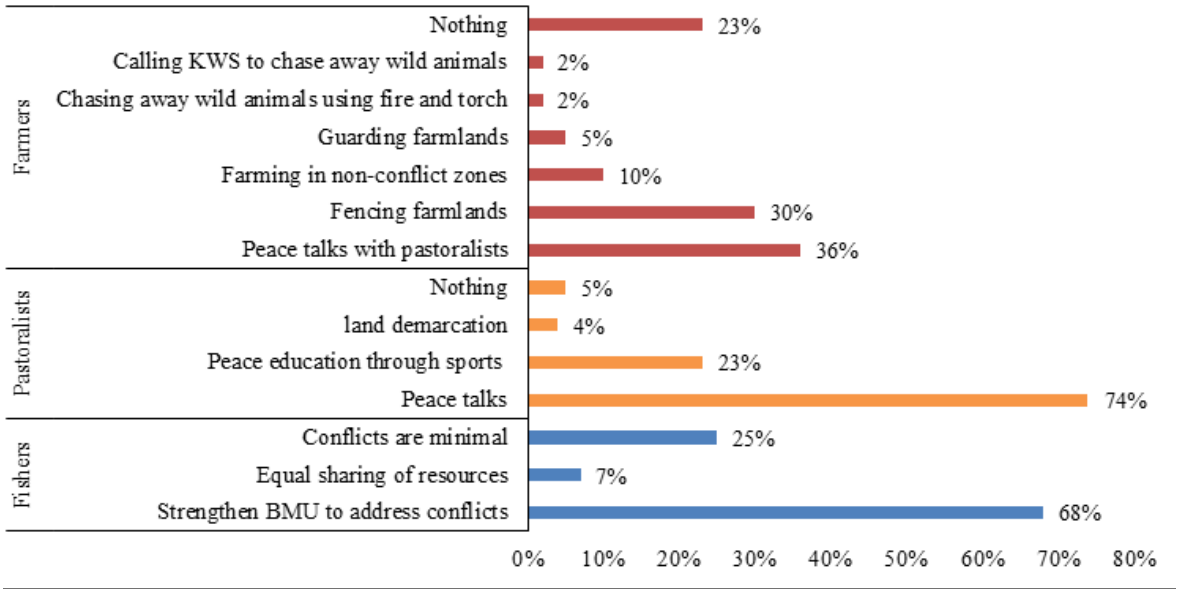
Migration (46 per cent) and reduction of the number of livestock (43 per cent) were the most common drought coping strategies adopted by pastoralists. During prolonged drought seasons, pastoralists often migrate towards the Tana Delta in search of pastures and partly water. As illustrated earlier, this normally creates pressure on delta resources thus triggering conflicts especially with farmers.

Livelihood diversification (27 per cent) through uptake of crop farming and medium and small-scale business enterprises are gaining popularity among pastoralists. The research revealed that most pastoralists have extremely limited farming skills. Also, at least a quarter of the pastoralists have introduced drought-tolerant livestock breeds with the help of the County Government of Tana River and development partners.

4.7.3 RESOURCE-BASED CONFLICTS

Farmers, pastoralists, and fishers have espoused several measures to curb resource-based conflicts. Peace talks were the most common measures applied by pastoralists and farmers (Figure 4.11). Peace talks including peace barazas are organized by area chiefs, the County Government of Tana River, the Ministry of Interior and Coordination of National Government through the Kenya Police Service and the Office of the County Commissioner, among other stakeholders. These talks and negotiations are led by elders. Some communities have set up community peace committees to promote farmers-pastoralists coexistence.

Figure 4.11 Coping strategies to resource-based conflicts



About 30 per cent of the farmers have fenced their farmland to fend off livestock and wildlife invasion, whilst 10 per cent prefer farming in areas less prone to conflicts. Farmers lamented that sometimes they are forced to guard their farmlands during the night to deter livestock and wildlife invasion.

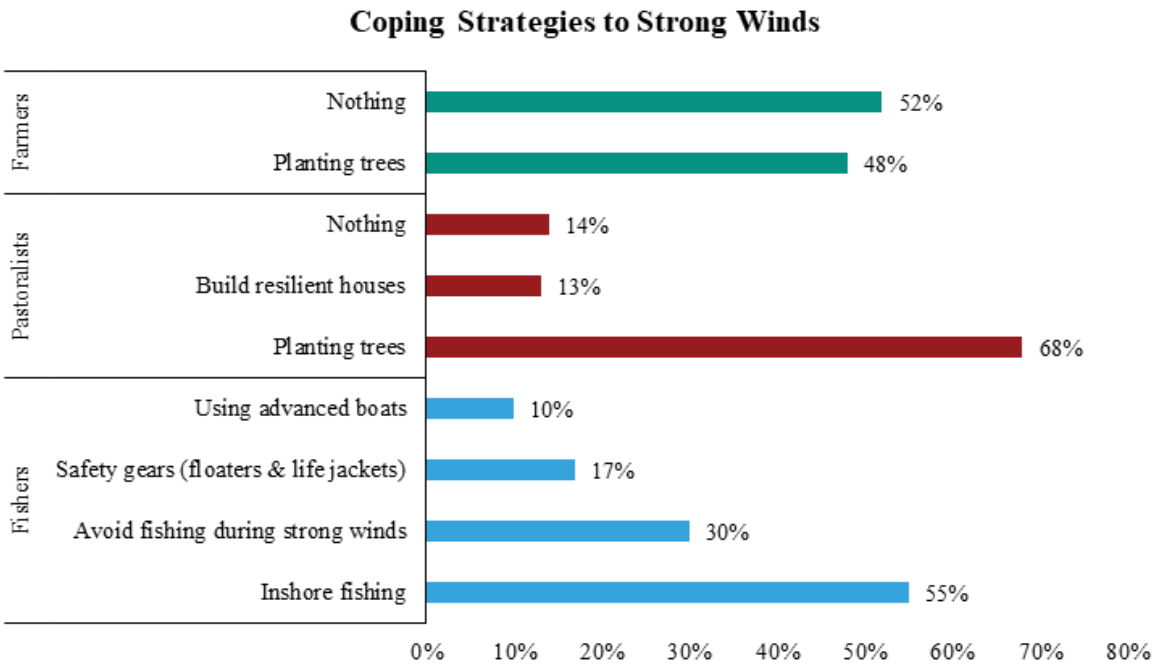
Peace education initiatives (23 per cent) have been adopted by the pastoral communities to promote peaceful coexistence among themselves and with the farmers. These initiatives are conducted through sports including football tournaments and marathons and are expected to promote peace among youths.

About 25 per cent of the fishers acknowledged that conflicts are minimal. About two-thirds of the fishers spelled out that they are strengthening their respective BMUs to effectively address fisheries-related conflicts.

4.7.4 STRONG WINDS

As exemplified earlier, strong winds are a challenge particularly to fishers. Pastoralists (68 per cent) and farmers (48 per cent) plant trees to reduce the impacts of strong wind (Figure 4.12). About 52 per cent of the farmers have not initiated any measure to reduce the impacts of winds. Fishers apply precautionary measures to avoid the impacts of strong winds. For instance, more than half of the fishers usually practice inshore fishing, whist 30 per cent avoid fishing during strong windy days/nights. Furthermore, 17 per cent use safety gears such as floaters and life jackets. However, it has been a challenge for fishers to acquire safety gears due to financial constraints. Also, 10 per cent of the fishers were using strong boats that can withstand strong wind.

Figure 4.12 Coping strategies to strong winds



4.7.5 SALTWATER INTRUSION

The research further investigated coping strategies adopted by the farmers to reduce the impacts of saltwater intrusion. About 95 per cent of the farmers had not enacted any measure to reduce the impacts of saltwater intrusion. This was partly because only 4 per cent of the farmers perceived saltwater intrusion to be a serious risk (Figure 4.7). 2 per cent of the farmers mentioned that their farmlands were less vulnerable to saltwater. Coping strategies adopted by 3 per cent of the farmers included the use of herbicides and planting salt-tolerant crops such as rice.

4.8 CLIMATE CHANGE PERCEPTION

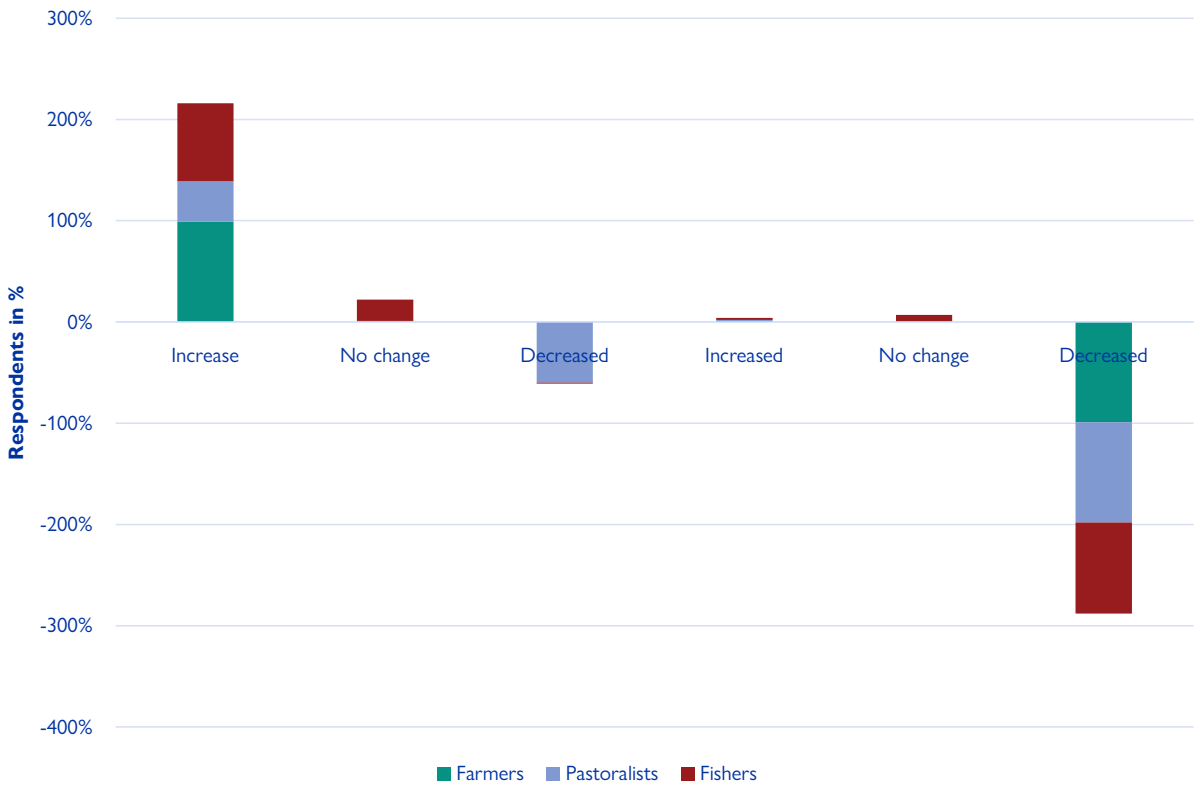
Based on their experiences, the respondents were asked how climate variables have changed in the last 20 years (2000-2020).

4.8.1 TEMPERATURE AND RAINFALL

Majority of the farmers and about 77per cent of the fishers asserted that temperature has increased in the last 20 years. However, 60 per cent of the pastoralists claimed that the temperature has decreased (Figure 4.13). The latter finding is inconsistent with other climate change studies where pastoralists perceive the temperature to be increasing in Kenya (Bobadoye et., 2016; Karanja and Abdul-Razak, 2018). Since this study focussed on coastal pastoralists, there is a probability some pastoralists used to live in inland arid and semi-arid counties or northern Tana River County where the temperature tends to be higher than Tana Delta Sub-County where this study was conducted.

Nevertheless, there was a consensus among the respondents that precipitation has declined (Figure 4.13). This is consistent with other similar climate change perception studies in Kenya (Bodadoye et al., 2016; Cun-Sanchez et al., 2018; Karanja and Abdul-Razak, 2018; Silvestri et al., 2012).

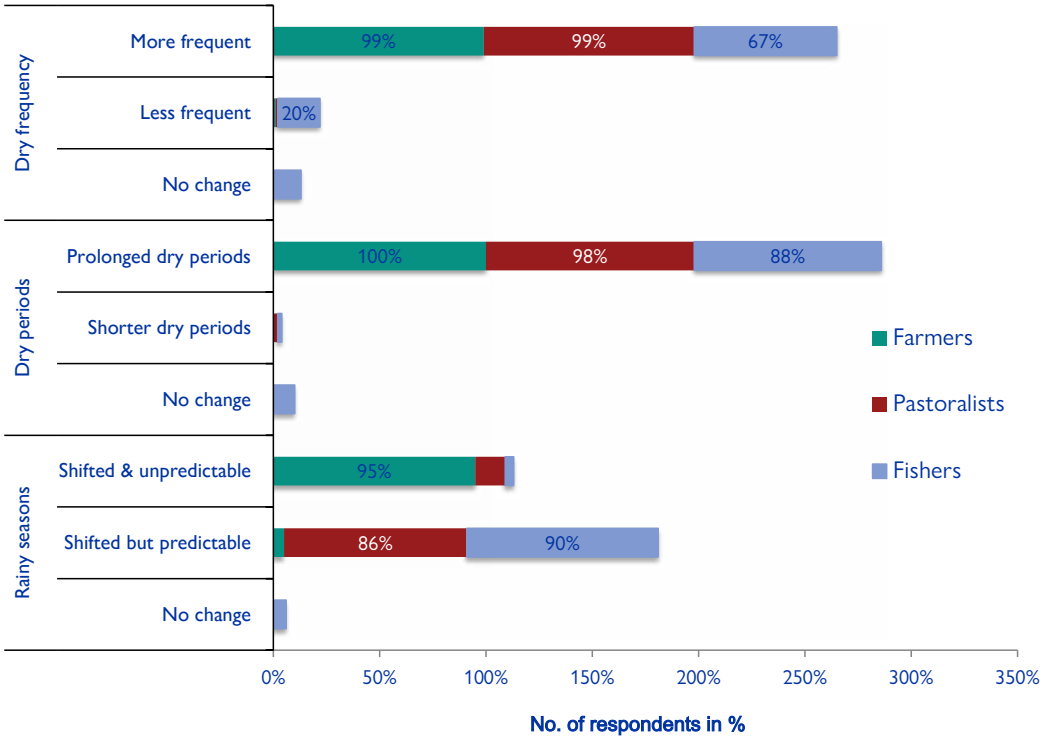
Figure 4.13 Perception about temperature and precipitation change



The research further explored how climate patterns have changed in the last 20 years. The respondents highlighted the dry periods occur more frequently and for a prolonged period (Figure 4.14). About 95 per cent of the farmers also illustrated that rainy seasons have shifted and are more unpredictable. However, 86 per cent of pastoralists and 90 per cent of the fishers noted that rainy seasons have shifted but are predictable. The difference in perception about the predictability of rainy seasons could be attributed to two factors. First, farming activities (such as ploughing and planting time) are very dependent on the correct timing of rains. This is important considering 88 per cent of the farmers were practising rain-fed agriculture. Although pastoralism also depends on rainfall, activities such as restocking are usually conducted several weeks after rains have started to ensure there is enough pasture and water for livestock. Considering most fishers were practising marine fishing, the predictability of rains rarely determines fishing activities.

Second, as later explored in section 4.12.1, pastoralists, and fishers, as opposed to farmers, had sophisticated traditional methods of predicting weather including rainfall. Therefore, rainy seasons were more predictable among pastoralists and fishers.

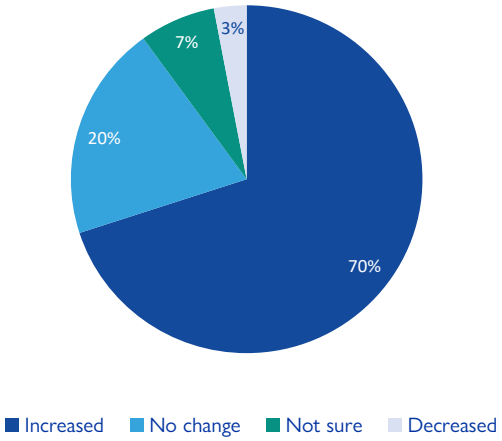
Figure 4.14 Perception about change in climate pattern



4.8.2 OCEAN TEMPERATURE

The fishers were asked how the ocean temperature has changed in the last 20 years. Most of the fishers (70 per cent) highlighted the ocean is now warmer compared to the year 2000 (Figure 4.15). Only 3 per cent perceived the ocean to be cooler. The findings are consistent with recent studies on ocean climate. For instance, the Intergovernmental Panel on Climate Change (IPCC, 2019) Special Report on the Ocean and Cryosphere in a Changing Climate revealed that there is compelling evidence that the oceans are warmer, acidic, and less predictive. In the Western Indian Ocean, the sea surface temperature is estimated to have increased by about 0.6oC from 1950 to 2009, with some spatial variability (Barange et al., 2018; Moustahfid et al., 2018).

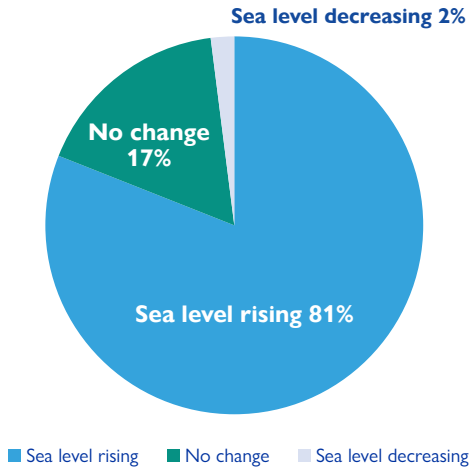
Figure 4.15 Fishers' perceptions about change in ocean surface temperature



4.8.3 SEA LEVEL RISE

Over 80 per cent of the interviewed fishers perceived sea level to have risen in the last twenty years (Figure 4.16). According to the IPCC (2019), sea level is rising at a rate of 0.36cm annually and accelerating. The study revealed that the coastal dwellers are already experiencing the effects of sea level rise. Due to sea level rise, accommodation facilities adjacent to the shoreline of Kipini beach were submerged. Sea level rise and strong storms have caused destructive erosion on the shoreline. Bosello & De Cian (2014) predicted that sea level rise would lead to shore erosion.

Figure 4.16 Perception about sea level rise

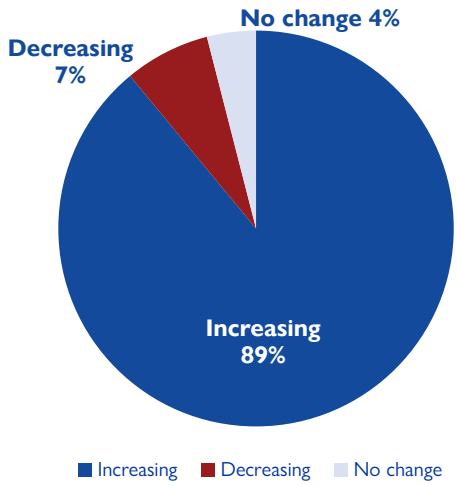


4.8.4 STRONG STORMS

About 55 per cent of the fishers indicated that they have experienced strong storms in the last five years (2015-2020). Among these fishers, 89 per cent indicated the frequency of storms has been increasing (Figure 4.17). Fishers' perceptions are consistent with the prediction of Bosello & De Cian (2014) and IPCC (2019).

Strong storms usually affect fishing activities since most of the respondents are artisanal and small-scale fishers. The storms impede offshore fishing and 97 per cent of the affected fishers stipulated that strong storm resulted in low fish catch leading to reduced incomes. 5 per cent of the affected fishers stated strong storms have led to the loss of lives of fishers. Another 2 per cent argued that they have destroyed building along the shoreline.

Figure 4.17 Frequency of strong storms

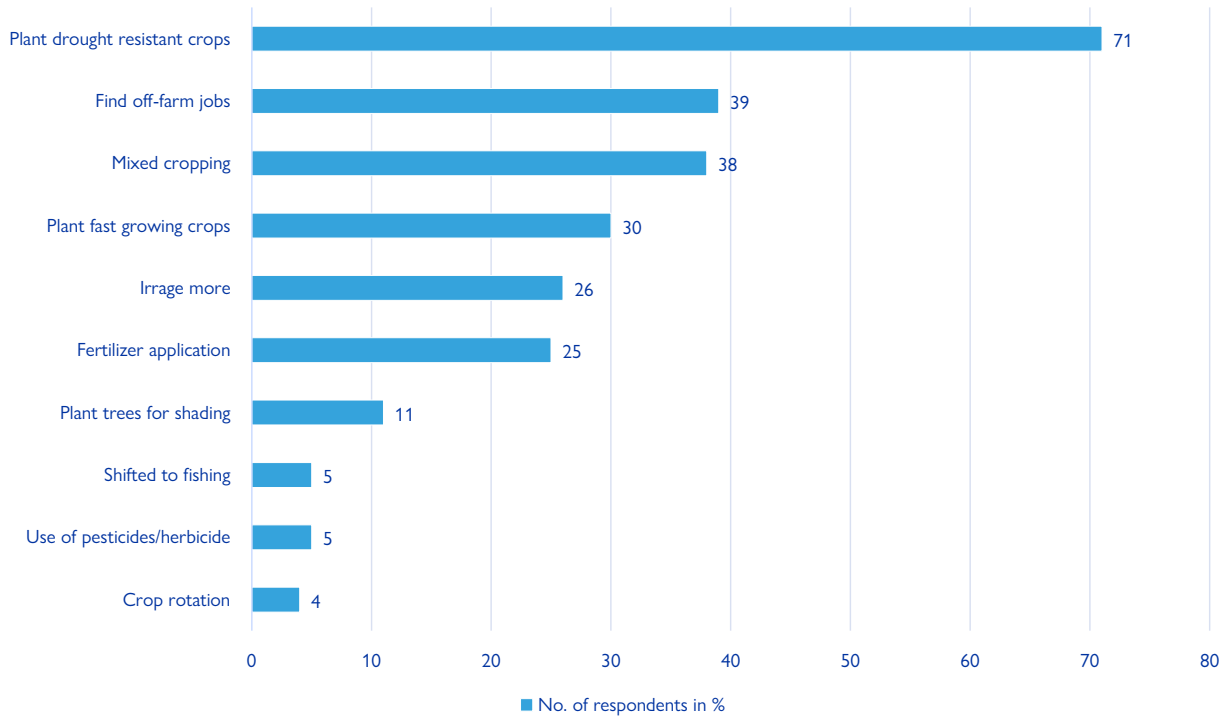


4.9 CLIMATE CHANGE ADAPTATION STRATEGIES BY LIVELIHOOD

4.9.1 FARMERS

Farmers have somewhat adjusted their farming strategies to adapt to the effects of climate change. Planting drought-resistant crops is the most prevalent adaptation strategy adopted by three-quarters of the farmers (Figure 4.19). Other common adaptation measures practiced by at least a quarter of the farmers include finding off-farm jobs, practicing mixed cropping, planting fast-growing crops, and irrigation. The findings are consistent with other studies conducted in Kenya (Asayehegn et al., 2017; Bryan et al., 2013; Mburu et al., 2015; Nyang'au et al., 2021; Ochieng et al., 2017; Ogalleh et al., 2012).

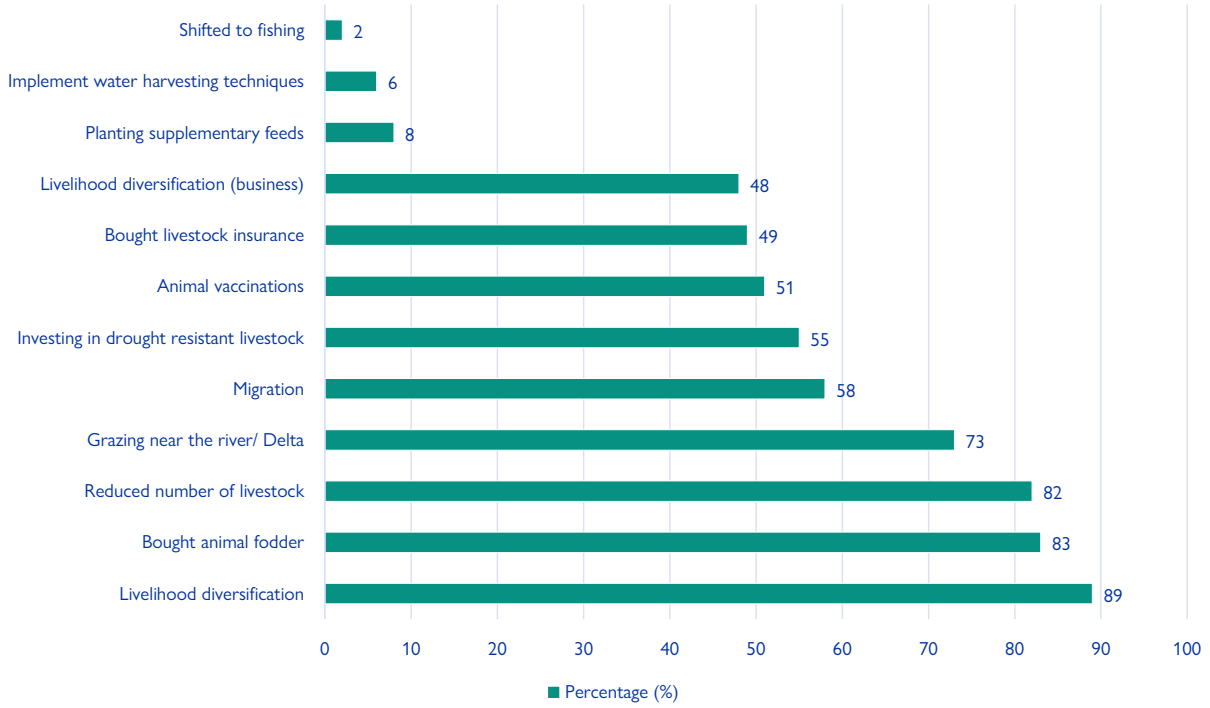
Figure 4.19 Farmers' climate change adaptation strategies



4.9.2 PASTORALISTS

Most of the pastoralists had adopted several strategies to adapt to climate change. Diversification of livelihoods through crop farming, buying animal fodder and reducing the number of livestock were the top three adaptation strategies adopted by over 80 per cent of the pastoralists (Figure 4.20). Other measures adopted by at least half of the pastoralists include grazing near the river/delta, migration towards the delta, investing in drought-tolerant livestock and animal vaccinations. The findings are consistent with other similar studies conducted in Kenya (Bobadoye et al., 2016; Cun-Sanchez et al., 2018; Silvestri et al., 2012).

Figure 4.20 Pastoralists' climate change adaptation strategies



4.9.3 FISHERS

The study sought to establish adjustments made by the fisherpersons due to reduction in fish catch potential and change in fish species. Livelihood diversification through crop farming was the main adaptation measure adopted by half of the respondents (Table 4.19). Other common adaptation measures adopted include changing of fishing grounds, increasing fishing duration and enhancing fishing techniques. The findings are consistent with other similar studies conducted in Kenya (Onyango et al., 2020) and Sub-Sahara Africa (Limuwa et al., 2018; Mafongoya et al, 2019).

Table 4.19 Fishers' climate change adaptation strategies

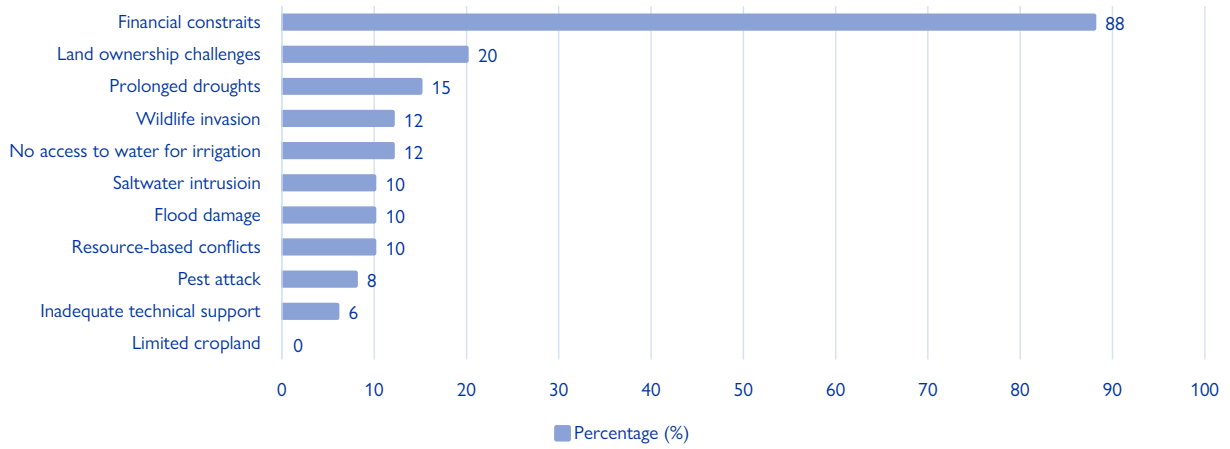
Adjustment measures/ coping strategies	Values (%)	
Diversification of livelihoods	Crop farming	39 (46%)
	Small-scale businesses such as grocery store, kiosks	8 (10%)
	Livestock keeping	2 (2%)
	Poultry	2 (2%)
Changing fishing grounds (largely focus on offshore fishing)		21 (25%)
Increasing fishing duration		12 (14%)
Deploying more/increasing the size of grill nets		10 (12%)
Adopting modern fishing gears		4 (5%)

4.10 FACTORS IMPEDING ADOPTION OF CLIMATE CHANGE ADAPTATION STRATEGIES

4.10.1 FARMERS

The interviewed farmers reiterated that they have experienced several constraints in changing normal farming ways to adapt to the effects of climate change. Inadequate financial resources to facilitate the transition to climate smart agriculture was cited as the most limiting factor. Figure 4.21). Lack of land ownership titles/ rights was another constraint experienced by nearly a quarter of interviewed farmers. Lack of security of tenure leads to land-based conflicts. Prolonged drought periods have also been a huge challenge for the farmers since they result to low crop yield. Farmers also illustrated that prolonged drought also affects the production of drought-tolerant crops. Farmers further indicated that wildlife invasion has been on the rise leading to crop damage. The farmers are rarely compensated. Farmers residing far away from the river affirmed that they are unable to practice irrigation. Most of them have limited capacity to dig boreholes or construct a water harvesting dam/pans for irrigation. Farmlands near the shoreline are experiencing the challenge of saltwater intrusion.

Figure 4.21 Constraints experienced by farmers in adopting to climate change



4.10.2 PASTORALISTS

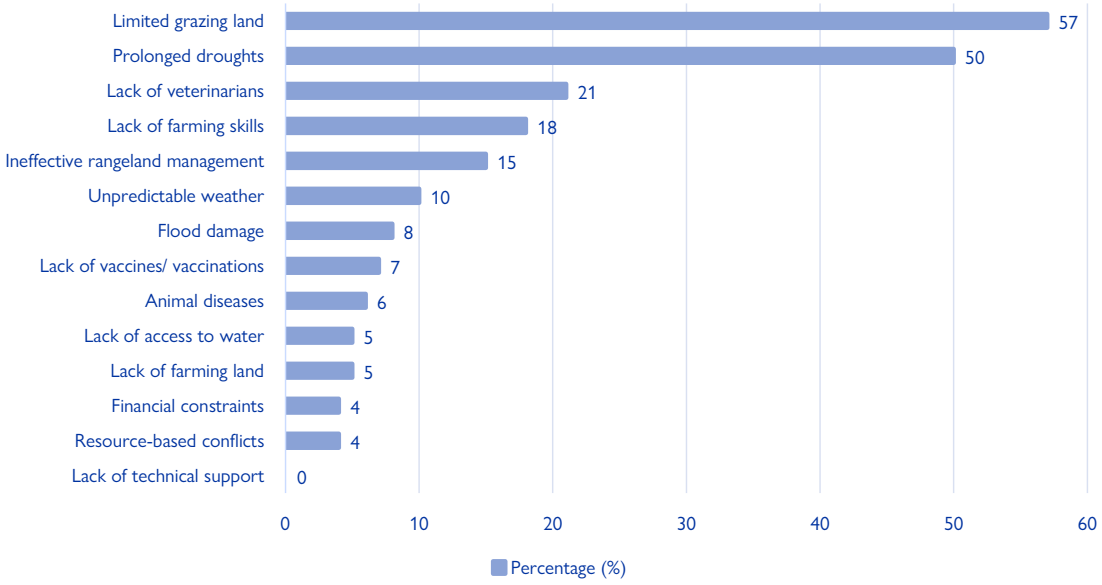
Limited grazing land and prolonged droughts are the main challenges cited by at least half of the pastoralists that hinder effective adaptation strategies to climate change (Figure 4.22). Pastoralists indicated drivers of shrinking grazeland to be farmland expansion, increasing wildlife conservancies and partly increasing pastoralists (due to population growth and migration to the delta) and urbanization.

Lack of veterinarians was also cited by nearly a quarter of pastoralists as a major challenge. This is further compounded by a lack of access to vaccines and limited vaccination programmes by the government. Herders clarified that vaccinations are essential particularly before and after disasters such as floods.

The study also revealed that pastoralists are increasingly interested in crop farming. 98 per cent are at

least somehow interested in practising crop farming as an alternative source of livelihood (Table 4.24). However, the adoption of crop farming is impeded a lack of farming skills as illustrated by 18 per cent of the pastoralists (Figure 4.22). Therefore, there is a need to capacity build pastoralists on crop farming techniques particularly through farm-based trainings.

Figure 4.22 Constraints experienced by pastoralists in adapting to climate change



4.10.3 FISHERS

About 88 per cent of the fishers indicated financial constraint as the major limiting factor hindering effective adaptation to climate change. Fishers expounded they are unable to procure modern fishing vessels and gears for offshore and deep fishing. Building the capacity of local fishers could transform their livelihoods.

4.11 WEATHER INFORMATION

The study also investigated how the respondents receive weather-related information and found radio was the main source of weather forecast information (Table 4.20). Karanja et al. (2019) also found out that radio was the most preferred source of information in Tana Delta. Family members, friends and government officials are the other main source of weather-related information. However, there is a disconnect in relaying weather forest information. The NDMA in collaboration with the Kenya Meteorological Department usually issues a monthly rainfall forecast. The NDMA also publishes a monthly drought early warning bulletin for Tana River County. Nevertheless, the information rarely trickles down to the farmers, pastoralists, and fishers. Therefore, there is need to develop an effective communication strategy to convey weather forecast information to the residents of Tana River County. Local and community radio stations and religious institutions could serve as a communication gateway for weather forecast information. The relayed information can be supplemented through other forms of communication including government officials (agriculture extension officers and veterinarians), local NGOs as well as community weather forecast experts.

Table 4.20 How the residents access the weather forecasting information

Source	Farmers	Pastoralists	Fishers	Total
Radio	81 (96%)	83 (99%)	74 (88%)	238 (94%)
Family member(s)	49 (58%)	40 (48%)	55 (65%)	144 (57%)
Friends in the village	43 (51%)	29 (34%)	63 (75%)	135 (54%)
Government officials	34 (40%)	73 (87%)	7 (8%)	114 (45%)
Religious institutions (church/mosque)	10 (12%)	37 (44%)	26 (31%)	73 (29%)
TV	24 (29%)	4 (5%)	34 (40%)	62 (25%)
Local NGOs	0	29 (34%)	1 (1%)	30 (12%)
SMS	1 (1%)	23 (27%)	0	24 (10%)
Internet/social media	3 (4%)	0	11 (13%)	14 (6%)
Public barazas	0	11 (13%)	0	11 (4%)
Newspaper	3 (4%)	0	1	4 (2%)
No Access	1 (1%)	0	2	3 (1%)

n=252

4.11.1 TRADITIONAL METHODS OF PREDICTING WEATHER

The study further assessed traditional methods of predicting the weather. Indigenous people and local communities often have rich knowledge of weather and climate change. Traditional weather foresting methods coupled with broadcasted weather forecast information can help local communities to make informed decisions especially in contemporary climate changing conditions. Most of the interviewed pastoralists (96 per cent) stressed they had at least one traditional method of predicting the weather (Table 4.21).

Table 4.21 Do you have a traditional method of predicting weather.

Attributes	Farmers	Pastoralists	Fishers	Total
Yes	38 (45%)	81 (96%)	51 (61%)	170 (67%)
No	46 (55%)	3 (4%)	33 (39%)	82 (33%)

n=252

Pastoralists had sophisticated methods of predicting the weather. Observing the moon, sun and stars is the most common methods. For instance, a circle around the moon or the sun is an indication of bad weather. Stars twinkling slowly is a sign of a non-windy day in the following day. About 43 per cent of the pastoralists also indicated that they have community weather forecast experts that predict the weather. Pastoralists' migration patterns are informed by these experts. Another method utilized by pastoralists is listening to donkey sounds. When donkey bray more often than usual, it is an indication that it will rain. Gonzalez et al., (2018) also affirmed that donkey behaviours can be used to predict the weather.

Less than half of the farmers had at least a traditional method of predicting the weather (Table 20). Farmers' weather predicting methods were based on weather patterns or animal behaviours. Observation of wind

directions and movement of safari ants were the most common methods. For instance, when winds switch direction and start blowing from the south towards the north, it is an indication it is about to rain. As a result, farmers start preparing for planting. Also, when safari ants start to store their food, it a sign it will rain.

Farmers and pastoralists observe baobab trees to predict the weather. When the baobab tree starts weathering or its fruits become about the size of the human hand, it is a sign of the start of a rainy season. This method is also utilized by some communities in Senegal (International Research Institute for Climate and Society, 2016). Other methods used by the farmers include observing clouds, change of temperature at night and livestock behaviour.

About 61 per cent of the fishers indicated they had at least a traditional method of predicting the weather (Table 4.20). Tree leaves colour change and change of wind direction were the most common prediction methods. Other methods utilized include birds' behaviour and movement; observing safari ants; monitoring the moon, sun, and stars; whale appearance; observing clouds; and monitoring the movement of sharks.

4.12 CAPACITY BUILDING

The interviewed respondents indicated that they have not received technical support to enhance their climate adaptation strategies and/or recover from a major disaster (Table 4.22). However, there is usually a high tendency among respondents to perceive technical support in terms of financial support. As such, this might not reflect technical support provided by national and county governments and development agencies such as the provision of drought-tolerant crops and livestock breeds as well as promotion of the uptake of fish farming as an alternative source of livelihood.

Table 4.22 Technical support provided to the respondents

	Farmers	Pastoralists	Fishers
No. of respondents that had received training in climate change	0	0	0
No. of respondents that had received technical support to enhance climate change adaptation	0	0	0
Have you received external support to enhance your recovery after a disaster	0	0	0

n=252

4.13 SOURCE OF LIVELIHOODS

4.13.1 SATISFACTION WITH THE MAIN SOURCE OF LIVELIHOODS

The study further investigated how the respondents were satisfied with their main source of livelihoods (Table 4.23). Farmers were the most dissatisfied group with 75 per cent indicating they were either dissatisfied or very dissatisfied. On the other hand, pastoralists were the most satisfied group (93 per cent). This is probably because livestock keeping is embedded into pastoralists' culture, it is not just a livelihood source, but it is also their lifestyle. Fishers were also largely satisfied with fishing (86 per cent).

Table 4.23 Satisfaction level with the primarily source of livelihoods

	Very dissatisfied	Dissatisfied	Somehow satisfied	Satisfied	Very Satisfied
Farmers	5 (6 per cent)	58 (69 per cent)	17 (20 per cent)	4 (5 per cent)	0
Pastoralists	0	0	0	6 (7 per cent)	78 (93%)
Fishers	0	5 (6 per cent)	7 (8 per cent)	72 (86 per cent)	0

4.13.2 VIABILITY OF ALTERNATIVE LIVELIHOODS

Diversification of livelihoods is one of the major strategies advocated to empower communities as well as to increase their resilience to climate change. Therefore, it is important to understand the viability of alternative livelihoods preferred by the three categories of respondents to inform suitable interventions. The study revealed that farmers were more flexible in adopting several types of livelihoods. Business, livestock keeping, and poultry were the three most common alternative sources of livelihood preferred by at least three-quarters of the farmers (Table 4.24). The most common business enterprises that farmers were interested in operating include grocery, buying and selling farm produce, operating M-Pesa shop, and running a retail kiosk (shop) (Table 4.27).

Table 4.24 Farmers' interest level with alternative livelihoods

Alternative Livelihoods	Not Interested	Somehow interested	Interested	Very Interested
Livestock keeping	13 (15%)	1 (1%)	63 (75%)	7 (8%)
Fishing	41 (49%)	6 (7%)	36 (43%)	1 (1%)
Fish farming	41 (49%)	4 (5%)	37 (44%)	2 (2%)
Poultry	8 (10%)	5 (6%)	65 (77%)	6 (7%)
Apiculture	47 (56%)	4 (5%)	32 (38%)	1 (1%)
Business	15 (18%)	1 (1%)	67 (80%)	1 (1%)

Pastoralists on the other hand were very particular about the types of livelihoods they were interested in. They were interested in doing business, poultry keeping, and crop farming (Table 4.25). The most common business enterprises that pastoralists were interested in running include operating a retail kiosk (shop), selling milk and ghee, operating a restaurant, and building houses for rentals (Table 4.27). Pastoralists were not interested in doing fishing, fish farming, and apiculture. Therefore, an intervention targeting pastoralists tailored towards these economic activities is likely to fail.

Table 4.25 pastoralists' interest level with alternative livelihoods

Alternative Livelihoods	Not Interested	Somehow interested	Interested	Very Interested
Crop farming	2 (2%)	28 (33%)	53 (63%)	1 (1%)
Fishing	82 (98%)	2 (2%)	0	0
Fish farming	83 (99%)	1 (1%)	0	0
Poultry	2 (2%)	13 (16%)	69 (82%)	0
Apiculture	77 (92%)	7 (8%)	0	0
Business	0	6 (7%)	78 (93%)	0

Unlike farmers and pastoralists, most fishers were not highly interested in having an alternative source of livelihoods (Table 4.26). Crop farming and fish farming were the two alternative livelihood sources that fishers somewhat preferred. Even so, at least 54 per cent and 18 per cent of the fishers were not interested in fish farming and crop farming, respectively. The alternative livelihoods least preferred by fishers include apiculture, business, and livestock keeping. For instance, only 13 per cent of the fishers were interested or somehow interested in investing in a business as an alternative source of livelihood. The types of businesses they were interested include operating a retail shop, buying, and selling fish, juice vendors, grocery, carpentry, and boda-boda taxi (Table 4.27).

Table 4.26 Fishers' interest level with alternative livelihoods

Alternative Livelihoods	Not Interested	Somehow interested	Interested	Very Interested
Crop farming	15 (18%)	32 (38%)	37 (44%)	0
Livestock keeping	73 (87%)	7 (8%)	3 (4%)	1 (1%)
Fish farming	45 (54%)	5 (6%)	34 (40%)	0
Poultry	65 (77%)	12 (14%)	7 (8%)	0
Apiculture	82 (98%)	1 (1%)	1 (1%)	0
Business	73 (87%)	7 (8%)	4 (5%)	0

Table 4.27 Type of business that farmers and pastoralists are interested in

	Farmers (n=69)	Pastoralists (n=84)
Retail shop	15%	48%
Grocery	41%	-
Selling milk and ghee	-	37%
Buying and selling farm produce	23%	-
Operating a M-Pesa shop	19%	2%
Restaurant	4%	17%
Building houses for rentals	2%	17%
Selling cloths	4%	7%
Agrovets	-	8%
Buying and selling livestock	-	6%
Motorbike spare parts store	-	1%

4.14 CHALLENGES IMPEDING SUSTAINABLE BLUE ECONOMY LIVELIHOODS

Sustainable food production (through farming, livestock keeping, and fish farming) and sustainable fishing are essential in achieving sustainable food security. Therefore, the study examined challenges impeding sustainable crop farming, pastoralism, and fisheries.

4.14.1 FACTORS IMPEDING SUSTAINABLE CROP FARMING

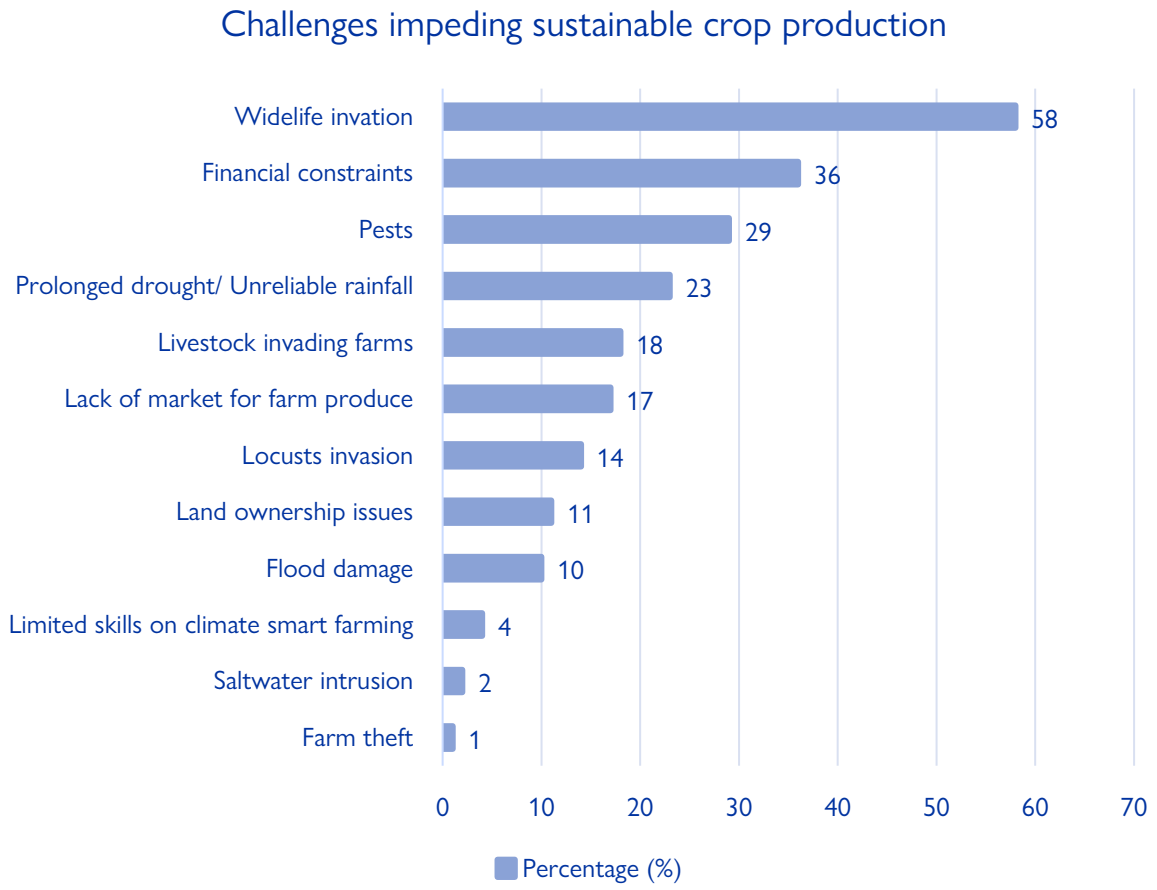
For the farmers, wildlife invasion was the most pressing challenge (Figure 4.23). Farmers-wildlife conflicts have been on the rise partly due to increasing wildlife conservancies as well shrinking rangeland. Wildlife invasion leads to crops damage and consequently reduced income for farmers since they are rarely compensated.

Limited financial capacity also hinders sustainable crop farming. For instance, due to limited financial capacity,

farmers are unable to fence their farms to deter wildlife and livestock invasion. Moreover, farmers are interested in adopting climate smart agriculture but their adaptation strategies, such as irrigation, greenhouse, and planting drought-tolerant crops, are hampered by financial constraints. Also, the adoption of climate smart agriculture has been impeded by limited skills in climate smart farming techniques.

Farmers also illustrated that pest invasion has been on the rise partly due to global warming. Furthermore, about 14 per cent of the farmers were affected by desert locust invasion that led to the destruction of crops.

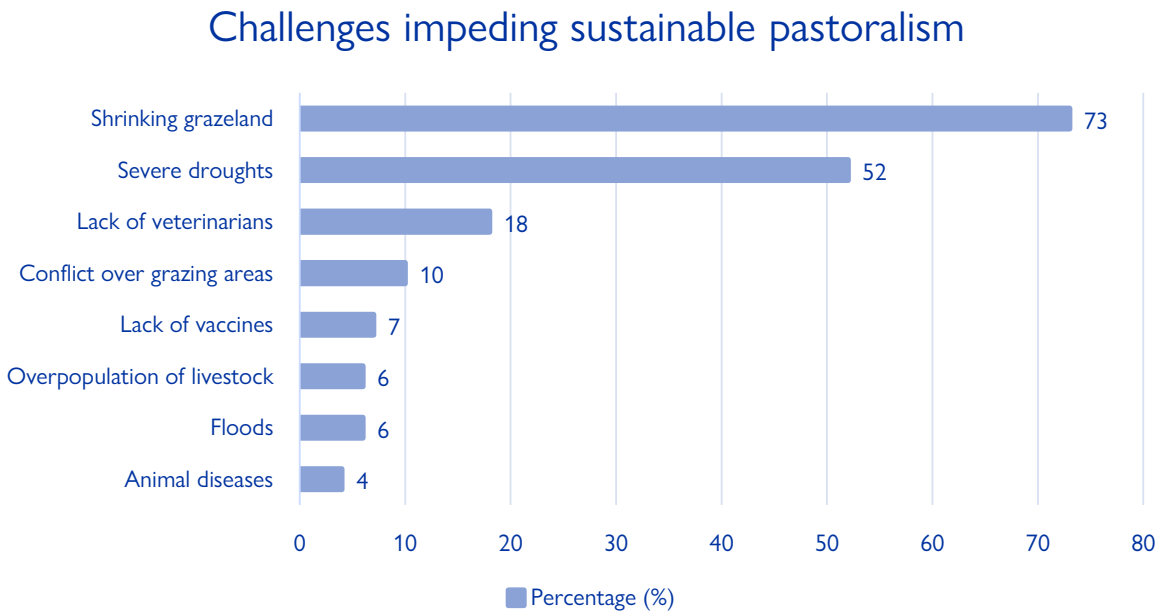
Figure 4.23 Challenges impeding sustainable crop production in Tana Delta Sub-County



4.14.2 FACTORS IMPEDING SUSTAINABLE PASTORALISM

Shrinking grazeland and prolonged droughts were the two main factors limiting sustainable pastoralists as acknowledged by more than half of the respondents (Figure 4.24). As earlier indicated, the shrinking of grazeland is largely triggered by farmland expansion and increasing wildlife conservancies and partly by increasing pastoralists population within the delta (due to population growth and migration) and urbanization. Therefore, there is need to develop a suitable land use plan to ensure sustainable pastoralism and minimize land-based conflicts. As indicated in Table 4.22, pastoralists are highly satisfied with practising pastoralism largely because it is embedded in their culture and practices. Therefore, future investments should strive to enhance pastoralism as opposed to replacing it.

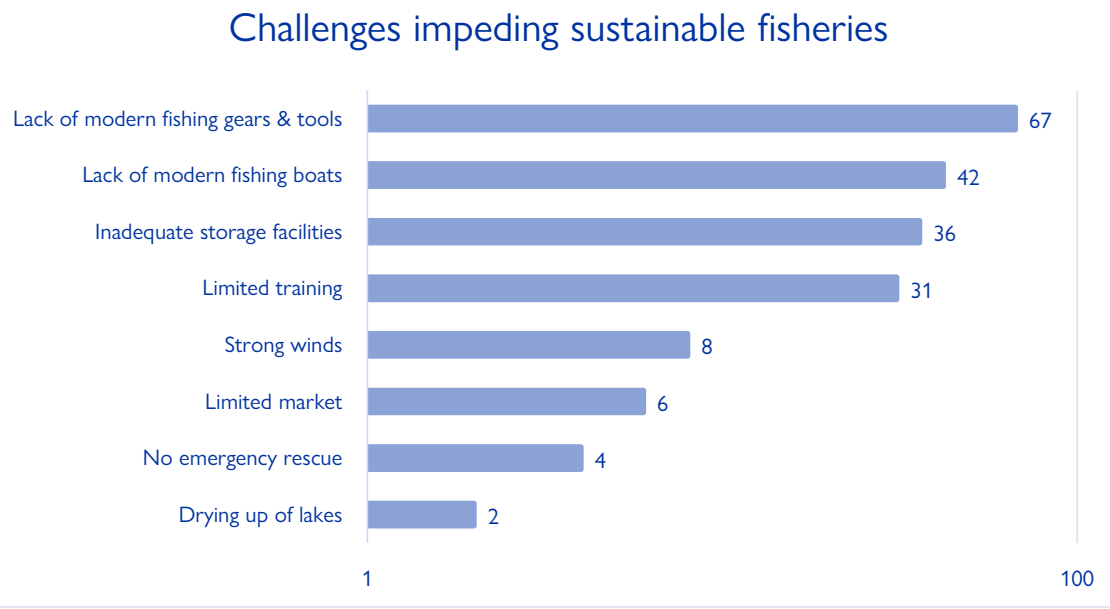
Figure 4.24 Challenge impeding sustainable pastoralism in Tana Delta Sub-County



4.14.3 FACTORS IMPEDING SUSTAINABLE FISHERIES

For fishers, lack of modern fishing gears, tools and boats was cited as the most pressing challenge limiting sustainable utilization of fisheries resources (Figure 4.25). To transform the fisheries sector in Tana Delta Sub-County, there is an urgent need to build the capacity of local fishers with modern fishing gears, tools, and boats to conduct offshore and deep-sea fishing. This will reduce fishing pressure on inshore fishing and increase fishers' adaptation strategy since the study found that the fish catch potential has reduced due to climate change (Table 18). Furthermore, enhanced fishing capacity will also augment fishers' income as well as boost food and nutrition security. Enhancing fishers' capacity is also essential since most fishers were not interested in exploring alternative livelihoods as elucidated by Table 4.25.

Figure 4.25 Challenges impeding sustainable fisheries in Tana River County coastal strip



4.15 CONCLUSION

The study found out that droughts pose serious and/or severe risks to crop farmers and pastoralists. Also, 86 per cent of the respondents indicated that droughts' frequency has been on the rise. However, only nearly a third of the respondents perceived flood risk to be serious. Resource-based conflicts were perceived to be more serious and severe among the pastoralists (94 per cent). The research further explored how climate patterns have changed in the last 20 years. The respondents highlighted that the dry periods occur more frequently and for a prolonged period. About 95 per cent of the farmers also illustrated that rainy seasons have shifted and are more unpredictable. However, 86 per cent of pastoralists and 90 per cent of the fishers noted that rainy seasons have shifted but are predictable. Majority of the fishers (70 per cent) highlighted that the surface ocean temperature has increased compared to 2000. Also, over 80 per cent of the fishers perceived sea level to have risen within the last two decades.

Climate change and disasters have impacted negatively on investigated blue economy livelihoods. For instance, at least two-thirds of the farmers have experienced crop failure and reduced harvests due to prolonged droughts, reduced precipitation, and erratic rainfall. About three-quarters of the pastoralists have lost their livestock due to prolonged droughts. Droughts cause a reduction of water levels in lakes and rivers. Furthermore, over 95 per cent of fishers argued that the fish catch potential, and the composition of harvested fish species have decreased or significantly decreased in the last twenty years. Nearly three-quarters of the fishers attributed this reduction to changing ocean climate.

Planting drought-resistant crops was the most prevalent climate change adaptation strategy by nearly three-quarters of the farmers. Four predominant adaptation strategies by over 80 per cent of the pastoralists include diversification of livelihoods through crop farming, buying animal fodder, reducing the number of livestock, and migration to the Tana Delta region. Livelihood diversification through crop farming was the main adaptation measure adopted by nearly half of the fishers.

Several constraints have hampered the adoption of effective climate change adaptation strategies. Farmers cited financial constraints as the main stumbling block towards the transition to climate smart agriculture. Similarly, 88 per cent of the fishers alluded those financial challenges have impeded the acquisition of modern fishing vessels and gears to enable offshore and deep-sea fishing. On the other hand, dwindling grazeland and prolonged droughts are threatening pastoralism. Farmland expansion and increasing wildlife conservancies were cited as the major drivers for shrinking grazeland.

Pastoralists in Tana River have been forced to move for long distances in search of pasture and water for their livestock due to the drying up of wells as a result of climate change. Photo: ©Moses Otunga/IOM 2022

5. RECOMMENDATIONS

5.1 GENERAL

- A communication synergy should be established to ensure weather forecast information is effectively and timely relied to the farmers, pastoralists, and fishers.
- The Tana River County government to strive to provide cluster villagers with decent housing, water supply (at least for domestic use) and other critical institutions such as schools and hospitals.
- The Tana River County government to develop an effective waste disposal plan for urbanizing Hola town.
- The Tana River County government in partnership with upstream counties such as Meru and Kitui to develop an integrated waste management plan to avoid water pollution within Tana River water basin.
- The county and national government to improve roads condition particularly within Tana Delta Sub-County to facilitate faster transportation of farm produce, livestock (meat) and fish.

5.2 CROP FARMING

- There is a need to train farmers and build their capacity on climate smart agriculture including planting drought-tolerant crops, irrigation and building green houses.
- Kenya Wildlife Service to work with the farmers to address increasing farmers-wildlife conflicts.
- The County government could establish weekly markets for farm produce and livestock possibility in the lower Tana Delta.

5.3 PASTORALISM

- The Tana River County Government, Kenya Police Service, Office of the County Commissioner, local chiefs and elders, communities, and development partners to collaborate to address intra and inter-ethnic conflict that have impeded sustainable pastoralism and crop-farming in Tana River County.
- Investors to establish more veterinary stores to make it easier to access livestock vaccines. The county government to promote or deploy more veterinarians to ensure at least each administrative location has one.

5.4 FISHERIES

The Tana River County Government in partnership with the State Department for Fisheries, Aquaculture and the Blue Economy and other development partners to initiate strategies for empowering local fishers to sustainably utilize underutilized fisheries resources along the coastal strip of Tana River County. For instance, the local fishers could be empowered to conduct offshore and deep-sea fishing and provided with modern fishing gears, boats as well as safety equipment.

- The Tana River County government in partnership with the State Department for Fisheries, Aquaculture, and the Blue Economy other development partners to empower BMUs to effectively conduct fisheries monitoring, control, and surveillance to deter illegal fishing activities. Also, every effort must be made to address current wrangles surrounding BMUs and ensure they have an inclusive membership to avoid potential conflicts in the future.
- The BMUs could also explore joint marketing and fish value addition to augment fishers' income.

"My feet are crossing the only water dam that once provided water to our local community. There is barely a drop of water left. Women in our community have to travel 10 kilometers to find water." Fatuma, Local Resident, Minjila, Tana River County, Kenya. Photo:© Angela Njuguna/IOM 2022

6. REFERENCES

Adey, M.

2015 Underlying causes of inter-ethnic conflict in Tana River County Kenya. Master's Thesis, University of Monitoba.

Asayehegn, K., Temple, L., Sanchez, B., & Iglesias, A.

2017 Perception of climate change and farm level adaptation choices in central Kenya. Cahiers Agricultures, 26(2), 25003.

Awuor, C. B., Orindi, V. A. & Adwera, A. O.

2008 Climate change and coastal cities: the case of Mombasa, Kenya. Environment and Urbanization, 20 (1), 231-242.

Barange, M., Bahri, T., Beveridgem M. C. M., Cochrane, K. L., Funge-Smith, S. & Poulain, F. (eds.)

2018 Impacts of climate change on fisheries and aquaculture: synthesis of current knowledge, adaptation and mitigation options. Rome: Food and Agriculture Organization for the United Nations (FAO).

Barbier, E. B.

2007 Valuing ecosystem services as productive inputs. Economic Policy, 22 (49), 178-229.

Barbier, E. B., Hacker, S. D., Kennedy, C., Koch, E. W., Stier, A. C., & Silliman, B. R.

2011 The value of estuarine and coastal ecosystem services. Ecologocal Momographs, 81 (2), 169-193.

Basu, S. & Mackey, K. R. M.

2018 Phytoplankton as key mediators of the biological carbon pump: Their responses to a changing climate. Sustainability, 10 (3), 869.

Bobadoye, A. O., Ogara, W. O., Ouma, G. O., & Onono, J. O.

2016 Pastoralist perceptions on climate change and variability in Kajiado in relation to meteorology evidence. Academic Journal of Interdisciplinary Studies, 5(1), 37.

Bosello, F. & De Cian, E.

2014 Climate change, sea level rise, and coastal disasters. A review of modeling practices. Energy Economic, 46, 593-605

Bryan, E., Ringler, C., Okoba, B., Roncoli, C., Silvestri, S., & Herrero, M.

2013 Adapting agriculture to climate change in Kenya: Household strategies and determinants. Journal of environmental management, 114, 26-35.

Climate Change Act

2016 Kenya Gazette Supplement No. 68 (Acts No. 11).

Coast Development Authority Act

1990 Act No. 20 of 1990. CAP 449.

Conservation International

2008 Economic Values of Coral Reefs, Mangroves, and Seagrass. A Global Compilation. Center

for Applied Biodiversity Science, Conservation International, VA, USA.

Costanza, R., Perez-Maqueo, O., Martinez, M. L., Sutton, P., Anderson, S. J., & Mulder, K.

2008 The value of coastal wetlands for hurricane protection. AMBIO: A Journal of the Human Environment, 37 (4), 241-248.

Cuni-Sanchez, A., Omeny, P., Pfeifer, M., Olaka, L., Mamo, M. B., Marchant, R., & Burgess, N. D.

2019 Climate change and pastoralists: perceptions and adaptation in montane Kenya. Climate and Development, 11(6), 513-524.

Energy Act

2019 Kenya Gazette Supplement No. 29 (Acts No. 1).

Environmental Management and Coordination (Amendment) Act

2015 Kenya Gazette Supplement No. 74 (Acts No. 5).

European Commission

2020 The EU Blue Economy Report 2020. Luxemburg: Publications Office of the European Union.

Fisheries (Beach Management Units) Regulations

2019 Republic of Kenya.

FAO

2016 The State of World Fisheries and Aquaculture 2016. Contributing to food security and nutrition for all. Rome: FAO.

Gaines, S. Cabral, R., Free, C. M. & Golbuu, Y.

2019 The expected impacts of climate change on the ocean economy. Washington, DV: World Resources Institute.

High Ambition Coalition for Nature and People

2021 50 countries announce bold commitment to protect at least 30% of the world's land ocean by 2030. High Ambition Coalition for Nature and People, January 21. Available at https://www.campaignfornature.org/50-countries-announce-bold-commitment-to-protect-at-least-30-of-the-worlds-land-and-ocean-by-2030.

Hoegh-Guldberg, O., Caldeira, K., Chopin, T., Gaines, S., Haugan, P., Hemer, M., Howard, J., Konar, M., Krause-Jensen, D., Lindstad, E., Lovelock, C. E., Michelin, M., Nielsen, F. G., Northrop, E., Parker, R., Roy, J., Smith, T., Some, S. & Tyedmers, P. (

2019 The Ocean as a Solution to Climate Change: Five Opportunities for Action. Washington DC: World Resources Institute.

Indian Ocean Commission

2014 Performance assessment of Beach Management Units along the coastlines of Kenya and Tanzania. Ebene: Indian Ocean Commission.

International Research Institute for Climate and Society

2016 El Niño Retrospective: Senegal, Part 2. Available at https://medium.com/@climatesociety/el-ni%C3%B1o-retrospective-senegal-part-2-765f7f4e1c26#.p39kfq5mn

IPCC

2014 Climate Change 2014. Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. (Eds.) The Core

Writing Team, Pachauri, R. K. & Meyer, L. Geneva: IPCC.

IPCC

2019 Technical Summary: IPCC Special Report on the Ocean and Cryosphere in a Changing Climate. (Eds.) Pörtner, H. O., Roberts, D.C., Masson-Delmotte, V., Zhai, P., Poloczanska, E., Mintenbeck, K., Tignor, M., Alegría, A., Nicolai, M., Okem, A., Petzold, J., Rama, B., & Weyer N.M. Geneva: IPCC.

Japp, D.

2012 Report: SF/2012/9. Kenya Fisheries Governance. Agrotec Consortium.

Kairo, J. G., Wanjiru, C., & Ochiewo, J.

2010 Net pay: Economic analysis of a replanted mangrove plantation in Kenya. Journal of Sustainable Forestry, 28 (3-5), 395-414.

Kanyange, N.

2012 Primary Survey of Beach Management Units (BMUS) in the Kenyan coastal marine Fisheries: Nairobi: FAO.

Karanja, J. M. & Abdul-Razak, Z.

2018 Africa and Climate Change Refugees' Quandary: Kenya Perspectives. In The Development of Africa (pp. 255-267). Springer, Cham.

Karanja, J.M. & Saito, O.

2018 Cost–benefit analysis of mangrove ecosystems in flood risk reduction: a case study of the Tana Delta, Kenya. Sustainability Science, 13(2), 503-516.

Karanja, J. M., Matsui, K., & Saito, O.

2018 Problems of public participation in the Ramsar CEPA programme at the Tana Delta, Kenya. Wetlands Ecology and Management, 26(4), 525-535.

KEMRI

2017 Kenya Marine and Fisheries Research Institute (KEMRI) history. Available at https://www.kmfri.co.ke/index.php/about-us/our-history.

Kenya Coast Guard Service Act

2018 No 11 of 2018.

Kenya Fisheries Management and Development Act

2016 Kenya Gazette Supplement. No. 35 of 2016.

Kenya Maritime Authority (Amendment) Act

2012 CAP 370.

Kenya Ports Authority Act

2018 Act No. 18 of 2018. CAP 391.

KNSL

2017 Reports and Financial Statements for the financial year ended 30 June, 2017. Mombasa: Kenya National Shipping Line.

Limuwa, M. M., Sitaula, B. K., Njaya, F., & Storebakken, T.

2018 Evaluation of small-scale fishers' perceptions on climate change and their coping strategies: Insights from Lake Malawi. Climate, 6(2), 34.

Mafongoya, P., Naidoo, D., Sibanda, M., & Muringai, R. T.

2019 Small-scale fishers' perceptions of climate change and its consequences on fisheries: the case of Sanyathi fishing basin, Lake Kariba, Zimbabwe. Transactions of the Royal Society of South Africa, 74(3), 248-257.

Mburu, B. K., Kung'u, J. B., & Muriuki, J. N.

2015 Climate change adaptation strategies by small-scale farmers in Yatta District, Kenya. African Journal of Environmental Science and Technology, 9(9), 712-722.

Met Office

2011 Climate: Observations, Projections and impacts-Kenya. Exeter: UK Met Office.

Ministry of Environment and Forestry

2020a Submission of Kenya's updated nationally determined contribution. Available at https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Kenya%20First/Kenya%27s%20First%20%20NDC%20(updated%20version).pdf.

Ministry of Environment and Forestry

2020b Implementation plan for the ban of single use plastics in protected areas. Nairobi: Republic of Kenya.

Ministry of Environment and Natural Resources

2016 Green Economy Strategy and Implementation Plan 2016-2030. Republic of Government

Moustahfid, H., Marsac, F. & Gangopadhyay, A.

2018 Climate change impacts, vulnerabilities: Western Indian Ocean marine fisheries. In (Eds.) Barange, M., Bahri, T., Beveridgem M. C. M., Cochrane, K. L., Funge-Smith, S. & Poulain, F. Impacts of climate change on fisheries and aquaculture: synthesis of current knowledge, adaptation and mitigation options. Rome: FAO, 251-279.

National Environment Policy

2017 Ministry of Environment, Water and Natural Resources of the Republic of Kenya.

National Tourism Board

2017 National Tourism Blueprint 2030: NTB 2030.

Navas González, F. J., Jordana Vidal, J., Pizarro Inostroza, G., Arando Arbulu, A., & Delgado Bermejo, J. V.

2018 Can donkey behavior and cognition be used to trace back, explain, or forecast moon cycle and weather events? Animals, 8(11), 215.

Ngugi, B.

2020 Kenya reveals Sh540bn nuclear power plant in Tana River. Business Daily, 18 August. Available at https://www.businessdaily.com/bd/economy/kenya-reveals-sh540bn-nuclear-power-plant-in-tana-river-2298908.

Nicholls, R., Brown, S., Hanson, S. & Hinkel, J.

2010 Economics of coastal zone adaptation to climate change. Washington DC: The World Bank.

Nyamasyo, G., Mari, N. & Musingi, J.

2017 Nature resource-based conflicts in Tana River County, Kenya. International Academic Journal of Human Resource and Business Administration, 2(3), 599-610.

Nyang'au, J. O., Mohamed, J. H., Mango, N., Makate, C., & Wangeci, A. N.

2021 Smallholder farmers' perception of climate change and adoption of climate smart agriculture

practices in Masaba South Sub-County, Kisii, Kenya. Heliyon, 7(4), e06789.

Obura, D., Gudka, M., Rabi, F. A., Gian, S. B., Bijoux, J., Freed, S., Maharavo, J., Mwaura, J., Porter, S., Sola, E., Wickel, J., Yahya, S. & Ahamada, S.

2017 Coral reef status report for the Western Indian Ocean. Global Coral Reef Monitoring Network (GCRMN)/International Coral Reef Initiative (ICRI).

Ocean Panel Secretariat

2018 Transformation for a Sustainable Ocean Economy: A vision for protection, production and prosperity. World Resources Institute

Ochieng, J., Kirimi, L., & Makau, J.

2017 Adapting to climate variability and change in rural Kenya: farmer perceptions, strategies and climate trends. Natural resources forum (Vol. 41, No. 4, pp. 195-208). Oxford, UK: Blackwell Publishing Ltd.

Oduor, S.

2021 Toxic dumpsite in Hola chokes residents. Daily Nations, 15 March. Available at https://nation.africa/kenya/counties/tana-river/toxic-dumpsite-in-hola-chokes-residents-3323346?fbclid=IwAR0jzMtlUxAIlfHvP4pUtsp-3wazK47hf7gJlblaouu-nJSREn5or-SqwIQ.

Ogalleh, S. A., Vogl, C. R., Eitzinger, J., & Hauser, M.

2012 Local perceptions and responses to climate change and variability: The case of Laikipia District, Kenya. Sustainability, 4(12), 3302-3325.

Onyango, R. D. L., Oludhe, C., & Amwata, D.

2020 Exploration of Knowledge, Perception and Adaptation Strategies of the Mbita Fisher Community to CC/CV. International Journal of Environment and Climate Change, 10(9), 154-169.

Renaud, F. G., Sudmeier-Rieux, K. & Estrella, M.

2013 The Role of Ecosystems in Disaster Risk Reduction. Tokyo: United Nations University Press.

Republic of Kenya

2018 The Kenya Gazette Vol. CXX-No. 76.

Sarker, S., Hussain, F. A., Assaduzzaman, M. & Failler, P.

2019 Blue Economy and Climate Change: Bangladesh Perspective. Journal of Ocean and Coastal Economics, 6 (2), 1-17.

SBEC Review Committee

2018a The Nairobi Statement of Intent on Advancing the Global Sustainable Blue Economy. Nairobi: Sustainable Blue Economy Conference (SBEC).

SBEC Review Committee

2018b Report on the Global Sustainable Blue Economy Conference, 26th-28th November 2018. Nairobi: Sustainable Blue Economy Conference (SBEC).

Setlur, B.

2020 Investing in a blue economy for Kenya's coastal communities. World Bank Blogs. Available at https://blogs.worldbank.org/nasikiliza/investing-blue-economy-kenyas-coastal-communities.

Silvestri, S., Bryan, E., Ringler, C., Herrero, M, & Okoba, B.

2012 Climate change perception and adaptation of agro-pastoral communities in Kenya. Regional Environmental Change, 12(4), 791-802.

The National Treasury

2016 National Policy on Climate Finance. Republic of Kenya.

The National Treasury

2020 Budget: The Mwananchi Guide FY 2020/21. Available at https://treasury.go.ke/component/jdownloads/send/208-2020-2021/1580-budget-highlights-fy-2020-21.html.

The Presidency

2016 Executive Order No, 1/2016. Organization of the Government of the Republic of Kenya.

The Presidency

2019 Boost for blue economy as President Kenyatta commission Bandari Maritime Academy. The Presidency, 8 July. Available at https://www.president.go.ke/2019/07/08/boost-for-blue-economy-as-president-kenyatta-commissions-bandari-maritime-academy/.

United Nations Conference on Trade and Development (UNCTAD)

2020 The COVID-19 Pandemic and the Blue Economy: New challenges and prospects for recovery and resilience. Geneva: UNCTAD.

United Nations Development Programme (UNDP)

2018 Policy Brief: Leveraging the Blue Economy for Inclusive and Sustainable Growth. Nairobi.

United Nations

2020 UN Ocean Conference: Lisbon, Portugal. Available at https://www.un.org/en/conferences/ocean2020/about.

United Nations

2022 2022 United Nations Conference to Support the Implementation of Sustainable Development Goal 14: Conserve and sustainably use the oceans, seas and marine resources for sustainable development. Available at https://documents-dds-ny.un.org/doc/UNDOC/GEN/N22/389/07/PDF/N2238907.pdf?OpenElement.

7. ANNEXES

APPENDIX 1: QUESTIONNAIRE FOR CROP FARMERS

Enumerator's name	
Location of the survey	
Date and time of the survey	

Informed Consent

Thank you for willing to participate in this research. My name is ……. a research assistant for the International Organization for Migration (IOM), the UN Migration Agency. This research is part of the IOM's project on "Engaging Migrants and Diaspora Communities for an Inclusive and Climate Resilient Blue Economy". This questionnaire survey aims to examine the impacts of climate change and disasters on crop farming in the Tana Delta region. The research will help governments, NGOs, and local communities to better understand these impacts and to develop policies, strategies and projects that can provide long-term support to strengthen resilience of local communities. The information provided will be completely confidential and shall solely be used for research purposes. Participation is voluntary and you will in no way be penalized if you prefer not to participate. However, there are also no benefits of participation, we do not provide any incentives. Please tell us whether you would like to participate in this survey.

Socio-Demographic Features

Gender	Male	Female						
Age (in years)	30-35	36-40		31-45		46-50	>50	
Education (Highest level attained)	No basic education	Primary		Secondary		College Diploma	University degree	
Farming experience in years								
Household size								
Type of farming practiced	Rain-fed only		Irrigation only				Rain-fed and irrigation	
Three Main crops planted								
Annual average income from crop farming (Ksh) (based on 2020 harvest								
Other source of livelihoods practiced in your household	Fishing	Fish farming	Livestock keeping	Poultry	Apiculture	Business (Specify)	Labourer	Others (Specify)

Climatic Risk and Vulnerability Assessment

1. How would you rate the following risks experienced in Tana Delta region

Risks	Insignificant	Minor	Moderate	Serious	Severe
Flood risk					
Drought emergencies					
Nature-based conflicts					
Pollution of the coastline					
Salt intrusion					

2. Over the past five years, has your household run out of food? Yes☐ No☐

2.1 If yes, kindly explain reasons for food shortage in your household?

……
……
……

Impacts of climate change on crop farming

3. From your experience, how has the following climate variables changed in the last 20 years? (For instance, comparison of 2000 and 2020).

Climate variables	Parameters		
Temperature	No change	Decreased (cooler weather)	Increased (warmer)
Precipitation	No change	Decreased precipitation	Increased precipitation
Dry seasons/periods?	No change	Shorter dry periods	Prolonged dry periods
Dry Period Frequency	No change	Dry periods occur less frequent	Dry periods occur more frequent
Rainy Seasons	No change	Shifted but predictable	Shifted and unpredictable

3.1 If you indicated that climatic variables have changed, how has the change affected crop farming?

Climate variables	Impacts on crop farming
Change in temperature/dryness periods	
Change in precipitation and rainy seasons	

4. Which adjustments in your farming have you made as a result of changing temperature and/or rainfall patterns? You can select more than one.

Irrigate more	**Plant fast growing crops**	**Change from crop to livestock**
Implement water harvesting technique	Shifted to fishing	Reduced cultivation acreage
Plant drought resistant crops	Shifted to fishing/fish farming	Increased cultivation acreage
Mulching	Crop rotation	Farm near the river
Mixed cropping	Plant trees for shading	Fertilizer application
Use of pesticides/herbicide	Bought crop insurance	Find off-farm jobs (specify…
Lease your land	Others (specify)…	

5. What were the main constraints/difficulties experienced in changing your farming ways? ……
…….....

……
……

Impacts of disasters on crop farming

6. How has the frequency of the following disasters/risks changed in the last five years? (Since 2015)

Parameters	**No change**	**Less frequent (fewer incidents**	**More frequent (Increased incidents**
Floods			
Droughts			
Conflicts			
Saltwater intrusion			
Strong wind			

7. How has the severity of the following disasters/risks changed in the last five years? (Since 2015)

Parameters	**No change**	**Less severe**	**More severe**
Floods			
Droughts			
Conflicts			
Saltwater intrusion			
Strong wind			

8. How do disasters/risks experienced in Tana Delta affect crop farming?

Disasters	**Impacts**
Floods	
Droughts	
Conflicts	
Saltwater intrusion	
Strong wind	

9. Which strategies have you adopted to reduce the impacts of disasters/risks on crop farming?

Disasters	**Adaptation strategies**
Floods	
Droughts	
Conflicts	
Saltwater intrusion	
Strong wind	

Adaptation support

10. How do you access the weather forecasting information?

No access	Radio	TV	Newspaper
Via SMS	Internet	Church/Mosque	Family member
Friends in the village	Government officers	Local NGOs	Others specify

11. Do you have a traditional method of predicting weather? Yes☐ No☐

11.1 If yes, please explain the method……..

12. Have you received any training about climate change? Yes☐ No☐

12.1 If yes, when and from which organization/institution?.....

13. Have you received technical support to strengthen your adaptation to climate change?

Yes☐ No☐

13.1 If yes, kindly illustrate the form of support and leading stakeholders (supporters)

……
……

14. Do you receive any external support to enhance your recovery after a disaster?

Disasters	**Supporter(s)**	**Support provided**
After a flood damage		
After a drought		
After a major conflict		

Alternative Livelihoods

15. How satisfied are you with crop farming?

Very satisfied	Satisfied	Somehow satisfied	Unsatisfied	Very Unsatisfied

16. To what extent would you be interested in practicing the following as alternative source of livelihood?

Economic activities	**Not Interested**	**Somehow Interested**	**Interested**	**Very Interested**
Fishing				
Fish farming				
Livestock keeping				
Poultry				
Apiculture				
Business(specify)				
Others (specify)				

17. Challenges impeding crop cultivation in Tana Delta

.....
.....
.....
.....

The End

APPENDIX 2: QUESTIONNAIRE FOR PASTORALISTS

Enumerator's name	
Location of the survey	
Date and time of the survey	

Informed Consent

Thank you for willing to participate in this research. My name is ……. a research assistant for the International Organization for Migration (IOM), the UN Migration Agency. This research is part of the IOM's project on "Engaging Migrants and Diaspora Communities for an Inclusive and Climate Resilient Blue Economy". This questionnaire survey aims to examine the impacts of climate change and disasters on pastoralism in the Tana Delta region. The research will help governments, NGOs, and local communities to better understand these impacts and to develop policies, strategies and projects that can provide long-term support to strengthen resilience of local communities. The information provided will be completely confidential and shall solely be used for research purposes. Participation is voluntary and you will in no way be penalized if you prefer not to participate. However, there are also no benefits of participation, we do not provide any incentives. Please tell us whether you would like to participate in this survey.

Socio-Demographic Features

Gender	Male	Female					
Age (in years)	30-35	36-40		31-45	46-50	>50	
Education (Highest level attained)	No basic education	Primary		Secondary	College Diploma	University degree	
Years of experience in livestock keeping							
Herd species	Cattle		Goats	Camels		Others (Specify).	
Household size							
Annual income from livestock (Ksh)							
Other source of livelihoods practiced in your household	Crop farming	Fishing	Fish farming	Poultry	Apiculture	Business (Specify)	Labourer	Others (specify)

Climatic Risk and Vulnerability Assessment

1. How would you rate the following risks experienced in Tana Delta region

Risks	Insignificant	Minor	Moderate	Serious	Severe
Flood risk					
Drought emergencies					
Nature-based conflicts					
Pollution of the coastline					
Salt intrusion					

2. Over the past five years, has your household run out of food? Yes☐ No☐

2.1 If yes, kindly explain reasons for food shortage in your household?

.....
.....
.....

Impacts of climate change on pastoralism

3. From your experience, how has the following climate variables changed in the last 20 years? (For instance, in comparison between 2000 and 2020).

Climate variables	Parameters		
Temperature	No change	Decreased (cooler weather)	Increased (warmer)
Precipitation	No change	Decreased precipitation	Increased precipitation
Dry seasons/periods?	No change	Shorter dry periods	Prolonged dry periods
Dry Period Frequency	No change	Dry periods occur less frequent	Dry periods occur more frequent
Rainy Seasons	No change	Shifted but predictable	Shifted and unpredictable

3.1 If you indicated that climatic variables have changed, how has the change affected livestock keeping?

Climate variables	Impacts on pastoralism
Change in temperature/dryness periods	
Change in precipitation and rainy seasons	

4. As a pastoralist, which adjustments you have you made as a result of changing temperature and rainfall patterns? You can select more than one.

Investing in drought resistant livestock such as camel	Migration
Reduced number of livestock	Shifted to crop farming
Increased number of livestock	Shifted to fishing
Implement water harvesting technique	Shifted to fish farming
Grazing near the river/Delta	Bought livestock insurance
Bought animal folder	Animal vaccinations
Planting supplementary feeds	Livestock diversification
Others (specify)	

5. What were the main constraints/difficulties experienced in changing your livestock keeping way? ……
…….....

……...……
……..

Impacts of disasters on pastoralism

6. How has the frequency of the following disasters/risks changed in the last five years? (Since 2015)

Parameters	**No change**	**Less frequent (fewer incidents**	**More frequent (Increased incidents**
Floods			
Droughts			
Conflicts			
Strong wind			

7. How has the severity of the following disasters/risks changed in the last five years? (Since 2015)

Parameters	**No change**	**Less severe**	**More severe**
Floods			
Droughts			
Conflicts			
Strong wind			

8. How do disasters experienced in Tana Delta affect livestock keeping?

Disasters	**Adaptation strategies**
Floods	
Droughts	
Conflicts	
Strong wind	

9. Which strategies have you adopted to reduce the impacts of disasters on livestock?

Disasters	**Adaptation strategies**
Floods	
Droughts	
Conflicts	
Strong wind	

Adaptation support

10. How do you access the weather forecasting information?

No access	Radio	TV	Newspaper
Via SMS	Internet	Church/Mosque	Family member
Friends in the village	Government officers	Local NGOs	Others specify

11. Do you have a traditional method of predicting weather? Yes☐ No☐

11.1 If yes, please explain……

12. Have you received any training about climate change? Yes☐ No☐

12.1 If yes, when and from which organization/institution?.....

13. Have you received technical support to strengthen your adaptation to climate change?

Yes☐ No☐

13.1 If yes, kindly illustrate the form of support and leading stakeholders (supporters)

……
……

14. Do you receive any external support to enhance your recovery after a disaster?

Disasters	**Supporter(s)**	**Support provided**
After a flood damage		
After a drought		
After a major conflict		

Alternative Livelihoods

15. How satisfied are you with livestock keeping?

Very satisfied	Satisfied	Somehow satisfied	Unsatisfied	Very Unsatisfied

16. To what extent would you be interested in practicing the following as alternative source of livelihood?

Economic activities	**Not Interested**	**Somehow Interested**	**Interested**	**Very Interested**
Crop farming				
Fishing				
Fish farming				
Poultry				
Apiculture				
Business (specify)				
Others				

17. Challenges impeding sustainable pastoralism in Tana Delta

.....
.....
.....
.....

The End

APPENDIX 3: QUESTIONNAIRE FOR FISHERS

Enumerator's name	
Location of the survey	
Date and time of the survey	

Informed Consent

Thank you for willing to participate in this research. My name is ……. a research assistant for the International Organization for Migration (IOM), the UN Migration Agency. This research is part of the IOM project on "Engaging Migrants and Diaspora Communities for an Inclusive and Climate Resilient Blue Economy". This questionnaire survey aims to examine the impacts of climate change and disasters on crop farming in the Tana Delta region. The research will help governments, NGOs, and local communities to better understand these impacts and to develop policies, strategies and projects that can provide long-term support to strengthen resilience of local communities. The information provided will be completely confidential and shall solely be used for research purposes. Participation is voluntary and you will in no way be penalized if you prefer not to participate. However, there are also no benefits of participation, we do not provide any incentives. Please tell us whether you would like to participate in this survey.

Socio-Demographic Features

Gender	Male	Female						
Age (in years)	30-35	36-40		31-45		46-50	>50	
Education (Highest level attained)	No basic education	Primary		Secondary		College Diploma	University degree	
Experience in fishing industry in years								
Type of fishing practiced	Marine fishing only		River fishing only			Both marine and river fishing		
Daily average quantity of fish you catch								
Monthly Income from fishing (Ksh)								
Other source of livelihoods practiced in your household	Crop farming	Fish farming	Livestock keeping	Poultry	Apiculture	Business (specify)	Labourer	Others (specify)

Fishing Vessel utilized	Swimming	Canoe	Fishing boat		
(Engine powered)	Commercial fishing vessel				
Your fishing gears	Basket trap (Malema / Madema)	Fence trap (uzio/zonga/ rakasa/ wando/ tando)	Handlining/ Hook & Line) (Mshipi)	Trolling (Mship wa kurambaza)	Longline (Zulumati)
	Speargun (Bunduki)	Spear and Harpoon (Mkuku/ Njoro na Shomo/ Mkondzo)	Gill Net-Stationary (Jarife-Nyavu ya kutega)	Gill Net-Drifting (Jarife-Nyavu ya kuogelesha)	Monofilament gill net (Nyavu ya mkano)
	Ring Net (Nyavu ya kufunga)	Prawn seine and cast net (Kidima and kimia)	Beach/Reef seine net (Juya/ Nyavu ya kukokota)	Scoop net/hand net (kimia)	Mosquito net (uduvi/tandilo)
	Others (please specify)				
Area(s) where you fish	Mainly Inshore	Mainly Offshore	Both inshore and offshore	Deep sea	
How long does it take you to get to fishing ground (in hours)					
What is your average fishing duration per day (in hours)					
On average, what is your daily harvested fish in Kgs					
Fish species mainly harvested					

Climatic Risk and Vulnerability Assessment

1. How would you rate the following risks experienced in Tana Delta region

Risks	Insignificant	Minor	Moderate	Serious	Severe
Flood risk					
Drought emergencies					
Nature-based conflicts					
Pollution of the coastline					
Salt intrusion					

2. How often do you eat fish?

3. Over the past five years, has your household run out of food? Yes☐ No☐

3.1 If yes, kindly explain reasons for food shortage in your household?

.....
.....
.....

Impacts of climate change on fisheries sector

4. From your experience, how has the following climate variables changed in the last 20 years? (For instance, in comparison between 2000 and 2020).

Climate variables	**Parameters**		
Temperature	No change	Decreased (cooler weather)	Increased (warmer)
Precipitation	No change	Decreased precipitation	Increased precipitation
Dry seasons/periods?	No change	Shorter dry periods	Prolonged dry periods
Dry Period Frequency	No change	Dry periods occur less frequent	Dry periods occur more frequent
Rainy Seasons	No change	Shifted but predictable	Shifted and unpredictable

4.1. If you indicated that climatic variables have changed, how has the change affected fishing activities?

Climate variables	**Impacts on fishing**
Change in temperature/dryness periods	
Change in precipitation and rainy seasons	

5. From your experience, how has the ocean surface water temperature changed in the last 10-20 years? (For instance, in comparison between 2000-2010 and now).

No change	Decreased (ocean is cooler)	Increased (ocean is warmer)	Not sure

6. From your fishing experience, how have fish catches and composition changed in the last 20 years (since from 2000).

Fishery features	**Significantly decreased**	**Decreased**	**Somehow decreased**	**No change**	**Somehow increased**	**Increased**	**Significantly increased**
Fish catch potential/ fish abundance							
Change in composition of fish species harvested							

6.1 Kindly explain why fish catches and composition have change or unchanged

……..……
……..……
……..……

7. How has the change in fish catches and composition affected your livelihoods/income?

……
……

8. Which adjustments have you made as a result of changing fish catch potential and fish species composition?.....

……
…….....

9. From your experience, how has the sea level rise changed in the last 20 years? (For instance, in comparison between 2000 and now).

No change	Sea level has decreased	Sea level has increased

9.1 If Sea level rise has changed, how has it affected your daily fishing activity/income?

……
……
……..

10. In the last five years (since 2015), have you experienced any strong storm?

Yes☐ No☐

10.1 If yes, how has the frequency of strong storms changed in the last 5 year (since 2015) For example, how many experiences per year?

No change	Decreasing	Increasing

10.2 If yes in question 10, how do strong storms impact on fisheries sector?

……...……
……..

…….....

Impacts of disasters on fisheries sector

11. How has the frequency of the following disasters/risks changed in the last five years? (Since 2015)

Parameters	**No change**	**Less frequent (fewer incidents**	**More frequent (Increased incidents**
Floods			
Droughts			
Conflicts			
Strong wind			

12. How has the severity of the following disasters changed in the last five years? (Since 2015)

Parameters	No change	Less severe	More severe
Floods			
Droughts			
Conflicts			
Strong wind			

13. How do floods experienced in Tana Delta affect fishery and aquaculture sector?

Sector	Impacts
River fishing	
Marine fishing	
Aquaculture	

14. How do droughts experienced in Tana Delta affect fishery and aquaculture sector?

Sector	Impacts
River fishing	
Marine fishing	
Aquaculture	

15. How do conflicts in Tana Delta affect fishery and aquaculture sector?

Sector	Impacts
River fishing	
Marine fishing	
Aquaculture	

16. Which strategies have you adopted to reduce the impacts of disasters on your fishing activity?

Disasters	Adaptation strategies
Floods	
Droughts	
Conflicts	
Strong wind	

Adaptation Support

17. How do you access the weather forecasting information?

No access	Radio	TV	Newspaper
Via SMS	Internet	Church/Mosque	Family member
Friends in the village	Government officers	Local NGOs	Others specify

18. Do you have a traditional method of predicting weather? Yes☐ No☐

18.1 If yes, please explain……

19. Have you received any training about climate change? Yes☐ No☐

19.1 If yes, when and from which organization/institution?.....

20. Have you received technical support to strengthen your adaptation to climate change?

Yes☐ No☐

20.1 If yes, kindly illustrate the form of support and leading stakeholders (supporters)

……
……

21. Do you receive any external support to enhance your recovery after a disaster?

Disasters	**Supporter(s)**	**Support provided**
After a flood damage		
After a drought		
After a major conflict		

Alternative Livelihoods

22. How satisfied are you with fishing?

Very satisfied	Satisfied	Somehow satisfied	Unsatisfied	Very Unsatisfied

23. To what extent would you be interested in practicing the following as alternative source of livelihood?

Economic activities	**Not Interested**	**Somehow Interested**	**Interested**	**Very Interested**
Fish farming				
Crop cultivation				
Livestock keeping				
Poultry				
Apiculture				
Business (specify)				
Others				

24. Challenges impeding sustainable fisheries in Tana Delta

……
……
……

THE END

Kenya Country Office
Sri Aurobindo Avenue, off Mzima Springs
Lavington, Nairobi, Kenya
T: +254 (0) 20 422 1000 | Email: iomkenyaPI@iom.int
www.kenya.iom.int

Follow / email us on:

@iomKenya International Organization for Migration - Kenya iomkenyaPI@iom.int