Climate Vulnerability and Capacity Analysis of the Lamu Land/ Seascape

Written by Kulima Integrated Development Solutions

based on fieldwork conducted by WWF and Kenya Wildlife Services

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Executive Summary

The coastal areas of Lamu County in northeast Kenya are rich in biodiversity, both marine and terrestrial. The area experiences many similar development challenges and socio-economic characteristics as other rural areas in Kenya, including high poverty levels, low education, and variable health.

Kiunga Marine National Reserve (KMNR) is located at the northernmost stretch of the Kenyan coastline (40º 07' E, 2º 00' S) in Lamu county. The 25,000 hectare reserve was designated as such in 1979 and extends from the shoreline to a discontinuous outer rocky reef. The communities are predominantly (80%) Bajun – a mix of Arab and Bantu ancestry. Inland (in the Boni- Dodori forest) are the Aweer people - former hunter-gatherers who now rely on small-scale agriculture and honey- harvesting. In 1996, WWF initiated collaborative management with the main purpose of establishing institutional and regulatory framework for effective management of Kiunga Marine National Reserve.

Characterised by a bi-modal rainfall pattern, the area has experienced variable rainfall based on observational records from 1979-2000 and verified by observations of community members. Models generally project an increase in rain day frequency from November through to April, with most positive change in extreme rainfall occurring in October and November, with a decrease between June to September for all types of rainfall frequency. A decrease in the dry spell duration during the dry season (January – April) is shown for most models suggesting that the period between rain events may increase into the future (CSAG, 2012). Although some months may have greater dry spell lengths, this may not necessarily translate into the long-duration dry spells that are defined as droughts.

The aim of study was to investigate the climate-related vulnerability and adaptive capacity of communities living within and adjacent to Lamu Land/Seascape, based on two objectives:

- **To understand community resource use and how this has been affected by climate.**
- **To understand the community's experience of changes in climate and how this has affected their livelihoods.**

In order to meet the two objectives, a methodology was designed based on CARE's climate vulnerability and capacity assessment (CVCA) toolkit (CARE, 2009) that comprises exercises based on resource and hazard mapping, historical timelines, seasonal calendars, vulnerability matrices and focus group discussions. Training on the CVCA methodology and process was conducted in August 2012 for staff from WWF, Kenya Wildlife Services (KWS), who jointly led the process, together with the Kenya Marine Fisheries Research Institute (KMFRI). Fieldwork was carried out in two stages by a multidisciplinary team of two streams (terrestrial and coastal), that each facilitated discussions with separate men's and women's groups simultaneously in 17 villages in total (9 coastal and 8 terrestrial).

Results show that the communities are highly dependent on natural resources for their livelihoods which involve fishing, crop farming, mangrove harvesting and, to a lesser extent, livestock farming. Natural resource availability has changed over time. This reflects a combination of climate and other factors. Important drivers of climate-related vulnerability

include droughts, floods, sea level temperature change, sea level rise and, most commonly noted – unpredictability of rainfall.

Other driving factors of vulnerability include changing access to resources (through land tenure patterns and the designation of the protected area). Accessibility to, and availability of, markets has also affected both natural resource and non-natural-resource-based livelihoods (including formal employment), with jobs in the tourism industry particularly sensitive to local insecurity and terrorism threats. Climate factors often indirectly contribute to these other drivers of livelihood vulnerability: for example human-wildlife conflict is further exacerbated when drought forces animals such as buffalo to move out of their normal inland foraging areas to raid the farms of coastal communities.

In order to respond to changing natural resource availability, a variety of response strategies have been employed, taking into account both spatial and temporal diversification of livelihoods. Some people have switched from one natural resource-based livelihood to another (e.g. crop farming to fishing), whilst others have modified their typical practices to take account of changing natural resource availability. This is particularly the case for crop farmers, who now plant different crops, and often at different times, in order to try and ensure a harvest, regardless of the conditions. Increased participation in informal trading has also been observed. Coping strategies including seeking assistance from others, both within and outside the village (including various government departments and NGOs) and, in some cases, selling valuable assets such as jewellery. Some communities mentioned that they now prepare for climate hazards by storing seeds, foods, or money with the express intention to use it when their livelihoods are under stress.

It is clear that both ecosystems and the livelihoods that depend on them in the Lamu land/seascape are vulnerable to climate change, and will continue to be in the light of the projected future climate (further modification to the timing of the southern (*Kusi [SEM])* northern (*Kaskasi [NEM])* monsoon systems is anticipated), with a decrease in total rainfall between June and September and increase in extreme rainfall in October and November). Although communities are responding to current changes, opportunities to explore and discuss both current vulnerabilities and future projected climate would greatly improve their capacity to adapt, and ensure that negative livelihood and resource outcomes do not occur.

The majority of the observed responses are examples of coping, rather than adaptation – i.e. they enable short-term survival, but do not affect underlying vulnerability. Thus when the communities are exposed to the same climate hazards in the future, they are likely to experience the same negative consequences. That said, there is potential for many of the responses to become adaptations if other criteria are met. Shifting from coping to adaptation is a key priority to ensure that climate change does not have adverse consequences in the Lamu sea/ landscape.

Several barriers to adapting were observed by the communities. Some past responses are no longer sustainable for various reasons, for example some spatial diversification and access to alternative land is restricted by the designation of protected areas and privatisation of land. Other barriers to adaptation include lack of access to financial resources, inadequate social capital (in terms of not being “plugged in” to networks for participating in markets), poor access to weather and climate information which would

enable them to make livelihood choices that are appropriate for anticipated weather and climate conditions, and also unsustainable actions from outside the communities that create (often unintentionally) perverse incentives to not adapt.

In addition to overcoming explicit barriers to adaptation, the communities identified a number of broader development priorities that would increase their capacity to adapt to climate change. These included improved education and awareness (affording their children a wider range of economic opportunities, as well as increasing the likelihood of them being able to access and understand weather and climate information), improved knowledge on climate-resilient farming techniques, improved water availability (for domestic use and for crop and livestock farming), improved security of land tenure (to provide superior incentives for sustainable resources management), improved food storage facilities (as a risk reduction mechanism and to provide the option of selling at market), reducing the risk of human-wildlife conflict (which occurs already and is exacerbated under conditions of climate change), improving transport and communication links, and facilitating further commercialisation of livelihood opportunities (potentially thereby reducing the level of dependence on natural resources).

The study makes three key recommendations. Firstly, that findings are comprehensively communicated to the village communities themselves, with technical support (e.g. from agricultural extension officers and fisheries officers) to enable them to plan more effectively for future conditions. Secondly, that climate change and vulnerability are incorporated into future management planning and decisions within the Kiunga Marine National Reserve, Boni Forest Reserve, Dodori Game Reserve and by village level fisheries management bodies (called Beach Management Units). Thirdly, the findings show that sustainable development that is appropriate in the context of a changing climate is also essential to reducing livelihood vulnerability in the Lamu land/ seascape, and that modifications to microfinance availability and repayment conditions are a useful first step in supporting such development. Last, but not least, this study has shown that the CVCA methodology is flexible enough to be appropriate for assessing climate vulnerability and adaptive capacity of livelihoods and ecosystems.

Acronyms

ALP	Adaptation Learning Programme
BMU	Beach Management Unit
CEAI	Coastal East Africa Initiative
CSAG	Climate Systems Analysis Group
CVCA	Climate Vulnerability and Capacity Analysis
EACC	East African Coastal Current
ECC	Equatorial Current Current
ESD	Education for Sustainable Development
FD	Fisheries Department
GCM	Global Climate Model
IPCC	Intergovernmental Panel on Climate Change
KFS	Kenya Forest Service
KMFRI	Kenya Marine and Fisheries Research Institute
KMNR	Kiunga Marine National Reserve
KWS	Kenya Wildlife Service
NEM	Northeastern Monsoon
NGOs	Non-governmental organizations
NTFP	Non-Timber Forest Products
PRA	Participatory Rural Appraisal
ROI	Reynolds Optimal Interpolated
SC	Somali Current
SEC	Southern Equatorial Current
SEM	Southeastern Monsoon
SST	Sea Surface Temperature
UNESCO	United Nations Educational, Scientific and Cultural Organisation
WWF	World Wide Fund for Nature

Glossary of terms

Adaptation to Climate Change	Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities (IPCC, 2007).
Adaptive capacity	The ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences (IPCC, 2007).
Climate Change	Any change in climate over time, whether due to natural variability or as a result of human activity (IPCC, 2007).
Hazard	In the context of disaster risk reduction, a hazard is defined as: A dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage (UNISDR, 2009).
Resilience	The ability of a community to resist, absorb, and recover from the effects of hazards in a timely and efficient manner, preserving or restoring its essential basic structures, functions and identity (adapted from UNISDR, 2009).
Vulnerability to climate change	Vulnerability to climate change has been defined as, the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity (IPCC, 2007).

Research Team

The research team was drawn from WWF, KWS, KMFRI and FD who acted as facilitators during the fieldwork. Most of the team previously participated in the field-training workshop in Mkokoni. Kulima Integrated Development Solutions from South Africa designed and ran the training and supervised the fieldwork in the first village; and then supported the writing up of results. The research involved two field teams, as shown in Table 1.

Table 1: Research team composition

Seascape (Marine) Team	Landscape (Terrestrial) Team
WWF	
Nassir Amiyo Lilian Mulupi Asma Awadh	Kiunga Kareko John Bett Elias Kimaru Samuel Mutahi
KWS	
Mike Olendo Syria Karisa Bernard Ogwoka	Dr. Mohamed Omar Jacqueline Bernard
KMFRI	
Elisha Mrabu	Dr. Melchizedek Osore Victor Mwakha
Ministry of Fisheries	Pwani University
Joseph Onyango	Abdulmajeed Omar Hashim Omar

Trainers and resource persons during CVCA training

Worldwide Fund for Nature
Jason Rubens Sarah Freeman
Kulima Integrated Development Solutions
Katharine Vincent Tracy Cull

1. Introduction

WWF's Coastal East Africa Initiative (CEAI) is an umbrella programme that aims to add regional strategic focus, both geographically and thematically, to WWF's work in Kenya, Tanzania and Mozambique. Priority areas of work include natural resources governance in nine priority landscapes and seascapes, governance of western Indian Ocean tuna fisheries, fisheries certification, especially shrimp fisheries in Mozambique, Africa-China natural resources trade, especially timber, and climate change adaptation.

Within the CEAI, the climate change adaptation programme was initiated early in 2011 and aims to ensure that WWF's conservation programme in coastal Eastern Africa recognises, and where possible addresses, the impacts of global climate change on priority ecosystems, and on communities that depend on the services and resources they provide. Among its key activities are to:

i. Develop a climate change adaptation strategy for WWF CEAI;

ii. Provide training on climate change adaptation to WWF management and programme staff in Kenya, Tanzania & Mozambique;

iii. Conduct climate change vulnerability assessments in at least 3 priority landscapes or seascapes, and develop climate change adaptation strategies as appropriate.

This report outlines the climate change vulnerability assessment that was undertaken in August to September 2012 and November 2013 in the Lamu land/ seascape, utilising CARE's Climate Vulnerability and Capacity Analysis methodology (CARE, 2009).

The report is structured as follows. Section 2 provides socio-economic and biophysical background to the Lamu land/ seascape, including an assessment of current climate and projections of future climate change. Section 3 outlines the CVCA methodology followed for the study, including information on its participatory approach, the identification of research questions and data needs, the design of instruments, and sampling approach followed, as well as limitations. Section 4 provides the results, organised into community relationship to, and use of, natural resources; community perceptions of climate and environmental change; community climate vulnerability; adaptive capacity and coping strategies; and community adaptation priorities. Section 5 outlines the conclusions and recommendations, including implications for the case study communities and lessons learned for integrating ecosystem and community paradigms into future CVCAs.

2. Background to Lamu land/ seascape

2.1 Socio-economic characteristics

The Lamu land/ seascape is located in the northeastern Kenyan coast and extends from the Kenya-Somalia boarder to the Tana River (see figure 1 for the location of the Lamu sea/ landscape relative to other CEAI areas). Administratively most of the sea- and landscape is under Lamu County, which covers an area of 6,273.1 km² and has a total population of more than 100,000 in approximately 22,000 households. Economic livelihoods are based on fishing, subsistence farming, sand and ballast quarries, ranching and commercial businesses. There are 70 primary schools and 11 secondary schools in Lamu county, and a handful of tertiary education institutions (including Youth Polytechnics and commercial colleges) (Ochiewo, 2009). Lamu has 42 health facilities of which one is a district hospital, two sub-district hospitals, five health centres, 20 dispensaries, 13 medical clinics and one nursing home. Lamu Island is recognized internationally as a World Heritage Site (UNESCO, 2010).

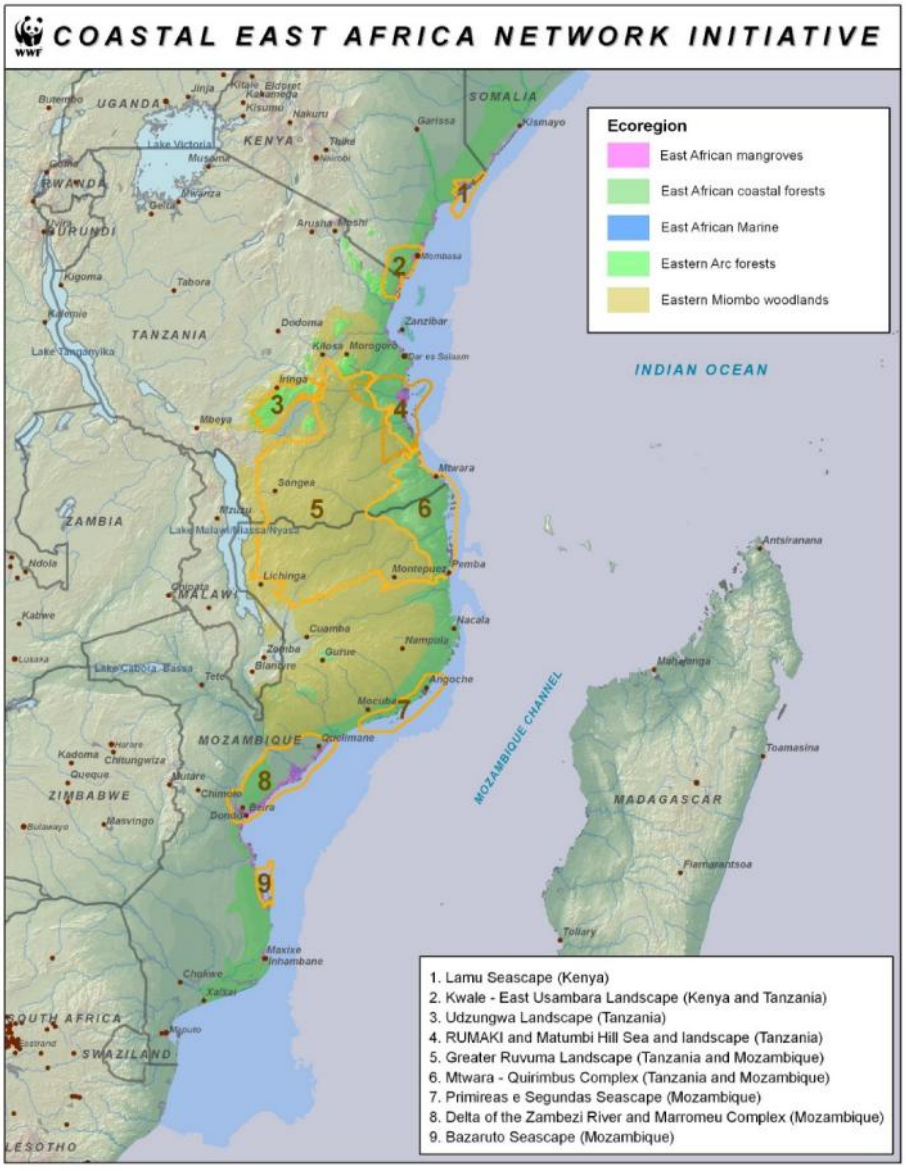

Figure 1: Location of the Lamu seascape in relation to other CEAI areas

2.2 Biophysical characteristics

2.2.1 Geomorphology

The geology of the area is composed of the residual coral limestone and columns of sand. Rock outcrops occur in the islands of Manda and Kiwayu while sand dunes are found in Lamu Island and parts of Mkokoni in Kiunga Division. The tectonic processes that opened up the Indian Ocean resulted in the formation of sedimentary rocks, both along the coast line, into the ocean, and offshore. Much of the Kenyan coast is formed by low, about 4 - 6m high limestone coral cliffs. Fossil coral reef deposits form the Coastal Plain, with reef flats or gently sloping beach formations, while beaches sheltered behind fringing reefs typically are backed by one or a series of wind-blown sand dunes up to 30m in height (e.g. north of Kipini, Shela, Kiwayu and Mkokoni). River plumes reduce, and sometimes prevent, offshore coral growth, particularly in the south of the seascape from Kipini to Lamu. From Lamu Island all the way to Ishakani, the reef is discontinuous and broken into islands and patch reefs.

2.2.2 Soils

Soils of the coastal region show considerable variety. The porous parent rocks of sedimentary origin generally give rise to soils of low fertility. However, patches of highly productive soils have been observed in areas of alluvial deposits. The principal soil types in the region include a narrow strip of coastal sands towards the north where it is permeated by narrow bands of grumosolis brown clay soils. The soil south of Lamu is composed of bi-alternate bands of loams beyond which the grumosolis are permeated by thick bands of ash and pumice soils. The shoreline in most of the region apart from the Malindi area is receding as a result of coastal erosion.

2.2.3 Hydrology

Reflecting the underlying porous limestone, surface water in the district is scarce. Apart from the Dodori channel and river Mangai, there are only seasonal rivers, Hadhi and Kibokoni Lake, which flow from the northwest to the southeast, none reaching the Indian Ocean. There are a number of lakes in the Tana delta area. Most of these lakes are quite small and shallow and are typical oxbow lakes (including Moa, Kenyatta and Dide Waride), remnants of the various meanders of the Tana River. Some of the lakes, especially the smaller ones, show swamp characteristics. These lakes are either recharged through ground water seepage or by the periodic flooding. The Tana River itself meets the sea in an estuarine delta.

2.2.4 Flora and Fauna

Vegetation varies with changes in soil types. Silt and sand support scrub bush, scattered palms and swamp grass. In areas less susceptible to flooding, the silty clays support thick bush consisting of palms, indigenous trees and scrubs. Grassy open swampy places dominate some parts that have drainage problems due to the low altitude. Common vegetation includes *Saliconria spp* and the succulent *Sanseveri spp*, stunted thorny bushes of *Commiphora spp* and *Salvadora spp*. The coastline has sandy beaches, some with mangrove swamps and a great variation of marine flora (including bivalves, snails, and other benthic invertebrates). Microscopic marine plants are absent from the upper part of the inter-tidal zone except for areas of *Bostrychia spp*.

In the inter-tidal sand and mud, the finer sediments below water, which are subject to less wave action, have become fixed by growth of marine angiosperms and there are extensive areas of green algae and *Zostera spp*. Dwarf shrub thickets of halophytes typical of this region littoral zone are common on the mainland, and species include *Ipomoea spp, Perus spp, Suaeda spp,* and *Tephrosia spp*. The largest mangrove forest stands in Kenya are found in the Lamu land/ seascape (more than 30,000 hectares from Lamu to Kiunga), where protective islands, gentle relief and slightly estuarine conditions/sheltered tidal waters predominate.

In terms of fauna, notable mammals include elephant, giraffe, buffalo, antelope, members of the cat family, hippopotamus, Lamu topi, waterbuck, topi and gazelle among others. Marine fauna include sea turtles, numerous reef fish, lobster, cetaceans and invertebrates among others.

The Lamu seascape is rich in biodiversity. Mangroves cover 345 km² that equates to about 60% - 70% of mangrove formations in Kenya (Kairo et al, 2002). It has extensive seagrass beds comprising eight main species (Gullström et al, 2002). In addition, there are patchy reefs with fringing reef in the northern part. Over 50 genera and 150 coral species have been identified in Lamu. Five sea turtle species forage here, together with; dugong, Humpback whales, and dolphins (Church and Palin 2003; Weru et al, 2001).

2.2.5 Oceanography

The Equatorial current is a major ocean current in Western Indian Ocean (WIO) and the Monsoon winds are influential in determining oceanographic conditions in WIO (Schott 2001; Spencer et al 2005).

The Kenyan coast experiences two distinct monsoon seasons, the Northeast monsoon (NEM) locally referred to as *Kaskasi* and the Southeast monsoon (SEM) locally referred to as *Kusi*. SEM runs from May to September and NEM from November to March. In between the NEM and SEM there is one to two months transition periods characterised by variable and lower winds locally referred to as *matlai* (Church and Obura, 2004) (the start and end of the two monsoon seasons varies for example in McClanahan (1988) SEM is March to October and NEM is October to March).

The interplay of monsoon winds, the north flowing East Africa Coastal Current (EACC) and the southwest flowing Somali current (SC) create unique conditions along the Kenyan coast (McClanahan, 1988; Obura, 2001; Benny, 2002; Spencer et al, 2005). These conditions are more pronounced on the northern coastline of Kenya (see figure 2). The area north of Lamu Archipelago is characterised by mild upwelling and eutrophic conditions. The Somali current (the only ocean current that changes direction) known for its high flow speed of up to 3.5 m/s on its top 200 meters reverses direction by 180º clockwise and emerges as a northward extension of EACC during the South East Monsoon (SEM) or South West monsoon or Summer monsoon as it may be referred to in literature (Gert 1989; Schott 2001; Spencer et al, 2005).

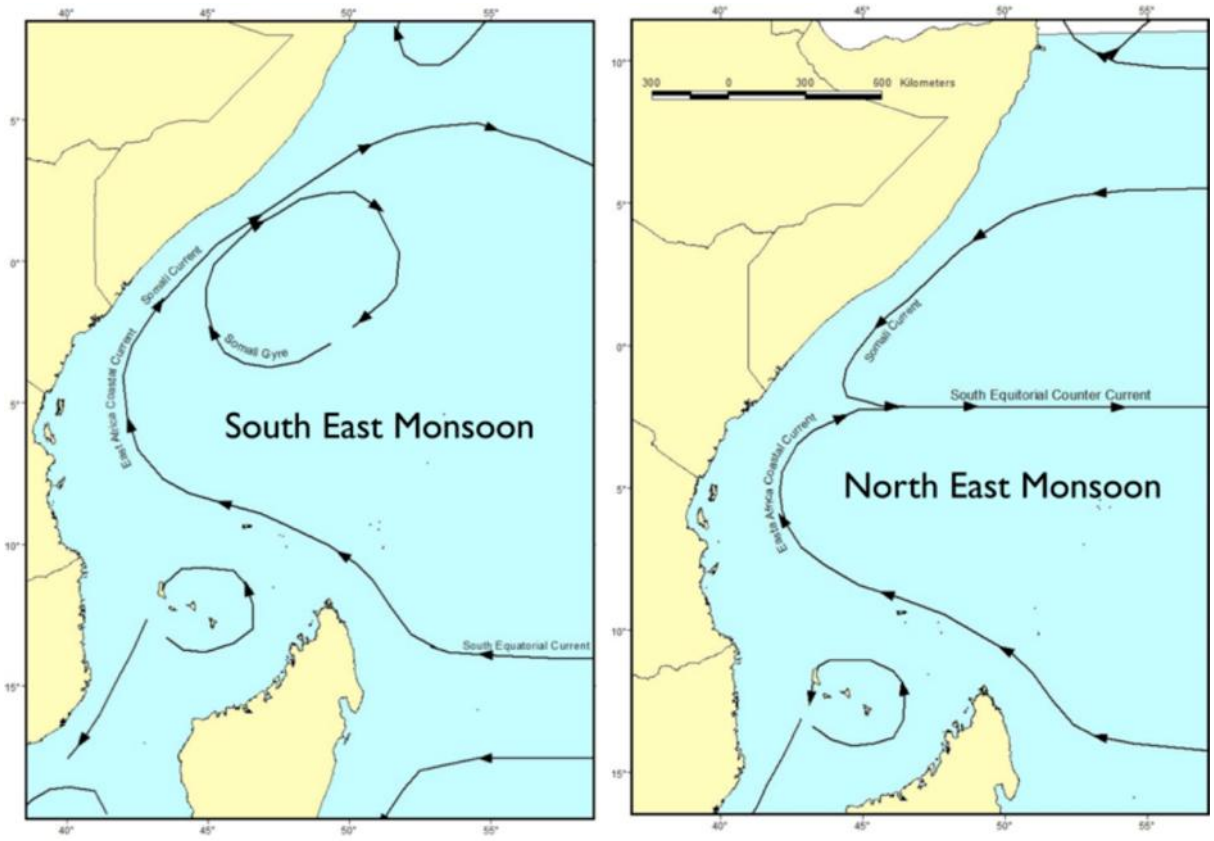

Figure 2: East African coastline, the ocean currents and the monsoon season (WWF-CKP)

Sea surface temperatures are highest during the North-East Monsoon, averaging 28.4°C (maximum 29°C) and lowest during the South-East Monsoon, averaging 26°C (minimum 24°C) (UNEP, 1998; Obura, 2001).

Seasonal temperature variations decrease with increasing water depth, with temperatures stabilizing at 6–7°C at 1000m and 2.5°C at 2000m depth respectively (Duineveld et al, 1997). Salinity variation of the EACC waters is low, ranging between 34.5 and 35.4 ppt (UNEP, 1998). This variation is primarily due to heavy rainfall between March and May and the associated terrestrial freshwater runoff, as well as input from rivers.

The Kenya coast experiences mixed semi-diurnal tides, with approximately two tidal cycles every 24 hours. The reference port for tidal observations in Kenya is Kilindini (Port of Mombasa), where the maximum tidal range generally does not exceed 3.8 m.

2.3 Resource management through the Kiunga Marine National Reserve

Kiunga Marine National Reserve (KMNR) is located at the northernmost stretch of the Kenyan coastline (40º 07' E, 2º 00' S) in Lamu county. The reserve was designated in 1979 under the Wildlife Conservation and Management Act of 1976 and it is under the authority of Kenya Wildlife Service (KWS) (Weru et al, 2001). The reserve measures 25,000 hectares (250 km^2), in the northern part of the Lamu Archipelago. It covers over 50 km in length by 3-5 km in width (see figure 3).

The reserve extends from the shoreline to a discontinuous outer rocky reef that in some places is as shallow as 8m, with its southern end within the reserve. Between the shore and the rocky reef, the bottom reaches a maximum of up to 40m and is mostly sandy. Beyond the rocky reef, the continental shelf slopes into deeper waters.

In 1980, KMNR, together with Dodori National Reserves, in recognition of their biological sensitivity and natural resource dependence by local communities, was granted 'Man and Biosphere Reserve' status by UNESCO.

The Kiunga Marine National Reserve (KMNR) is located in Lamu County, 8km south of the Kenya-Somali coastal border (figure 3). The communities are predominantly (80%) Bajun – a mix of Arab and Bantu ancestry. Inland (in the Boni-Dodori forest) are the Aweer people - former hunter-gatherers who now rely on small-scale agriculture and honey-harvesting. In 1996 WWF initiated a collaborative management of the reserve with the main purpose of establishing institutional and regulatory framework for effective management of Kiunga Marine National Reserve. This has been pursued through the following set of objectives:

1. Strengthening KMNR management operations
2. Collection, analysis and use of ecological and socio-economic information for management
3. Improve community and stakeholder understanding of and support for conservation needs
4. Promote sustainable use of KMNR resources to improve livelihoods.

Natural resource management in Lamu has now taken on a wider scope within a newly-started coastal Kenya programme that now has a terrestrial project and a cross-cutting Education for Sustainable Development (ESD) project. The KMNR project itself has widened its scope to cover the larger Lamu and Tana seascape. The terrestrial project works mainly in the Boni-Dodori forest ecosystem in which the two national reserves of Boni and Dodori are located as well as with the neighbouring Aweer community, in a corridor that runs in between them. The ESD project works in both the marine and terrestrial ecosystems mainly with schools and youth to enhance participation in natural resources management while fostering sustainable development principles.

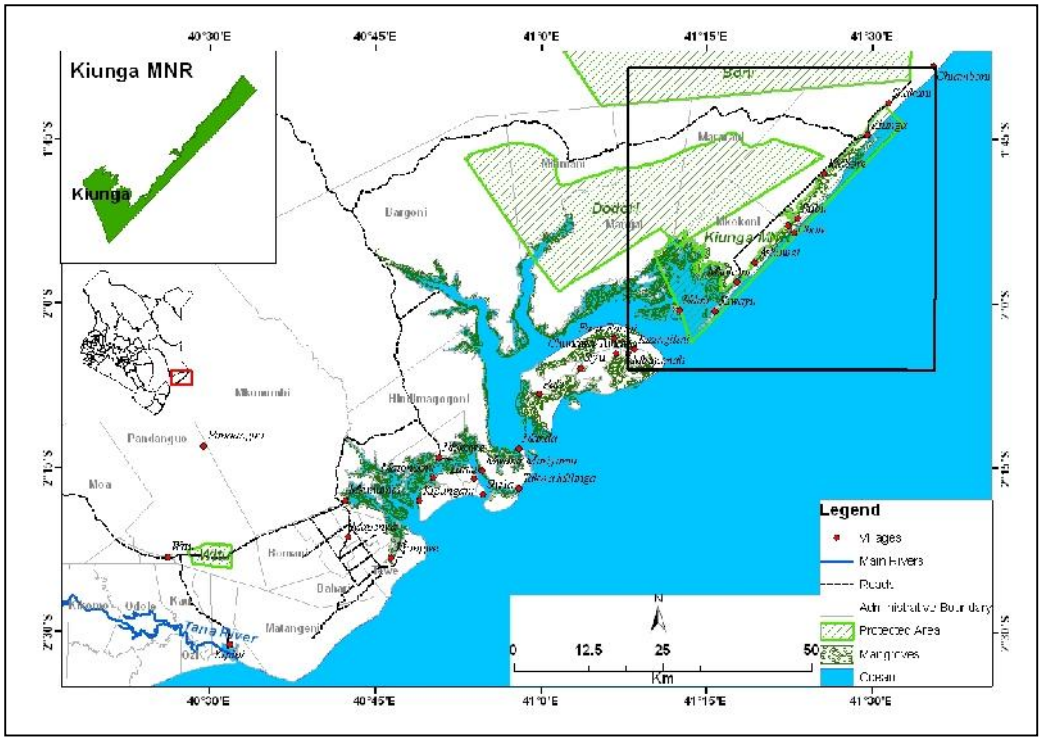

Figure 2: Lamu priority seascape (entire area shown, inset box is Kiunga Reserve)

2.4 Current climate

Based on the Köppen-Geiger climate classification, Lamu county can be said to be between the Tropical Monsoon and Arid Steppe Hot climate (Peel et al. 2007). The area is characterized by bimodal rainfall distribution of ca. 540 mm per year and a mean temperature of 28°C. The tides are semidiurnal, with a mean range of 2.5 m to 3 m and a maximum range of approximately 4 m (Church and Palin, 2003; Weru et al., 2001).

The climate and weather patterns on the Kenyan coastline are dominated by large scale pressure systems of the western Indian Ocean (El Nino, Indian Ocean Dipole and the Madden Julian Oscillation) and two distinct monsoon seasons. This leads to a bimodal rain distribution throughout the year with annual averages of 500-900mm on the north Kenyan coast.

From November/December to early March, a predominantly dry system - the northeast monsoon (NEM or *Kaskasi*) - is prevalent in the coastal weather. During March and April, a transition period, the wind blows in an east-to-southerly direction with strong incursions of maritime air from the Indian Ocean bringing heavy rains (the “long rains”) from mid-April to the end of June. In the months of May to August, the South-Easterly Monsoon (SEM or *Kusi*) influence sets in and the weather becomes stable with cooler temperatures. Between September and December, the northeast monsoon, dominates again, bringing “short rains” from November to December.

The rainfall pattern is greatly influenced by the Monsoon winds with the main rains coming between late March and early June and decreasing from August. The short rains come in November and December decreasing rapidly to a minimum in January and February.

Temperatures are strongly related to rainfall patterns. The range of temperature is from 23ºC to 32ºC throughout the country, but highest temperatures are in spring, since rains tend to cause a reduction due to increased cloud cover and the latest heat of evaporation from moist surfaces. The mean temperature is 27.9ºC. The coldest months are May to July while the hottest months are December to April. Mean monthly evaporation ranges from 1,650 to 2,300 mm/year in the north. Wind speeds usually peak in *Kusi (SEM)* and drop in *Kaskasi (NEM)* and also show variability in direction.

2.4.1 Changes in observed climate to date

Data quality and length of a record are significant obstacles to producing any kind of statistically significant trend analysis for a station location. The Lamu weather station provides precipitation data for the period 1979-2000 (see figure 3) which is rather less than the 30 year minimum recommended for long-term trend analysis. A short period of trend analysis also runs the risk of overlooking other sources of inter-annual variability that may be playing a role on decadal time scales to longer. That said, a linear regression to the monthly time series data for observed station records to show trends in seasonality finds that rainfall is more frequent and intense during the long rains (April to June), and extreme rainfall (greater than the 90th percentile) experienced most often in May (CSAG, 2012)

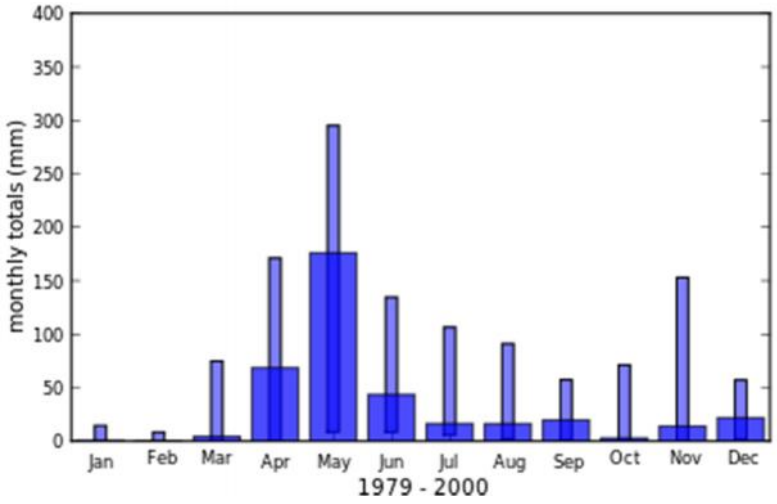

Figure 3: Annual cycle of monthly rainfall (mm) for Lamu station
(Source: CSAG, 2012)

According to the Reynolds Optimal Interpolated (ROI) Sea Surface Temperature (SST) dataset (Reynolds et al, 2002), SSTs in the Indian Ocean have generally increased at a rate of as high as 0.2°C/decade in the last decade. Regional trends in SST are however more complex due to shifts in ocean circulation as well as coastal effects such as upwelling. Sea level rise data is not available for Lamu, but figure 4 shows an extract for areas along the coast of Kenya from 1981-2000, showing a steady increase over time (with linkages to El Nino events, including markedly in 1997). The role of El Nino in the east African climate has been the subject of much research, but typically means consistently wetter conditions during El Nino, particularly in the *Kaskasi* (NEM) short rains (October-December). The

opposite occurs during the cold La Nina phase, with drier conditions in Kenya (Nicholson and Kim, 1997).

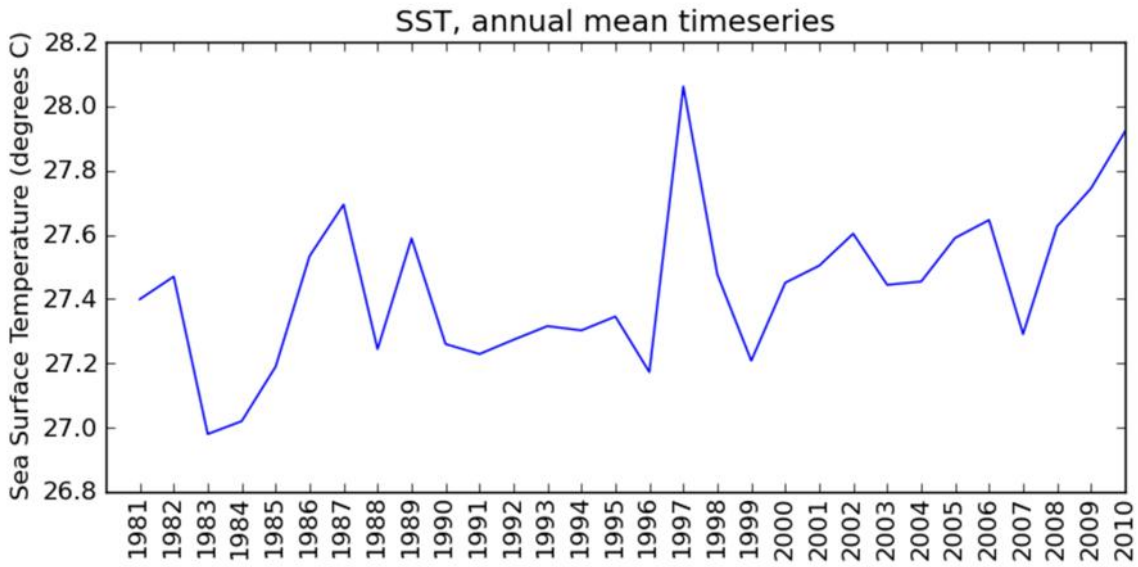

Figure 4: SST time series from 1981 – 2010 for the coast of Kenya
(source: CSAG, 2012)

2.5 Projected future climate

For most of the east African region the latest Global Climate Model (GCM) projections largely agree on wetter conditions for the area. Given their global focus, however, GCMs can overlook critical regional dynamics which may change local level climate. The future projected climate change for the Lamu land/ seascape has been downscaled to the weather station at Lamu by the Climate Systems Analysis Group (CSAG) at the University of Cape Town, using two future socio-economic scenarios: A2 ("business as usual" growth in greenhouse gas emissions) and B1 (a rapid growth path but based on regional convergence and the introduction of more efficient technology)(CSAG, 2012). Figure 5 shows the change in total monthly rainfall projected into the future (2046-2065). The two graphs on the left are for the A2 scenario; the two graphs on the right are for the B1 scenario. The top graphs (in red) show monthly projected rainfall totals, whilst the blue shows the rainfall anomaly (i.e. anything above the line is more rainfall expected than was experienced in the 1979-2000 period, whilst anything below the line shows less rainfall expected than was experienced in the 1979-2000 period).

Models generally project an increase in rain day frequency from November through to April, with most positive change in extreme rainfall occurring in October and November, with a decrease between June to September for all types of rainfall frequency. A decrease in the dry spell duration during the dry season (January – April) is shown for most models suggesting that the period between rain events may increase into the future (CSAG, 2012) Although some months may have greater dry spell lengths, this may not necessarily translate into the long-duration dry spells that are defined as droughts.

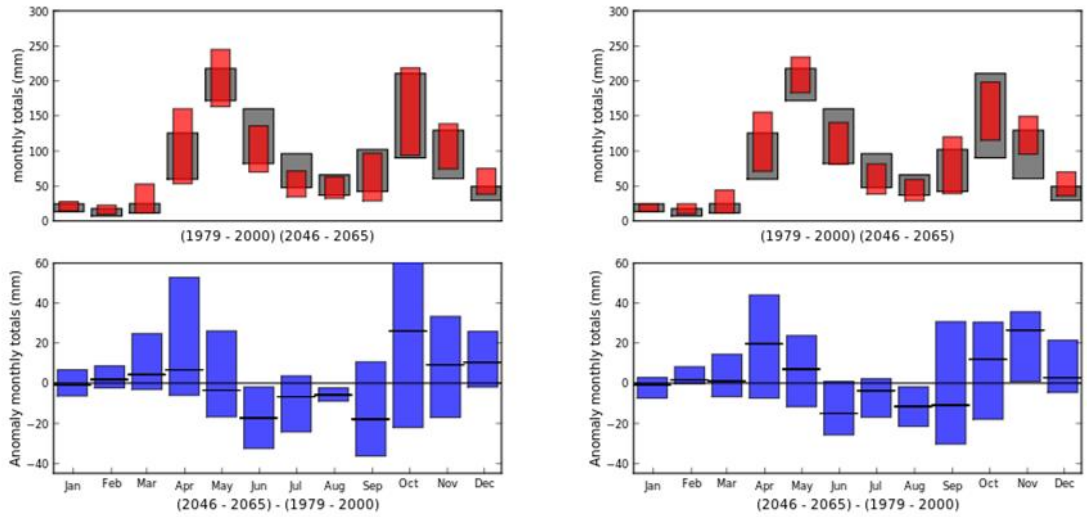

Figure 5: Change in monthly total rainfall for Lamu station under SRES A2 (left) and SRES B1 (right) emissions scenarios.

3. Methodology

Whilst understanding the likely nature of future climate is important to understand the potential impacts, it is not the only important factor. How exposure to climate parameters is experienced depends on the sensitivity of the biophysical environment (also known as biophysical vulnerability) and the social vulnerability of the people living in that environment. Biophysical vulnerability is higher for ecosystems that are already near the margins of their tolerance: for example an increase in temperature of one degree in the middle of the desert will have less impact than the same magnitude of increase on the desert margins, where it may prompt a shift from a semi-arid to arid environment. Similarly, humans and social systems experience the same physical changes in different ways, depending on the inter-relationship of a variety of factors that affect their social vulnerability. Tropical cyclone-based floods of similar magnitude affecting Florida and Bangladesh have very different effects: in Florida monetary damage to infrastructure and loss of property may be relatively higher, but in Bangladesh the death toll is typically relatively higher. These differences reflect their respective vulnerability and adaptive capacity. Whilst there are often similarities in driving forces between poverty and vulnerability, it is important to note that the two phenomena are not the same, and thus it is not accurate to assume that higher wealth unproblematically leads to lower levels of vulnerability.

Attempting to assess the future impacts of climate change in the Lamu land/ seascape therefore requires not only knowing what the climate might look like, but also how this is likely to affect the ecosystems and human and social systems that are there – each of which has their own level of vulnerability. In the same way that projecting future climate change has inherent issues of uncertainty, trying to model how vulnerability (both biophysical and

social) might change into the future is also problematic, since it depends on a variety of interacting driving forces that are also uncertain. It has become accepted that assessing current levels of vulnerability is an appropriate proxy: since if there is already current vulnerability there is a need to reduce that through adaptation in order to avoid future adverse effects of the physical changes.

CARE's Climate Vulnerability and Capacity Assessment (CVCA) is a qualitative methodology designed to interrogate local levels of vulnerability and capacity to adapt to climate change. Based on participatory research with community groups, it also looks at the embeddedness of local communities in wider local and national level institutions and processes that can, in turn, augment or reduce their vulnerability.

The two key objectives of CVCA are:

- To conduct data collection and preliminary assessment of vulnerability and adaptive capacity
- To combine community knowledge and scientific data to improve understanding about local impacts of climate change.

The CVCA toolkit was designed to be adaptable to different circumstances and aims – and has been used before in East Africa (CARE, 2011). The aim here was to investigate the climate-related vulnerability and adaptive capacity of communities living within and adjacent to the ocean and landscape in Lamu, based on two objectives:

- **To understand community resource use and how this has been affected by climate.**
- **To understand the community's experience of changes in climate and how this has affected their livelihoods.**

3.1 Research team training

Given the inadequate experience of WWF, KWS and other participants in this work, training was provided by Kulima Integrated Development Solutions to support the undertaking of CVCA in August 2012. The training work was generic enough to be appropriate for undertaking any CVCA, whilst at the same time structured so as to scaffold the process of designing the CVCA for the Lamu land/ seascape, by building on (and eventually refining) the objectives and research questions, and selecting the appropriate tools that could be used to answer those research questions. In that sense, the implementation plan was not just for the pilot, but also formed the basis of the subsequent CVCA. In-field support was provided for the pilot research site, as part of the preparation of the team for undertaking a full CVCA in the Lamu land/ seascape.

3.2 Research questions and data needs

Within the broad aim and objectives, the research team was responsible for distilling key research questions and data needed to answer those questions, based on their extensive local knowledge. Table 2 summarises these research questions and data needs.

Table 2: Research questions and data needs in relation to objectives

Objective	Question	Part	Data needs
To understand community resource use and how this has been affected by climate.	Community resource use	Level of dependence on different resources and importance for livelihoods both direct and indirect	• Type of resources available • Livelihood activities and changes over time as well as reasons for the change. Include other stressors • Proportion of people dependent of different resources • Cash or subsistence • Accessibility of different resources (physical/ social/ legal/ etc.) • Availability of alternatives • Daily activities • Satisfaction/ preference • Competition for resources (including access)? • Understanding of ecosystem functions and services as well as laws governing ecosystems • Mobility of species
		Other significant interactions with the different natural resources, habitats or species	• Cultural values attached to different resources • Understanding of ecosystem functions and services as well as laws governing ecosystems • Accessibility of different resources (physical/ social/ legal/ etc.) • Livelihood activities and changes over time as well as reasons for the change. Include other stressors • Cash or subsistence • Market demands • Conservation practices/ wildlife conflict • New species introduced
		Effect of human activities on resource availability and ecosystem services	• Type of resources available • Livelihood activities and changes over time as well as reasons for the change. Include other stressors • Daily activities • Development programmes and humanitarian interventions in the community • Change in production levels • Competition for resources (including access)?

			• Understanding of ecosystem functions and services as well as laws governing ecosystems • Change in perceptions and attitudes
	How weather and climate have affected natural resources and their use by the community	What weather and climate hazards has the community experienced?	• Weather and climate hazards have the community experienced • Impacts of those hazards
		How have communities responded to weather events and what has affected their response?	• Coping and adaptation strategies as well as constraints and the ideal • Outcomes of these strategies • Accessibility of different resources (physical/ social/ legal/ etc.) • Availability of alternatives • Development programmes and humanitarian interventions in the community • Livelihood activities and changes over time as well as reasons for the change. Include other stressors • Daily activities
		How has the natural environment changed and in response to what?	• Type of resources available • Change in production levels • Satisfaction/ preference • Event-related and trends in natural resource (habitats and species)/ ecosystem change as well as perceived causes

To understand the community's experience of changes in climate and how this has affected their livelihoods.	Community perceptions of climate and environmental change	How has climate changed in living memory?	• What weather and climate hazards have the community experienced and the impacts? • Long term climate trends
		How has the natural resource environment changed, and what role has climate played?	• Type of resources available • Change in production levels • Satisfaction/ preferences • Event-related and trends in natural resource (habitats and species)/ ecosystem change as well as perceived causes • What weather and climate hazards have the community experienced and the impacts? • Long term climate trends
		Have there been changes in the way community members earn a	• Livelihood activities and changes over time and why? • Proportion of people dependent of different resources

	How weather and climate have affected livelihoods	living, and what role has climate played?	• Cash or subsistence • Accessibility of different resources (Physical/ social/ legal/ etc.) • Availability of alternatives • Daily activities • Satisfaction/ preferences • Development programmes and humanitarian interventions in the community
		What have been the impacts of major climate events?	• Change in production levels • What weather and climate hazards have the community experienced and the impacts? • Event-related and trends in natural resource (habitats and species)/ ecosystem change as well as perceived causes • Livelihood activities and changes over time and why? • Proportion of people dependent of different resources • Cash or subsistence • Accessibility of different resources (Physical/ social/ legal/ etc.) • Availability of alternatives • Daily activities • Satisfaction/ preferences • Development programmes and humanitarian interventions in the community
		What information does the community use to predict weather?	• Sources and medium of information for weather and climate • What information is used/ most useful

3.3 Methods

The CVCA toolkit outlines a selection of Participatory Rural Appraisal (PRA)-based tools which can be adapted for the particular aims, objectives, and research questions of each CVCA. Qualitative research and facilitation skills are key to the success of CVCA: rather than being a linear question-and-answer-based process, CVCA requires that the facilitator probes emerging issues, and thus is responsive to what emerges. This means that planning for each exercise involves identifying key themes to be explored, and perhaps one or two open, probing questions to get into each theme, but then the facilitator must be prepared to respond to the nature of the discussion and direct it, keeping within the themes but remaining open to emerging issues. Facilitating teams were allocated, comprising a lead and deputy facilitator and at least one note-taker, to accurately capture the nature of discussions arising out of each exercise with the participants.

Particular tools were selected from the CVCA toolkit based on their capacity to be used to gather the data needs identified to answer the research questions and address the study's objectives (see table 2). Given that each tool is useful for eliciting different types of data, this also required the research team to reallocate their data needs as appropriate for each tool, meaning that one tool might be collecting data that would eventually feed back into answering different research questions under one or both objectives. Five exercises were ultimately designed. In some cases, taking into account the good practice principle of triangulating data through different methods where possible, data needs were addressed in more than one exercise. These five exercises comprised a hazard and resource map, historical timeline, two focus groups (each one exploring different themes), and a seasonal calendar. Given the importance of gender differences, each of the exercises were planned to run simultaneously with a group of men and a group of women (each led by a facilitating team of the same sex). One exercise was planned each morning and afternoon, in order to give the facilitating team time to reflect on, and write up, their results, and to make any required modifications for the next exercises.

3.3.1 Hazard/resource map

A resource map is a good introductory activity as it enables an insight into what the community deems to be resources. The group members are encouraged to draw a map of their village, highlighting the location of key resources. As the participants compile the map, probing questions can be asked regarding:

- What has changed over time (population increase, farming land abandoned, change in infrastructure etc.) and why?
- Whether access varies between community members (e.g. men and women) and if it has changed over time?

As a picture of the changing resource availability emerges, probing questions can switch to hazards which have affected resource availability. Participants can be asked if there have been any disasters or hazards in previous years, and to mark down where they have had impacts. Further probing questions can be asked regarding:

- What the impacts of hazards and disasters have been?
- Who in the community has experienced them the worst, and why?

- What they do when the particular hazards/disasters happen?

3.3.2 Historical timeline

The purpose of a historical timeline is to map out key events that have taken place in the village and what effects those have had. Participants for historical timeline exercises ideally need to contain older members of the community, who have the longest memories. In some cases, it is possible to exceed the 30-40 years of individuals' memories, and include histories that have been passed down through generations. Exact dates are not essential – the key is to identify events that are perceived by men and women in the community to be important, and to ascertain the way in which they have been important. Some flexibility is sometimes required in getting relative occurrences determined (e.g. did X occur before or after Y?) Asking people to link to their own life events, such as birth of their children, is a useful way of dating particular events. Undertaking a historical timeline after a hazard and resource map gives an additional temporal context around resource availability and hazards, and can also be used to probe participants' perceptions of potential future trends and events.

The particular purpose of the historical timeline related to research questions here is to look at:

- What is the relative importance of climate events relative to others?
- Are there any trends or changes in the frequency of events over time?
- What are current strategies to cope during the difficult events? Are they working?
- Have coping strategies changed based on the changing frequency of events?
- What events do you expect will occur in the future? When?
- Does this perception of future events affect your plans for the future?

3.3.3 Seasonal calendar

Seasonal calendars provide useful insights on the (gendered) nature of livelihoods in a village, and the time commitments of engaging in those livelihoods throughout the year. The idea is ask participants to take a typical year, and ask them to mark down key activities in the months in which they occur, separating between men and women.

Once this has been done, further probing can ask about:

- how seasonal calendars have changed over time, and why?
- Do climate-related factors play a key role?
- To what extent are changes due to variations in resource availability?

3.3.4 Vulnerability matrices

Vulnerability matrices play a key role in determining the role of weather and climate hazards in affecting livelihood outcomes, relative to other driving forces. As such, they rare critical to ensure that the role of climate is not overplayed by ignoring the multiple other driving forces of dynamic livelihoods. Participants are asked to identify their main livelihood activities, which are used to fill one axis of the matrix, and then the greatest hazards to their livelihoods in the other axis. Discussion should then ensue to score the effect of each hazard on each livelihood (e.g. big, medium or small, or for greater resolution numerical scoring can also be used – for example providing a number of beans and asking each

member to place the beans according to their perception, where they have the opportunity to use them all for one hazard/livelihood combination, or spread them out as they see fit.

3.3.5 Focus groups

Focus groups are group interviews that enable the gathering of a set of opinions (and, where possible, consensus opinion) on a variety of issues. Although the aforementioned tools all take place within focus group settings, focus groups that are not using particular tools can be useful to probe further on specific issues – and are often used after tools-based exercises. Two focus groups took place to probe information gathered during the historical timeline and then also to look at coping and adaptation and opportunities for the future.

The purpose of the first focus group is to build on knowledge gathered during the timeline – which identified major weather and climate events and the impacts. In this focus group further discussion of these impacts took place, distinguishing how impacts differentially affected different groups, and determining whether responses have changed over time (e.g. perhaps something worked in the past but is now no longer effective, or no longer an option, for some reason). The idea is to be able to distinguish coping vs. adaptation, and changes in coping and adaptation over time. Particular attention was paid to asking what prevents people from responding (money, knowledge, role in society) – in order to illuminate what might constitute sustainable adaptation options as these are what should be promoted. At the end of some of the women's focus groups, women were asked to rank their key activities, which was useful to see their priorities and ensure that climate-related factors were not unduly given importance in the context of the study.

The purpose of the second focus group was to build on previous analysis of community problems (for example through the hazard map), and responses (and barriers to responses) to past weather and climate events. The aim was to further distil where participants feel the priorities are for vulnerability reduction, and in particular where they feel they do not already have adaptive capacity.

3.3.6 Key informant interviews

Key informants are those people, either within the community or outside, whose particular roles mean that they are likely to have valuable insights into the various research questions are thus are worth interviewing individually. In this study a number of key informant interviews were undertaken with community leaders (village headmen) to investigate their experiences of natural resource variations, livelihood change, and the relative role of weather and climate hazards. In addition a government Fisheries Officer was interviewed in Kipini.

3.4 Sampling

Systematic sampling was used to select a combination of coastal and terrestrial villages within the Lamu land/ seascape. Villages were selected based on distance from the sea, previous knowledge on their natural resources and basic livelihood activities. In the first round of fieldwork, terrestrial villages were Ziwani, Ndambwe, Moa and Milimani; while the coastal villages were Mkokoni, Kiunga, Kipini, Ndau, Faza, Pate and Amu (see table 3). Fieldwork took place in August and September 2012 and was conducted jointly by WWF,

KWS, FD and KMFRI staff. A second round of fieldwork was planned to expand the spatial range and also to fill in gaps in understanding which arose the first time around. As a result, although the investigations were all along the same theme, not all the same exercises and all the same foci took place in both the first and second rounds (hence in the results there are cases where results from the first round predominate, and then results from the second round predominate). In the second round of fieldwork in November 2013, terrestrial villages were Dide Waride, Koreni, Mangai; and coastal villages were Kipini (repeat location of 2012 fieldwork, although other community members were sampled), Matondoni, Kizingitini and Kiunga/Ishakani. Since members of each of the organizations had contacts within each of the villages, they were able to arrange for the occurrence of groups in advance, including those with particular criteria (e.g. the historical timeline group requiring older members of the community).

Table 3: Fieldwork timetable.

Date	Village (coastal)	Village (terrestrial)
August 2012	Mkokoni	
September 2012	Kiunga	Ziwani
	Ndau	Ndambwe
	Faza	Moa
	Kipini (Pate island)	Milimani
	Amu	Moa
November 2013	Kipini (Pate island)	Dide Waride
	Matondoni	Koreni
	Kizingitini	Mangai
	Kiunga/Ishakani	

3.5 Limitations

As is typical, some methodological and practical limitations arose during the course of the fieldwork which are mentioned here in the interests of transparency being required for evaluation of the robustness of the findings.

The first challenge in the pilot village (Mkokoni) was the arrival of Eid, which required some rearrangement of previously-planned groups (essentially a one day delay) whilst festivities were celebrated.

The second challenge was in the village of Moa, where the fieldwork for this survey was interrupted by insecurity issues due to clashes between the Orma and Pokomo communities, giving rise to significant tension within the village.

The third challenge related to the overall time available for fieldwork. It is not the intended spirit of CVCA to use the methodology for rapid appraisals, with often only one day of fieldwork in each village. Instead it is aimed to support a longer-term, facilitated, process in

which communities themselves are empowered through the collective knowledge generated in the exercises to not only better understand their problems but, more importantly, to identify their own solutions for community-based adaptation. Methodological limitations from one day in each village, even with multidisciplinary research teams running parallel groups of men's and women's exercises, include the fact that findings are necessarily based on people who happened to be available that day, and may not always be representative. That said, working in multiple villages of similar characteristics, and having two periods of fieldwork over a year apart, enabled any particularly unusual findings to be contrasted against an emerging overall picture for the sea- and landscape.

4. Results

4.1 Community relationship to, and use of, natural resources

Livelihoods in the Lamu land/ seascape are strongly natural resource-dependent, with the exact nature of livelihoods reflecting the geographical context (e.g. inland terrestrial, coastal or island). Farming (primarily crops, but also livestock), fishing and harvesting of other natural resources (such as mangroves) featuring prominently in all study villages.

4.1.1 Farming

Crops planted in the area include maize, cowpeas, green peas, ground nuts, cashew nuts, pigeon peas, cassava, watermelon, pumpkin, sweet melon, sesame, sweet potatoes, cassava, sorghum, millet, pepper, cotton, coconut, papaya, lemon and mango. Livestock that are kept include cattle, donkeys, sheep, goats, poultry and ducks. Cattle raising and pastoral-based livelihoods are typical for those of Somali origin (see also ALP, 2014).

4.1.2 Fishing

Fisheries exploited include open water fin fish fisheries, using a combination of seine nets (*juya*), gill nets (*jariffe*), longlines and hand-lines; as well as crustaceans (including lobster, crabs), cowry shells and sea cucumbers in the shallow littoral zone using basket traps and snorkel gear.

4.1.3 Other natural resource-based livelihoods

Forest resources are used for the harvesting of both timber and non-timber forest products (NTFP). Mangrove harvesting takes place through a combination of clear- and selective cutting of poles, including poles and frames. In some villages, such as Ndau, selective mangrove cutting is the primary livelihood for the men of the community, whilst in others it is not so important. Honey-gathering takes place in mangrove and terrestrial forests.

4.1.4 Non-natural-resource-based livelihoods

Small proportions of each community are fortunate to have formal sector employment, for example as teachers, or in the police or army, or other government agencies (such as KWS) or NGOs (such as WWF). On the whole, formal employment typically accounts for less than 10% of economic livelihoods across all the case study villages. Mkokoni in particular was

very dependent on the now defunct tourist resort, Kiwayu Safari Village (closed due to al Shabaab attack), for both formal and informal employment opportunities (e.g. the selling of souvenirs).

In addition to natural resource-dependent livelihoods and formal employment, a number of other economic opportunities exist in the various case study villages. These include boat construction and repairs, sand harvesting and quarrying (to create construction materials), and micro-enterprises selling everything from raw and cooked fish to chapatti, fuel wood, charcoal, clothes, handicrafts (for example weaving of papyrus and papyrus-like reeds known as *usitu*) to airtime and money transfer (for example as agents for Kenyan cellphone-based money transfer scheme, M-PESA). Services such as henna painting and hairstyling are also often offered. It is common for women to engage in micro-enterprises, with women in Amu saying that it enables them to depend less on their husbands. Microfinance often supports the creation of these micro-enterprises, for example from the Kenya Women's Finance Trust, FAULU and TORRES. Boat and donkey transport is also provided for hire by certain community members.

4.1.5 Women's livelihoods

As well as economic livelihoods, women are typically charged with fetching water and fuel wood for household consumption purposes. Men also engage in mangrove cutting for construction of houses and fencing. Preferred species for domestic use include *mtendee* and *munga, mpanda* and *iyongoo*).

Table 4 highlights the priorities of economic activities according to women in the coastal villages researched during the first fieldwork phase, which was determined by providing women in each group with a fixed number of beans that they could allocate to each livelihood activity to show its relative importance to their household and then summing those results. Informal employment through business and formal employment are the most important in terms of contributing to economic livelihoods; followed by crop farming, fishing, and mangrove harvesting. Livestock rearing is of minimal importance in Amu and Faza, but does not feature at all in other coastal villages and likely reflects the geographical circumstances. Microfinance is a key enabler, particularly in Amu, Faza and Kiunga.

Table 4: Ranking of key activities according to women in coastal communities during the first fieldwork phase

	Mangrove Harvesting	**Fishing**	**Crop farming**	**Livestock rearing**	**Business (e.g. weaving)**	**Formal employment**	**Microfinance**
Amu	0	3	4	4	23	7	19
Faza	3.9	14.4	10.8	1.2	23.6	12.1	8.8
Kiunga	0	5	16	0	7	31	11
Ndau	13	10	7	0	7	13	0
Pate	6.5	12	11	0	16	4.5	0
Mkokoni	0	9	17	0	15	13	0
AVERAGE	**23.4**	**53.4**	**65.8**	**5.2**	**91.6**	**80.6**	**38.8**
RANKING	**6**	**4**	**3**	**7**	**1**	**2**	**5**

4.1.6 Differences between villages

Tables 5 and 6 provide additional detail by village, divided into terrestrial and coastal communities, of the key livelihood activities which take place by each sex within each of the broad categories. Key observations here are that farming and fishing are key livelihood activities in both terrestrial and coastal communities, and that the specific livelihood mix in each village reflects a combination of gendered roles and the particular geographical context.

Both men and women farm and fish; although there are greater gender differences within fishing-based livelihoods. Women are typically concerned with mangrove-based collection of shells, and hand-line fishing. Men may also collect lobster and crab, and are engaged in open water fin fisheries using nets. Broadly speaking, women play a larger role in crop farming than men, although there are exceptions in certain coastal villages (e.g. men farm in Ndau, Kiunga and Faza). Livestock farming takes place with cattle and smaller stock (e.g. goats, pigs, poultry) and typically men are in charge of the large stock whilst women are in charge of smaller stock and milking (the exception being Faza, where women reported rearing cattle as well as men). Mangrove cutting is an activity in both terrestrial and coastal communities, and is largely a male activity (particularly when used for commercial purposes), although women may gather wood for fuel or for home construction and, in one case (Matondoni) also reported involvement in charcoal production, which was otherwise a male activity. Results from this fieldwork show very little participation in formal employment in terrestrial communities (only men reported this in Ndambwe), whilst both men and women have formal employment in the majority of coastal communities (with Kizingitini the sole exception where no formal employment was reported). Informal micro-enterprise businesses are very varied between men and women, again reflecting the geographical context (in terms of both resource availability and markets) – but exist across the board - in both land- and coastal communities in the Lamu land/seascape.

Table 5: Livelihoods in terrestrial communities, divided by sex

	NDAMBWE		MANGAI		DIDE WARIDE		KORENI	
Livelihood	**Men**	**Women**	**Men**	**Women**	**Men**	**Women**	**Men**	**Women**
Crop farming		Maize, cotton, cowpeas, legumes, ground nuts, cassava, cashew nuts, pigeon peas, cotton, sesame, sweet potatoes, sweet melons, pumpkin, watermelon and mango.		Maize, green grams, yams, watermelon, cassava, pawpaw, bananas, cashew nuts, finger millets, mangoes and cow peas			Maize, beans, peas, cassava, casuarinas	
Livestock farming				Goats and poultry		Milking		Milking
Fishing								
Business/ other forms of income	Mat making/ Makuti Charcoal burning; Honey harvesting		Honey harvesting and selling, casual labour in Kiunga	Weaving mats, casual labour on farms and construction		Fish traders, weaving mats, selling milk, small medium enterprises (shops), casual work, transport services, tobacco farming	Selling fish, Honey harvesting and selling	Weaving mats, selling milk, informal stalls selling fruit and vegetables
Formal employment	Masonry, Politics							
Forestry	Mangrove cutting		Mangrove cutting; timber; herbal medicine, charcoal production	Gathering of wild food	For building, charcoal production	Firewood	For building and selling, charcoal production	Firewood, thatching

Table 6: Livelihoods in coastal communities, divided by sex

	KIPINI		NDAU		KIUNGA		FAZA		KIZINGITINI		MATONDONI	
Livelihood	**Men**	**Women**	**Men**	**Women**	**Men**	**Women**	**Men**	**Women**	**Men**	**Women**	**Men**	**Women**
Farming		Maize, cotton Green grams, legumes, millet, cassava, coconut and mangoes	Maize, cowpeas, sesame	Maize, sesame, cowpeas, sorghum, pumpkins, watermelon, sweet melon	Sesame, green peas, cassava, mangoes, coconut and cashew nuts.	Maize, cow peas, millet, sesame, green grams, peppers, coconuts, cashew nuts, mangoes, papaya, lemon, cassava, sweet melon, pumpkin, watermelon	Maize, cow peas, horticultural crops, cashew nuts, mangoes, coconut, pawpaw, water melon, ground nuts.					Maize, cow peas, green grams, cucumber, tomato, cassava, ground nuts, sesame, plantain, black beans, water melon, kales, chillies and capsicum
Fishing		Prawns, lobster and fin fish	Gill nets, hand lines, beach seines	Nets, handlines, gill nets, basket fishing	Lobster, fin fish, cowrie shell, sea cucumber.	Nets (*juya, jariffe*), snorkelling (lobster), sea cucumbers, crabs, cowrie shells, shells.	Beach seining, gill nets, crates, hand lines, long lines			Lobster, fin fish, crab, octopus, sea cucumber, shells		
Livestock rearing				Poultry	Poultry, goats, cattle, donkeys and sheep.	Goats, cows, donkeys, sheep, poultry, ducks.	Cattle, goats, sheep, chickens, ducks.	Cattle rearing		Milking only		

Table 6: Livelihoods in coastal communities, divided by sex (continued)

	KIPINI		NDAU		KIUNGA		FAZA		KIZINGITINI		MATONDONI	
Livelihood	**Men**	**Women**	**Men**	**Women**	**Men**	**Women**	**Men**	**Women**	**Men**	**Women**	**Men**	**Women**
Business/ other sources of income	Tourism	Tourism (cultural dances, tour guides)	Boat repairs, construction Sand harvesting, quarrying	Weaving	Shop keeping, restaurants, boutiques, fish retailing, quarrying, Construction/ quarrying Honey gathering	Cooking food for sale (*mofa, mahamri, chapatti,* cake*, kaimati, viazi, samosa,* donut*);* Papyrus/ reed weaving (*usitu*); Clothes (*leso*); Tailoring shops; General merchandise Foodstuffs for hotels; Guest houses; Construction (e.g. making blocks; sieving) Honey gathering Commercial firewood gathering Savings wheels (*merry-go-rounds")*	Small business (food items, shops, fish trade, livestock trade, calcium carbonate, building material, restaurants). Unskilled labour (labour in construction industry, labour on farms, boat construction loaders, net mending). Skilled labour (boat construction, electrical technicians)	Small business (cooking, food stuff), clothes and tailoring, groceries. Mat making (from coconut fronds Weaving (usitu)			Sand harvesting, quarrying Curio production	Boat owners, fishmongers

Table 6: Livelihoods in coastal communities, divided by sex (continued)

	KIPINI		NDAU		KIUNGA		FAZA		KIZINGITINI		MATONDONI	
Livelihood	**Men**	**Women**	**Men**	**Women**	**Men**	**Women**	**Men**	**Women**	**Men**	**Women**	**Men**	**Women**
Formal employment	Masonry, wildlife research			Formal employment (Teachers, police)	Formal employment (Police, army)	Formal employment (Teaching)	Formal employment (teachers, health care workers, watchmen, cleaners, and office staff).	Formal employment (Teachers, nursery, hospital)			Tour guides	Tour guides
Micro-finance						Money transfer (M-Pesa)		Money transfer				
Forestry	Mangrove cutting	Poles, firewood	Mangrove cutting (*Boriti, vigingi* and *Madio)*		Mangrove cutting, timber, charcoal production	Firewood	Firewood, mangrove cutting, furniture	For construction and subsistence use			Mangrove harvesting, Charcoal production	Charcoal production

4.2 Seasonality of resource use

As outlined above, the Kenyan coast experiences two distinct monsoon seasons. From November/December to early March, a predominantly dry system - the northeast monsoon (NEM or *Kaskasi*) - is prevalent in the coastal weather. During March and April, a transition period, the wind blows in an east-to-southerly direction with strong incursions of maritime air from the Indian Ocean bringing heavy rains (the "long rains") from mid-April to the end of June. In the months of May to August, the South-Easterly Monsoon (SEM or *Kusi*) influence sets in and the weather becomes stable with cooler temperatures. Between September and December, the northeast monsoon, dominates again, bringing "short rains" from November to December.

Villages in the study area indicate a high level of dependence on natural resources, and the particular mix of livelihood activities in a given village at any one time reflects resource availability, which is highly dependent on weather patterns and seasons. *Kusi (SEM)* and *kaskasi (NEM)* affect farming and fishing (see table 7). Broadly speaking, when the particular nature of men's and women's involvement in livelihood activities is interrogated, it emerges that processing and the control of sale of any products from the natural resource-based livelihoods (whether crop or livestock farming or fishing) is likely to be within the control of the men within the community. When inputs need to be procured, men also tend to play the important role, suggesting that they control the bulk of the cash economy within the Lamu sea/ landscape.

4.2.1 Seasonality in farming

Farmers make the most of the two rainy seasons by farming long season and short season crops. Long season rains (*kusi [SEM]*) crops include mangoes, cashew nuts and cassava, and require an annual cycle of preparation, planting and harvesting. Short season rains (*kaskasi [NEM]*) crops include maize, sesame, green peas and watermelons, and these can be planted twice per year – in both the long and short rainy seasons. Tables 7 and 8 shows that women take primary responsibility for crop farming, particularly after seeds are planted (e.g. weeding, spraying and guarding against fire and animals). Men contribute to preparing the land for planting, alongside women, particularly for maize and sesame, and also play a role in harvesting many crops. Selling crops is also the sole domain of men.

As shown above, livestock farming is far less important as a livelihood activity overall. With regard to large livestock such as cattle, in both terrestrial and coastal communities men are in charge of meat production, which can include such activities as migration in search of fresh pastures (if necessary), spraying against the tsetse fly and, as with crops, selling the products, both milk and meat. Women may be involved in livestock farming through milking in terrestrial communities, and only through the supporting of grazing in coastal communities (see table 7).

4.2.2 Seasonality in fishing

For fishermen, the sea is rough and visibility is generally poor in the *kusi* (SEM - long rains) season. That said, the lower sea water temperatures are productive for fin fisheries, and characterised by low effort (rough seas hamper fishing activities in this season) and high landings. In contrast, the *kaskasi* (NEM) season is particularly productive for lobster and sea cucumber fisheries. Crabs, cowry shells, and sea cucumbers are gathered throughout the

year in both seasons, and typically by women (see table 8). In terrestrial communities, women reported involvement also in freshwater fishing in certain months (January-March and July-August), and some involvement in selling fish. In coastal communities, women reported involvement in ocean-based fishing throughout the year. However, selling of fish was entirely undertaken by men.

The period prior to the onset of the rainy season (April/May) is typically the most difficult time of the year to earn a living, due to a combination of it being low fishing season and prior to the planting of the long season crops. Lobsters are not fished, and mangroves are also typically not harvested during this period.

4.2.3 Seasonality of other livelihood activities

Other livelihood activities reflect a combination of non-natural resource-based, such as business, sand harvesting and weaving mats (as reported in both terrestrial and coastal communities), which occur throughout the year, and then other activities whose intensity varies with the availability of the resource. In terrestrial communities mangrove cutting and forestry are reported as occurring year round, although peak production periods are noted in particular months; whilst in coastal communities forestry occurs year round but cutting mangrove poles only occurs for 10 months out of the year. Other important livelihood tasks reported in both types of communities to occur throughout the year included fetching water, house construction and household chores.

Table 7: Seasonal activity maps for terrestrial communities, divided by sex (Male / Female)

	LIVELIHOOD	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
FARMING: CROPS[1]	Land clearing/ preparation of land												
	Acquiring seeds												
	Digging (tractor, manual)												
	Burning												
	Ploughing												
	Irrigation												
	Planting												
	Weeding												
	Spraying												
	Guarding against animals												
	Harvesting and storage												
	Applying fertiliser												
	Selling crops												

[1] Villages included: Ndambwe (Men + Women); Moa (Women); Ziwani (Women); Dide Waride (Men), Koreni (Men + Women), Mangai (Men + Women)

	LIVELIHOOD	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
FARMING: LIVESTOCK[2]	Slaughtering												
	Milking/ selling milk												
	Herding												
	Grazing												
	Grazing area survey (during drought)												
	Migration to unflooded areas												
	Migration for pasture (drought)												
	Livestock Production												
	Spraying against tsetse fly												
	Selling products of livestock												

[2] Villages included: Ndambwe (Men); Moa (Women); Ziwani (Women); Dide Waride (Men); Koreni (Men + Women), Mangai (Men + Women)

	LIVELIHOOD	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
FISHING[3]	Preparation of inputs												
	Catching fish (Ocean)	Peak	Peak	Peak					Peak	Peak	Peak	Peak	Peak
	Catching fish (Fresh water)												
	Boat repair												
	Buying inputs (nets, hooks)												
	Selling fish												

[3] Villages included: Dide Waride (Men), Koreni (Men + Women), Mangai (Men + Women)

	LIVELIHOOD	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
OTHER[4]	Mangrove cutting				Peak	Peak				Peak	Peak	Peak	
	Weaving mats												
	House construction/ construction												
	Business												
	Fetching water												
	Household chores												
	Fetching firewood				Peak	Peak				Peak	Peak	Peak	
	Making charcoal												
	Making holes to attract bees												
	Collecting honey												
	Processing honey												
	Selling honey												
	Social networking[5]												
	Wildfires (during drought)												
	Deforestation/ Timber												

[4] Villages included: Ndambwe (Men + Women); Moa (Women), Ziwani (Women), Dide Waride (Men); Koreni (Men + Women); Mangai (Men + Women)

[5] Including women's groups

	Collecting herbal medicine													
	Water purification plants													
	Tourists													
	Wildlife (flora and fauna) conservation													
	Sand harvesting													
	Harvesting wild fruits													

Table 8: Seasonal activity maps for coastal communities, divided by sex (Male / Female)

	LIVELIHOOD	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
FARMING: CROPS[6]	Land clearing/ preparation of land												
	Burning												
	Fencing of farms												
	Ploughing												
	Acquiring seeds												
	Planting												
	Fertilising/ manure application												
	Weeding												
	Spraying												
	Guarding against animals												
	Harvesting and storage												
	Harvesting coconuts	3 times per year											
	Irrigation (horticulture)												
	Selling crops												

[6] Villages included: Kipini (Men + Women); Matondoni (Men + Women); Kiunga (Men + Women); Kizingitini (Women)

	LIVELIHOOD	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
LIVESTOCK[7]	Purchase of stock												
	Grazing												
	Watering												
	Milking					Peak	Peak	Peak	Peak			Peak	Peak
	Disease control												
	Supplementary feeding												
	Migration (for pasture)												
	Branding												
	Slaughtering												
	Selling livestock products												

[7] Villages included: Kipini (Men + Women); Matondoni (Men + Women); Kiunga (Men + Women); Kizingitini (Women)

LIVELIHOOD		JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
FISHING[8]	Fishing preparation												
	Testing fishing grounds												
	Fishing (ocean)	Peak					Peak	Peak				Peak	Peak
	Fishing (fresh water lakes)												
	Fishing (rivers)												
	Processing												
	Selling fish												

[8] Villages included: Kipini (Men + Women), Matondoni (Men + Women); Kiunga (Men + Women); Kizingitini (Women)

	LIVELIHOOD	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
OTHER[9]	Harvesting building poles												
	Harvesting building materials												
	Collecting firewood												
	Charcoal burning												
	Timber												
	Collecting herbal medicine												
	Kilns												
	Selling forest resources												
	Conservation and research												
	Tourism												
	House repairs												
	Sand harvesting, transporting and selling												
	Sinking boreholes/ digging wells		Peak										
	Employment												
	Small business												

[9] Villages included: Kipini (Men + Women); Matondoni (Men + Women); Kiunga (Men + Women); Kizingitini (Women)

	Weaving mats and baskets *(Makuti)*												
	Tailoring/ dress-making												
	Business/ Trade												
	Fetching water												
	Household chores												
	Social networking[10]												
	Frying fish												

[10] Including women's groups

4.3 Community perceptions of climatic and environmental change

Given their strong reliance on natural resources, it is not surprising that men and women in all communities perceive variability and change in climate and environment. For further details, see the historical timeline (appendix A).

With regards to perceptions of climate change, groups referred to an increase in the occurrence of hazards, such as floods and droughts (each observed by 4 coastal and 3 terrestrial villages); as well as longer-term incremental change, including sea level rise and increases in sea temperatures (observed by 2 and 1 coastal communities, respectively)(see table 9). The most widespread climate change, however, is increased unpredictability of rains, cited in 5 coastal and 3 terrestrial villages. Men and women in the majority of groups mentioned the change in traditional seasons. The longer *kusi* (SEM) rains, which traditionally began in April, sometimes now only arrive as late as June, and often end earlier too, reducing the overall length of the season. The women of Faza explained that that there is now little difference between the so-called "long" and "short" rains. Within the season rainfall was also cited as sporadic by the women of Mkokoni and erratic by the women of Ndau, who explained that it rarely covers the full farming season. The preceding three years, since the last major El Nino event of 2009, were seen to be particularly bad, with women in Mkokoni explaining how, at the time of fieldwork (September 2012), their road would normally be impassable but that there had been a noticeable decline in rainfall. Many previously-seasonal rivers now do not flow, which has led to the drying out of seasonal lakes, such as in Ndambwe.

There is greater understanding across the case study villages that extreme events such as floods are often coincident with the occurrence of El Nino events. El Nino also brings with it changes in sea temperatures which can destroy fish spawning areas and lead to loss of coral through bleaching. The women of Mkokoni explained that the abundant rainfall that typically accompanies El Nino is a positive phenomenon, as it leads to high yields. However, higher yields do not necessarily translate into improved livelihoods, as storage facilities are themselves vulnerable to the higher levels of rainfall. Some communities also spoke of how tsunamis have led to a decline in the availability of fish.

Table 9: Climate-related hazards experienced in each village in the first round of fieldwork

Hazard	Village									
	Coastal						Terrestrial			
	Amu	Faza	Mkokoni	Kiunga	Ndau	Kipini	Moa	Milimani	Ndambwe	Ziwani
Flood	✓		✓	✓		✓		✓	✓	✓
Drought	✓		✓	✓		✓		✓	✓	✓
Sea level rise				✓		✓				
Increase in sea temperatures		✓								
Unpredictable rains	✓	✓	✓	✓	✓		✓	✓	✓	

Environmental change is also perceived to be a significant problem for the natural resource-dependent communities of the Lamu land/ seascape. Algal blooms had been observed in both Ndau and Kiunga. The latest occurrence in Kiunga was in 2002, and fishing was temporarily banned to allow tests to be carried on the samples taken to the government laboratory. Such algal blooms typically lead to fish kill.

4.4 Community Climate Vulnerability

As outlined above, perceptions of climate and environmental change are widespread and have significant implications for community livelihoods, infrastructure, and natural resources.

Table 10 outlines the effects of the climate hazards that each village has experienced. The nature of effects varies with exposure to each hazard/incremental change (floods, droughts, sea level rise, increase in sea temperature and the most common – unpredictable rains), together with the vulnerability of the village, which depends on the particular livelihood activities and the extent to which they are influenced by climate. It is important to note that, although predominantly negative, some positive effects of a changing climate have been observed. For example, in Faza, a coastal village, positive impacts have been observed for farmers due to higher soil moisture levels that remain after the floods have receded. Likewise, in Ziwani, floods have positive impacts as they increase stock levels in the inland lake where the villagers fish. Droughts and unpredictable rains cause more widespread problems as the lack of water has implications for people and for livestock and crops. Similarly, sea level rise affects freshwater availability in the coastal villages of Kiunga and Ndau, where boreholes have become brackish due to saltwater intrusion. This impact tends to have particular implications for women, since gendered roles put them in charge of fetching water, and they thus experience increasing burdens on their time when they have to travel further in search of fresh water. These findings on impacts of climate hazards are very similar to another vulnerability assessment in Bagamoyo District, Tanzania (Tobey, et al., 2011).

Table 10: Effects of climate hazards in each village in the first round of fieldwork

Hazard	Village	Effect (-) or (+)
Floods	Amu	(-) Collapsing of houses (-) Diarrhoeal diseases
	Faza	(-) Increased siltation of mangroves, sea grasses and coral reefs (+) Higher soil moisture levels
	Kipini	(-) Influx of refugees from other villages since Kipini is on high ground (-) Disease (cholera, bilharzia and malaria)
	Kiunga	(-) Impassable roads (-) Reduced fish prices
	Ndambwe	(-) Influx of refugees since Ndambwe is on higher ground
	Ziwani	(+) Stock of fish increases in the lake
Drought	Kipini	(-) Wells turn salty and pastures dry.

		(-) Certain lakes such as Lake Mnuji and the Jendewi Swamp have dried up due to lack of rains (leads to resource conflicts when pastoralists arrive from Ijara and Djibouti) (-) Lack of water for livestock (according to the women)
	Kiunga	(-) Lack of access to drinking water for humans (water from wells is hard so rely on KWS for buzzers) and livestock (-) Cattle/livestock/poultry diseases and death (-) Loss of harvest in 2011 (-) Declining fish catch
	Milimani	(-) River dries up (-) Shift where they collect honey (disappears from *wahari* area) (-) Causes livestock to move to invade farmland
	Ndambwe	(-) Loss of some species, e.g. *papa*
Sea level rise	Kipini	(-) 1km of land lost to encroaching mangroves
	Kiunga	(-) Saltwater intrusion of boreholes
	Ndau	(-) Saltwater intrusion of boreholes
Increase in sea temperatures	Faza	(-) Decline in fish catch
Unpredictable rains	Milimani	(-) Disappearance of certain food crops, e.g. bananas, sweet potatoes
	Faza	(-) Water shortages (including for drinking) (-) Reduced crop production and famine (no longer self-sufficient, as in the past)
	Ndau	(-) Shortage of drinking water (*djabia* have run dry so dependent on rain) (-) Famine

4.4.1 Climate-driven vulnerability

Changes in rainfall affect the farming season, and the overall decline in rainfall is particularly evident in a reduction in harvest, particularly in sorghum and sesame. Farmers in Moa also explained how they now tend to get 2-3 sacks of maize per acre compared to a few years ago when they used to get 7-8 sacks per acre. The women in Faza village were particularly concerned about the increased unpredictability of rainfall. Their community has now suffered two major fire disasters, in 1990 and 2009 and, despite funds raised, not all the houses have yet been rebuilt. The 2009 fire occurred when winds occurred in a drought season, allowing fire to easily take hold and move from one thatched house to the next. They perceived that drier conditions may increase their infrastructural vulnerability.

4.4.2 Non-climate-driven vulnerability: environmental change

Natural resource availability has also been affected by climate and environmental change, as well as human activities. Resource degradation and unsustainable practices were observed in the terrestrial communities. The Ziwani men explained how overgrazing of livestock leads to the siltation of the lake. There has also been a loss of trees in the area due to clear cutting and charcoal burning, and general overharvesting of mangrove resources

(according to the women from Amu and Ndambwe and the men from Ndau). Reduction in mangrove trees in turn reduces fish nurseries.

Declining availability of fish is also a consequence of climate and environmental change. Tsunamis were attributed with changing availability of fish, with particularly notable reductions in rabbitfish, rainbow runner, grunts/ haemuids, sailfish, groupers, snappers, mullets, rays and tuna (according to the women of Mkokoni and Pate). Fish stocks were also perceived to have decreased as a result of the increase in use of destructive techniques (women from Amu and Ndambwe, in particular, blamed on this on the use of beach seines). In addition, beach seining (operationalized by fishers from Kizingitini and Faza villages) was cited as a cause of environmental change. They use small mesh size beach seines which are non-selective, catching all the fish that have been surrounded while causing havoc to the ecosystem. Sea grass and corals are destroyed as the beach seine is dragged on the sea bottom, according to the men's group in Ndau. Other causes of marine fish loss were the use of bombs by Chinese boats for oil exploration, which kills young fish (according to the men from Amu). Freshwater fisheries on Lake Kenyatta were also perceived to have declined, according to men from Ziwani.

Disease outbreaks (for humans and animals) and pests cause a problem for livelihoods and resources. Human diseases reported as problems included cholera (in Amu), plague and amoebiosis (in Kiunga), all of which can be exacerbated in prevalence and/or severity by climate-related factors. Livestock diseases reported include tsetse fly/trypanosomiasis (in Ziwani), whose prevalence may also change with changing temperatures. Current pests that cause a problem for crops include army worms, renewed outbreaks of which have also been attributed to climate change (Cheke and Holt, 1999).

Human-wildlife conflict is a particularly problem in the communities that are dependent on farming. Wildlife invasion of farms by hippopotamus, monkeys, buffaloes, baboons and elephants was cited as a problem in Moa, Ziwani, Amu, Kiunga and Mkokoni. In Mkokoni it was reported that invasion by elephants is now less common due to poaching of the species by bandits, and so now buffaloes are the major problem. Invasion by any species leads to rapid crop destruction and, certainly in Mkokoni, such invasion was seen as a bigger problem than changes in rainfall.

4.4.3 Non-climate-driven vulnerability: human factors

In addition to climate and environmental change, there are a number of other factors in the Lamu land/ seascape that have contributed to livelihood change. These factors occur independently of climate and environmental change, but interact with, and may be exacerbated by, climate and environmental change.

Competition for natural resources is not restricted to humans and animals – it also exists between humans. The Amu men explained that the airport expansion and grabbing of beachfront land for hotels on Lamu Island had reduced the availability of their farming land. Instead they are only able to access "take as much as you can/*jikatie kwa uwezo wako*". Land tenure arrangements are viewed as less than ideal here, as they do not allow for private ownership, which would be the preference of the Amu men to enable long-term investment. Women in Kiunga reported similar issues with an increase in fishing pressure on what were traditionally "their" grounds, which are now fished from people from outside.

Both human-wildlife conflict and human competition for resources can be exacerbated by a changing climate. Women in Mkokoni explained that buffaloes are more likely to invade their farms in dry periods, when their existing forage sites further inland are depleted. Pastoralists from far away also enter many of the villages when water is scarce. In Kipini people come from Lamu, and from as far away as Malindi, to fish at Ziwayu island when fish stocks are lower than usual, for example during El Nino events.

Resource conflicts can also be precipitated by another major driver of livelihood concern in the Lamu land/ seascape – that of security of the human environment, which can prompt migration. Northeast Kenya (the Northern Frontier District) has long experienced conflict between Kenyans and ethnic Somalis. During the Shifta War (1963-67) ethnic Somalis in the area attempted to secede and join their fellow Somalis in a Greater Somalia (Mainyu, 2012). The Kenyan government forced civilians into "protected villages" (essentially concentration camps) until a ceasefire was signed in 1967. Since then there have been numerous skirmishes and incidents of terrorism, known locally as "Al-Shabaab". The peace is regularly broken around elections. In Moa village the fieldwork for this survey was interrupted by insecurity issues due to clashes between the Orma and Pokomo communities, giving rise to significant tension within the village. The women of Amu and Mkokoni also voiced their fears, as did the women of Faza, who complained that the police and army do not do enough to help them to feel safe. Both post-election violence and terrorism have affected tourism arrivals, with implications for those employed in tourism (e.g. in Mkokoni and Kipini coastal communities).

Formal and informal employment opportunities in a number of the case study villages are created in the tourism industry (for example waiting and cleaning staff and security; and opportunities for selling honey and handicrafts as souvenirs). However, tourism arrivals can be very sensitive to changes in the human environment and relate strongly to perceptions of human security. The men of Amu stated that post-election violence had reduced tourism, affecting their livelihoods. The income of Mkokoni village has also been greatly affected by the closure of a neighbouring resort, the Kiwayu Safari Village, following the capture of a British tourist by al Shabaab or its affiliates. This has increased the economic vulnerability of the population and increased their exposure to climate change since more people have returned to natural resource-dependent livelihoods.

Vagaries of markets are not restricted to the tourism industry but also to the fish and farm produce, and mangrove wood, of the Lamu land/ seascape. Tourism resorts were typically big markets for fish. The women in Faza village sell coconuts, cashew nuts and mangoes but, whilst the cost of farming these products remains high, lack of markets and low prices for coconuts and mangoes makes them economically unviable. Mangrove cutting is the major income earner in the sea village of Ndau. Poles are cut and transported by boat to Mokowe jetty or Lamu town from where they are offloaded and reloaded in lorries for transportation to licensed traders in Mombasa. The cutters have, however, seen their income slightly decline after the export market was banned in 1980. The local market is poor and the price is low. However, whilst livelihoods have been adversely affected, this change has been good for regeneration of the natural resource base and likely improved the quality of mangrove-based fisheries.

In response to the natural and human drivers of change, a number of conservation-based regulations have been put in place in order to protect the natural resource base. These have also affected community livelihoods and vulnerability to climate change.

Mkokoni is one of the communities that has had longstanding exposure to a neighbouring (terrestrial or marine) protected area. The women explained that they initially saw this measure as negative, but now appreciate its function in maintaining resources for future generations. They also benefit from economic incentives, such as scholarships, by way of compensation for lost livelihood opportunities. Other communities explained that the shift away from clear-cutting to selective cutting of mangroves has increased the availability of crabs, and thus enabled greater collection of that resource for economic income. The Amu women reported some restrictions to their traditional fishing areas. In other locations some skepticism remains, particularly around the mangroves, where Ndau men are convinced that selective cutting allows faster regeneration, and would thus like this to be allowed within the Kiunga Marine Reserve. As long as sustainable alternative livelihoods are available, conservation measures need not increase community vulnerability to climate change. In fact, in Ndau the men and women also observed that regeneration of mangroves had reduced likelihood of flooding (through the regeneration of ecosystem services).

Community members are also aware of how their own livelihoods are embedded in a wider geographical context. In particular, a major port development is planned in Lamu (the Lamu Port and Southern Sudan and Ethiopia Transport (LAPSSET) Corridor project) that is intended to provide easy access to international shipping routes for Kenya, Ethiopia and South Sudan. The men in Amu expressed their hope that the new harbour and resulting infrastructure development would bring about greater formal employment opportunities to the region, thereby reducing their dependence on natural resources and, in turn, reducing their vulnerability to climate change. Infrastructure developments have certainly had positive livelihood impacts for other villages in the region. The women of Kiunga village highlighted the importance of the improved road for connecting them with markets.

4.5 Response strategies in the face of climate hazards

Adaptive capacity and coping strategies are not interchangeable terms. On the one hand, coping refers to short term mechanisms to ensure survival in the face of a livelihood stress that do not change the underlying vulnerability. On the other hand, adaptive capacity or adaptation refers to longer term shifts in behaviour and practices which reduce vulnerability in the face of the same livelihood stress occurring in the future (Vincent et al., 2013). Whilst a large body of literature points to evidence for community level coping, it is adaptive capacity that needs to be probed and explored, since promoting coping will not be sufficient to enable sustainable livelihoods responses in the context of a changing climate.

A variety of coping and adaptive responses are observed in response to the perceived changes in climate. These are essential in determining whether exposure to a climate hazard translates into a negative impact, or can be mediated with minimal effects on livelihoods and natural resources. Observed responses can be divided into diversification of livelihoods (spatially and temporally), and reliance on others. In this section particular attention is paid to what determines whether or not particular communities, and people

within communities, are able to cope or adapt, as enabling such changes will be essential to reduce future negative impacts of climate change. Whilst it is difficult to project coping and adaptive capacity into the future, because it depends on the interplay a variety of factors, any communities that are unable to cope with current climate variability and change are priorities for enabling adaptation activities.

Livelihood diversification is a common adaptive response in natural resource-dependent communities, and improves the likelihood that, even if one strategy fails, the livelihood can be maintained from other activities (e.g. ALP, 2014; Tobey et al, 2011). As shown in tables 5 and 6, livelihoods in the Lamu sea/ landscape are already diversified in that households engage in various activities, many of which differ along gender lines. This diversification acts as a risk spreading mechanism in the case of exposure to climate hazards, as not all activities are likely to be affected to the same degree by particular hazards. This was emphasised by the groups in Matondoni, who said that by depending on multiple livelihoods (including small businesses, casual work, mat weaving, fishing, farming, selling of firewood, and transportation of sand, blocks and ballast by the fishing boats when they cannot go out to sea, they are responding to the variable climate, natural and human environment in which they are embedded.

Livelihood diversification can also involve changing the timing of existing activities (temporal diversification), conducting existing activities in new places (spatial diversification) or engaging in completely new activities.

4.5.1 Temporal diversification

Temporal diversification within farming is common in response to the changing rainfall patterns. The farming women in Kipini and Mkokoni, for example, explained that they now plant as many different crops as they can so that if one fails, at least they are likely to get a harvest on the others. In Faza planting behaviours are now varied: so in the past where specific crops would always be planted in particular months, now they often wait to see when the rains arrive. In Dide Waride and Koreni, the women said that maize is their preferred crop but should that fail (e.g. due to lack of rains), they will replant their farms immediately after the rains with alternatives such as green grams, cowpeas and sesame. Diversification strategies can bring about positive benefits in addition to enabling survival: in Mkokoni community members explained how in 2011 they experienced a glut of cow peas due to the rare occurrence of high rainfall together with a decrease in the usual amount of human-wildlife conflict. In Mangai, the women reported that men will often sleep on the farms during droughts in order to scare off the animals that tend to encroach on village land when their foraging resources are reduced.

Temporal diversification can also mean shifting livelihood type in relation to resource availability. The women in Kipini, for example, explain that they fish during the dry season and farm during the rainy season. The men in Kipini reported reducing their livestock feeding schedule during times of drought, so that animals eat twice a day instead of three times.

4.5.2 Spatial diversification

Spatial diversification refers to the use of different spaces to earn a living, and is a strategy used within all natural livelihood types. In cases of low rainfall and drought, male livestock

farmers in Dide Waride and Koreni reported having to roam further afield in search of pasture and extra fodder crops (with Koreni farmers mentioning Garissa, Kitui, Ijara, Taveta and Garsen as among the places to which they would travel). This strategy has become so common that farmers now tend to conduct a reconnaissance survey (known locally as *Aburu*) to search for pasture and watering points before moving their herds, in order to maximise efficiency of movement (and taking into account the increasing competition for resources that occurs when their availability is reduced). Under flood conditions, Dide Waride, Koreni and Kipini farmers will move their livestock to higher ground in order to reduce the likelihood of death and disease. In Kiunga, farmers reported farming on a larger scale in order to capitalise on micro-variations in conditions.

Spatial diversification within fishing also often means seeking new grounds to fish or sell fish. The women in Mkokoni, who typically engaged in fishing in the shallows during *kaskasi* (NEM), explained that catches have got so poor due to seasonal changes that they now have to fish in the open water as they have no other livelihoods. This example is particularly interesting as open water fishing is typically the domain of men. Other examples of spatial diversification include engaging in various informal micro-enterprises, which may include selling chapattis, firewood or honey, or traditional wild foods such as *mariga* (a cassava-like product that is dug up, soaked in water overnight, and cooked the following day for eating). When climate hazards affect markets (e.g. when local purchasers can no longer afford to pay appropriate prices), fishermen in Kiunga reported transporting their commodities to markets further afield in order to obtain a better price.

4.5.3 Changing livelihood type and variety

As well as temporal and spatial diversification within existing livelihood portfolios, another common response to climate variability and change in the Lamu sea/ landscape is to change to another livelihood type. In Ndau the men reported that more people are turning to mangrove cutting as a source of livelihoods as farmers shift from the land, which gives them such unpredictable returns. This is not solely a response to climate factors though: increasing private land tenure means that traditional shifting cultivation methods, which are perhaps better suited to variable resource availability, are no longer possible.

Shifting to alternative livelihood types takes different forms, depending on the predominant livelihood type in each community. In Kipini when there is a drought, fishermen might shift their reliance onto farming (of drought-tolerant crops), or engage in small enterprises such as charcoal production. When there is flooding, on the other hand, farmers tend to shift to fishing. Farmers in Dide Waride also reported charcoal production as an alternative livelihood when farming becomes unviable; whilst fishermen seek alternative livelihoods from selling labour for house construction and herding for others.

When natural resource-based livelihoods are no longer viable, seeking other formal or informal employment opportunities is a common response. This is particularly the case for men, who are less tied to the household and reproductive responsibilities of childcare than women. In Koreni, like the Dide Waride fishermen, men reported seeking casual labour, particularly in times of flood. In Koreni, women explained that in particular young people who are members of the Orma community will move out to nearby towns, such as Lamu and Mpeketoni, in search of odd jobs. In Kipini and Mangai, for example, men reported

migrating further afield in search of labour opportunities, often walking long distances in search of piece work.

Typical gendered roles around livelihoods are relaxed to a certain extent during times of livelihood stress. Women in many communities (Koreni, Kiunga, Mangai, Matondoni) reported participating in small businesses (e.g. selling fruits and vegetables outside their homes) or enterprises (e.g. mat weaving) to complement household income, and even participating in casual labour (although to do so likely places additional burdens on their time, since the requirements of the household will be constant regardless of the external conditions).

Both temporal and spatial diversification can be considered an adaptation, if they reduce vulnerability to the same climate exposure in the future. However, another important consideration is whether adaptive responses are sustainable in terms of natural resource availability – since typically diversification in the Lamu land/ seascape involves shifting from one natural resource-based livelihood to another. In particular, the element of sustainability needs to be considered when promoting certain responses, to ensure that problems are not merely transferred from one place to another.

4.5.4 Human responses to climate hazards

As well as affecting livelihoods, climate hazards (more so than incremental trends) can result in people needing to respond. In the case of flooding, for example, people in Dide Waride, Kipini and Kiunga reported that they would move their families to higher and safer grounds until such time as the floods subside. In Koreni the women reported making changes to the internal layouts of their houses in the case of floods: they build raised platforms which are temporarily used as kitchens for cooking and then after the floodwaters have receded they transform them into sleeping areas.

Procuring resources necessary for livelihoods also requires alternative strategies in times of climate hazards. Water (of appropriate quantity and quality) is arguably the most critical resource that is scarce in both droughts and floods as well as under the conditions of variable rainy seasons. In order to secure, various strategies are in place. In Koreni they have to purchase piped water known locally as *lakwa*. In Kipini when the wetlands and lakes dry up, women dig for water in the wetlands. In Matondoni after floods the women reported constructing water pans to store water for the animals. In Mangai people reported the need to buy food that they would normally have grown themselves.

There are some gendered dimensions evident in the human responses to climate hazards, particularly in the secondary (and subsequent) responses. In Dide Waride, for example, the women explained that, after securing immediate survival, there may be a longer term need to reduce household expenditure, particularly in the case of severe or long-lasting shocks. If a household is forced to remove any of its children from school, boys will be prioritised for education because they have a better chance of securing white collar jobs in the future, and thus will be able to transfer money to their families. They gave the example of one family in their community where two men are working and provide support to their sister, who is a widow. Such actions obviously both reflect, and in turn reinforce, the underlying gender inequality in society: even educated women are deemed less likely to benefit from

employment opportunities as their male counterparts and, as a result, families give greater opportunities to their boy children.

4.5.5 Seeking assistance from others-within the village

Whilst diversification is often an adaptive response, coping strategies were also observed (i.e. those which allow immediate survival but do not reduce vulnerability to the same future exposure). A commonly-cited coping response was to seek assistance during hard times from others. Borrowing and/or loaning food supplies during hardship was mentioned by several communities (including Koreni and Ndau). The women in Kiunga and Koreni explained that they seek credit from local shopkeepers in times of livelihood stress, with the agreement to pay for food items at a later date when their financial conditions improve.

As well as ad hoc support, several communities highlighted the existence of collective mechanisms. The Matondoni women explained that the community depends on "standing together during hard times", and gave several examples of what they did; for example when the roads were impassable they got one boat to be used to transport the sick to hospital; and during the fire outbreak they provided shelter and food to those who were affected, including mothers taking turns to make porridge and serve it to the children at school. They also explained their belief in the occurrence of rain being related to spirits, and so in times of drought the community performs rituals to "call the rain". The Kipini women and Koreni men noted a similar practice, where the ceremony involves an animal being sacrificed at the farms followed by prayers for rain.

Similarly the Mkokoni women explained how they have a community support programme designed to assist those in times of need. Such community mechanisms can be very useful in responding to idiosyncratic shocks, which affect small numbers of people – such as the death of a family member. However, they become overwhelmed in the case of covariate shocks such as those relating to climate change, which are likely to affect large numbers of the community at any one time. If there is a flood, for example, many people are likely to be affected through their houses, as well as through their livelihoods, and the needs may overwhelm the capacity of the community to provide the support itself. That said, they can often provide much-needed emotional support: in Milimani, for example, women pray in a traditional sacred site in the forest called *wahari* during drought.

4.5.6 Seeking assistance from others-outside the village

External support from government and NGOs was also a common coping mechanism in response to climate hazards in the Lamu land/ seascape. In Dide Waride it was particularly mentioned that this response follows from the failure of being able to cope using the traditional community mechanisms, which was often the case after intense flooding or prolonged drought. Dide Waride, Koreni, Ndau, Kiunga, Mangai, Mkokoni and Faza in particular mentioned that they rely on relief from various government departments, UN agencies and NGOs. These included the UN (in Koreni), the Red Cross (in Mangai, Mkokoni and Dide Waride) and World Concern (in Faza and Mangai), who have been providing food parcels, such as rice, maize and cooking oil. On the whole, reliance on such external support is a coping mechanism as it enables immediate survival but does not reduce vulnerability to the same negative livelihood outcomes occurring in the future. That said, the Ministry of Agriculture provides drought-resistant seeds and trains farmers in improved agricultural techniques, which could be an adaptation for those farmers that benefit. Similarly in

Mangai the Kenya Red Cross is currently engaging the community on irrigation, targeting high value horticultural crops. Longer-term initiatives such as these, as long as they promote activities that will be resilient in the face of a changing climate, can help promote adaptation within the communities of the Lamu land/ seascape.

Seeking assistance from outside the village typically means tangible benefits to secure immediate survival, e.g. food and water. However, the women in Kiunga said that they implore Kenya Wildlife Services to provide support to them in stopping the human-wildlife conflict and crop raiding which results from wild animals heading towards the villages in response to their usual food sources becoming depleted. The fact that human-wildlife conflict exists and is exacerbated by climate change thus suggests that addressing it should be a priority to ensure adaptation and sustainable livelihoods.

All of the communities surveyed in the Lamu land/ seascape reported a wide variety of institutions that are operational. In addition to the above, active government ministries include Arid Lands, Social Services, Water, Fisheries Department, Kenya Forest Service, Kenya Marine and Fisheries Research Institute. Each village also has various community groups that deal with conservation issues including forest conservation, wildlife and fisheries. Beach Management Units, for instance, are created with the purpose of co-management with the Fisheries Department and other stakeholders for sustainability of the fishery resources. There are BMUs in both lakes and sea landing sites. Other important local institutions include the mosques, churches and women's groups. Although none of these institutions were directly credited with providing support for coping or adaptation to climate change, there is certainly potential to work to support adaptation through such existing institutions.

4.5.7 Sale of assets

Although it was not often mentioned, sale of assets also emerged as a coping response. Livestock are often used as stores of financial capital but can become a burden during drought, because of the additional effort required in order to find water and pasture. In Dide Waride, Koreni and Kipini the sale of livestock was mentioned as a coping strategy. However, the timing of selling livestock is also important – because if farmers wait too long the prices can drop as the numbers entering the market increase. However, in Kenya there is a government programme in place, and the women of Dide Waride said that emaciated animals could be sold during the government livestock off take programme, administered by the Department of Livestock (of course there is a risk involved in waiting until this stage, as this programme only kicks in during particularly prolonged droughts). In Koreni, in contrast, households reported slaughtering any emaciated animals to use for food.

In addition to livestock assets, other physical capital can be liquidated during times of livelihood stress. The women of Amu village told of how they use their gold jewellery for collateral to obtain loans in times of need; and women in Kizingitini mentioned selling jewellery and property. Any sale of assets is a coping mechanism, as reducing a household's financial capital base will not reduce its vulnerability to climate exposure in the future. The women of Faza village mentioned that the repeated need to take loans as a coping mechanism regularly undermined their Sacco/co-operative, since members were unable to make their repayments.

4.5.8 Preparation for hazard exposure

One (proactive) response which is very much an adaptation to climate change is the storage of seeds and/or food for use in times of hardship. Very few of the communities mentioned doing this – only Dide Waride and Koreni. In Dide Waride they dig holes and sterilize them by burning so that they can then store food that will last for up to 7 years, providing a risk reduction measure in case of exposure to drought. Similarly they mentioned storing seeds for planting on house rooftops, directly above the fire place (so that smoke can aid drying and the development of a protective coating that prevents insects from eating them), thereby reducing their likelihood of being lost in flood events. In Koreni communities mentioned saving money expressly for use to buy food when conditions require it.

It is important to note that, just because communities have found ways of responding to past climate hazards, even coping responses are not always fully successful, or engaging in coping responses does not always come without additional cost. In the process of moving livestock, for example, there is additional risk of death (and thus further loss of assets). Table 11 summarises the responses observed and, using the criteria mentioned above (that coping does not affect underlying vulnerability whilst adaptation does) analyses whether the responses can be classified as examples of coping or adaptation. As the table shows, it is not always simple to determine whether a particular strategy is coping or adaptation as it depends on a variety of conditions, including the timescale in question and other intermediate factors.

Table 11: Classifying response strategies as coping or adaptation

Category	*Example*	*Coping or adaptation?*
Temporal diversification	Planting and fishing in line with resource availability	Adaptation (which could be better enabled if they were aware of what conditions to expect)
Spatial diversification	Moving herds, changing fishing grounds Engaging in new activities	Adaptation (as long as land tenure allows it) Adaptation (as long as they are environmentally sustainable and financially viable)
Changing livelihoods type and variety	Switching to other natural resource-based livelihoods Casual labour, migration	Coping (on a long timescale as ultimately all resources are affected by climate) Adaptation (diversion from natural resources)
Human responses	House modifications Alternative water resources	Adaptation Can be an adaptation (as long as exploitation is sustainable)
Seeking assistance inside the village	Food relief Social support	Coping
Seeking assistance outside the village	Food relief Training in climate-resilient agriculture etc.	Coping Adaptation
Sale of assets	Animals, jewellery	Coping

Preparation for hazard response	Storing seeds and food	Adaptation

4.6 Factors affecting the availability of coping and adaptive responses

4.6.1 Past responses that are no longer available

Some coping and adaptive responses that were available in the past are no longer options. This can relate to overexploitation of resources or changing access to those resources. In Koreni, for example, the community highlighted that seeking wild fruits, and wild berries in particular, was a traditional coping strategy in the case of crop failure, but with more people having to resort to this strategy on a more regular basis, the availability of wild fruits has declined and thus the strategy is no longer viable. The women of Mkokoni, for example, explained that in case of famine in the past they would seek game meat as an alternative source of livelihood, but that since the protected area has been designated, this is no longer possible.

As mentioned above, shifting cultivation is the traditional farming method in the Lamu land/ seascape, but with changes of land tenure and increasing private ownership this is often no longer possible. As well as contributing to some former farmers moving away from the land to the mangroves (for example in Ndau), in other places there has been a shift to tree crops such as mangoes, coconuts and cashew nuts. As well as diversifying their livelihoods, planting of long-term tree crops, which can take several years before the first harvest, acts as a greater claim to land than short-term seasonal crops.

As outlined above, disentangling climate vulnerability and response from the variety of other factors that affect livelihoods can be difficult. In the same way that the vulnerability of some communities to climate change has increased as a result of the wider economy, this can also affect the availability of coping responses. The women of Mkokoni, for example, spoke of how they had to stop one of their communal coping mechanisms – a merry go round rotating cash society – after the closure of the Kiwuyu Safari Village as many members could no longer afford to participate. That said, they explained that their vulnerability was also reduced as the result of a desalination plant in another nearby hotel that supplies free water to the village – although, again, their access to this response is dependent on the continued functioning of the hotel.

4.6.2 Barriers to adaptation

As well as some former strategies no longer being available, other barriers exist which particularly impede adaptations and restrict communities in the Lamu sea/ landscape to coping only, meaning that their underlying vulnerability is not changed and thus they are likely to experience the same negative impacts when next exposed to the same climate hazard.

Access to financial resources is often an underlying enabler for coping and adaptation, even if the ability to use those resources is dependent upon human capital and the understanding of the situation and the various options. The women in Dide Waride mentioned that some members of the community have rebuilt their houses (after flooding) as more permanent structures with stone walls that can withstand the flooding, but that not everyone can

afford to construct a permanent house. In Amu, some men mentioned switching to speed boats as an adaptive response, as this enables them to reach further fishing grounds and also to transport any catch to market. However, given the expense, this is not an option that is open to all.

Relative to many developing countries, the communities of the Lamu land/ seascape, particularly the women, do already seem to have substantial access to microfinance, for example through the Kenya Women's Microfinance Trust, but ensuring that this is maintained does enable raising of capital when required, either on a short- or longer-term. In particular it would be ideal if microfinance lenders could bear in mind that climate change may require extensions to the period of loans in order to improve the likelihood of timely payback without negative implications for the borrowers.

Access to social capital in the form of the required contacts is also necessary, particularly in the case of adaptations (and coping responses) that require the community members to engage within market circles. In Koreni, although mangrove harvesting was identified as a coping strategy for members of the Orma community, they pointed out that common practice is for a stockist to provide a down payment as commitment that he will purchase the poles – and so finding a stockist is a prerequisite to having a market for the poles. In Matondoni, one response undertaken by the women is to contribute to household income through weaving mats and baskets to sell, but due to transport problems (including the prohibitive cost of travelling to market) they sell them through middlemen who pay them a low price. So in this case having financial resources (and time) to travel themselves to market would make the strategy more lucrative; but in the absence of that they also need to know of the middlemen who will come and collect in their villages.

Access to weather and climate information is also a critical prerequisite that determines whether communities are able to effectively respond to climate change. Decisions relating particularly to temporal diversification, for example, will likely be more effective if farmers (in particular, since temporal diversification is a key strategy for them) have some idea of what the weather will be like over the coming season. It can reduce their likelihood of crop loss by ensuring that they plant at the right time, particularly since increasing unpredictability means the traditional notion of waiting until the rains to start to plant is often unreliable. The women of Mkokoni explained that when they know low rainfall is predicted, they plant on less acreage to reduce the risk of loss; or they plant sesame or crops that require little rainfall.

The communities were asked about the existence of traditional and indigenous mechanisms for predicting the weather. Religion and cultural beliefs play an important role in the communities predicting weather and also in sharing information about anticipated weather patterns and hazard events. Amongst the men in Kiunga, cultural and religious guiding principles made up as much as 75% of the information the community used to predict the weather and put in place processes to safeguard their livelihoods.

Natural indicators, such predicting rainfall through observing the behaviour of birds, insects (especially ants) and buffaloes or the direction and intensity of the wind, are another way in which villagers have foretold the weather. According to the women of Pate, frogs croaking, an increase in the sea level, cooler and cloudier weather conditions are all early warning signs of an upcoming storm.

There is, however, recognition that the "old ways" of predicting the weather – using natural indictors or following traditional religious and cultural beliefs – no longer hold. The women at Mkokoni village identified more modern methods, such as weather stations (with information spread through the radio, by word of mouth or mobile phones) as being more reliable.

Unsustainable actions from outside the communities were also variously identified as impeding adaptive responses. In Koreni the men noted that food relief provided by the UN actually led to dependency syndrome, discouraging community members from changing their own lifestyles and livelihoods to match changing conditions because they knew they had the safety net of assistance from outside. Well-meaning development interventions that do not consider their impacts on climate vulnerability can also impede adaptive responses: in Kizingitini women explained that a desalination plant had been installed, funded by the Kenya Red Cross Society, but that the water was insufficient for community demand, and the situation only worsened during periods of climate-induced water stress. Political decisions taken at local and even national level also affect the decision-making context at community level, and thus can also create an environment that is conducive to adaptation, or discourages it. In Matondoni, the women recounted a situation where their governor had lost a petition against him, with the ultimate result that the implementation of the local development plans were impeded. As a result, locally-driven livelihood improvement projects were not being implemented, and they were seeking alternative funding from the Kenya Coast Development Project in the meantime for implementation.

4.7 Community adaptation priorities

It is clear that although there is some adaptive capacity and some adaptations being implemented in the communities of the Lamu sea/ landscape, the predominant responses are coping which have no effect on the underlying vulnerability. With existing observed climate variability projected to continue and intensify into the future, it is imperative to build adaptive capacity so that this exposure does not further undermine the livelihoods or the ecosystems on which they depend.

Education and awareness are important for communities to understand the risks (and opportunities) that climate change may bring, and how they may act to reduce those risks (or exploit the opportunities). Beyond direct climate change relevance, investing in education can enable future adaptive capacity by building human capital which reduces vulnerability to climate change and has wider development benefits. The women of Kiunga highlighted the need to improve education standards and literacy levels among children, so that they have the necessary human capital to participate in a wider range of formal sector employment (even if it means leaving the village).

Improved knowledge on climate-resilient farming techniques is a particular form of awareness identified as important by a number of communities. Changing practices, such as intercropping on farms with a combination of biennial and perennial crops would improve productivity per unit area without bringing about soil degradation. Improved inputs, such as certified seeds and machinery, such as tractors, would also enable improved efficiency and yields in crop farming, even in the context of a changing climate. There is a role for

government in supporting these changes, but also NGOs – the women in Matondoni in particular mentioned their trust in the Kenya Red Cross as an organization that can support their transition to an adaptive community.

For crop and livestock farming, and more broadly, **improving water availability** in the Lamu sea/ landscape is important. Reflecting increasing droughts and unpredictable rains, improved availability of water for irrigation was cited as one mechanism of maintaining crop production in the context of a changing climate, and deemed particularly important by the women in Koreni and Matondoni. Men mentioned desalination facilities in order to make the most of available sea and brackish water, and in Dide Waride there was recognition of the need to de-silt wells and lakes, such as El Boko and Gonga, to return to use by the livestock farmers. Apparently there is a government plan in place to transfer money from the mainland to Pate Island to address some of the shortages.

Given the pressures on land and the predominance of land grabbing, **improving security of tenure**, and equity of land distribution, through the provision of title deeds was cited as a priority by the women of Dide Waride and Kiunga. There is a well-developed literature that shows that when land is privately owned (or at least there is security of long-term tenure) those with tenure are more likely to act as custodians of the resources with a long-term perspective in mind, because they know that efforts they make at resource conservation and preserving ecosystem integrity cannot be undermined by others and that they will experience the benefits. This is in contrast to communally-owned land, where the individual incentives to overexploit exceed those to conserve (e.g. Hardin, 1968). Whilst climate change will affect the availability of natural resources, security of tenure is one way to support effective ecosystem-based adaptation for the communities of the Lamu sea/ landscape.

Flooding risk was identified as a problem by 4 coastal and 3 terrestrial villages (see table 8), partly for the role it plays in destroying the existing harvest. **Improving food storage facilities**, in order to ensure that both end products (farming and fish) and seed can be preserved for the next season, was also identified as a priority that would play a role in reducing hunger and famine situations, for example in Dide Waride (crops) and Kizingitini (where cold stores would be required for fish). In Mkokoni, the women expressed an interest in facilities for the smoking and drying of maize, which is currently difficult when there is a lack of sun and heavy rainfall.

Reducing the risk of human-wildlife conflict was highlighted, with some community members, such as those in Kiunga, speaking of the need to guard against buffaloes to protect their crops. Although some fences exist, herds of animals can easily move through these, and the cost of installing electric fences is prohibitive. Kiunga residents also suggested supplying water pans for animals, thereby hopefully reducing their likelihood of roaming towards the villages where the human-wildlife conflicts occur.

Expanding to the big picture, some community members also echoed the Kiunga experience of having improved transport links. **Improving infrastructure and transport availability** opens communities up to a wider range of potential livelihood activities, including formal employment, and connects them better with markets for trading – both of which can reduce natural resource dependence and hence variability as a result of climate drivers and hazards.

As well as improved infrastructure and transport, **facilitating further commercialization of livelihood opportunities** would contribute to economic development in the Lamu sea/ landscape whilst also reducing dependence on natural-resource dependent livelihoods. In Koreni there was interest in the establishment of cottage industries for value addition around their existing agricultural products, particularly milk. In Matondoni there was interest in obtaining boat engines to enable fishermen to venture further out to sea, and also to expand the opportunities for employment at the new Lamu port.

Promoting these adaptive actions will have different implications for men and women, and in the interests of not inadvertently reinforcing gendered vulnerability it is important to take a gender equitable approach. In practice, this may mean that different initiatives targeted at men and women should be supported. Women did particularly mention the importance of having options for saving money (that are more secure than hiding money within the house), and potentially a role of group savings (although concerns were expressed over the potential lack of transparency and accountability). In addition the women of Kizingitini mentioned their interest in being involved in small businesses to complement men's income – but some individuals were aware that such an activity would disrupt the unequal nature of gender relations and potentially their husbands might leave them.

5. Conclusion and recommendations

This report has shown the results of a study that aimed to investigate the climate-related vulnerability and adaptive capacity of communities living within and adjacent to the ocean and landscape in Lamu, based on two objectives:

- **To understand community resource use and how this has been affected by climate.**
- **To understand the community's experience of changes in climate and how this has affected their livelihoods.**

Results show that the terrestrial and coastal communities are highly dependent on natural resources for their livelihoods, which variously involve fishing, crop farming, mangrove harvesting and, to a lesser extent, livestock farming. Natural resource availability has changed over time. This reflects a combination of climate and other factors. Important drivers of climate-related vulnerability include droughts, floods, sea level temperature change and rise and, most commonly noted, unpredictability of rainfall. Other driving factors of vulnerability include changing access to resources (through land tenure patterns and the designation of the protected area). Accessibility to, and availability of, markets has also affected both natural resource and non-natural-resource-based livelihoods (including formal employment), with jobs in the tourism industry particularly sensitive to local insecurity and terrorism threats. Climate stresses often indirectly contribute to other factors: for example human-wildlife conflict is further exacerbated when drought prompts animals to move out of their normal inland forage areas in search of water.

In order to respond to changing natural resource availability, a variety of response strategies have been employed, taking into account both spatial and temporal diversification of livelihoods. Some people have switched from one natural resource-based livelihood to another (e.g. crop farming to fishing), whilst others have modified their typical practices to

take account of changing natural resource availability. This is particularly the case for crop farmers, who now plant different crops, and often at different times, in order to try and ensure a harvest, regardless of the conditions. Increased participation in informal trading has also been observed. Coping strategies including seeking assistance from others, both within and outside the village (including various government departments and NGOs) and, in some cases, selling valuable assets such as jewellery. Some communities mentioned that they now prepare for climate hazards by storing seeds, foods, or money with the express intention to use it when their livelihoods are under stress. The majority of the observed responses are examples of coping, rather than adaptation – i.e. they enable short-term survival, but do not affect underlying vulnerability. Thus when the communities are exposed to the same climate hazards in the future, they are likely to experience the same negative consequences. That said, there is potential for many of the responses to become adaptations if other criteria are met. Shifting from coping to adaptation is a key priority to ensure that climate change does not have adverse consequences in the Lamu sea/ landscape.

Several barriers to adapting were observed by the communities. Some past responses are no longer sustainable for various reasons, for example some spatial diversification and access to alternative land is restricted by the designation of protected areas and privatisation of land. Other barriers to adaptation include lack of access to financial resources, inadequate social capital (in terms of not being "plugged in" to networks for participating in markets), poor access to weather and climate information which would enable them to make livelihood choices that are appropriate for anticipated weather and climate conditions, and also unsustainable actions from outside the communities that create (often unintentionally) perverse incentives to not adapt.

It is clear that both ecosystems and the livelihoods that depend on them in the Lamu land/ seascape are vulnerable to climate change, and will continue to be in the light of the projected future climate exposure (which anticipates continued modification to the timing of the *Kusi* (SEM) and *Kaskasi* (NEM) monsoon systems, with a decrease in total rainfall between June and September and increase in extreme rainfall in October and November). Although communities are responding to current changes, improved awareness and understanding of the current vulnerabilities and future projected climate would greatly improve their capacity to adapt, and ensure that negative livelihood and resource outcomes do not occur. Overcoming these barriers to adaptation is a priority.

In addition to overcoming explicit barriers to adaptation, the communities identified a number of broader development priorities that would increase their capacity to adapt to climate change. These included improved education and awareness (affording their children a wider range of economic opportunities, as well as increasing the likelihood of them being able to access and understand weather and climate information), improved knowledge on climate-resilient farming techniques, improved water availability (for domestic use and for crop and livestock farming), improved security of land tenure (to provide superior incentives for sustainable resources management), improved food storage facilities (as a risk reduction mechanism and to provide the option of selling at market), reducing the risk of human-wildlife conflict (which occurs already and is exacerbated under conditions of climate change), improving transport and communication links, and facilitating further commercialisation of livelihood opportunities (potentially thereby reducing the level

of dependence on natural resources). When considering the potential for any of these mechanisms, outside agencies should also be aware that promoting such adaptive actions will have different implications for men and women, and in the interests of not inadvertently reinforcing gendered vulnerability, it may be necessary to design interventions that involve different aspects for men and women in order to support gender-sensitive adaptation.

In terms of next steps, the analysis of the CVCA findings should be comprehensively communicated to the village communities themselves. This will likely require an in-depth process in each village, building on the existing knowledge and linkages between WWF and KWS with the communities. As well as identifying sources of vulnerability, the projected future changes in climate, and their implications for seasonality, should be outlined, so that community members are aware that the changes they have observed are likely to become more pronounced. One adaptation measure which is both critical and win-win (i.e. it would have positive development impacts even if, theoretically, the climate never varied) is improving the availability of weather and climate information to communities, in order that they can make appropriate livelihood decisions. The increased unpredictability of rainfall in recent memory was remarked upon by almost all communities. Droughts were also mentioned (perhaps not surprisingly, given that the most recent time period in memory, 2009-12, has been characterised by drought), but future projections from models show that there will actually be more rainfall in the future. If men and women perceive that the most current observation will continue, they may make permanent changes to their livelihoods, when in reality shorter term and more temporary coping strategies may be more appropriate if their activities will be feasible in the long-term.

Within the context of the broad priorities identified for adaptation in the fieldwork – the implementation of which, of course, would require a long-term collaboration by a variety of government and non-government (including private sector) actors - a consultative process should encourage communities themselves to discuss what further specific livelihood modifications and/or support that this might require. Often this might involve external agencies looking at the feasibility of interventions – developing a shortlist that fits within the broader priorities - and then presenting a broad picture to the communities in order that the specific priorities within those realms can be explored. Communication of shorter-term weather information (e.g. seasonal forecasts, ideally updated throughout the season) can also inform climate-smart decisions, for example overcome the cited problem of planting and then loss of crops when an unanticipated dry spell occurs. Additional technical inputs should also be presented by experts in the major livelihoods types; for example agricultural extension officers and fisheries officers, regarding any recommended changes (e.g. in seed type and planting behaviours, or fishing methods and/or locations) for continued sustainable resource use.

What the broad priorities for adaptation do highlight is just how important it is to consider general development activities within the context of a changing climate, because climate change runs the risk of undermining development improvements and creating new vulnerabilities, if it is not taken into account. Since existing management plans already exist for the area, in terms of the Kiunga Marine National Reserve and the Beach Management Units, the findings of this CVCA should be incorporated in order that climate change and vulnerability are incorporated into future management decisions. In particular, immediate

adaptive options include the strengthening of the fence that keeps wildlife within the KMNR, in order to reduce the likelihood of climate-induced human wildlife conflict when animals try and expand their range in search of water. Improved patrolling of the boundary could support this. At local level, Beach Management Units may wish to modify their plans based on awareness of climate risks. For mangrove areas, cutting bans (in highly degraded areas) and selective cutting (as opposed to clear cutting) can allow regeneration of this resource, which helps to protect beaches from rising sea level and storm surges. Improved community management of their own resources is enabled when higher authorities provide back-up through ensuring that local conservation measures are not negated by outsiders who come in and undermine local measures.

Last, but not least, this study has shown that the CVCA methodology is flexible enough to be appropriate for assessing climate vulnerability and adaptive capacity of livelihoods and ecosystems. Research questions can be devised as relevant to the context, and the toolkit provides the basis of tools which can be modified and adapted to answer those questions. WWF and KWS are thus recommended to continue employing this methodology as part of their Flowing Forward process. The only consideration is that, if the majority of staff are trained in the ecosystem side of the process, they will require training in CVCA and participatory qualitative methodologies in order to ensure that they generate the most useful results.

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7. Appendices

Appendix A: Historical timeline (compiled from men, women and key informants)

Date	KIPINI	NDAMBWE	MILIMANI	DIDE WARIDE	KORENI	MANGAI	MATONDONI	KIZINGITINI	KIUNGA
1700s	Start fishing						Farming of maize, sim, mango, coconut and cashews on 3 – 5 hectares	First borehole dug (Mchova – Shindambwe Island	
1800s							Start of fishing *(uzio – uvivi wa tata).* Expanded fishing to other areas including Dodori, Ndununi, Milihoi, Kiunga, Mbilingii and Salama	Start of farmlands (no title deeds) Start of fishing (turtle, dugong, use of traps *(uzio)*, madema and gill nets To the present: Mangrove harvesting.	
1846				Rinderpest outbreak killed animals					
1848				Smallpox outbreak					

Date	KIPINI	NDAMBWE	MILIMANI	DIDE WARIDE	KORENI	MANGAI	MATONDONI	KIZINGITINI	KIUNGA
1900s	Shifta threats led to forest clearing (thus the name Kipini from the Swahili upini)								
1914 – 1918 (WW1)				Long period of drought and famine (*madobesa).* Livestock deaths due to malnutrition, lack of water and diseases (*turndig)* Vaccinations for livestock and humans					
After WW1				Flooding causing famine and loss of animals. Villages marooned by rising water					
1920					Outbreak of rinderpest killing livestock. People dispersed to Garsen, Lamu, Ijara.				

Date	KIPINI	NDAMBWE	MILIMANI	DIDE WARIDE	KORENI	MANGAI	MATONDONI	KIZINGITINI	KIUNGA
Before 1930s						Farming started – sorghum; maize; pumpkin; cassava and rice			
1930				Outsiders start fishing in Dide Waride *(Luos)*. Later joined by locals					
1942							Diarrhoea		
1946				Flooding without rainfall (*Ege)* killed cattle					
Early 1950s									Kiunga – Lamu road developed
1950s	Drought							Cholera	Drought Fires destroyed property
1950								Drought	
1953				Drought *(Adholes Maletha)*					
1956									Floods killing wildlife, farms destroyed

Date	KIPINI	NDAMBWE	MILIMANI	DIDE WARIDE	KORENI	MANGAI	MATONDONI	KIZINGITINI	KIUNGA
1959									Drought Air/ waterborne diseases
All of the 1960s	First trawlers. Fresh water prawn fishing. Certain fish species disappeared due to heavy trawling. Village protection from hazards rituals (e.g. against shifta)	Shifta wars leading to displacement of people. Most of the people ran towards Kipungani. Food insecurity. Flooding led to the loss of livestock, destruction of farms. After the floods there was bumper harvest maize and sesame. The government during this period did help the people with financial support							

Date	KIPINI	NDAMBWE	MILIMANI	DIDE WARIDE	KORENI	MANGAI	MATONDONI	KIZINGITINI	KIUNGA
Early 1960s				Advised to change from livestock to crop farming as the number of cattle was expected to decrease					
1960						Shifta used to invade frequently. Raped and tortured people. Many deaths and relocation to Rasini and other areas due to fear		Drought Cholera	
1961	Flooding *"Gharika"* Continuous 7 days of rains led to massive death of fish , salinity of sea water decreased			Flooding (*Seli)*		Floods (*Didor Sher)*		Floods	

Date	KIPINI	NDAMBWE	MILIMANI	DIDE WARIDE	KORENI	MANGAI	MATONDONI	KIZINGITINI	KIUNGA
1962	Minor floods leading to flooding of farms; relief food being brought into the area and the destruction of infrastructure (e.g. roads)		Flooding called *mfuniko* destroyed crops leading to famine/ food insecurity. Relief food from the government - first helicopter from government bringing food aid because of the area's inaccessibility (roads closed). Human, livestock and wildlife deaths Disease have existed outbreaks	Attacks by Shiftas in the northern corridor. Happened continuously until stopped by KPR in 1995	Until 1968: Shifta invasion and increase in the years that followed. Led to dispersal of people to Ndambwe, Lamu, etc. Floods *(Gir wenow)*	Floods (*Didor Sher)* Malaria, cholera, diarrhoea, measles outbreak			

Date	KIPINI	NDAMBWE	MILIMANI	DIDE WARIDE	KORENI	MANGAI	MATONDONI	KIZINGITINI	KIUNGA
1963	Until 1966: Shifta attacks Rodgers geographical society survey for oil	*Shifta* invasion causing insecurity			And continuing: Human – wildlife conflicts Shifta war displaced populations		Lions invaded the village and killed donkeys and cows. Floods *("mwaka wa simba")* Malaria, waterborne diseases Drought	Floods causing famine	Shifta attack – claiming of Kenya's coastal strip by Somali
1964	BP Shell oil exploration	*Shifta* invasion causing insecurity							
1965		*Shifta* invasion causing insecurity	*Shifta* invasion						Residents dispersed due to insecurity in Mtengawada, Amu, Mombasa, Malindi, Kilifi, Watamu and Ngomeni) – all farms abandoned
1966			*Shifta*						

Date	KIPINI	NDAMBWE	MILIMANI	DIDE WARIDE	KORENI	MANGAI	MATONDONI	KIZINGITINI	KIUNGA
1967	To 1994: Bandits/ poachers led to the formation of the anti-poaching unit KWS)		*Shifta* invasion led to some of them moving to Somalia; deaths; illiteracy was high (no learning at schools); no harvest - famine; diseases						
1968			*Shifta* invasion						Drought Eye diseases Fires
1969			*Shifta* invasion						Kiunga residents resettled. All houses destroyed due to insecurity.

Date	KIPINI	NDAMBWE	MILIMANI	DIDE WARIDE	KORENI	MANGAI	MATONDONI	KIZINGITINI	KIUNGA
All of the 1970s		Relatively good agricultural production. Increase in population of elephants in the area leading to an increase in human wildlife conflict.		Neighbouring villages attached leading to displacement of people. Residents of Dide Waride lived in fear of being attacked – most of the inhabitants had to flee to Reketa (a village in the Tana River District)					
1970	The sea started receding. *Shifta* invasion targeting elephants. Bumper harvests (maize, sorghum, green grams)				Resettlement at Koreni (especially the herders). Establishment of Mpeketoni town. Drought (*Abar/ Adolesa)*			Oil exploration (BP Shell)	Shifta attacks continued – livestock theft and destruction of houses

Date	KIPINI	NDAMBWE	MILIMANI	DIDE WARIDE	KORENI	MANGAI	MATONDONI	KIZINGITINI	KIUNGA
1971	Bumper harvests (maize, sorghum, green grams)								Fires
1972	Bumper harvests (maize, sorghum, green grams)			Drought *(Bon Gomu)* Oil exploration (BP, Shell)	To 1974: People dispersed again as a result of anti-poaching exercise		Strong winds led to house roofs being blown off; trees were felled; boats capsized and 2 people died	Drought Cholera Oil exploration (Rodgers)	Attacked by bandits – people fled their homes and settled on Pate Island
1973	Bumper harvests (maize, sorghum, green grams)		Drought – has led to poor honey harvest; no harvests, lack of water, displacement of pastoralists, death of livestock, human/wildlife conflict, insecurity			Fishing started along River Mangai, fresh water lakes and the ocean	Eye disease		Floods Diarrhoea

Date	KIPINI	NDAMBWE	MILIMANI	DIDE WARIDE	KORENI	MANGAI	MATONDONI	KIZINGITINI	KIUNGA
1974	Bumper harvests (maize, sorghum, green grams) Heavy destruction of farms by elephants					Drought *(ora bona)* killed wildlife Until 1977: People died daily from diseases associated with the droughts and floods Wildfires led to death of wildlife	Drought	Unpaved road	Drought
1975	Bumper harvests (maize, sorghum, green grams)					Boni-Dodori Reserve; Boni and Lungi forest			Strong winds Airborne diseases
1976	Bumper harvests (maize, sorghum, green grams)								
1977	Bumper harvests (maize, sorghum, green grams)								

Date	KIPINI	NDAMBWE	MILIMANI	DIDE WARIDE	KORENI	MANGAI	MATONDONI	KIZINGITINI	KIUNGA
1978	Bumper harvests (maize, sorghum, green grams)		Operation to flush out poachers. Loss of wildlife (elephants, buffalos, rhinos and zebras) on the rise. Education stopped Economy tumbled Limited free movement including access to forest resources						

Date	KIPINI	NDAMBWE	MILIMANI	DIDE WARIDE	KORENI	MANGAI	MATONDONI	KIZINGITINI	KIUNGA
1979	Floods Severe cholera outbreak. Diarrhoea.		Operation to flush out poachers. Loss of wildlife (elephants, buffalos, rhinos and zebras) on the rise. Education stopped Economy tumbled Limited free movement including access to forest resources		Drought (*Abar/ Adolesa)* Flash floods				
Before 1980							Massive harvesting of mangroves, mostly *boriti*, for trade to Middle East		
All of the 1980s	Strong winds blow off roofs Use of seine nets begins. Jumbo/ Marine prawn fishing	Increase in the population of the village leading to the opening of more land for settlement and farming		Current generation embraced farming albeit on a small-scale	Resettlement again at Koreni (by farmers and some pastoralists)		Drought		

Date	KIPINI	NDAMBWE	MILIMANI	DIDE WARIDE	KORENI	MANGAI	MATONDONI	KIZINGITINI	KIUNGA
1980	Drought led to famine. Wildfires (continuing to the present) Malaria outbreak. Eye diseases. To the present: Sacrifices made because of droughts and floods	Wildlife (especially elephant, buffalo and monkeys) invasion of farms	Operation to flush out poachers. Loss of wildlife (elephants, buffalos, rhinos and zebras) on the rise. Education stopped. Economy tumbled. Limited free movement including access to forest resources *Shiftas* invasion led to: Lack of education and insecurity, low business, economy decline, no free movement, limited access to honey					Fire	Fires

Date	KIPINI	NDAMBWE	MILIMANI	DIDE WARIDE	KORENI	MANGAI	MATONDONI	KIZINGITINI	KIUNGA
1981		Drought. Change of water in the wells around in the village from fresh to salty. Wildlife (especially elephant, buffalo and monkeys) invasion of farms	*Shiftas* invasion led to; Lack of education and insecurity, Low business, economy decline, no free movement, limited access to honey						
1982	Outbreak of cholera – deaths. Displacement of people due to flooding Drought and famine - distribution of relief food from the government. To 1984: Witu-Kipini settlement scheme phase 1	Wildlife (especially elephant, buffalo and monkeys) invasion of farms Drought – yellow maize distributed. Crops and animals dies	*Shiftas* invasion led to; Lack of education and insecurity, Low business, economy decline, no free movement, limited access to honey	Spill over effects of clashes with neighbouring villages			Floods Malaria, waterborne diseases	Floods Cholera	Drought

Date	KIPINI	NDAMBWE	MILIMANI	DIDE WARIDE	KORENI	MANGAI	MATONDONI	KIZINGITINI	KIUNGA
1984	Famine caused by drought, leading to yellow maize relief food. Influx of immigrant farmers (land-grabbers). To 1985: Wildlife causes many human deaths	*Shifta* invasion taking all animals and leaving residents poor	*Shiftas* invasion led to; Lack of education and insecurity, Low business, economy decline, no free movement, limited access to honey. Lack of honey, food and water Drought – has led to poor honey harvest; no harvests, lack of water, displacement of pastoralists, death of livestock, human/wildlife conflict, insecurity	Drought *(Adholes Dharganya)* Influx by pastoralists	Drought (*Abar/ Adolesa)*	Floods *(Gonu Dako)* Drought *(ora bona)* Malaria, cholera, diarrhoea, measles outbreak			

Date	KIPINI	NDAMBWE	MILIMANI	DIDE WARIDE	KORENI	MANGAI	MATONDONI	KIZINGITINI	KIUNGA
1985									Floods Strong winds Cholera, malaria, diarrhoea, typhoid, TB
1986							Fire *(moto wa mkunguni)* affected village – 67 houses destroyed Fishermen attacked by bandits at Dodori		
1987	Introduction of multi political parties – famine as food, etc. could not reach the village - roads closed due to sanctions. Flooding Dynamite fishing						First *AIDS* victim (*uwambe)*	Strong winds – school roof blown off	

Date	KIPINI	NDAMBWE	MILIMANI	DIDE WARIDE	KORENI	MANGAI	MATONDONI	KIZINGITINI	KIUNGA
1988	Introduction of multi-parties in the political system – area experienced famine due to the fact that food and other essentials could not reach the village as roads had been								
1989				Typhoid outbreak (8 deaths)			Fire *(moto wa mtaa wa pwani)* affected village – 37 houses destroyed. Belief that it was caused by witchcraft		
1990s	Strong winds blow off roofs of schools				Relief food by UN led to dependence syndrome on aid changing lifestyles	First borehole constructed			

Date	KIPINI	NDAMBWE	MILIMANI	DIDE WARIDE	KORENI	MANGAI	MATONDONI	KIZINGITINI	KIUNGA
1990						Most of the Boni community changed from hunting and gathering to farming	Fishermen attacked by bandits at Dodori		
1991	Refugees from Somalia settled in the Kipini Primary school.			Creation of Witu settlement scheme/ grazing corridor				Unrest in Somalia – influx of refugees	
1992	Human – wildlife conflict leads to loss of human lives			(Continuing) Influx of outsiders into the Witu scheme leading to conflicts Spill over effects of clashes with neighbouring villages					Captain Morgan-led forces attacked Kiunga. Kiunga residents dispersed again – lives lost
1993	High influx of people leading to intensive destruction of forests for planting of crops.			Grazing corridor invaded by farmers (Wetemere)					

Date	KIPINI	NDAMBWE	MILIMANI	DIDE WARIDE	KORENI	MANGAI	MATONDONI	KIZINGITINI	KIUNGA
1994	American troops training in the area. Led to the flight of certain bird species due to helicopter noise. Drought leading to famine.								
1995	Drought leading to famine.	GTZ build water pipe (LAKWA – Lake Kenyatta Water Association)							
1996	Decrease in rain. Attributed to the cutting down of trees as the population of Kipini grew. Drought leading to famine.				Onwards: Pastoralists resettle			Strong winds – roofs were blown off	Kiunga residents resettled again

Date	KIPINI	NDAMBWE	MILIMANI	DIDE WARIDE	KORENI	MANGAI	MATONDONI	KIZINGITINI	KIUNGA
1997	El Nino. Led to the destruction of roads and resulting in the sea being the only mode of transport. Other negative impacts included famine; death of mangroves and coral reefs and an outbreak of diseases such as malaria, typhoid and cholera. Death of people and livestock. Government brought in relief food via helicopters. On the positive side, fisherman experienced a good catch of fish and	El Nino leading to diseases, food insecurity, increase in fish stock, and increase of crop yield after the floods subsided, financial hardship and the destruction of infrastructure.	Roads destroyed but built after the El Niño flooding Bumper harvests after heavy flood Migration of pastoralists to Milimani area because of lack of lack of water, and livestock feeding grounds Death of livestock and wildlife Wildlife – human conflict Insecurity Change of landscape – flat places became hilly and hilly places became flat High farm yield after El Niño	Flooding *(El Nino)* Over 40 people killed due to cholera outbreak Livestock (especially cattle) deaths due to cold caused by continuous rains for 2.5 months Famine (people forced to eat pumpkin leaves	Inhabitants who had been displaced by the Shifta war returned and were joined by Somalis 5 years later. Floods *(Gir wenow)* – El Nino Water borne diseases outbreak e.g. cholera	Floods *(El Nino)* To 1998: Malaria, cholera, diarrhoea, measles outbreak. Led to deaths, at least 2 people daily	Floods *(El Nino* – called locally *"Kibati cha mungu").* Characterised by erratic and unreliable rain Caused livestock and human (diarrhoea, cholera, typhoid) diseases (called *"upepo mbaya"* [bad wind]), deaths, impassable roads, houses collapsed, the cost of living shot up.	Floods Cholera, diarrhoea, typhoid, malaria Road to Mtangawanda was impassable Fish deaths, coral reefs were destroyed	Floods *(El Nino)* Destroyed crops, livestock and houses. Serious famine and people were forced to eat sea grass to survive

	lobsters while farmers had a bumper harvest once the floods had subsided. Cholera, diarrhoea, malaria outbreak. Heavy destruction of farms by elephants Strong winds Endangered mangrove species (*Heritiera litoralis)* extinction because of cultivation of land, floods (El Nino)		School and Mosque were built after the El Niño Change in frequency of harvest season There was a period of drought after the El Niño - led to poor honey harvest; no harvests, lack of water, displacement of pastoralists, death of livestock, human/wildlife conflict, insecurity						

Date	KIPINI	NDAMBWE	MILIMANI	DIDE WARIDE	KORENI	MANGAI	MATONDONI	KIZINGITINI	KIUNGA
1998	El Nino and its effects: Flooding leading to disease, hunger and destruction of roads Kipini community by conservation group						Fire *(kwa Zaujati)* affected village	Cholera, eye disease	Cholera, malaria, diarrhoea, typhoid, TB
1999	El Nino: Flooding - disease, hunger and destruction of roads La Niña - increased atmospheric temperatures and diseases for human, livestock and crops. Mchelelo settlement scheme established				And continuing: Land grabbing by immigrants with links to political class		Fishermen attacked by bandits at Dodori Drought caused food scarcity		Drought

Date	KIPINI	NDAMBWE	MILIMANI	DIDE WARIDE	KORENI	MANGAI	MATONDONI	KIZINGITINI	KIUNGA
2000	Livestock killed by wildlife Tree planting, rise in high water mark eroding *casuarina* trees. River Tana water floods upstream. Change in high water mark Intensive charcoal burning (the Akamba)				Reduction in vegetation cover. Deforestation using power saws	KWS created an outpost at Mangai To the present: Drought *(ora bona)*			
2001	Drought				Flooding forced many villagers to move in search of food				

Date	KIPINI	NDAMBWE	MILIMANI	DIDE WARIDE	KORENI	MANGAI	MATONDONI	KIZINGITINI	KIUNGA
2002	Bilharzia Kipini Fishermen Association TAFMEN	Drought and famine. Influx of Somali cattle Drought leads to conflict between pastoralists and farmers.			Drought (*Abar/ Adolesa)* Since 2002 rainfall has been decreasing		Strong winds led to boats capsizing and 1 person died		
2003	Little rain Livestock killed by wildlife				Drought (*Abar/ Adolesa)* Floods *(Gir wenow)*			Drought	
2004	Little rain Human – wildlife conflict leads to loss of human lives	Stopped farming some crops (e.g. cotton) because of lack of market and shortage of rain						Fire	
2005	Use power saws to cut down terrestrial trees			Piped water introduced			Sea wall constructed.	Tsunami	Floods Waterborne diseases

Date	KIPINI	NDAMBWE	MILIMANI	DIDE WARIDE	KORENI	MANGAI	MATONDONI	KIZINGITINI	KIUNGA
2006	Tsunami hit the shores of the village. The tsunami has had the long term effect of changing the tide of the ocean since then. Establishment of Kipini-Witu settlement scheme Start of BMU DEFCO (turtle) – Tana delta friends of conservation			Poisonous floods as a result of opening up dams upstream in the Rift Valley – livestock deaths Beach Management Units (BMU) formed					

Date	KIPINI	NDAMBWE	MILIMANI	DIDE WARIDE	KORENI	MANGAI	MATONDONI	KIZINGITINI	KIUNGA
2007	Poor rains/ change in rainfall Poor crop yields. Loss of certain crops (e.g. tomatoes, chilli, bananas) Crop diseases (e.g. '*asali', 'chuma'*/ infestation by pests) Loss of pastures - competition with outside communities. High influx of people due to post election violence. Mangrove harvesting using power saw begins Woodsite – oil exploration				Floods *(Gir wenow)* Rift Valley Fever – human and livestock deaths				

Date	KIPINI	NDAMBWE	MILIMANI	DIDE WARIDE	KORENI			KIZINGITINI	KIUNGA
2008		Poor rains and a change in rainfall patterns have been witnessed. Poor crop yields. Loss of certain crops such as tomatoes, chilli, bananas Diseases in crops such as '*asali', 'chuma'*/ infestation by pests Loss of pastures leading to competition with outside communities		Drought *(Adholes Anagabedi)* Wolqabeda conservation initiative started.				Strong winds – boats capsized Start of a long dry spell	Floods

Date	KIPINI	NDAMBWE	MILIMANI		KORENI				
2009	Ocean tide has been getting higher, mangroves growing more towards the ocean and a change in the wells from fresh to salty water. Very low rainfall Saaco oil exploration	Poor rains and a change in rainfall patterns have been witnessed. Poor crop yields. Loss of certain crops such as tomatoes, chilli, bananas Diseases in crops such as '*asali', 'chuma'*/ infestation by pests Loss of pastures leading to competition with outside communities Beach management units formed.	Drought – has led to poor honey harvest; no harvests, lack of water, displacement of pastoralists, death of livestock, human/wildlife conflict, insecurity				Drought		

Date	KIPINI	NDAMBWE	MILIMANI		KORENI				KIUNGA
2010	To the present: Influx of pastoralists/ cattle into the area leading to overgrazing, the drying up of lakes and swamps (e.g. Lake Mnuji; Kangawati; Jenderi; Luvu; Lumshi and Kenze) and the disappearance of wildlife from the nearby conservancy. Ocean tide has been getting higher, mangroves growing more towards the ocean and a change in the wells from fresh to salty water. Very low rainfall (men) A lot of rain (key informant)	Poor rains and a change in rainfall patterns has been witnessed. Poor crop yields. Loss of certain crops such as tomatoes, chilli, bananas Diseases in crops such as '*asali', 'chuma'*/ infestation by pests Loss of pastures leading to competition with outside communities. Wildlife invasion of farms.	Drought – has led to poor honey harvest; no harvests, lack of water, displacement of pastoralists, death of livestock, human/wildlife conflict, insecurity		Influx of wildlife over water and pasture Disease outbreak				Placing of power posts by KENGEN started Strong winds

	Pneumonia for humans. Foot and mouth disease (livestock) Human – wildlife conflict leads to loss of human lives Prawn fisheries management plan Anadaco oil exploration								

Date	KIPINI	NDAMBWE	MILIMANI	DIDE WARIDE	KORENI	MANGAI	MATONDONI	KIZINGITINI	KIUNGA
2011	Ocean tide has been getting higher, mangroves growing more towards the ocean and a change in the wells from fresh to salty water. Very low rainfall. Erratic rains started. Mysterious fire destroys houses To the present: Soil erosion leading to infrastructure destruction To the present: Deterioration of farm quality due to trespassing reducing farm production.	Poor rains and a change in rainfall patterns has been witnessed. Poor crop yields. Loss of certain crops such as tomatoes, chilli, bananas Diseases in crops such as '*asali', 'chuma'*/ infestation by pests Loss of pastures leading to competition with outside communities	Drought – has led to poor honey harvest; no harvests, lack of water, displacement of pastoralists, death of livestock, human/wildlife conflict, insecurity	Establishment of conservancy				Al Shabab attack: ban on night fishing led to a drop in income levels	

Date	KIPINI	NDAMBWE	MILIMANI	DIDE WARIDE		MANGAI	MATONDONI		
2012	Ocean tide has been getting higher, mangroves growing more towards the ocean and a change in the wells from fresh to salty water. Very low rainfall To the present: Conflicts between pastoralists and farmers over access to water and pastures. Human – wildlife conflict leads to loss of human lives	Poor rains and a change in rainfall patterns have been witnessed. Poor crop yields. Loss of certain crops such as tomatoes, chilli, bananas Diseases in crops such as '*asali', 'chuma'*/ infestation by pests Loss of pastures leading to competition with outside communities	Drought – has led to poor honey harvest; no harvests, lack of water, displacement of pastoralists, death of livestock, human/wildlife conflict, insecurity	Spill over effects of clashes with neighbouring villages (54 people killed) Internal conflict attributed to either political brinkmanship or competition for resources between pastoralists and farmers. Led to loss of human life and displacement of communities. By 2013 some people had still not been resettled.		Initiatives to start AWER conservancy started. Started community collaboration initiatives with KWS	Jigger infestation (human disease) Fire *(kwa Saada)* affected village	Drought Strong winds Fire Oil exploration (Adaco)	

Date	KIPINI	NDAMBWE	MILIMANI	DIDE WARIDE	KORENI	MANGAI	MATONDONI	KIZINGITINI	KIUNGA
2013	Floods Kipini community conservation management forum						Rural electrification project started. Water well dug – pipes laid Currently prolonged drought periods and severe drought	Fire	