Republic of Mozambique

MINISTRY FOR THE COORDINATION OF ENVIRONMENTAL AFFAIRS

CENTRE FOR SUSTAINABLE DEVELOPMENT OF COASTAL ZONES

Catalogue of Climate Change and Natural Resources Management in Govuro District (Nova Mambone Administrative Post)

SUPPORTED BY

CC DARE: Climate Change and Development – Adapting by REducing Vulnerability

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Authors
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General Coordination
Manuel Victor Poio **(**MSC on Land Planning and Coastal Zones Management)

CDS Coastal Zones Technical Team
Henriques Jacinto Balidy (Degree in Biology)
Jacinta Laissone (Degree in Geography)

Collaborators
Provincial Directorate for Coordination of Environmental Action in Inhambane
Diogo Borges David (Director)
Afonsina Fernando (Head of Environmental Management Department)

Govuro District Staff
Massanda Augusto
Pita António Pita

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Acronyms

APEGO - Govuro Fishers Association
AJOAGO - Govuro Youth and Friends Association
ADEGO - Govuro Development Association
ACAGO - Govuro Farmers Association
CC DARE - Climate Change and Development - Adapting by REducing Vulnerability
CDS - Centre for Sustainable Development
CRiSTAL - Community-based Risk Screening Tool – Adaptation and Livelihoods
CVCA - Climate Vulnerability and Capacity Analysis
EbA - Ecosystems-based Adaptation
ENSO - El Niño Southern Oscillation
FAO - Food and Agriculture Organization
GED - Group for Renewable Energies and Sustainable Development
INE - National Statistics Institute
INGC - National Disaster Management Institute
INAM - National Meteorology Institute
IISD - International Institute for Sustainable Development
IUCN - International Union for Conservation of Nature
ITCZ - Inter-tropical Convergence Zone
MAE – Ministry of State Administration
MICOA - Ministry for Coordination of Environmental Affairs
NAPA - National Adaptation Programme of Action
NGO - Non Governmental Organization
MINAG - Ministry of Agriculture
US - United States
UN - United Nations
UNEP - United Nations Environment Programme
WFP - World Food Programme

EXECUTIVE SUMMARY

In January 2010, a household survey was conducted in Govuro District (Nova Mambone and Pande localities) to understand the climate change-related problems, current and future copping strategies in local communities. The purpose of this study is to promote disaster planning by documenting climate-related natural hazards which includes floods, drought, cyclone and extreme heat. Historical records are examined to identify frequency and other characteristics of their occurrence. In some cases, distinct temporal and spatial patterns are evident. Impacts and mitigation opportunities are also discussed.

The impact of climate change in Govuro District is a reality, in terms of observed uneven distribution of rainfall, increasing frequency and intensity of floods and droughts, increasing temperatures, cyclones and strong winds. This is already impacting on the viability of the major community livelihoods in the district through reduced water availability for crop production which is mainly rain-fed, water for livestock watering and for domestic use. Other impacts include reduced availability and quality of pasture for livestock and a general increase in ecosystem degradation leading to reduced forest products and other ecosystem goods and services.

Projections of rainfall are expected to decrease in southern Mozambique and increase in the coast. Being Govuro in the coastal south, combined effects of floods and droughts are expected. Rainfall variability will have more adverse effects on all economic sectors of Govuro district, including crop production, livestock, food security, access to safe water, availability of forest products and on health.

Communities in Govuro are aware of climate change and have plenty of ideas on how to prepare to future climate change and a willingness to get out of poverty and take their future into their own hands. However, their ability to adapt is constrained by many factors, including increasing scarcity in key resources, limited access to information (including weather forecast, climate change, market, pest and disease outbreak information); limited education, skills and access to financial services and markets required to diversify their livelihood activities.

Enhancing the adaptive capacity of these communities will require community-based and community-led interventions, but will also require tailored support from all stakeholders. To effectively do this, the district must integrate climate adaptation into mainstream development planning.

Several institutions are involved in disaster management in Govuro and mechanisms for coordination of activities have been gradually established, as is raising awareness about the relationship between poverty and disasters. The main actors include government institutions, NGOs, UN agencies and other bodies (bi) multilateral.

The National Institute of Disaster Management is the institution responsible for coordinating the daily activities of disaster management; these include prevention, mitigation emergency, rehabilitation and reconstruction.

INTRODUCTION

The African continent, especially in sub-Saharan Africa and the Indian Oceans Islands has been prone to natural hazards during very recent years, causing unpredictable damages to infrastructures and loss of lives. The severity, spatial distribution and frequency of occurrence of these natural hazards have been observed to be increasing over the past few decades.

Historically Mozambique is the country most affected by natural disasters in the Southern African region. According to the world report on disasters, more than 8 million Mozambicans were affected by natural disasters in the last 20 years. Mozambique registered a total of 53 disasters in the last 45 years, representing in average 1.17 disasters per year. The combined effect of flooding and cyclones in the years 2000/2001 is estimated in US$ 600 million. These disasters displaced 500,000 people, destroyed infrastructures and caused a very negative impact to the national economy (GED, 2007).

Mozambique has the third longest maritime coast in the African Continent extending about 2,700 kilometres, characterized by a vast variety of ecosystems such as estuaries, dunes, mangrove forests, coastal lakes, banks and coral reefs, marine weed and swamps. Its proximity to the Indian Ocean, long coast line with regions at low elevation, including some below sea level, makes it particularly vulnerable to extreme weather events.

This study assess the vulnerabilities to climate change of the communities of coastal district of Govuro, in Nova Mambone Administrative Post through the identification of current climate hazards and their impacts on communities, the existing mechanisms used by the communities to cope with the impacts of climate variability and change.

This survey was designed as part of CC DARE Project entitled Sustainable Development of Govuro Coastal Zone through adaptation to climate change using a community based integrated coastal zone management approach.

This report presents the findings of the household survey in Nova Mambone using the CRiSTAL (Community Based Risk Screening Tool – Adaptation and Livelihoods) in order to identify vulnerabilities of the community to impacts of climate change and to understand their current coping strategies, the resources important to coping and the constraints to coping.

The expected outcomes of this study are:

- Local Government, civil society, communities and other stakeholders informed, sensitized and empowered on environment and climate change issues;
- Community coping mechanisms to climate change enhanced;
- Communities' livelihoods options identified and diversified.

There is an urgent need for the country and the district in particular to use resources, innovation abilities and competitiveness to devise means of coping with climate change challenges. This report shall provide input for the formulation and implementation of local adaptation strategies and policies.

BACKGROUND

Govuro district is located in the north of Inhambane Province, about 431 Km from the capital Inhambane, South of Mozambique (**Map 1**). The district borders in the south the districts of Inhassoro, in the North the district of Machanga (in Sofala Province) through Save River, in the east the Indian Ocean and in the west the district of Mabote. Govuro covers an area of 3.961 km^2 (MAE, 2005) and according to the last population census, about 34.494 inhabitants leave in the district and the population density is 9 inhabitants per km^2. About 55% of the populations are women and 45% are youths under 15 year (INE, 2007).

The district is dived in two Administrative Posts, namely Save and Nova Mambone (**Map 1**) and five localities (Jofane, Luído, Machacame, Pande and Nova Mambone).

The climate in the area is tropical dry type and humid, as it approaches the coast, with two seasons: hot and rainy from October to March and fresh and dry from April to September (MAE, 2005).

The coastal zone of the district with rough and permeable soils is favourable for agriculture and livestock farming, presenting medium temperatures between 18 ^oC to 33 ^oC. The annual medium precipitation in the rain season (October to March) is 1500mm, with more incidence in the months of February and March, were floods occasionally occur. The inland zone is characterized by the occurrence of sandy and sandy-clay soils and an average annual rainfall of 1000mm to 1200mm, with high temperatures, which cause water scarce (MAE, 2005).

The main economic activity is a subsistence agriculture, which normally takes place between October and April. Generally, agriculture is practiced in small family farms on a mixed cropping systems based on local varieties.

The predominant type of farming in Govuro is the bush fallow system, with holdings ranging from 0.5 to 2 ha. Up to 10 different crops are traditionally grown in mixed stands in one season, with rain fed upland rice dominating. Cassava, maize and rice are grown as substance crops. The level of mechanization is almost nil and as a rule, fields are worked using traditional tools like hoe.

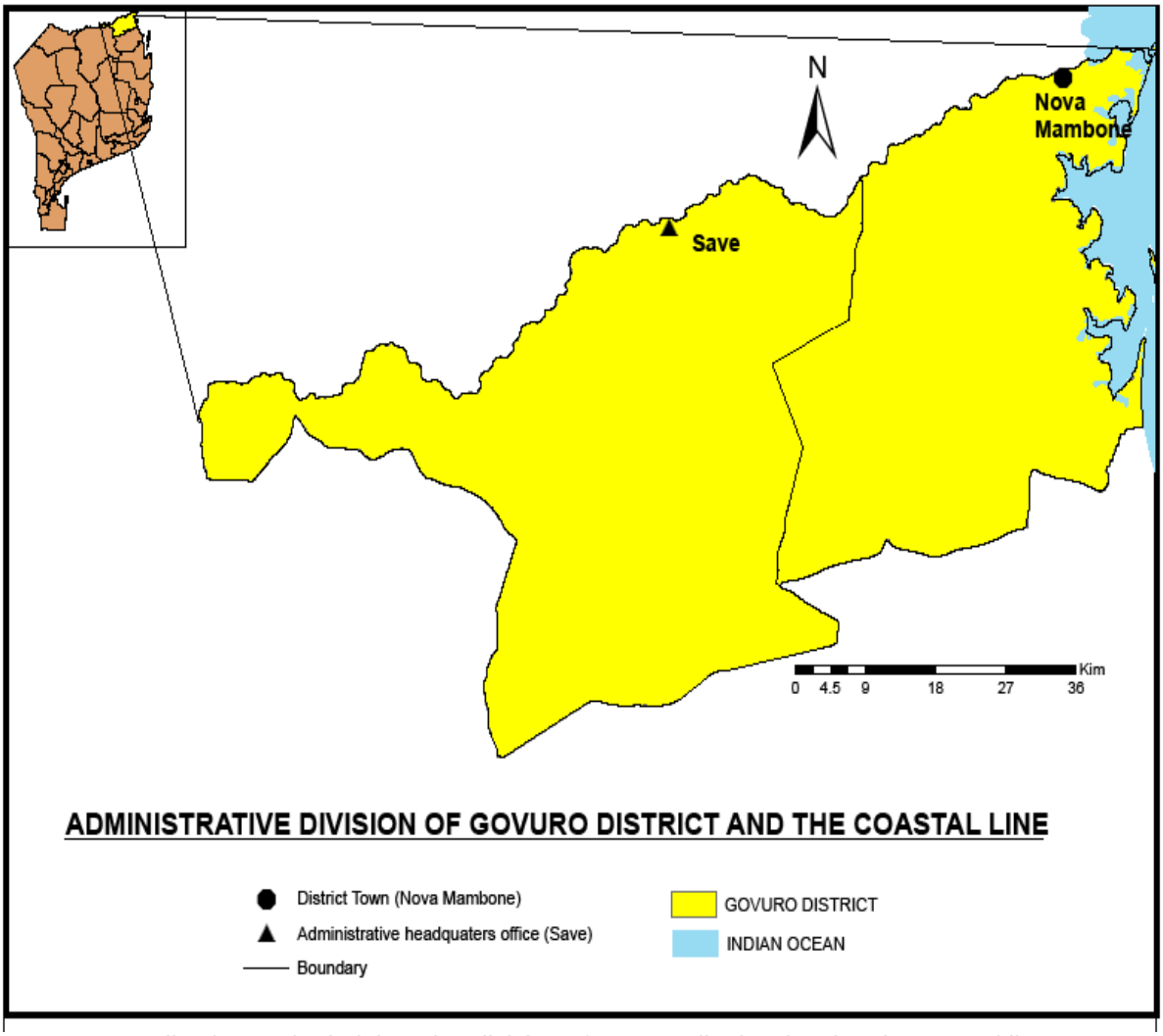
The irregularity of rainfall and the greatest vulnerability to natural disasters affects the agricultural production potential in the district. The changes in the temporal and spatial distribution of rainfall has adversely affected agriculture and food production of farming communities both directly through changes in agro-ecological conditions; and indirectly by affecting growth and distribution of incomes; and thus demand for agricultural produce.

Fishing and raising livestock are secondary activities. Fishery problems in the area include: over-fishing; use of destructive fishing methods like trawling and small-meshed nets and destruction of nursery areas (mangroves) by floods, cyclones and for

construction. The use of destructive fishing methods and the frequency of hazards is affecting the fishing stock and consequently the livelihood of local community.

The livelihood strategies adopted by families are incomes diversification from sources such as agricultural, fishing, livestock keeping, charcoal and wood production. The majority of the population in Nova Mambone relies on natural resources (sale of forest products such as fruits, vegetables, firewood, charcoal) for their subsistence and those resources are not enough to meet the people needs.

Livestock keepers hold small to medium herds of cattle, about 5 to 200 herds per family. Overall in Govuro there are 7.000 cattle, of which 4.000 of the private sector and remaining 3.000 in the family sector. Traditional practices encourage keeping large herds of livestock as a sign of wealth and power. Other livestock include pigs and goats though in smaller numbers than cattle. The district has in the past experienced outbreaks of foot and mouth disease. Logging, harvesting of wood for poles, firewood and charcoal are the main non-agricultural income generating activities.



Map 1: Localization and administrative division of Govuro district showing the coastal line

METHODOLOGY

The process of gathering information for this report included a review and analysis of available baseline data on the project area and information relevant to the study on climate change and variability, its impacts on livelihoods and coping strategies. A field work data collection were also done between 5th to 16th January 2010 in Nova Mambone and Panda Localities, Govuro District, Inhambane province and involved 5 technicians: 3 from CDS Zonas Costeiras, 1 provincial technician (from Inhambane) and 1 district technician.

Data from field work was obtained trough inquiries to the staff working in the district and consultations from different groups of the community. There were conducted two consultation meetings, one in Nova Mambone and another in Panda localities and it was attended by various community groups such as men, women, elders, youth, community and religious leaders, NGOs and associations.

A Community-Based Risk Screening Tool – Adaptation and Livelihoods (CRiSTAL) was used during the community consultations. Apart from CRiSTAL, the other tools used on field were the seasonal calendar and vulnerability matrices (see in the annex) and the Climate Vulnerability and Capacity Analysis (CVCA) (**Table 1**).

Table 1. Summary of tools used during field work

Tool	*Objectives*	*For more information*
Seasonal Calendar	- To understand what is "normal" rainfall/temperature from the perspective of community members - To examine trends in rainfall/temperature - To brainstorm on future rainfall / temperature scenarios and potential responses - To evaluate use of climate information for planning	See Annex 1, Field Guide 1.
Vulnerability Matrix	- To determine the hazards that have the most serious impact on important livelihoods resources - To determine which livelihoods resources are most vulnerable - To discuss who has control over and access to livelihoods resources - To identify coping strategies currently used to address the hazards identified, and explore new potential strategies	See Annex 2, Field Guide 2.
CRiSTAL (Community Based Risk Screening Tool – Adaptation and Livelihoods)	- To better understand linkages between livelihoods, climate and project / proposed activities - To identify which livelihood resources are most vulnerable to climate hazards, and which resources are important for adaptation - To assist project planners and managers in making project / programme adjustments to improve its impact on community resilience to climate change	www.cristaltool.org
CVCA (Climate Vulnerability and Capacity Analysis)	- To analyze vulnerability to climate change and adaptive capacity at the community level, based on a framework of 'enabling factors' for community-based adaptation - To combine community knowledge and scientific data to yield greater understanding about local impacts of climate change	http://www.careclimatechange.org/cvca

The information collected was then compiled and introduced in the CRiSTAL software and finally analyzed to produce this report.

GENERAL CLIMATE INFORMATION FOR MOZAMBIQUE AND STUDY AREA

Mozambique is located on the eastern coast of southern Africa between 10°S and 26°S, 30°E and 40°E. The climate is mostly tropical, characterized by two seasons; a cool and dry season from May to September and a hot and humid season between October and April. The rainfall distribution in the country follows a east-west gradient, with more abundant rainfall along the coast, where the annual average varies between 800 and 2000mm, reaching as high as 1500mm on the coastal areas of Beira and Quelimane (INGC, 2009).

Seasonal variations in temperature are around 5° between the coolest months (June, July and August) and the warmest months (December, January and February). Geographically, temperatures are warmer near to the coast, and in the southern, lowland regions compared with the inland regions of higher elevation. Average temperatures in these lowland parts of the country are around 25-27°C in the summer and 20-25°C in winter. The inland and higher altitude northern regions of Mozambique experience cooler average temperatures of 20-25°C in the summer, and 15-20°C in winter ((McSweeney, C. et al. 2008).

The wet season lasts from November to April, coinciding with the warmer months of the year. The Inter-tropical Convergence Zone (ITCZ) is positioned over the north of the country at this time of year, bringing 150-300mm of rainfall per month whilst the south receives 50-150mm per month. Topographical influences, however, cause local variations to this north-south rainfall gradient with the highest altitude regions receiving the highest rainfalls (INGC, 2009).

The South of Mozambique is generally drier, more so inland than towards the coast, with an average rainfall lower than 800mm, decreasing to as low as 300mm in Pafuri District, Gaza province (INGC, 2009).

Mozambique's coastal regions are in the path of highly destructive tropical cyclones that occur during the wet season, and which are often associated with heavy rainfall events that may contribute a significant proportion of annual rainfall in a very short period. Considering the 1980-2007 period the number of landfalling cyclones in Mozambique was fifteen (15), eight (8) of which made landfall in the central districts of the country while 4 and 3 made landfall respectively in the northern and southern regions (INGC, 2009).

Inter-annual variability in the wet-season rainfall in Mozambique is also strongly influenced by Indian Ocean Sea Surface Temperatures, which can vary from one year to another due to variations in patterns of atmospheric and oceanic circulation. The most well documented cause of this variability is the El Niño Southern Oscillation (ENSO) which causes warmer and drier than average conditions in the wet season of Eastern Southern Africa in its warm phase (El Niño) and relatively cold and wet conditions in its cold phase - La Niña (McSweeney, C. et al. 2008).

Govuro is a coastal district with rough and permeable soils, favourable for agriculture and livestock farming, presenting medium temperatures between 18 oC to 33 oC. The climate in the area is tropical dry type and humid, as it approaches the coast, with two seasons: hot and rainy from October to March and fresh or dry from April to September The annual medium precipitation in the rain season (October to March) is 1500mm, with more incidence in the months of February and March, were floods occasionally occur. The inland zone is characterized by the occurrence of sandy and sandy-clay soils and an average annual rainfall of 1000mm to 1200mm, with high temperatures, which cause water scarce (MAE, 2005).

Mozambique has serious problems regarding the number of climatologic stations and the regularity in local climate data collection. INGC (2009) notes that the approximate station density is 1 station to 29, 000km^2, a small density if compared with South Africa (approximately 1 station every 1,000 km^2).

OBSERVATIONS OF CLIMATE VARIABILITY AND CHANGE IN MOZAMBIQUE AND STUDY AREA

Rainfall variability

Most of the rainfall in Mozambique occurs during the Southern Hemisphere summer, from October to April. Two seasons are usually distinguished, early summer (October to December) and late summer season (January to March). During the rainy season, the highest values in amount of rainfall occur in January, February and March, corresponding about 45% of the total annual rainfall. Such precipitation is generally caused by migration and activity of the Intertropical Convergence Zone (ITCZ). In north region typical values of monthly average rainfall are 20–200 mm/month in wet season and 5–30 mm/month in dry season. The central has approximately 30–200 mm/month for wet period and 20–40 mm/month in dry period. The south has the lowest recorded values of about 40–130 mm/month in wet season and 20–40 mm/month in the dry season (INGC 2009).

The coastal region has significant rainfall of about 40–200 mm/month in wet season and 20–60 mm/month in dry season (INGC 2009). In the costal south where Govuro is located, the recorded values are about 71–151 mm/month in wet season and 27–63 mm/month in the dry season (**Figure 1**).

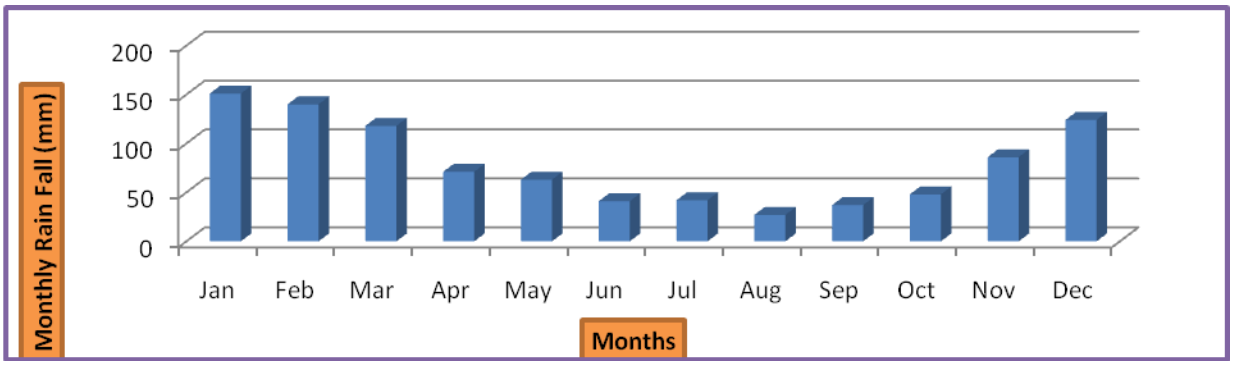


Figure 1: Seasonal variation of monthly mean rainfall in the Coastal South of Mozambique. (Source: INGC, 2009)

The mean annual rainfall over Mozambique has decreased at an average rate of 2.5mm per month (3.1%) per decade between 1960 and 2006.

In **Figure 2**, is shown the annual mean values of precipitation observed in the coastal of Mozambique from 1960-2006. The coastal region receive around 800 –1200mm/year, with the central coast receiving an exceptional values well above 1500mm. An inter-annual variability is also evident in this region with annual means of about 700mm (e.g. 1970, 1992, 2002) and well above 1000mm (e. g. 1967, 1978, 1999, 2000) being recorded.

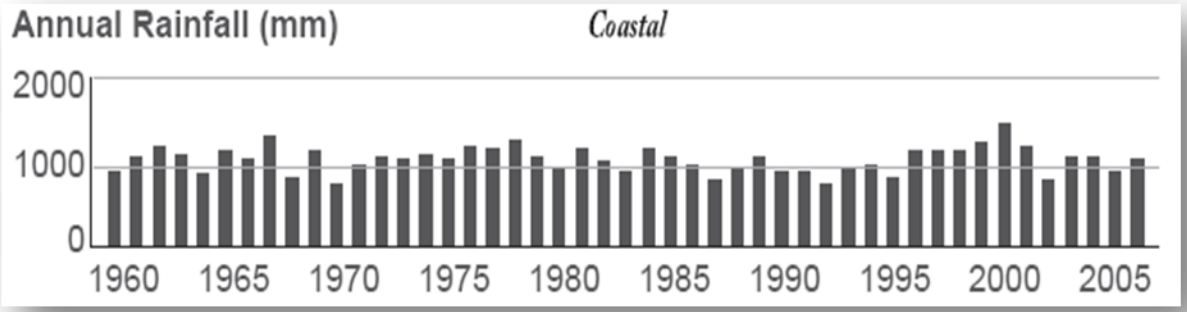


Figure 2: Annual observed precipitation in the coastal region of Mozambique (Source: INGC, 2009)

The daily precipitation observations indicate that despite observed decreases in total rainfall, the proportion of rainfall falling in heavy events has increased at an average rate of 2.6% and 5-day maximum annual rainfall have increased by 8.4 mm per decade (McSweeney, C. et al. 2008).

Rocha and Simmonds, 1997 cited by INGC, 2009 says that extremes of inter-annual climate variability can often create stress in many aspects of human life. In **Figure 3**, rainfall deviations from the climatological average in coastal region, indicates whether extreme events, such as floods and droughts, occurred in each year.

Coastal rainfall deviations (**Figure 3**) are characterized by the similar signature of the south region (**Figure 4**), may be due to high data density in the South compared with the Centre and North. The South region is characterized by high frequency of droughts with extensive drought periods during the early 80's and late 90's (**Figure 4**).

It is important to note that whilst droughts are more common in the south, the magnitude of floods in this region can be very high and cause high damages (INGC, 2009).

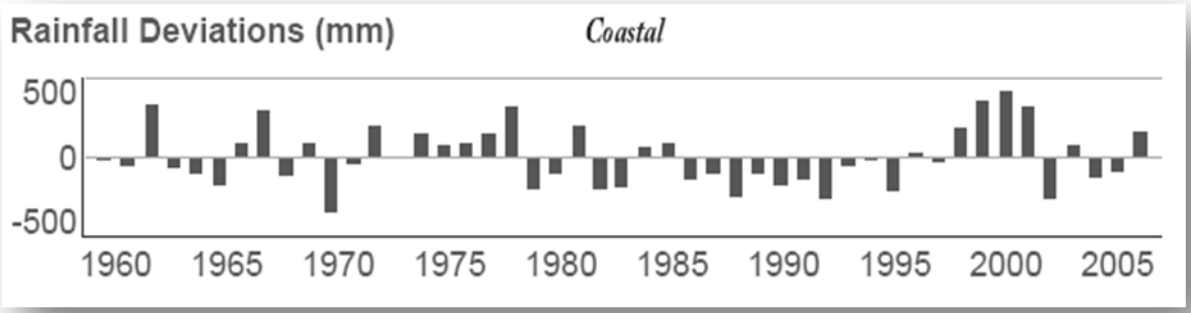


Figure 3: Rainfall deviations showing the likelihood for occurrence of floods and droughts in the coastal region of Mozambique (Source: INGC, 2009)

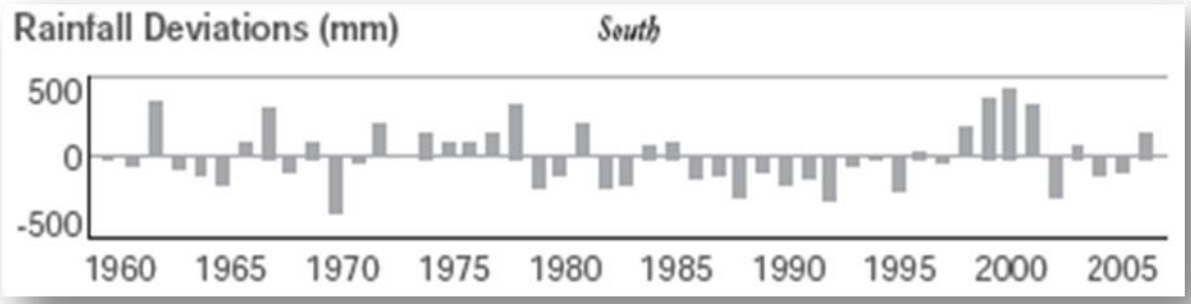


Figure 4: Rainfall deviations showing the likelihood for occurrence of floods and droughts in the South region of Mozambique (Source: INGC, 2009)

Combined effects of drought and floods in the area have a negative impact on the livelihood system of the communities.

There are reports of both decreasing rainfall and more unpredictable rainfall pattern; consequently, there is an increasing chance of crop failure. Meanwhile, heavy and excessive rains also occur occasionally in the district, causing the water level of the Save River to rise. This causes large areas of lowland zones to become flooded, including farms that are usually established along the flood plains.

The floods that hit Govuro in 2000/01 were devastating, leading to almost total loss of the agricultural season and affected the entire population of the district and causing the deaths of 96 people in the district (MAE, 2005). The communities are thus very much affected by climate variability and are extremely vulnerable to the anticipated impacts of climate change.

Temperature variability

In general country wide monthly minimum average temperatures range between 18 - 22°C in summer and 14-18°C in winter. Furthermore the northern region has the lowest recorded minimum temperatures. Monthly maximum average temperatures are typically between 28-32 °C in summer and 24-28°C in winter (**Figure 5**). It is noted that between May and September is the period with lower temperatures (winter), October and April with high temperatures (summer). The central and coastal has the highest maximum temperatures along the country (INGC, 2009).

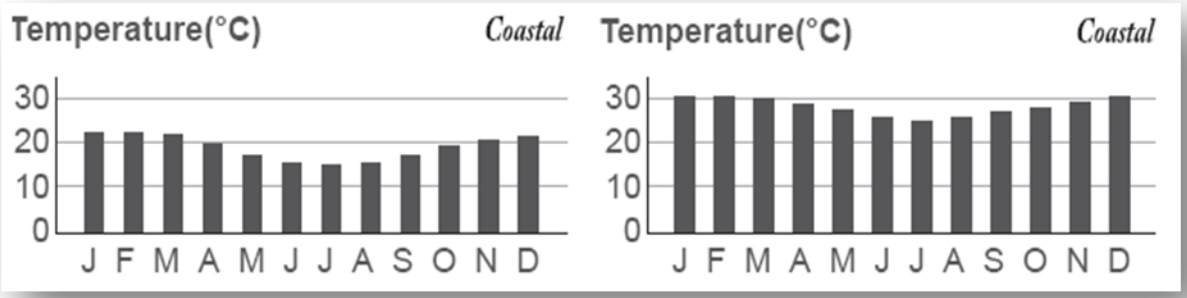


Figure 5: Seasonal variation of minimum and maximum averages temperatures in the Coastal region of Mozambique (Source: INGC, 2009)

Annual means of both minimum and maximum temperatures from 1960 to 2006 shows significant changes, particularly from the early 1990's (**Figure 6**). Annual mean minimum temperatures show noticeable increase in the northern and southern regions (INGC 2009). The mean annual temperature has increased by 0.6°C since between 1960 and 2006, an average rate of 0.13°C per decade while daily temperature observations show significantly increasing trends in the frequency of 'hot' days and nights in all seasons.

McSweeney, C. et al. (2008), observes that the average number of 'hot' days per year in Mozambique has increased by 25 (an additional 6.8% of days) between 1960 and 2003. On the other hand, the average number of 'hot' nights per year have increased by 31 (an additional 8.4% of nights) between 1960 and 2003. The rate of increase is seen most strongly in December to February when the average number of hot DJF nights has increased by 3.6 days per month (an additional 11.6% of December to February nights) over this period.

The frequency of cold days and nights have decreased significantly since 1960 in most of the seasons with the average number of 'cold 'days per year decreasing by 14 (3.9% of days) between 1960 and 2003. On the other hand the average number of 'cold' nights per year has decreased by 27 (7.4% of days) (McSweeney, C. et al. 2008).

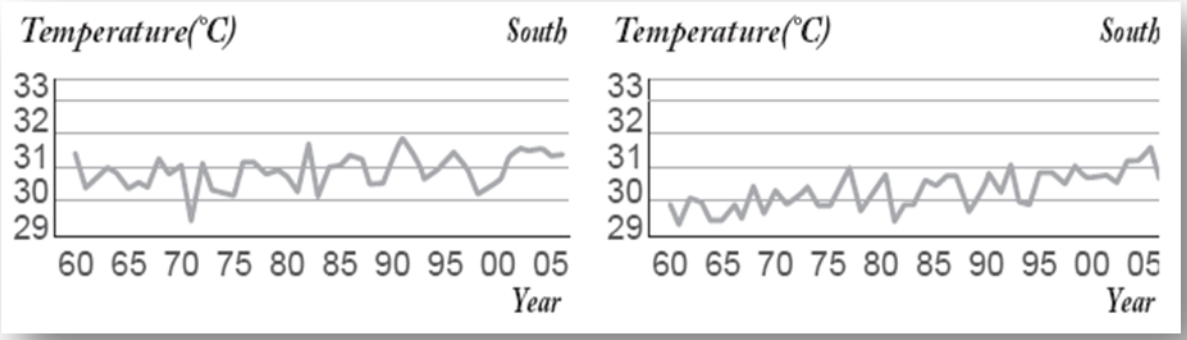


Figure 6: Annual mean maximum temperature (left) and annual mean minimum temperature (right) for north, central and south Mozambique (Source: INGC, 2009)

GLOBAL CIRCULATION MODELS PROJECTIONS OF FUTURE CLIMATE FOR MOZAMBIQUE

The climate messages presented here are based on analyzing: observed data collected from 32 weather stations across Mozambique since 1960. This data is used for downscaling projections of future climate; only 27 of the 32 stations had sufficient temperature and rainfall data for statistical downscaling to be applied. Important challenges and considerations related to these messages are limited coverage of station data over the country (especially in Gaza and Tete provinces), with an average station density of 1 station every 29,000 km2 (as compared with 1 station every 1000 km2 in South Africa), although there is obviously not an even spread (the majority are along the coast of Mozambique).

Future Temperature

All the models show an expected increase in temperatures between now and the middle of the century (i.e. 2046-2065). These increases in temperature are expected to be higher inland than in the coastal areas it seems that temperatures in the September - November period i.e. spring will increase by the most - an increase of 2.5 - 3 ^{o}C in some places. By the end of the century (i.e. 2081-2100) spring time temperatures in the central region may have risen by as much as 5 - 6 ^{o}C. The models suggest that the likelihood of experiencing extremely hot days (that is days with a maximum temperature over 35 ^{o}C) will increase over all parts of the country, by about 7% by the middle of the century and 25-33% by the end of the century.

According to McSweeney, C. et al. (2008), the mean annual temperature is projected to increase by 1.0 to 2.8°C by the 2060s, and 1.4 to 4.6°C by the 2090s. Under a single emissions scenario, the projected changes from different models span a range of up to 1.8°C.

Annual, projections indicate that 'hot' days will occur on 17-35% of days by the 2060s, and 20-53% of days by the 2090s. Days considered 'hot' by current climate standards are projected to occur in 26-76% of days by the 2090s. Nights that are considered 'hot' for the annual climate of 1970-99 are projected to increase more quickly that hot days, occurring on 25-45% of nights by the 2060s and 29-69% of nights by the 2090s. Nights that are considered hot for each season by 1970-99 standards are projected to increase most rapidly in DJF, occurring on 47-97% of nights in every season by the 2090s.

According to McSweeney, C. et al. 2008, all projections indicate decreases in the frequency of days and nights that are considered 'cold' in current climate. These events are expected to become exceedingly rare, and do not occur at all under the highest emissions scenario (A2) by the 2090s.

Future Rainfall

Downscaled projects from 7 Global Circulation Models (GCMs) suggest an increase in rainfall in the December-May period between now and the middle and end of this century, particularly in the coastal areas, but the spread of models is large, in other words some are showing a big increase, some a much smaller increase, and a few even suggesting a possible decrease.

Projections of mean rainfall do not indicate substantial changes in annual rainfall. The range of projections from different models is large and straddles both negative and positive changes (-15 to +20mm per month, or -15% to +34%). Seasonally, the projections show a more coherent picture, with the projections tending towards decreases in dry season rainfall occurring during September to November, offset partially by increases in wet season rainfall occurring in December, January and February (McSweeney, C. et al. 2008).

Projected rainfall changes in the months of June to August range from -54 to +19% with ensemble median changes of -11 to -24% and during September to November, -48 to +26% with ensemble median values -10 to -12%. Projected changes in the December to February rainfall range from -9 to +25% with ensemble median values of +1 to +8%. The increases in December to February rainfall are largest in the north of Mozambique (McSweeney, C. et al. 2008).

Overall, the models consistently project increases in the proportion of rainfall that falls in heavy events in the annual average under the higher emissions scenarios, of up to 15% by the 2090s. The proportion of total rainfall that falls in heavy events is projected to increase in during December to February in projections from all models and all

scenarios, by up to 18%. Models are also broadly consistent in indicating increases in March to May rainfall, but decreases in June to August rainfall and September to November rainfall (McSweeney, C. et al. 2008).

The models consistently project increases in 1- and 5-day rainfall maxima by the 2090s under the higher emissions scenarios of up to 20mm in 1-day events, and 34mm in 5-day events. These also generally increase in the December to February rainfall and March to May rainfall, but decrease in June to August rainfall and September to November (McSweeney, C. et al. 2008).

Linking Temperature and Rainfall

In order to try and understand the possible combined effect of changing temperatures and rainfall in a given area researchers explore changes in evaporation rates i.e. how quickly water is 'lost' from liquid on/in the ground (that humans, plants, animals easily use) to vapour in the air. For all regions in Mozambique it seems that increases in evaporation will be greater than increases in rainfall during the winter and early summer (June-November), which means that the dry season will be even drier (especially over the central region) (Tadross, 2009).

NATURAL RESOURCES USE IN NOVA MAMBONE AND PANDE LOCALITIES

Fishing

Traditional fishing is the principal economic activity of the Nova Mambone community, which is closest to the sea, occupying over 60% of the population. Fishing provides an important source of protein for families living in Nova Mambone. Even without sophisticated equipment and methods, the fisherman do not only manage to satisfy personal needs but can also dry some of the fish to sell to people locally and to other communities as well. The type of fishing practised is hand trawling to the beach (**Figure 7**). Other frequently used methods include fishing with hook and line. Large varieties of fish are caught in the sea (**Figure 7**) and are often dried and stored for later consumption.

Fishing practise (hand trawling to the beach)

Type of fish in Nova Mambone

Figure 7: Fishing practise and type of fish caught in Nova Mambone

According to local fishermen, it is becoming more difficult to catch fish in the last 5 years. This suggest that the current level of fishing my be unsustainable.

Hunting

Hunting is an activity practised by Pande community witch is far from the sea. All residents are aware that hunting is prohibited. Through informal conversation, we learned that many families depend on game meat for their subsistence (**Figure 8**), but all survey respondents denied hunting, apparently for fear of incrimination.

Prior to modern hunting laws the traditional hunting method was for small bands of 4-5 hunters to go to the bush for a co-ordinated hunting effort, with results to be shared among the larger community on return. Now this system is illegal the practical result is that an organized public system being replaced by a situation in which individuals may act independently to hunt discreetly according to personal needs.

Figure 8: Sale of game animals in Pande locality

The most commonly hunted animals are grey duiker, impala and wild pig. Animals are caught using wire snares, which are set and shacked periodically or less often, bow and arrow. Hunting is likely to have cultural or non-use values in addition to direct use values of meat consumption. At least in the past, hunts were preceded by traditional ceremonies among men.

Reports by the community indicate that even the current level of hunting my be unsustainable and the number of animals is declining. These reports merit further inquiry. Better estimates of animal population are needed as well as the level of hunting that is occurring.

Wild Plants

More than forty plant species are collected in Nova Mambone and Pande localities for use as food, drinks, construction, firewood, coal, crafts and medicine. Some of the more important species include palm (*hyphaen coreacea*), marula (*Screrocarya birrea*), lebombo ironwood (*Androstachys johnsonii*), pod mahogany (*Afzelia quanzensis*), black monkey orange (*Strychnos madagascariensis*), spine-leaved monkey orange (*Strychnos pungens*) and mopane (*Colophosphermum mopane*) (**Figure 9**).

Hyphaene coreacia (used to make local drink, crafts)	*Screrocarya birrea* (used to make local drink)	*Strychnos pungens* (used for food)	*Afzelia quanzensis* (used for wood, construction)

Figure 9: Some of the most used plants in Nova Mambone

Wild foods comprise an important part of the diet of families living in Nova Mambone and Pande, particularly during the disaster period (floods or drought). The most commonly collected fruit for food is black monkey orange (*Strychnos madagascariensis*). Onother important food is the seed of marula (*Screrocarya birrea*).

The local palm wine (uchema), is a vital part of the area`s economy. Many households produce and cell palm wine regularly. Palm wine is not only produced by many households but also it is produced in large quantities.

Plants and trees also are collected for construction and craft making. Families harvest them for making poles, mats, pestles, household utensils, fishing traps, sieves, and constructing their houses (**Figure 10**).

mats

household utensils

Construction of houses

Figure 10: Use of plants in Govuro (craft making and construction)

ANALYSIS OF CURRENT CLIMATE CHANGE VULNERABILITY

Exposure to climate Hazards

Climate change exposure is assessed by addressing three aspects namely; magnitude, character and rate of climate change in a given geographic area of concern. Due to the lack of long-term and/or continuous meteorological records in many parts of the developing world and due to the lack of scientific climate change projections at the scale of interest (projections are usually only available at the regional or national scale and there are often very high uncertainties when downscaling projections at smaller scales), scientific information is often insufficient to analyze exposure of local communities to climate hazards and change. This scientific information needs to be complemented by an analysis of local-level climate perceptions, through consultations with communities and other local actors who are at the frontlines of climate change.

Plot timing of rainfall and temperature in past years

A calendar for recent four years (2006-2009) was developed to understand the rainfall patterns and temperature observations throughout the year that the community of Nova Mambone and Pande localities is experiencing (**Table 2**).

Tabela 2: Seasonal Calendar

	MONTHS	J	F	M	A	M	J	J	A	S	O	N	D	Notes on Quality, intensity, variability, seasonality and shifts in Rainfall, temperature, wind and diseases
YEARS														
2009	Rainfall	IR	IR	IR	IR	NR								IR – Intensive Rain NR – Normal Rain (enough to plant and harvest from the farms)
	Temperature	NH	NH	NH	NH	C	C	C	NH	NH	NH	NH	NH	NH – Normal Hot C- Cold
	Flood													No floods registered
	Drought													No droughts
	Cyclone													No cyclone
2008	Rainfall	IR	IR	NR							NR	NR	NR	Good harvest from the farms
	Temperature	NH	NH	NH	NH	C	C	C	NH	NH	NH	NH	NH	
	Flood	F												Human, livestock and crop loss. People removal
	Drought													No droughts
	Cyclone													No cyclone
2007	Rainfall		IR	IR								NR	IR	
	Temperature	VH	NH	NH	NH	C	C	C	NH	NH	NH	NH	NH	
	Flood												F	Human, livestock and crop loss. People removal
	Drought	D												No harvest from the farms
	Cyclone			Cycl										Loss of infrastructure: Houses, schools…..
2006	Rainfall	IR	IR	IR								NR	IR	Good harvest from the farms
	Temperature	NH	NH	NH	NH	C	C	C	NH	NH	NH	NH	NH	
	Flood													No floods (Good harvest from the farms)
	Drought													No droughts (Good harvest from the farms)
	Cyclone													No cyclone

Main climate related hazards

The three main climate related hazards pointed out by the community in Nova Mambone and Pande are floods, droughts and tropical cyclones. According to the community, between December 2007 and January 2008 there were floods, in January 2007 there were drought and in March 2007 there were a tropical cyclone (**Table 2**).

During the consultations the community mentioned that the floods are becoming more frequent and the drought period is becoming longer with time. They also observed that extreme heat is becoming worse. In relation to cyclone they mentioned that the frequency is not increasing.

According to local perceptions, temperatures have increased significantly both day and night over the years. The elders reported that daily hotness used to occur mainly in the afternoon, but now begin much earlier in the mornings while night temperatures are also warmer than before from September to March. The hottest months are also the months when the area receives rainfall, a challenge to crop and pasture growth due to high evaporation and evapo-transpiration leading to quick loss of soil moisture soon after it rains and consequently loss of crop production.

The communities have also reported irregularity in rainfall. Rains which used to start in October have been observed to now start later in December and tend to end earlier than before in February. Combined effects of floods and droughts have increased since 2000 in the project area. According to the community, floods have become more frequent and more severe, interfering in farming.

The mentioned hazards by the communities and their perceptions of the climate variability are in line with the projections for the country. For instance community observations of increasing temperatures are consistent with scientific observations and projections for Mozambique as whole and the increasing frequency of drought are consistent with climate change projections for southern Mozambique. Due to lack of local climatic data it is not possible to downscale predictions to the district or community level.

Impacts of climate-related hazards and climate variability on livelihoods in Nova Mambone and Pande communities

Climate-related hazards such as floods, droughts, cyclones and extreme temperatures affect more people and cause more losses globally than all other natural hazards combined. Disasters exact an enormous toll not only on lives, but also on livelihoods, homes, basic services and infrastructure.

In Nova Mambone, the community main livelihood is based on fishery and farming (livestock and crop production), while in Pande, the community main livelihood is based on farming including crop and livestock production.

The impacts of the main hazards affecting the community in Nova Mambone and Pande are summarized in **Table 3**.

Table 3. Impacts of climate related hazards in Nova Mambone and Pande

Hazard	Impacts
Floods	Human loss
	Crop loss
	Livestock loss
	Damage to Infrastructure
	Lack of drinking water
	Increased human disease (diarrheal diseases)
	Loss of mangrove
Cyclone	Damage to crop
	Damage to Infrastructure
	Damage to trees
	Loss of soil moisture
	Human disease
Drought	Water scarcity
	Crop failure
	Death of livestock
	Shortage of pasture
	Livestock weight loss
	Increased disease
	Food insecurity
	Decreased availability of forest products
	Decreased livestock price
	Decreased incomes
Extreme Heat	Crop loss
	Poor crop growth
	Poor condition of livestock (leading to loss of weight and death)
	Decreased water availability
	Poor pasture growth
	Decreased pasture availability
	Increased human and livestock disease
	Decreased incomes

This exposure analysis clearly indicates that the community in Nova Mambone Administrative Post has been highly exposed to the climate change hazards of Flood, drought, extreme heat, occasional Cyclone and the impacts on their livelihoods are already being felt.

SENSITIVITY TO CLIMATE HAZARDS

Sensitivity to climate change is the degree to which a community is adversely or beneficially affected by climate-related stimuli. It mainly depends on the main livelihood activities of the community (including its dependence on livestock and rain-fed agriculture), its key livelihood resources, and the impacts of climate hazards on these key resources.

In Nova Mambone the communities are mainly artisanal fishers and farmers and in Pande, the communities are mainly subsistence farmers growing crops and keeping livestock. In Pande community, the main crops grown as identified by the community consulted include Maize, Rice, sorghum, beans, Groundnuts, Pineapple, Pumpkin, Watermelon, Sweet potato and banana. The common livestock include cattle, goat, chickens and ducks.

Based on several fish resources assessment surveys carried out in the study area, four major fish fauna groups have been identified according to their habitats, namely demersal resources (species associated with the benthic habitats), small pelagic resources (species that dwell in the water column), large pelagic resources and mesopelagic resources.

According to the communities, fishing production is decreasing but when asked if it is due to climate change, they said is more related to man made causes than natural, besides the destruction of large areas of mangroves by floods in the year 2000. Fishery problems in the area include: over-fishing; use of destructive fishing methods like trawling and small-meshed nets.

Climate change impacts on fisheries cannot be understood without considering fishing pressures. A number of threats to fish production have been identified, but how this will transfer into fisheries production remains unclear. Climate variability is a major determinant of fish distribution and abundance, but how these affect fisheries varies from region to region. The frequency and intensity of extreme events can alter fisheries and aquaculture production. Temperature extremes or changes in water salinity are shown as examples of the kind of extremes that could affect this sector.

Both livestock and crop production are considered to be highly climate-sensitive as they are impacted by changes in rainfall patterns, water accumulation, extreme events, ecology of pests and diseases, temperature, and carbon dioxide concentrations.

The community in Nova Mambone and Pande reported that farming activities have been negatively affected by the combined effects of floods and droughts and less reliable rainfall to the extent that some members of the community do not consider farming as a viable livelihood activity. Maize and rice are the main and preferred crop grown by the community in Pande and Nova Mambone respectively and the community are using local varieties which are not suitable to the changing agro-conditions.

The three key livelihood activities (Rain-fed crop farming, fishing and traditional livestock keeping) for the community in Nova Mambone and Pande, are highly sensitive to the climate hazards being experienced and as such climate change is posing a serious challenge to the community wellbeing. A more detailed sensitivity review of the community to climate hazards is demonstrated through an analysis of the impact of the hazards on key livelihood resources for the community.

The impact of frequent droughts have also affected livestock due to reduced pastures and water as most of the traditional livestock management practices in Nova Mambone and Pande, depend on communal grazing areas with minimal or no supplementary feeding. The pasture and water available for livestock has become scarce leading to poor condition of livestock and an increase in livestock diseases.

Water availability is a key resource for agriculture. Rain-fed crops dominate agriculture production in the area and droughts are a major threat to these food-producing systems. Droughts have been increasing and are expected to continue doing so, thus directly affecting rain-fed crops. Increases in drought in rangelands can have large effects on animal mortality, and increase land degradation.

Much of the most productive land in Nova Mambone is in the low lands and is subject to inundations. Tropical storms, with their strong winds and heavy rain threaten many highly productive areas, as well as human infrastructures. Heavy rainfall can originate excess soil moisture and increase production losses. Increase flooding in low-land can equally reduce crop productivity.

The main livelihood resources identified by the communities in Nova Mambone and Pande are listed in **Table 4**. The resources highlighted are those that are already significantly affected by floods, cyclone, drought, extreme heat. As can be seen, most of the natural, financial and human resources on which the Nova Mambone and Pande communities depend are already significantly affected by climate-related hazards.

Table 4: Key Livelihood Resources impacted by Climate hazards (highlighted) and resources important for coping strategies (all).

Asset Type	Key livelihood Resources Identified
Natural	Farmland
	Water (sea, ponds and river)
	Forest
Physical	Farming implements
	Boats
	Roads
Financial	Sell of crop
	Sell of livestock
	Sell of forest products
	Sell of fish
Human	Farming skills
	Educational skills
	Health skills
Social	Associations (APEGO, AJOAGO, ADEGO, ACAGO)
	Saving and credit groups
	Church
	NGO's (CARE, Samaritans)

CURRENT IMPACTS ON LIVELIHOOD RESOURCES

Impacts on natural resources

Four natural resources namely farmland, forest and water (sea, ponds and river) are the most important natural resources in Nova Mambone and Pande. The Community and government officials are observing significant negative impacts of floods and drought on these natural resources and have all mentioned the increase in land degradation and declining availability, productivity and quality of pastures, crop land and water resources. This is due to changing environmental conditions (heavy precipitation, more frequent droughts, shorter rainy seasons), land degradation (due to the uncontrolled bushfires, overgrazing, and changing climatic conditions), deforestation (due to land clearing for crop production and charcoal production).

About two-thirds of the population collect water from ponds and river, and according to local community, both floods and droughts affect the availability of drinking water. During floods, there is a lot of water but is usually contaminated and is not suitable for human consumption. During the dry season, there is water scarcity because most of the rivers and ponds dry up, and no drinking water is available.

The crop production and grazing potential of the land has reducing due to shorter rainy seasons, frequent droughts, erratic rainfall and overgrazing. The water resources available for domestic use, livestock watering and farming has reduced tremendously resulting into low yields, poor condition of livestock and poor sanitation and hygiene

Frequent droughts in Nova Mambone and Pande have reduced the productivity, particularly, of wild fruits and vegetable on which many women depend for income generation. In addition, one of the major coping strategies undertaken by communities in times of drought is fire wood and charcoal selling (**Figure 11**) which lead to increased deforestation and loss of non-timber forest products among other forest services and products the community derives from the local forest.

Although small initiatives exist to incentive planting trees in schools, tree planting (or reforestation) does not seem to be a common activity in the area, and very few community groups consulted identified it as a potential adaptation strategy in the face of future climate change.

firewood

charcoal

Figure 11: Sell of firewood and charcoal in Govuro District

Impacts on physical resources

Roads, farming implements and boats are the most important physical resources in Nova Mambone and Pande. Govuro district has road connection with the main points of the South and Center of the country through the National Highway EN1 (**Figure 12a**) and is served by road and sea. Few physical resources are impacted by drought, however, Impacts of flooding on transportation are particularly noteworthy. Flooded streets and roads block transportation and make it difficult for emergency vehicles to respond to calls for service. Floodwaters can washout sections of roadway and bridges **(Figure 12b)**. Most importantly, the majority of fatalities that occur in floods are the result of people trying to dry on roads covered by floodwaters.

a) Road access to Govuro District

b) Destruction of road by floods in the year 2000

Figure 12: The road in Govuro District

Impacts on financial resources

The main financial resources on which the communities in Nova Mambone and Pande depend on are, sale of crops, sale of fish (fresh or dry), sale of livestock (cattle, goats

and chickens) and sale of forest products (firewood and charcoal), including fruits and vegetables (**Figure 11 and 13**). These financial resources depend on climate-sensitive natural resources, such as pasture, farmland and forests, which are strongly impacted by floods, drought or extreme heat.

Sell of pineapple and maize

Sell of sweet potato and tomato

Sell of dry fish

Figure 13: Some financial resources in Govuro

According to local community, when flooding occurs during the growing season, farmers can suffer widespread crop loss, but in some cases, there may be an opportunity for a second planting of a less profitable crop. Livestock farmers lose their livestock because they are unable to find safety from rising floodwaters.

Drought leads to decreased pasture and water availability, access and quality, which in turn leads to livestock emaciation and death, reduced livestock productivity (in terms of milk and meat), decreased livestock disease resistance. Local community reported that amongst livestock species, cattle are especially vulnerable to climate change while goats and donkeys are more drought resistant and are less affected by pasture degradation.
Drought also leads to damage to plant communities, by loss of trees and increased number and severity of fires. In long term it can lead to loss of biodiversity, reducing the income of those who depend on forest.

Rice, millet and maize are cereal crops of preference even though the communities know that maize is not drought tolerant and does not produce good yields under the changing climatic conditions (floods or droughts). Rice is more cultivated in Nova Mambone community where more farmlands are located in a floodplain. Millet is also widely grown cereal crop and the farmers know is more drought resistant than maize. However, they prefer maize because millet and rice are more prone to bird attack and more difficult to process for eating. The other drought tolerant crops grown widely are cassava, sweet potato, groundnuts, water melon and pineapple. The drought tolerant crops and varieties will become important for coping to future climate conditions.

As stated by all community groups, when there is a flood or drought, income generated through livestock and crop sales is not sufficient anymore, leading to food insecurity and increased poverty. The community groups consulted seemed to agree that diversification of financial resources and income generating activities is key to adapting

to changing conditions, whether this means engaging in drought tolerant crops, firewood and charcoal selling, selling of livestock or wage labour.

Impacts on human resources

Floods and Droughts affect human resources which are important for people's livelihoods, including education, health, human labour and various abilities/capabilities. Crop loss due to floods or droughts, decreases the availability of food and affects local communities as this reduces human disease resistance, human labour productivity, and human capability to undertake different activities such as farming. Climate change related food insecurity may result in especially high health risks for women as they traditionally often eat last and least, making them susceptible to illness.

Impacts on social resources

The main social resources in the community are churches and NGOs. NGOs are said to assist the community in the provision of social services. In Govuro, there are very few NGOs and Civil Society Organizations operating in the areas of agriculture, livestock management and water supply.

The traditional resource management systems are important as most of the natural resources are communal with headmen and elders having control on the use of the resources for the benefit of all. These will require capacity building as the scarcity of water and forest resources may soon lead to conflicts between suitable harvesting and food security or survival with increased drought frequency.

Most of the climate hazards experienced in the area have no significant impacts on the social resources important to the community various areas.

IMPLICATIONS OF PROJECTED CLIMATE CHANGE FOR RURAL LIVELIHOODS IN GOVURO (FLOODS, DROUGHTS, CYCLONE AND EXTREME HEAT)

Carney (1998) as cited by the International Institute for Sustainable Development (IISD, 2003) defines livelihood as comprising the capabilities, assets and activities required for a means of living. IISD (2003), defines livelihood assets as the means of production available to a given community that can be used to generate material resources sufficient for the community's survival. In the definition, the five forms of livelihood assets are given as natural, social-political, human, physical and financial capital.

Govuro is located in the south of Mozambique and future climate change scenarios for this region is decreasing rainfall and increasing temperatures. Govuro is also a coastal district and according to future climate change scenarios, increasing rainfall is expected for this region. Overall, combined effects of droughts and floods can be expected for Govuro in future scenarios.

Natural resources occupy a predominant place in the lives of the community in Govuro. The success of their main livelihood activities (agriculture, fishery and livestock rearing) and their survival depend directly on the availability, quality, access and control over natural resources such as water, pastures, arable land, and forests/trees.

Govuro village is placed in a floodplain and any type of agricultural, commercial, or residential development located in a floodplain is vulnerable to flooding. Floodplains, as traditional areas of special importance for rural communities, offer favourable conditions for human settlement, economic development and assets for sustainable livelihood support. At the same time natural hazards threaten these areas as hazardous floods go hand in hand with economic and other livelihood activities (Adger 2000; Rolfe, 2006). The limited capacity of local communities to deal with the resulting disasters is one of the major challenges facing local authorities in Govuro.

According to local communities, vulnerability to floods is closely linked to access to resources because these are a principal means by which people reduce their vulnerability to famine. Climate variability is also a major problem for many rural communities where the majorities of the population still live and are directly and indirectly dependent on rain-fed agriculture.

Generally, significant correlation coefficients were noted between flood impact variables such as crop damages, dropping out of school by children (high absenteeism from school), flooding of homes and flood related illnesses and death, on the one hand, and proximity to the flood plains. A disease outbreak is usually associated with the disruption of the clean water supply and persistence of water in the low-lying areas, which created breeding places for mosquitoes (Gwimbi, 2009).

Climate variability and change has already had adverse effects on human health and these include: heat stress, vector-borne diseases such as malaria and water-borne diseases such as diarrheal. Climate change is likely to exacerbate the occurrence and intensity of these and other disease outbreaks.

Severe flooding can cause extensive damage to public utilities and disruptions to the delivery of services. Loss of power and communications can be expected. Flooded streets and roads block transportation and make it difficult for emergency vehicles to respond to calls for service. Floodwaters can washout sections of roadway and bridges.

Poor road infrastructure might also reduce market access for communities, thereby limiting their capacity to rapidly sell their livelihoods.

One of the most apparent impacts of projected climate change in Govuro is water shortages. The predicted reduction in precipitation and an increase in temperatures for Southern Mozambique will likely lead to enhanced water evaporation rates, as temperatures are already very high, thereby leading to increased water scarcity. This will affect human well being, agricultural production with potential widespread food insecurity. Increasing temperatures and more frequent hot days and nights projected, will likely affect pasture growth, availability and quality, as well as crop yields. Communities in Govuro (Pande) are already mentioning high temperatures as a key hazard, leading to decreased pasture availability (subsequently leading to pasture shortage, overgrazing, and land degradation), crops wilting and decreased crop yields.

There is strong linkage between climate change and agricultural productivity especially in poor rural communities who depend solely on rain-fed agriculture. This makes rural livelihoods extremely vulnerable in terms of food security as rainfall variability increase and the growing seasons shrink. Pasture and water for livestock is also impacted as these resources become scarce. With increasing environmental degradation, livestock populations in Govuro (Nova Mambone) may decrease in the long term. Some breeds of livestock may not cope well with extreme heat events and could suffer high mortality due to increased incidences of weather-related diseases.

More frequent and severe droughts, coupled with a degraded environment, scarcer water resources and decreased disease resistance will contribute to a decrease in body mass, reproductive capacity (in terms of the survival of young ones) and milk production.

In rural communities of Govuro, people and social structures are likely to be strongly affected by future climate change, mainly as a result of climate change impacts on key natural resources, crops and livestock. Significant impacts can be expected on human health and nutrition, social structures and interactions, and markets and prices. Changes in agro-ecological conditions and increases in extreme events (such as floods, droughts and extreme heat) might increase food assistance needs. Unless communities switch to improved livestock management and drought resistant crops, food security will become a serious challenge in Govuro.

Given the predictions that it will get hotter and dryer, sanitary and vector-transmitted diseases could change in distribution, range, prevalence, incidence and seasonality. Similarly, higher temperatures and increased rainfall intensity that may lead to flash floods might result in more water-borne diseases during the rainy season. However,

there remain high uncertainties regarding the impacts of future climate change on diseases.

With more frequent droughts in the area, pasture and water scarcity will impact negatively on livestock and production of maize. This has an adverse implication on the availability of food for home consumption as well as income to purchase food from nearby towns during bad harvest years. Therefore, with anticipated higher temperatures and increased rainfall unpredictability, combined with increasing land degradation, food security and nutritional challenges might increase in the future.

ADAPTIVE CAPACITY

Adaptive capacity is the capacity of a system to adapt if the environment where the system exists is changing. It is applied to e.g., ecological systems and human social systems.

The adaptive capacity of a community is its ability to adjust to climate change, to moderate or cope with the impacts, and to take advantages of the opportunities. Adaptive capacity is often a function of economic wealth, literacy rate, access to information, markets, technology, services and assistance, institutional capacity, and the underlying causes of vulnerability. In many developing countries, adaptive capacity in the face of climate change is very low, due to inadequate access to resources, technologies, services and information, and low institutional capacity.

One aspect to consider when looking at climate change impacts is the non-climatic factors which may lead to the same impacts or aggravate them. The vulnerability to climate change in Govuro is not only caused by climate change but through a combination of social, economic and other environmental factors that interact with climate change. The interaction of all these multiple stressors, make Govuro vulnerable to climate change and these vulnerabilities include population growth, limited alternative livelihood activities, environmental degradation, poverty, a lack of technical capacities, poor infrastructure and weak institutions.

Population growth

Natural resources are under increasing pressure as the population grow, leading to water shortages, soil exhaustion, loss of forests, air and water pollution, and degradation of coastlines. Improving living standards without destroying the environment is a global challenge.

Increasing human populations in the research areas and current imbalance between population density and available natural resources have been mentioned as drivers of vulnerability by community members and government officials in Govuro. Increasing human populations can be attributed to various factors, including immigration and settlement along the major road and coastal areas, leading to high population density pockets in some areas. With increasing populations, there is higher demand for harvesting of natural resources and for clearing of new farmland. All these lead to increased land degradation.

Environmental degradation

Environmental degradation is a result of the dynamic inters play of socio-economic, institutional and technological activities. Environmental changes may be driven by many

factors including economic growth, population growth, urbanization, intensification of agriculture, rising energy use and transportation.

Poverty still remains a problem at the root of several environmental problems in Govuro. Some climate change copping strategies being employed by the community (cutting trees to produce charcoal and firewood for sale (**Figure 11**) can contribute to further environmental degradation and reduce community resilience to climate change as resources become scarcer. Increasing deforestation rates, pasture and farmland degradation are important drivers of vulnerability in Govuro.

With forest loss, the local community also loses the system that performed valuable but often underappreciated services like ensuring the regular flow of clean water and protecting the community from flood and drought. The forest acts as a sort of sponge, soaking up rainfall brought by tropical storms while anchoring soils and releasing water at regular intervals. This regulating feature of forests can help moderate destructive flood and drought cycles that can occur when forests are cleared.

When forest cover is lost, runoff rapidly flows into streams, elevating river levels and subjecting downstream villages, cities, and agricultural fields to flooding, especially during the rainy season. During the dry season, such areas downstream of deforestation can be prone to months-long droughts which interrupt river navigation and wreak havoc on crops.

Recurrent drought increased felling of trees for firewood, charcoal production and overstocking which leads to overgrazing, agricultural expansion and inappropriate agricultural practices can lead to increased soil erosion, lower quality of pasture and farmland and reduced carrying capacity for livestock and humans per unit area. The increased frequency of droughts do not give rangelands enough time to recover, leaving large areas bare, thus susceptible to soil erosion by wind and water. Furthermore, when heavy intensive rains fall on bear soils, there is increased erosion and poor ground water recharge as the run-off is rapid. This also causes severe land degradation.

Poor access to infrastructure and services

The quality and coverage of infrastructure services such as electricity, water, sanitation, telecommunications and transport have a major impact on living standards and economic growth. At the most basic level, access problems occur when there is simply not effective transport infrastructure (sealed roads, useable railway lines, or ports) in place.

Govuro is served by road with very poor access in remote areas, making it extremely uncompetitive for communities in these areas to travel on difficulty routes to reach the market. Therefore, many people have very limited access to markets, financial resources, and information, technology, education and health services. With few

resources at their disposal and limited access to quality social services, most of the community tends to be very vulnerable when hazards occur:

- ☑ During the onset of drought, people in far off remote areas may be unable to quickly transport livestock to the village town for sale. When livestock and human diseases break out, the appropriate medical attention and medication are not readily accessible and have to depend on traditional methods which may not be effective on new diseases.
- ☑ During the floods the roads are not passable, and then vital goods and services will not be able to be accessed by those in the region. These goods and services may be medicines or health services, fresh water, fresh food or uninterrupted education services.

On an economic level, inadequate transport infrastructure results in higher transport and production costs.

Lack of technical capacities and weak institutions

Effective adaptation to climate change can only take place when there is adequate capacity in terms of knowledge, information, infrastructure, skills, enabling policies and strategies at various levels including at the grass roots for natural resources management. One of the major contributors to the vulnerability of the community in Govuro is the inadequate capacity and institutional support for sustainable natural resources management and creation of alternative off-farm livelihood activities for the majority of the community. Being agriculture the measure activity in the area, the lack of technologies to improve production and lack of knowledge on the use of climate information to maximize agricultural production is leaving the community very vulnerable to climatic changes.

CURRENT COPING STRATEGIES IN GOVURO DISTRICT

Indigenous peoples interpret climate change in various ways. Their interpretation depends on personal observations, experiences and local cultural framework. As extreme climatic events are expected to increase in frequency and intensity, traditional skills for disaster risk reduction deserve recognition.

Populations have developed a number of coping mechanisms in order to live with climate variations and uncertainty, such as diversification of crops and sources of income, migration, collection of wild fruits, switching to non-farming activities, selling assets and in extreme cases reliance on remittances and social networks (Orindi *et al*, 2006). Most individuals and households employ a combination of responses to the impacts of climate on heir livelihoods (David et al, 2005).

The current coping strategies being implemented by the communities in Govuro are presented in **Table 5.** These strategies can be summarized as follow:

- Fishing
- Collect and eat wild fruits
- Sell forest products (firewood and charcoal)
- Sell livestock
- Migration to other areas (upper or lower) looking for better conditions for humans or animals
- Exchange of labour
- Engage in small scale commerce.

It is important to note that not all current local strategies to cope with hazards are efficient or appropriate for long term adaptation. Some strategies, based on short-term considerations, survival needs, lack of information or imperfect foresight, can worsen environmental degradation and thereby diminish future adaptive capacity and livelihood options (Eriksen,2001).

According to local community, all copping strategies are working but some are not sustainable and they fear for worse conditions. The sustainability of different coping strategies depends on the intensity, duration and frequency of the hazard. For example, traditional coping strategies such as charcoal and firewood selling and shifting to new fields might be efficient coping strategies for now but in the long term they can accelerate land degradation and massive deforestation, intensifying climate change impacts.

The opportunities available for effective use of these coping strategies depends on the introduction of new technologies and support from agencies that may start to work in the area given that the local institutions and service provision is weak.

Table 5. Main hazards and strategies in Govuro

Hazard	Coping strategies	Working or not?(Yes/No)
Floods	☑ Selling of fish ☑ Consumption of fish ☑ Selling of firewood and charcoal ☑ Consumption of forest products (wild fruits, tubers and vegetable) ☑ Selling of wild fruits and vegetables (eg. macuacua, massala, cacana)	▪ Yes
Drought	☑ Consumption of forest products (wild fruits, tubers and vegetable) ☑ Sale of fish ☑ Consumption of fish ☑ Sale of craft products (mat, basket, sieve, wooden spoon, etc) ☑ Sale of firewood and charcoal ☑ Petty trading ☑ Sale of livestock ☑ Sell of wild animals (grey duiker, impala and wild pig) ☑ Digging deeper wells for water ☑ Planting shed trees ☑ Cultivating along the river (eg. Save river) ☑ Shifting to new grazing areas ☑ Opening new fields in lower areas	▪ Yes
Cyclone	☑ Migration to secure areas or places ☑ Planting wind breaks ☑ Protective measures ☑ Rebuilding the structures damaged ☑ Replacement of livestock and crops	▪ Yes
Extreme heat	☑ Planting shed trees ☑ Grazing livestock in the morning and evening ☑ Shifting to new grazing areas ☑ Opening new fields in lower areas	▪ Yes

The major threat to most of the coping strategies is their lack of sustainability in the face of current and projected climate change impacts which will lead to ecosystem degradation and loss of goods and services from the natural resources on which this community depends on. With the increase in the frequency and intensity of droughts and high temperatures anticipated, it is likely that the adaptive capacity of the Govuro community will progressively be weakened. The resources they draw upon to build their resilience will be eroded and the impacts of climate change may be progressively damaging in the near future.

ALTERNATIVE COPING STRATEGIES FOR CURRENT AND FUTURE CLIMATE CHANGE IMPACTS IN GOVURO DISTRICT

During the consultations, local community suggested potential strategies they would like to adopt which would help them to deal with the hazards in the future, based on their own experiences, priorities and strategies. Starting with coping strategies being undertaken by the community, a number of adaptation options were formulated using the CRiSTAL Tool which takes into account sustainability in view of projected climate change impacts. This was done by analyzing all the coping strategies in terms of sustainable development and climate change. The strategies suggested are considered not to deplete economic assets, not to have potential to degrade the environment but improve it while enhancing livelihoods of households. These suggestions are detailed below:

Construction of habitation in low and high lands

Throughout history lowlands have been optimum locations for the development of human settlements. The reasons for this predilection for lowland sites are quite obvious. At the dawn of history settlements were associated with agriculture, an activity requiring plentiful water and fertile soils, elements found in river deltas and other lowland areas (ISLT, 1998).

Great number of human settlements in Govuro District, including Govuro Village (Nova Mambone), are located in lowland area (along save river), a vulnerable area to a variety of natural hazards, principal amongst these is the natural propensity to floods.

During the 2000 floods, there was identified a high land area for resettlement of populations, 18 km from Nova Mambone village. Infrastructures including houses are being built (**Figure 14**), for the future administrative headquarter office of Nova Mambone.

Houses	Water infrastruture	Shool

Figure 14: Construction of habitations and infrastructures in the resettlement area (18 Km from Nova Mambone village)

According to consultations with communities in Nova Mambone, the identification of areas above floodwater levels, elevating buildings or moving them outside the floodplain, can reduce the impacts of floods. In the other hand lowland areas are

important for agriculture during the drought, and habitations in these areas are also important because high land areas are far away from floodplains (about 18 Km), becoming difficult to travel for farming.

Public health and sanitation

Climate change will influence the functioning of many ecosystems and their member species. Likewise, there will be impacts on human health. The first detectable changes in human health may well be alterations in the geographic range (latitude and altitude) and seasonality of certain infectious diseases – including vector-borne infections such as malaria and food-borne infections, which peaks in the warmer months (Haryanto, 2008).

The health impacts of known weather and climate changes in Govuro are as follows:

Deaths and injuries:

- Floods and windstorms cause death and injuries

Infectious diseases and mental disorders:

- Flooding disrupts water supply and sanitation systems and may damage transport systems and health care infrastructure
- Floods may provide breeding sites for mosquito vectors and lead to outbreaks of disease
- Floods may increase post-traumatic stress disorders

Starvation, malnutrition and diarrhea and respiratory diseases:

- Drought reduces water availability for hygiene
- Drought increases the risk of forest fires
- Drought reduces food availability in populations that are highly dependent on household agricultural productivity and/or economically weak

Mosquito, tick-borne diseases and rodent-borne diseases:

- Higher temperatures shorten the development time of pathogens in vectors and (such as malaria, dengue, tick-borne encephalitis and Lyme diseases) increase the potential transmission to humans
- Each vector species has specific climate conditions (temperature and humidity) necessary to be sufficiently abundant to maintain transmission

Malnutrition and undernutrition:

- Climate change may decrease food supplies (crop yields and fish stocks) or access to food supplies.

Waterborne and foodborne diseases:

- Survival of disease-causing organisms is related to temperature
- Climate conditions affect water availability and quality
- Extreme rainfall can affect the transport of disease-causing organisms into the water supply.

According to local communities, future strategies for public health and sanitation my include a support to the campaigns by the Ministry of health on improved hygiene and protection from diseases which have become more prevalent as a result of floods, droughts, strong winds and high temperatures and. Malaria prevention activities such as mosquito breeding areas spraying and management of stagnant water from intermittent flush floods should be mainstreamed into general hygiene and sanitation. Planting of multi-purpose trees around the fields and homesteads will in addition to reducing the impacts of strong winds also help to improve the homesteads and provide other benefits to the households.

Rehabilitation and construction of catchments and water infrastructure for improved water availability

Water supply needs to be improved for domestic use, livestock watering and small scale irrigation to help the communities cope with the impacts of climate change (water scarcity). It is recommended that investments be made by government and NGOs in water supply infrastructure for the community in Govuro. This should include rehabilitation of defective boreholes, drilling new ones and training communities on improved maintenance of the facilities (**Figure 15**).

Figure 15: Water infrastructures in Govuro

According to local communities, investments should also be made for the construction of tanks connected to the roofs of houses, to collect water during the rain season (**Figure 16**).

Figure 16: Example of tanks connected to the roofs of houses in Nova Mambone.

Planting of multi-purpose trees, restoration of wetlands, and gulley reclamation should be promoted for reversing land degradation as one of the factors that contribute to the changing climate in Govuro is deforestation. This is critical for the restoration of ecosystems services which include improving water availability.

Catchments rehabilitation should also be made by promoting planting of appropriate trees to encourage ground water recharge. Water harvesting though not widely practiced should be promoted hand in hand with soil and water conservation measures.

Planting of trees should also be done along Save River, to protect watercourse against siltation and river bank erosion (**Figure 17**).

Figure 17: Erosion along Save River (Nova Mambone)

Sustainable management of forests, reducing emissions from deforestation and forest degradation, afforestation/reforestation and forest restoration, as well as sustainable produced wood products that replace more carbon-intensive materials and fuels, are important mitigation options. These adaptation measures help to protect water and soil resources and biodiversity and reduce the vulnerability of the forests and forest dependent people.

Modification of farming practices

Strategies for climate and weather risk management are closely linked to well-established sustainable agriculture practices. Negative impacts on soils from adverse weather-related events (such as extended drought, flooding, and extreme temperatures) can be reduced with sustainable land resource management.

Local communities in Govuro have suggested the following adaptation options in farming:

- ✓ Diversify Crops: A diversity of crop types and varieties should be grown in rotation and choosing a variety of crops that require a range of growing

conditions (**Figure 18**). Improved provision of extension services for improved farming practices through conservation farming using suitable crops and varieties of drought resistant or early maturing cereal and legume crops such as groundnuts, millet, sorghum, cassava, beans etc.

rice

maize

sorghum

Figure 18: Some crops grown in Govuro

- ✓ Land Resource Management: Conservation tillage practices for reducing risks from drought. These include: enhancing moisture retention (**Figure 19**); reducing soil erosion and minimizing soil compaction. Use of minimum and reduced tillage technologies in combination with planting of cover crops and green manure crops should be encouraged as these help in reversing soil erosion and nutrient loss due to climate change. It is recommended that agricultural practices that improve soil fertility such as agroforestry be promoted, given the declining productivity of the soil.

Figure 19: One of the techniques used for moisture retention.

- ✓ Provision of farmers with short-term weather forecast data from the National Meteorological Department tailored made for farmers such as 7-10 day forecasts for improved management decision making that reduce climatic uncertainties in their daily farming operations such as choice of on crop varieties, timing of farming activities and general planning. This will help farmers to adjusting to the seasonal changes in the onset and cessation of rainfall by changing their planting dates to, for example coincide with the new rainfall regimes.

Improved livestock management practices

In pastoral and agro-pastoral systems, livestock are key assets for poor people, providing multiple economic, social, and risk management functions. The impacts that climate change will bring about are expected to exacerbate the vulnerability of livestock systems and to reinforce existing factors that are simultaneously affecting livestock production systems such as rapid population and economic growth, increased demand for food (including livestock) and products, increased conflict over scarce resources (i.e. land tenure, water, biofuels, etc). For rural communities losing livestock assets might lead to the collapse into chronic poverty with long-term effects on their livelihoods (Livestock Thematic Papers, document in press).

Main users of range resources are pure pastoralists (nomads) and semi-sedentary pastoralists or agro-pastoralists. Participatory development approaches involving all users have relevant effects on the reduction of conflicts among pastoralists and sedentary communities as well as on land improvement activities (investments in livestock and water infrastructures).Given that livestock management is still mainly traditional, efficient and affordable adaptation practices have to be developed for rural poor not able to buy expensive adaptation technologies. It is important to sensitize the community on the need for matching livestock numbers with the carrying capacity as the pastures and water resources for livestock are getting scarce due to climate change impacts.

Destocking initiatives providing for the intentional removal of animals from a region before they die and restocking initiatives necessary to supply livestock owners with breeding animals in order to increase herd size over time (lost or decimated) are important to reduce vulnerability of livestock to emergency situations. Restocking, accompanied by improved provision of veterinary services/infrastructures and rangeland management extension should be prioritized in the coming years (**Figure 20**). There is also need for livestock diversity and adjustments in herd composition towards less grazers (cattle and sheep) and more browsers and drought-tolerant species such as goats. This shift will be important as droughts become more frequent and temperatures get higher.

veterinary infrastructure

rangelands

Figure 20: Some veterinary infrastructures and rangelands in Govuro

Provision of shade and water to reduce heat stress from increased temperature; change in livestock/herd composition (large animal versus small animal, etc.) and improved management of water resources through the introduction of simple techniques for localized irrigation (e.g. drip and sprinkler irrigation), accompanied with infrastructure to harvest and store rainwater, such as small superficial and underground dams, tanks connected to the roofs of houses, are also efficient and affordable adaptation practices that can be developed in Govuro.

In addition communities should be sensitized on the importance of veterinary services for improved livestock management and support should be given to the training and functioning of Community Animal Health Workers for provision of basic veterinary interventions.

Community-based participatory Natural Resources Management

Poverty reduction is closely linked with natural resource conservation, because poor people in developing countries depend on natural resources for their livelihoods. It is therefore important to ensure sustainable management of these resources. Effective and equitable natural resource management and conservation, on the other hand, require genuine involvement by the social actors who depend on the resource (Danida, 2007).

The dependence of the Govuro community on natural resources which are being over exploited requires that an effective system of natural resource management is put in place to promote sustainable management of the resources as more pressure is exerted by the increasing population dependent on the forest products. Support to community forest management by establishing Joint Forest Management Systems for conservation and controlled harvesting and marketing of indigenous fruits and vegetables from the forest for income diversification is suggested as priority adaptation option.

This environmental integrity would only be achieved if there is marked and sustained reduction in the environmental effects of household poverty alleviation strategies. That is, reducing deforestation, soil erosion, wetland depletion, reduced fish stocks, land fragmentation, to mention but a few

Diversification of livelihood activities for communities

Alternative livelihoods are necessary for the sustainability of the environment. The alternative livelihoods that we suggest are those which can be implemented without compromising environmental integrity. It is based on the understanding that many of the present livelihood activities may be injurious to the environment, or are implemented in an unsustainable manner. Agriculture for instance is practiced using poor technologies without due regard for environmental and natural resource conservation. An alternative livelihood strategy would enable households and communities to reduce or eliminate unsustainable practices, and at the same time contribute to sustainable poverty alleviation and local development.

The presence of land and sea in Govuro can reduce the high dependence of the population on agriculture and have the fishery activity as alternative livelihood. It is also important to promote and facilitate micro-financing support for the community for income diversification in some non-agricultural off-farm activities. Activities such as improved harvesting, processing and marketing of forest products need to be promoted while growing of fruit trees and vegetables through irrigation from improved water supply are the other suggested options.

The communities should get engaged in different kinds of income generating activities such as petty trading, seasonal work, and other forest based entrepreneur activities. For this, it is necessary to work with local people to identify and develop opportunities for positive change in their livelihoods that are based on their strengths and capacities that take proper account of factors that help and inhibit livelihood change and that reflect people's aspirations and hopes for the future.

Diversification of livelihoods would balance the need to meet economic objectives with the need to maintain environmental integrity. This environmental integrity would only be achieved if there is marked and sustained reduction in the environmental effects of household poverty alleviation strategies. That is, reducing deforestation, soil erosion, wetland depletion, reduced fish stocks, land fragmentation, to mention but a few.

Raising community awareness

Adapting to climate change impacts requires a mindset shift by all stakeholders and this can best be achieved by putting place awareness raising activities on climate change issues, projections and potential adaptation strategies for all stakeholders, so that they can prepare as much as possible for the coming impacts.

The first and foremost step in regard to education, training and public awareness is to develop a process National, provincial and local level to prepare teaching material to impart education, training and create public awareness. This has to be done under a multi-tier approach:

- Preparation of materials on climate change ("What is Climate Change"; "How it affects our life - our economic prosperity and our health and other welfare"; and "How all of us together can save the environment for our benefit and for our future generations); for the use and consumption of the common man, civil society, community (particularly for students at different levels of school education). These materials have to be in simple language that people understand as well as to introduce such an education as a part of school curriculum in primary, middle and at higher levels.
- District and local level workshops and seminars should also be organized at regular intervals for faster dissemination and exchange of information among various groups and categories of people, communities, civil societies etc. Such a process will accelerate the process of education and training for officials, professionals and schoolteachers to update and exchange their knowledge and experiences.

ENABLING CONDITIONS AND CONSTRAINTS TO IMPLEMENTING SUGGESTED STRATEGIES

The main constraints and enabling conditions to the implementation of the different adaptation strategies suggested by communities in Nova Mambone and Pande are presented in the **table 6**. These constraints and enabling conditions are important to analyze the effectiveness and sustainability of the coping strategies at local level.

Table 6. Enabling conditions and constraints to implement suggested strategies in Nova Mambone and Pande

Strategy	Enabling conditions	Constraints
Construction of habitation in low and high lands	☑ Existence of high area already identified; ☑ Existence of local material for construction, ☑ Government support	☑ Lack of financial resources to buy other building material (cement, zinc sheets, etc) ☑ Possible resistance by the community to have 2 houses in different place
Public health and sanitation	☑ Existence of NGOs in Govuro that promote public health (CARE, samaritano)	☑ Lack of public health pamphlets in local languages ☑ Limited numbers of environmental health workers ☑ Possible resistance by the community to adopt hygienic practices
Rehabilitation and construction of catchment and water infrastructure for improved water availability	☑ National Strategy for water resources in Mozambique (2007), which is promoting drilling of boreholes and construction of dams and river basin management for sustainable development ☑ Many community are willing to maintain and rehabilitate existing water infrastructure and participate in the construction of new infrastructure ☑ Availability of local materials for building	☑ Rainfall scarcity in the area ☑ Low water table for groundwater harvesting ☑ Mostly salty borehole water in the area ☑ Some Water infrastructures may lead to ecological problems (overgrazing, erosion, etc.) ☑ There are maintenance issues regarding current water infrastructures ☑ Lack of knowledge in the techniques

Modification of farming practices	☑ The people of Govuro are traditionally farmers ☑ The existing National Green Revolution Strategy which focus on agricultural intensification ☑ Presence of high school of agriculture and rural development in neighbour district Vilankulos for undertaking adaptation studies in crops and livestock ☑ existence of the CARE International project on conservation agriculture operating in Govuro district	☑ Limited knowledge/skills to adapt practices to the new conditions ☑ The lack of local weather station to provide forecasts for farmers ☑ Lack of an efficient extension service in the area, ☑ Lack of inputs such as improved seed of drought resistant crops and varieties ☑ Possible resistance to new crops and varieties ☑ Lack of knowledge on the management of drought resistance crop species ☑ New varieties may be susceptible to pests and diseases ☑ Shortage of oxen and seeds during the planting time
Improved livestock management practices	☑ The existence of the National Fire Action plan ☑ Livestock keeping is a cultural aspect of the community ☑ The existence of local veterinary knowledge ☑ Market access for livestock ☑ Communities are aware of the decline in pasture availability and quality ☑ The presence of trained para-vets that are capable of providing basic services if supported with drug kits	☑ Lack of knowledge on the types of animals that are better adapted to the new and projected climatic conditions ☑ Lack of training in improved management techniques such as supplementary feeding ☑ Cultural resistance to destocking ☑ Poor animal health services in the community with no pharmacies or drug stores ☑ Shortage of extension staff in the area to facilitate destocking
Community-based participatory Natural Resources Management	☑ The willingness by the community to address the impacts of climate change on the livelihood resources ☑ The existence of some natural resources Management Committees and associations	☑ Lack of experience in community-based natural resource management in the area ☑ Limited number of NGOs dealing with natural resource management
Diversification of livelihood activities	☑ Community members have the willingness to undertake other livelihood activities	☑ Limited financial support and credit access to engage in different kinds of business activities ☑ Limited market access information ☑ Limited skills to engage in new income generating activities ☑ Limited water resources available for farming and irrigation in many areas ☑ Firewood and charcoal selling is leading to depletion of forest resources
Raising community awareness on climate change	☑ There is a willingness amongst community members to learn more about climate change in order to better prepare themselves	☑ Most local organizations and communities have no access to seasonal forecasts and other climate information

The successful implementation of adaptation strategies will depend to a great extent on the ability of practitioners, communities, NGOs and Government to address these constraints and build on existing enabling conditions.

CONCLUSIONS AND RECOMMENDATIONS

Much of Govuro communities are poor and hance are likely to be hit hardest by climate change, and the capacity to respond to climate change is lowest in the community and among the poorest people in the district. It seems clear that vulnerability to climate change is closely related to poverty, as the poor are least able to respond to climatic stimuli.

The community in Govuro depends directly on the services provided by ecosystems and number of underlying causes of vulnerability, particularly environmental degradation continue to contribute to the reduction of the capacity of ecosystems to meet the people's needs for food and other products, and to protect them from the climate hazards.

The participants in the consultations, identified recommendations to address the following areas of action: data and research, policy, adaptation options, awareness and capacity building.

Data and research

There is an urgent need to collect more accurate and comprehensive meteorological, environmental, and socioeconomic data and indigenous knowledge at local level. For this, should be established practical partnerships with weather and climate institutions, particularly with the Mozambique Meteorological Agency, other Research institutions dealing with weather issues, natural resources management and the National Institute for Disasters Management (INGC). These partnerships may be important to provide the needed estimates of the biophysical impacts of climate change at the local level and improve the local responses for community livelihoods in the district. These bodies should be engaged to regularly provide targeted climate data and information on expected seasonal weather conditions as well as medium to long -term climate projections. Such data and information will be useful for household level planning and adjustment of activity schedules to ensure that livelihoods and welfare of communities are safeguarded and improved in the face of current climate variability and change.

More research will be needed to complement and deepen the findings of this research. Key research priorities may include:

- Better understand how climate change could interact with population growth and other drivers to affect water quantity and quality, and food security.

- Analysis of the resources (natural, financial, human, etc.) required to adapt to climate change, although this might include large uncertainties related to different development pathways, climate change mitigation efforts, and the adaptation strategies chosen.

- ➲ Better understand the relationships between non-climatic factors (such as population growth, policies, land use changes, etc.) and local vulnerability to climate change.
- ➲ Develop environmental indicators for monitoring and evaluating the impacts of climate variability and change and how they are evolving over time.

Adaptation options

Adaptation measures are urgently needed to address the projected impacts of climate variability and change in the area:

- Use a systems-based approach to develop adaptation options that increase resilience to the full range of drivers that affect population health.

  Adaptations should be:

  - ➢ implemented over the short, medium, or long term;
  - ➢ specific to the local health determinants and outcomes of concern;
  - ➢ facilitate the development of community based resource management, and;
  - ➢ determine the costs and benefits of different interventions.

- Use a traditional knowledge and starting from what people are already doing on the ground:

  Local knowledge and technologies that are viable should be promoted and enhanced with full participation of the community. In Govuro, communities are already implementing coping and adaptation strategies and efforts to improve climate change adaptation can benefit from a greater understanding of what people are already doing on the ground and of the effectiveness and sustainability of current coping strategies.

  Participatory community consultations should be used to develop sustainable alternatives to replace ineffective or unsustainable practices. It is therefore, important to build on what is being done by the community to ensure buy-in and make sure that adaptation strategies are community-led and based on local traditions and norms.

- Promote sustainable water resource use and management

Sustainable water resource use and management is important to prevent, mitigate, and adapt to the forthcoming water scarcity. Ecological sanitation solutions should be considered.

- Promote ecosystem health to build community resilience and adaptive capacity to climate change

The direct dependence of the community on natural resources in Govuro district makes ecosystem management central to building the resilience of the community. The natural ecosystems are resistant and resilient and provide a full range of goods and ecosystem services, including natural resources such as water and forest products on which the community depends.

An investment in sustainable management of forest (including mangrove) and wetland ecosystems in the district is important as it will offer cost-effective solutions to reducing community vulnerability to climate change impacts. This will also help restore ecosystem service and livelihood benefits healthy ecosystems have always provided the community such as intact firewood, clean water, fiber, medicine and food, while acting as natural buffers to climate hazards.

Approaches using the “Ecosystem-based Adaptation” (EbA) which refers to a range of local and landscape scale strategies for managing ecosystems to increase resilience and maintain essential ecosystem services, and thereby reduce the vulnerability of people and nature in the face of climate change are recommended. The proposed ecosystem-based approach to adaptation is compatible and complementary with a wide range of local and national development objectives, with ongoing adaptation efforts at community level, and with existing priorities identified in Nova Mambone and Pande localities.

Enhancing understanding of the links between food security and ecosystems is important because, healthy, diverse and productive ecosystems will continue to be the key in providing multiple services, goods and other benefits to the community in Govuro.

- Increasing access to markets for the rural poor

Poverty has to be addressed at its root causes through investment in the capacity of people to make better longer term decisions with regard to the resources at their disposal. At the same time, attention needs to be given to enhancing the efficiency of markets for natural resources and enhancing access or breaking down the barriers to those markets for poor and marginalized communities. Practitioners should therefore, advocate for the improvement of market conditions e.g. development of policies that support fair trade that enhances rural livelihood incomes. Direct support could be in the form of: construction of abattoirs at strategic points (e.g. market centers) in the region and training community members on hygienic slaughter, preservation and transportation of produce. They could also be trained in, and provided with, facilities for hygienic meat drying and packaging as well as forest products processing and packaging. Export markets for these products could be sought and cooperatives established and strengthened to effectively engage in, and benefit from such trade.

- Addressing constraints to adaptation and building on enabling conditions

The main constraints and enabling conditions to the implementation of the different adaptation strategies suggested by communities in Nova Mambone and Pande localities are presented in **Table 6**. The successful implementation of adaptation strategies will depend to a great extent on the ability of practitioners, communities and governments to address these constraints and build on existing enabling conditions.

Awareness and capacity building

- Build awareness amongst political and financial leaders, including local and religious leaders, of the projected impacts of climate variability and change.

Awareness of climate change impacts, projections, and of the National Adaptation Programme of Action (NAPA) should be enhanced at all levels (from the national to the local level), to allow government officials, financial leaders, including local and religious leaders to better deal with current climate risks and prepare for projected climate change.

- Improve information and knowledge sharing

The climate change phenomenon is new to many and there are many uncertainties. It is therefore important to bringing lessons from various experiences from different organizations and governments who work with communities, to share experiences on climate risks and different adaptation strategies. This will help prevent the implementation of adaptation strategies that have already been shown to be unsustainable in the long run and could favor collaborative development of new adaptation strategies.

Practitioners should aim to facilitate information sharing between weather and climate institutions and local communities. Seasonal weather forecasts and early warnings for climate hazards should be available to local communities and translated into local languages. In addition, communities should be supported in using climate information for planning of their livelihood activities.

- Develop learning resource materials for local communities (particularly women and children), and other relevant professionals, and local media on the potential impacts of climate variability and change:

  - Develop materials on climate change, and behavioral change committees.
  - Develop local school curriculum.
  - Ensure that school and media programmes are of sufficient length and frequency that critical information is communicated.

- Ensure that messages are communicated effectively, including translation into local languages.

Coordination, communication, and information sharing between different government agencies from national to the local levels should be promoted, especially regarding weather, climate and food security information. The information pathways should be improved, so that local communities can access seasonal weather forecasts and early warnings for climate hazards as early as possible and in their own languages, and so that governments can be promptly informed of poor rain conditions and food insecurity issues. The capacity building process should combine training workshops and hands on activities, for example: pilot adaptation projects for demonstration.

Policy

- Ensure that findings from this study receive full consideration in ongoing policy processes at the national and local levels.

Livelihood resources identified in this research as being sensitive to (or highly impacted by) climate hazards are listed in **Table 4**. Development programmes should aim to decrease the sensitivity of these resources (for example by promoting a shift to more drought tolerant livestock species and crops, or by promoting strategies to reduce diseases and land degradation which make resources more sensitive to climate hazards) or should aim to decrease the dependence of communities on these climate-sensitive resources by for example, promoting alternative income generating activities that are not climate-sensitive.

To increase local resilience to climate change, development plans and policies must integrate adaptation to climate change at all levels involving all stakeholders in the community. Given that local priorities on social, political, institutional and economic issues interact with and have an important influence on vulnerability, capacities and prospects for adaptation, it is advisable to link the selection of potential responses to climate change to the overall development plans for Govuro district.

Government should aim to address the underlying drivers of vulnerability mentioned in **table 6.** This should involve enhancing access to vital infrastructure, resources and services in the community, enhancing the security of farmland and rangelands, restoration of the environment, creation of more efficient markets and putting in place strategies to reduce population growth, in particular through education and women empowerment.
A critical issue for mainstreaming climate change adaptation into development strategies is financing (Greene, 2004). Unfortunately sometimes there is a tendency in the development assistance community to rely on additional climate funding to realize climate change mainstreaming. However, the inherent risk of climate change to successful implementation of development programmes in fact warrant the use of core development funding for effective mainstreaming. This requires integrating climate

change adaptation in poverty reduction strategies and development plans at various levels.

Donors should allow enough funding flexibility to enable practitioners to adjust interventions in the face of climate change uncertainties. In addition, donor funding should include funds for emergencies and contingencies to provide projects and programmes with adequate resources to address climate-related emergencies without threatening the achievement of programme/project goals and objectives. In addition, donor funding for adaptation to climate change should support all the four pillars of community based adaptation, namely: building resilient livelihoods, disaster risk reduction, capacity building, and addressing the underlying causes of vulnerability (more information on these four pillars are provided in the CARE CVCA Handbook: http://www.careclimatechange.org/cvca).

REFERENCES

1. **ADGER, N.W., HUGHES, T.P., FOLKE, C., CARPENTER, S.R. & ROCKSTRON, J. 2005**. Social-ecological resilience to coastal disasters. Science, 309(5737):1036-1039

2. **CARNEY, D (Ed), 1998**. Sustainable Rural Livelihoods: What Contribution can we make? DFID

3. **DANIDA, 2007**. Community-based natural resource management. Ministry of Foreign Affairs of Denmark; Danida. Technical Advisory Service.

4. **Eriksen, S. 2001**. Linkages between climate change and desertification in East Africa. Arid Lands Newsletter 49.

5. **FAO. 2009**. Draft Report from FAO as a contribution to the baseline study. UN Joint Programme on Environmental Mainstreaming and Adaptation to Climate Change in Gaza. UNJP/MOZ/085/SPA

6. **Fischer G., Shah M. and van Velthuizen H. (2002)**. Climate Change and Agricultural Vulnerability. International Institute for Applied Systems Analysis. Report prepared under UN Institutional Contract Agreement 1113 for World Summit on Sustainable Development. Laxenburg, Austria INAM. 2009

7. **GED, 2007**. Vulnerability to Climate Change in Mozambique. Group for Renewable Energies and Sustainable Development, July 2007.

8. **Greene, W., 2004**. Aid fragmentation and proliferation: Can donors improve the delivery of climate finance? IDS Bulletin 35, 66-75.

9. **Gwimbi. P. (2009).** Linking rural community livelihoods to resilience building in flood risk reduction in Zimbabwe. Department of Environmental Health, National University of Lesotho.

10. **Haryanto, B. (2009).** Climate Change and Public Health in Indonesia Impacts and Adaptation. Austral Policy Forum 09-05S, 3 December 2009.

11. **INGC. 2009**. Main report: INGC Climate Change Report: Study on the Impact of Climate Change on Disaster Risk in Mozambique. [Asante, K., Brundrit, G., Epstein, P., Fernandes, A., Marques, M.R., Mavume, A , Metzger, M., Patt, A., Queface, A., Sanchez del Valle, R., Tadross, M., Brito, R. (eds.)]. INGC, Mozambique.

12. **IPCC. 2001**. Climatic Change 2001: Impacts, Adaptation and Vulnerability. Summary for Policymakers.

13. **INTERNATIONAL INSTITUTE FOR SUSTAINABLE DEVELOPMENT (IISD). 2003**. Livelihoods and Climate Change: Combining disaster risk reduction, natural resource management and climate change adaptation in a new approach

to the reduction of vulnerability and poverty. A Conceptual Framework Paper Prepared by the Task Force on Climate Change, Vulnerable Communities and Adaptation. [WEB:] http://www.iisd.org/pdf/2003/natres_livelihoods_cc.pdf

14. **ISLT. 1998.** International Symposium on Lowland Technology. Organized by The Institute of Lowland Technology, Saga University; Saga, 4-6 November 1998

15. **McSweeney, C.; New, M.; and Lizcano, G. 2008**. UNDP Climate Change Country Profiles. *Mozambique in http://country-profiles.geog.ox.ac.uk,* (Accessed January, 2009)

16. Ministério da Administração Estatal, 2005. Perfil do Distrito de Govuro*, Província de Inhambane*

17. **PMA. 2009**. Estudo de base. Programa conjunto das Nações Unidas em Valorização Ambiental e Adaptação à Mudanças Climáticas

18. **Littlejohn, G. and Borges-Coelho, J. 2007**. Mozambique Country Case Study*: Impacts and Responses to the 1997-98 El Niño Event*. In: http://www.unu.edu/env/govern/elnino/countryreports/inside/mozambique/Appendixes/Appendixes_txt.html

19. Tadross, M. (2009). Climate Change modelling and analysis for Mozambique, March 2009.

20. **Thomas, D.; Osbahr, H.; Twyman, C.; Adger, N. and Hewitson, B. 2005.** ADAPTIVE: Adaptations to climate change amongst natural resource-dependant societies in the developing world: across the Southern Africa climate gradient. Tyndall Centre for Climate Change Research. Technical Report 35

21. **Orindi, V.; Kibona, E.; and Moindi, D. 2006**. Addressing climate change in the developing process in Tanzania. Ecopolicy 18.Acts Press

22. **ROLFE, R. E. 2006**. Social Cohesion and Community Resilience: A Multi-Disciplinary Review of Literature for Rural Health Research. Department International Development Studies, Faculty of Graduate Studies and Research. Saint Mary's University. Halifax, NS.

ANNEXES: Field guides used to collect information

FIELD GUIDE 1: Seasonal Calendar

Objectives

- To understand what is "normal" rainfall / temperature from the perspective of community members
- To examine trends in rainfall / temperature
- To brainstorm on future rainfall / temperature scenarios and potential responses
- To evaluate use of climate information for planning

How to Facilitate

This activity should take approximately 1 hours.

***NOTE**: Throughout the exercise and discussions, listen and take note of any mention of the following issues:*

- *Coping strategies (note whether they are currently being used, or whether they would like to use them, and if it is the latter, try to find out why they are not using them – what are the constraints?)*
- *Changes in environment, conditions, hazards, livelihoods*
- *Social or political issues that may have implications for vulnerability*

STEP 1 – Prepare the calendar.
Use the ground or large sheets of paper. Mark off the months of the year on the horizontal axis. Mark off a range of years (from the SCUK historical timeline) which includes a good year, a bad year, a drought year and an average year. Try to select the most recent years.

STEP 2 – Plot timing of rainfall in past years.
Explain to the participants that you would like to develop a calendar to understand the rainfall patterns that they are experiencing. For each of the years on the calendar, plot the start and end of the rainy season(s), and note the quality of the rain (light/heavy) and the distribution (did it fall all at once, was it distributed over the season, etc.,etc.). Do the same for temperature observations throughout the year.

STEP 3 – Present a future scenario.
- The climate change predictions

- Present a future scenario using the calendar if you think it will make it clearer.

STEP 4 – Discuss impacts of future scenario on livelihoods.
Ask the group how they think the future scenario will affect their livelihoods.

STEP 5 – Discuss response to potential scenario.
Ask the group how they would respond if the future scenario were to occur next year.

STEP 6 – Discuss preparation for future climate change.
Ask the group what they might do to prepare for this possible future scenario in terms of changing livelihoods strategies.

FIELD GUIDE 2: Vulnerability Matrix

Objectives

- To determine the hazards that have the most serious impact on important livelihoods resources
- To determine which livelihoods resources are most vulnerable
- To discuss who has control over and access to livelihoods resources

How to Facilitate

This activity should take approximately 3-4 hours.

***NOTE**: Throughout the exercise and discussions, listen and take note of any mention of the following issues:*

- *Coping strategies (note whether they are currently being used, or whether they would like to use them, and if it is the latter, try to find out why they are not using them – what are the constraints?)*
- *Changes in environment, conditions, hazards, livelihoods*
- *Social or political issues that may have implications for vulnerability*

STEP 1 – Prepare the matrix.
Prepare a matrix in advance. This can be done on the ground or on flip chart paper.

STEP 2 – Identification of the major livelihood system and the livelihoods resources.
Ask the group to identify THEIR most important livelihood system and the associated livelihood resources. These do not have to be resources that they currently have, but those that they consider to be most important in achieving well-being. They may create a long list of resources. As they brainstorm, organize the list based on the different categories of resources – human, social, physical, natural and financial. Use the reference list of resources to prompt people. They may particularly need help in identifying social and human resources.

***NOTE**: It is unlikely that community members will categorize their resources in terms of these categories – it is the job of the facilitation team to organize their ideas within the different categories. Also, the concept of resources may be difficult. It may be better to ask participants about how they gain their livelihoods, or what they do in a typical day, and then ask them what things they need to undertake these activities. This can lead to an identification of resources.*

***NOTE**: It is very important to make it clear to the participants that you want them to talk about their own experiences. In order to disaggregate data, it needs to be clear that participants are providing information based on their own experiences, priorities and strategies, not those of the household. This is particularly important with women's groups, who may be more inclined to speak about the activities and priorities of their husbands than their own.*

STEP 3 – Prioritize livelihoods resources.
For each of the categories, ask the group to identify the THREE resources that they consider to be MOST important in achieving well-being. If they only listed three or less during the brainstorm, just use these. List these priority resources down the left side of the matrix on the vertical. Use symbols if this will help participants to better understand.

STEP 4 - Discuss control of resources and access to facilities and services.
Using the resource list, discuss who has control over the different resources that were prioritized. If the resources are facilities or services, ask participants if they are using them, and if not, why.

STEP 5 – Identify climatic hazards.
Then ask the group to identify the greatest climatic hazards to THEIR livelihoods. Hazards may be natural or man-made. Do not limit the discussion to only climate-related hazards, but you may want to prompt the group if they are not identifying environmental hazards.

***NOTE**: It is important to be specific in the hazards, and to ensure that the issues identified are actually hazards. Participants may identify conditions such as "food insecurity" as hazards. It is up to the facilitator to ask the group to break down these conditions to determine if they are caused by hazards (e.g. food insecurity may be the result of a drought, which is a hazard). Similarly, some groups may identify scarcity of resources, such as "lack of money", as a hazard. In this case, it should be determined whether the lack of a resource is the result of a hazard, or in some cases, whether the resource should be added to the list of priority resources identified in the previous step.*

STEP 6 – Prioritize and rank the hazards.
Ask the group to prioritize the three hazards that have the greatest impact on their livelihoods.
The THREE most important hazards should be listed horizontally across the top of the matrix, again using symbols if necessary.
Ask the community to decide on a scoring system for the hazards against the livelihoods resources, identifying significant, medium, low and no hazard. The scoring system should be as follows:

- 3 = significant impact on the resource
- 2 = medium impact on the resource
- 1 = low impact on the resource
- 0 = no impact on the resource

You can use stones, symbols or different colours of markers (e.g. red = significant risk to resource, orange = medium risk, green = low risk, blue = no risk). Ensure that all members of the group understand the scoring system. Take note of the top 3 hazards.

STEP 7 - For each of the top 3 hazards, discuss any changes to the hazard.
Ask participants if the hazard is different now than it was 10/20/30 years ago (depending on age of participants). If they say the hazard has changed, ask them how (e.g. more frequent, more intense, different timing, etc.).

STEP 8 – Name /identify the impacts of each of the top 3 hazards on the major livelihood system
Ask the participants to decide on the degree of impact that each of the hazards has on the livelihood (Use the impacts on and each of the livelihood resources to have a clear picture of the impacts of the hazards. This will involve coming to consensus as a group. The note taker should note key points of discussion that lead to the scores assigned, and any disagreements on the scores. Rank the impacts and take note of the top 3.

***NOTE**: Ensure that you are asking the right question of the participants. The question is how much the HAZARDS affect the RESOURCES. Note that some hazards may have no impact on particular resources. It must be made clear to participants that they shouldn't struggle to find an impact – it is perfectly fine to say that it has no impact.*

***NOTE**: The note taker must note down the justifications for the different scores, as this will be important in understanding the data later.*

STEP 9 - Discuss current coping strategies for each of the top 3 impacts of the hazard.
For each of the top 3 impacts identified, ask the group members how THEY are CURRENTLY coping with the impacts of the specific hazards identified.
Ask them if the coping strategies are working or not and if they are sustainable or not.

***NOTE**: It is very important to make it clear to the participants that you want them to talk about their own perspectives. In order to disaggregate data, it needs to be clear that participants are providing information based on their own experiences, priorities and strategies, not those of the household. This is particularly important with women's groups, who may be more inclined to speak about the activities and priorities of their husbands than their own.*

STEP 10 - Discuss potential alternative coping strategies or adaptation strategies.
Ask the group members if there are any strategies they would like to adopt which would help them to deal with the hazards in the future. Discuss the constraints or opportunities that exist to adopt these strategies.

STEP 11: Are there any other non-climatic causes of the impacts discussed under the hazards? If Yes, What are these?

STEP 12: Repeat Steps 8 -11 for all other 2 top hazards