Climate Change Adaptation in Mozambique

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1.0 Background

Adaptation efforts in Mozambique, organized through the climate department in the Ministry for the Coordination of Environmental Affairs (MICOA), have been stimulated by NCAP activities as well as the emergence of an improved, effective pre- and post-disaster planning capacity in the reorganized administration of the National Institute for Disaster Management (INGC).

A wide range of issues have been covered with substantial production of policy papers. Distribution of these papers initially only occurred within government offices rather than reaching a wider range of concerned stakeholders such as local authorities and NGOs. The first national communication to UNFCCC was posted in 2006, with support from NCAP, and there is active debate on what the second national communication should contain based on the adaptation work described in this chapter. To consolidate the link with the INGC, there has been a series of provincial level disaster planning seminars under the joint ownership of the MICOA and the INGC.

The program began with an overview of the capacity to respond to natural disasters in Mozambique. The conclusion of this first study was the need to build local resilience capacity at community level based on existing experience. Moving up the scale, there was need for sector planning, especially agriculture and water, to incorporate a level of risk calculation. At the national level, there was a need to integrate climate adaptation issues into pre-disaster planning. From local to national level, all of this had to be done by focusing on the groups who were most vulnerable to climate risk. There was also a need to organize the government and NGOs into effective pre-disaster planning.

Parallel to this review of capacity was a review of climate induced disasters from 1999 to 2005. This focused on exploring positive experience which could be used for the future. It reviewed the role of various agencies focusing particularly on the south and central region of Mozambique, the area most affected by tropical cyclones. It recognized that vulnerability was closely tied to economic capacity. The paper captured the changes in the INGC which has central responsibility for pre and post disaster planning. It recognized that there was need to use global warning systems, including FEWSNET. At provincial level, it was argued that pre-disaster planning was needed by joint exercises between MICOA and INGC building on the positive experience in the Buzi locality and Sofala province.

The Climate Change Action Plan (NAPA) linked with the Plan to Combat Desertification (NAP) as well as the Strategic Plan to Conserve Biological Diversity (NBSAP). This was later updated to a specific plan that linked implementation of the 3 conventions to the poverty reduction strategy which was, and is, the Government of Mozambique's key economic development policy.

Mozambique has very little scientific information available at national level and, unsurprisingly, even less at provincial and district levels. One of the substantial efforts of NCAP Mozambique

was to build a national profile of weather variation from 1860 to 2000. This showed a significant increase in temperature from 1980 onwards. More detailed data was provided for the 20th century based on 10 recording sites for the whole country. Rainfall in general showed a decrease, although the data was substantially distorted by the extreme flooding of 1999 and 2001.

One of the tasks completed was to look in detail at training requirements in order to complete the second report for the UNFCCC. Particular attention was paid to the agricultural sector. Three vulnerability reports were completed, one focusing on fisheries, one focusing on the coastal zones and one on the vulnerability of hydrological resources to climate change.

Significant effort was made to establish capacity for vulnerability analysis, largely through the University of Eduardo Mondalane. The initial results of these efforts are contained in this chapter.

1.1 Mozambique's Climate Regime

The country can be divided into four climatic regions, according to Köppen Climate Classification System.

- The northern and coastal regions, representing 60% of the total area of the country, have a tropical rain savannah climate.
- The inland parts of the central and southern sedimentary terrains, representing 28% of the country, have a dry savannah climate; this is most of the area south of the Save, and Tete province south of the Zambezi river.
- A small area around the Limpopo River (2%), in Gaza province, has a dry desert climate.
- The upland areas (10%) have a humid temperate climate; this covers areas in Gurué, Manica, Angónia and Lichinga.

In the south of the country, the mean temperature varies between 23°C in the coastal areas and 25°C in the interior, where the climate is drier. In the north, temperatures are in general higher, with an annual mean of 25 to 26°C in the low-lying coastal areas. In the higher areas, the temperature is lower: this is the case with the city of Lichinga in the far Northwest, located at 1,200m above the sea level, where the mean annual temperature is 18°C. In the central region of the country, the mean annual temperature is 25°C, but in upland areas it falls to 20°C. The average relative humidity is 71% in the coastal areas, and 64% on the border with Zimbabwe.

There is a great variation in rainfall between the north and the south of the country, and between coastal and inland areas. Along the coastal strip, mean annual rainfall is in the order of 800 to 1,000mm. South of Pemba there is a reduction to below 800mm, and between Beira and Quelimane, the figure is higher than 1,200mm. Because of the influence of the northwest monsoon, which affects the north and centre of the country, and the influence of the high altitude, this area has mean annual rainfall of 1,000 to 2,000mm, except in the region between Tete and Chemba, where just 500 to 600mm of rainfall occurs. The rainy season, which is a hot and wet period, runs from November to March, and is followed by a dry and relatively cold season between April and October.

1.2 Mozambique's Water Regime

The demand for water in Mozambique is divided between urban supply, supply for the rural population, irrigation, hydropower production, industry and mines, and forestry. In Mozambique, irrigation is the major consumer of water, followed by urban water supply, industry, and rural water supply.

Most of Mozambique's rivers run from west to east draining water from the high plateaus of central Africa to the Indian Ocean. Mozambique has 104 river basins that flow directly into the Indian Ocean. The coastal area is regarded as a single basin.

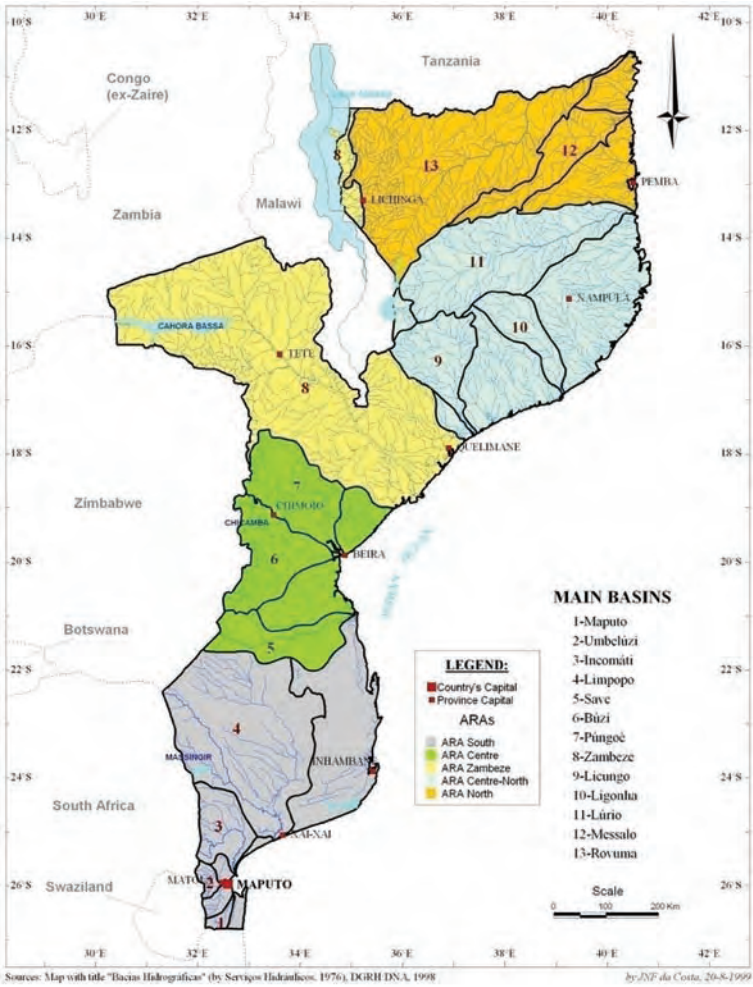

Figure 1: River Basins of Mozambique

With the exception of small rivers that drain into the coastal areas, most of the rivers have a torrential regime, with high levels of water for three to four months and reduced flows for the rest of the year. The basins south of the Save River mostly consist of the terminal sections of international rivers, such as the Maputo, Umbeluzi, Incomati, Limpopo and Save. These basins are characterized by reduced runoff coefficients, heavy intrusions of salt water at the river mouths (reaching more than 50km into the interior), broad and shallow valleys, with reduced storage potential, and consequently heavy evaporation losses and extensive flood plains.

In the centre of the country the basins are almost all located within Mozambique. Buzi and Pungue are the international river basins in the centre. The rivers rise in the mountainous border areas and gradually descend to the sea, where there is also heavy salt-water intrusion. These rivers have a more permanent runoff regime compared with the rivers in the south, not merely because of the climatic differences between the regions, but also because of the increasing use of water upstream in the international basins of the southern region.

The Zambezi River flows across a narrow valley near the border, and between Mpanda–Nkuwa and Tete, after which the river widens and becomes a vast delta as it approaches the Indian Ocean.

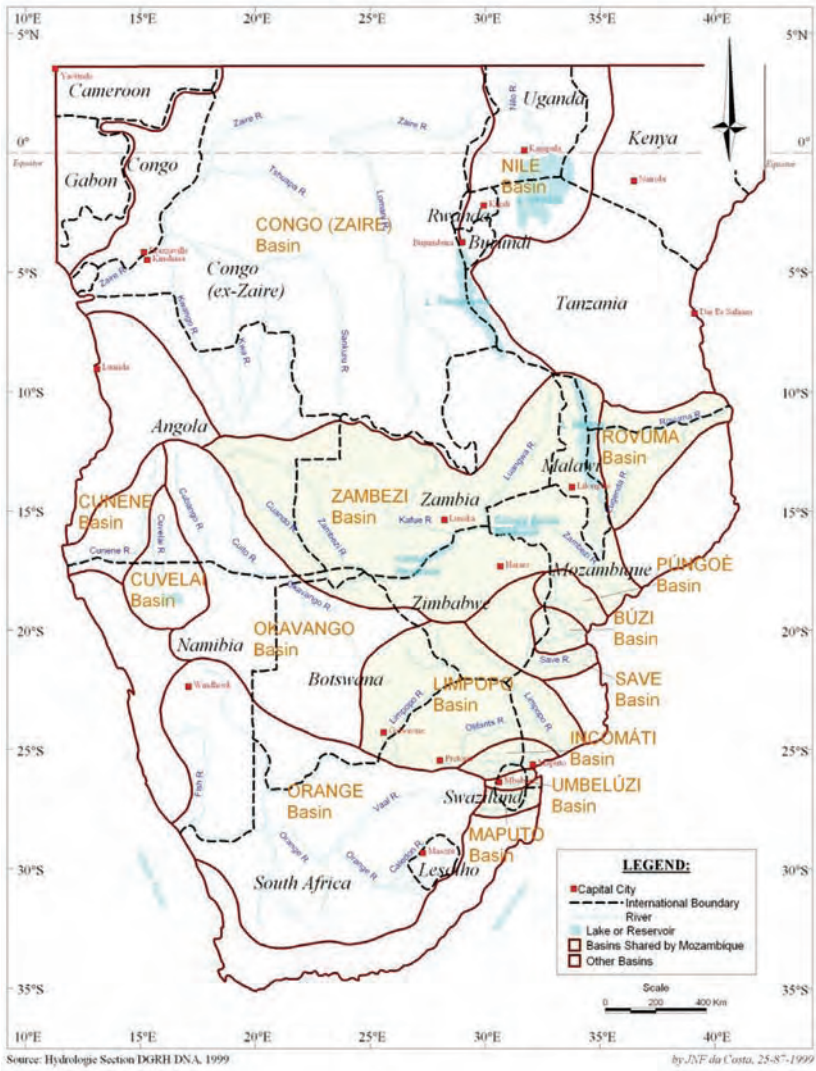

Figure 2: The International River Basins of Mozambique

This river has a large hydropower potential in the upstream reaches, and further downstream, extensive areas of land that can be irrigated, which are, however, subject to flooding.

The rivers of the northern region rise in the plateaus and the mountains. Some of the rivers have important waterfalls and steep slopes, with good hydropower potential, the Lurio, Licungo, Messalo and Ligonha in particular. The Rovuma River forms the border with Tanzania. The surface waters are the country's main water resource. Mean annual runoff is estimated at 216,000 million m^3, of which only 100,000m^3 originates from rainfall inside Mozambique. The remainder originates in countries upstream: this figure is falling with the increased use of water in these countries. The basin of the Zambezi River represents almost 50% of the surface water resources and about 50% of the flow from countries located upstream.

In Mozambique, the availability per capita of surface water resources is currently about 5,556m^3/inhabitant/year, taking into account only the runoff generated in the country, or 12,000m^3/inhabitant/year, including the flows from neighboring countries.

Compared with other parts of the world, Mozambique has a shortage of water. Indeed in Mozambique per capita water availability (excluding the inflows from countries upstream) is below the African average. This situation is worsened by the geographical and seasonal distribution of the water in the country, which results periodically in serious droughts in some parts of Mozambique, in addition to regional droughts covering all of southern Africa.

Three hydro geological formations can be identified in Mozambique, which coincide with the three main geological formations:

- Aquifers related to the geological formations of the Crystalline Complex (Palaeozoic and Pre-Cambrian);
- Aquifers occurring in the Karoo formations;
- Aquifers related to the post-Karoo formations (Mesozoic, Tertiary and Quaternary).

Ground water is the main water source for supplying the rural areas. To this end boreholes and wells with manual water pumps are used, but these have a limited capacity particularly for irrigation purposes. The hydro geological conditions of Mozambique make it possible for these systems to be deployed across the entire country, with some exceptions in the area of the crystalline complex or where the ground water is at too great a depth for the use of hand pumps. This is the case in the interior of the Gaza province and the far south of Manica province, where the aquifers are at a depth of over 100m.

Ground water is also used to supply some of the major cities – Pemba, Tete, Quelimane, Xai-xai, and Chokwe – as well as smaller towns (Ilha de Moçambique and Manhiça, among others). The use of ground water, however, is sometimes hindered by low water quality, caused by salt-water intrusion in the coastal areas, ancient marine intrusions, or contamination from the discharge of effluent. In substantial areas of the interior of Gaza and Inhambane provinces, as well as in the coastal strip of Zambézia province, the ground water is unfit for consumption due to high levels of salinity.

1.3 Impacts of Climate Change on Hydro Resources

According to the IPCC Fourth Assessment Report (AFR) climate change will lead to decreasing water availability and increasing drought in mid-latitudes and semi-arid low latitudes, with negative impacts on ecosystems. Hundreds of millions of people will be exposed to increased water stress. By 2020, between 75 and 250 million people in Africa are projected to be exposed to increased water stress due to climate change. In some countries, yield from rain-fed agriculture could be reduced by up to 50%.

Work done by the INGC, shows that the Limpopo river basin is one of the most vulnerable to flooding in the country. The Limpopo basin is the second largest of the nine international basins in Mozambique. It has no large dams to control the flow, which makes it highly vulnerable to the extreme precipitation occurring upriver in South Africa, Botswana and Zimbabwe. This basin is also vulnerable to drought: a large part of the basin receives less than 500mm precipitation each year. In the Pungwe river basin, dry conditions will get drier; there will be less water available for water supply, irrigation, and hydropower production; there will be a change in living conditions for fish in the rivers; the agricultural production season will get shorter; there will be a decrease in crop yield for rain-fed agriculture and an increased demand for irrigation, which imposes a need to choose suitable crops and to secure livestock fodder; there will be a risk of poor water quality due to low dilution when there is less water in the rivers; and finally there will be difficulties for the infrastructure in Beira City and other coastal settlements due to higher sea water level. For water sector adaptation, there is a need to prepare now for reduced water availability.

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 have been 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. These disasters displaced 500,000 people, destroyed essential infrastructure and caused significant negative impact on the national economy.

1.4 The Impact of Drought and Flood

Drought is a common phenomenon in Mozambique, where accumulated impact is greater than flood. Drought occurs in cyclical time frames of 7 to 11 years. The 1991 to 1992 droughts were the worst in recent years, affecting a large area of southern Africa.

Climate events such as the floods of 2000 and 2007 have undone years of development efforts and the adverse impacts of climate change may further slow Mozambique's development. The recovery costs following recent climate extremes (table 1) provide an indication of the magnitude of the annually occurring damages. In Mozambique annual growth was estimated at only 2% after the devastating floods in 2000, having severely declined from 8% beforehand.

The National Institute of Meteorology (INAM) has analyzed the risk of drought on the basis that 500mm of rainfall is the minimum acceptable for rain-fed agriculture. Figure 3 shows areas of vulnerability for droughts based on this analysis. The southern parts of the country are most at risk.

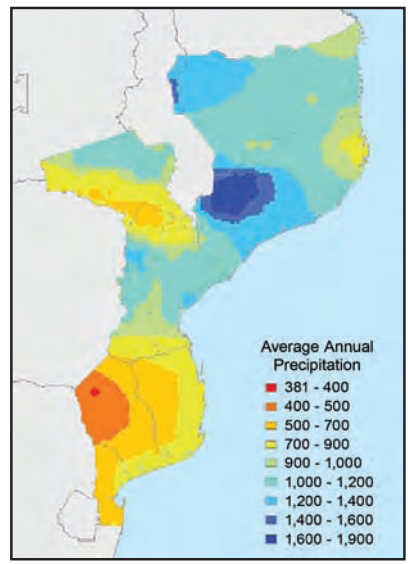

Figure 3: Annual average rainfall (mm)

Floods in Mozambique are due to both internal rainfall and water flows from neighboring countries as a result of precipitation in the upstream countries, frequently linked with inefficient management of dams. Although floods have negative impacts, they are also part of an ecological regenerative cycle, bringing nutrients to the soil, increasing agricultural productivity and replenishing groundwater.

There are 4 classes of flood vulnerability defined in the country:

- The risk of lowest level flooding is 1.7 million ha at an altitude of less than 20m above sea level, and up to 10km from the major hydrographical basins, representing about 6% of the national coverage. These areas can be inundated in years of medium to good rainfall;

Table 1: Recovery costs following climate impacts between 2002 and 2004.

Province	Rural Poverty	Recovery costs (thousand USD)								
		Droughts			Floods			Cyclones		
		2002/ 2003	2003/ 2004	2004/ 2005	2002/ 2003	2003/ 2004	2004/ 2005	2002/ 2003	2003/ 2004	2004/ 2005
Cabo Delgado	64.8	2,324	113	50	231	2,385	76	589	589	82
Gaza	61.0	2,222	8	208	903	2,757	707	419	1,548	373
Inhambane	84.7	8,199	182	27	894	329	866	1,504	75	8
Manica	32.0	1,715	248	73	233	1,303	145	0	85	80
Maputo	83.0	4,523	9,095	285	576	4,873	281	380	60	312
Nampula	58.7	4,032	117	438	529	1,166	94	4,998	2,836	738
Niassa	49.7	1,587	93	35	448	0	0	0	0	0
Sofala	40.8	1,185	970	250	191	806	1,028	434	1,300	709
Tete	57.8	2,276	2,081	2,191	90	83	3,160	0	0	0
Zambezia	45.0	4,695	521	819	987	844	1,786	666	442	1,019
Total	55.2	32,756	13,428	4,376	5,082	14,456	8,143	8,991	6,935	3,321

- The risk of the second level is defined for altitudes between 20 and 50m above sea level, representing 2.7 million ha, some 9.6% of the total land area;
- The third level risk is defined for altitudes between 50 and 100m above sea level, with 10km proximity of the main rivers, representing almost 4 million ha, some 14% of total land area;
- The fourth level risk is less likely to occur than the other three types, and will have effects in years in which floods risk is associated with waters coming from regional rivers.

Figure 4 shows areas at risk of flooding in Mozambique.

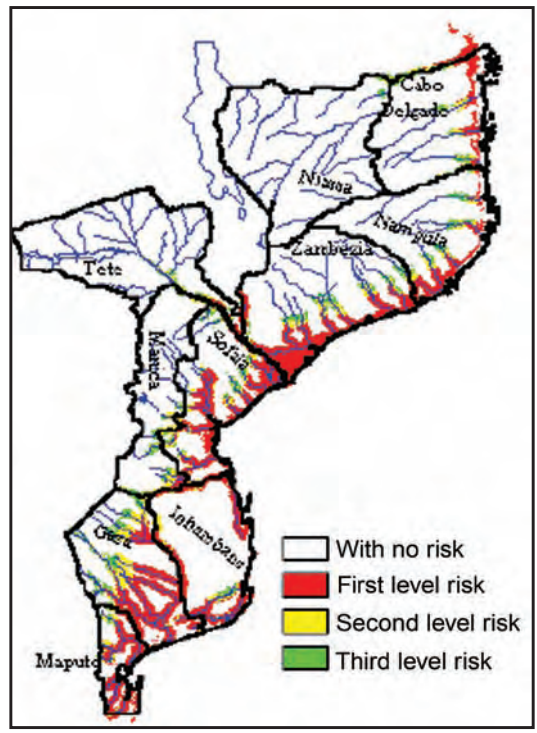

Figure 4: Areas at risk of flooding in Mozambique

According to the latest IPCC Fourth Assessment Report, the region of southern Africa will experience less water availability. The little rain expected will be available in very short periods. These situations will lead to both floods and droughts. The country has to learn to live with both phenomena.

Therefore there is a need to adopt proactive actions to these natural disasters before, during and after their occurrence. Major adaptation measures to be adopted can be summarized in short, medium and long term categories:

Short Term

- Building awareness of the relevance of climate change in development pathways, ensuring that climate change is recognized as relevant and an urgent priority across sectors;
- Reinforcement of the early warning mechanisms;
- Reinforcement of institutions dealing with climate change adaptation and disaster management;
- Building of technological adaptation through construction of dams for water control and storage, use of groundwater resources, harvesting of rain water, among others;

Table 2: Climate-Impact Matrix for MDG 1 'Eradication of extreme poverty and hunger'

MDG 1	Impacts of climate variability and change	Currently exposed areas	Affected social groups
Eradicate extreme poverty and hunger	*Current climate variability:* • Straining food security due to reduction or failure of agricultural production • Reducing peoples' livelihood assets, including housing, education centers, health provision sanitation supply and road infrastructure as well as the access to water • Tying up work force due to climate-related diseases • Reducing income opportunities *Future climate change:* • Straining food insecurity as a result of high flood and erosion risks for the majority of agricultural areas • Destroying maladjusted infrastructure, e.g. housing, roads, education and health centers • Impeding economic development due to destroyed productive assets and diseases • Posing a potential disincentive for investments in high risk areas	*High drought exposure:* Main areas of Maputo and Gaza and parts of Cabo Delgado, Inhambane, Manica, Nampula, Sofala and Tete *High flood exposure:* River valleys and coastal zones: Inhambane, Gaza, Maputo, Sofala, Tete and Zambezia *High cyclone exposure:* Coastal zones: Inhambane, Nampula, Sofala and Zambezia *High exposure to food insecurity:* Gaza, Inhambane, Niassa, Sofala, Tete and major parts of the remaining provinces	• Remote rural communities • Smallholders • Women and girls are more severely affected

Medium Term
- Mainstreaming climate change into development, enabling climate change issues to be integrated into different aspects of development planning;
- Reinforcement of scientific and technical capacity in climate change issues, to inform development policies and plans;
- Reinforcement of the capacity of forecasting climate patterns up to several months into the future, in order to enhance the capacity to respond to disaster situations;
- Expansion of the hydro meteorological network and introduction of modern technologies for data collection, transmission and processing;
- Computerization of hydrological databases and publication of the hydrological yearbooks, including systematic and regular exchange of information with neighboring countries.

Long Term
- Translation of scientific information into a format that is applicable to practical action by
- different stakeholders;
- Building of institutional receptivity across different sectors and organizations to receive such information;
- Undertaking of comprehensive studies of water resources, both surface and ground, covering the different aspects, like physical, ecological, and salt intrusion issues, among others;
- Promotion of the use of water desalination technologies for both sea water and water from boreholes, which in many cases have a high salt content in arid and semi-arid areas.
- Little progress has been made in relation to the MDG 1 (eradication of extreme poverty and hunger), which primarily targets the 86% of the Mozambican population living in rural areas.
- As a result of the combination of the high exposure to climate events, the high sensitivity and the low adaptation level, climate events have already severely affected poor rural communities.

While climate is not directly addressed in the MDGs, the examples above show the difficulties with attaining the MDG 1 given current climate variability. Moreover, climate change is posing further challenges to livelihoods and future development progress may be impeded by the increasing frequency and intensity of climate extremes.

2.0 Vulnerability Studies in Maputo Province

Maputo province covers an area of 26,058km^2 and is located in southern Mozambique. The province consists of eight administrative districts. Figure 5 shows the locations of three of the study sites which are the Moamba, Marracuene and Matola districts. Guijá is approximately 300km north of Maputo city. The main languages in the study areas are Changane and Portuguese.

The methodology copied the vulnerability survey protocol of Tanzania which is described in more detail in the Tanzanian chapter. There was training in the delivery of the survey instrument for university staff and graduate students. The initial surveys were done immediately around Maputo and then the MICOA conducted surveys further into Maputo Province.

Albazine

Albazine (Distrito Urbano No.4) is around 16km north of Maputo City and approximately 10km from the coast. There is no population data available for Albazine. There is a thriving market and a well-stocked local grocery shop in Albazine, and relatively good transport links to Maputo city (compared to Tenga and Marracuene). There are treated domestic water supplies in Albazine which cost between 51 to 100,000 MZM per month[1]. There is a combination of large and small agricultural landholdings in Albazine which are served by an extensive and well maintained canal system. The majority of local household food production is for sale in local markets as well as for domestic consumption. The main crops grown include bananas and sugar cane (which are vulnerable to high winds), as well as maize, carrots and vegetables. Fish and sea produce are brought from the coast to be sold in Albazine.

1 £1 equals 47,745MZM as of 21st April 2006.

There is a railway line through Albazine and a local hospital as well as a malaria spraying program every 3 months. There are lots of chapas (local mini-bus taxis) between Albazine and various locations in Maputo city, it costs around 7,500 MZM to get to Maputo in a chapas. Though the quality of the roads is highly variable, there are tarmac roads into Albazine and a mixture of tarmac and dirt roads within the district.

Guijá

Guijá district is situated in Gaza province 23º50'S and 24º50'S and between 32º25'E and 33º40'E approximately 300km north of Maputo city, and about 60km west of Xai-Xai, capital of Gaza province. Guijá has a semi-arid climate with an annual average temperature between 25 and 26°C, and annual average precipitation levels of 400 to 600mm. There are over 50,000 people, living in an area of 4,207km^2. Population density is estimated to be 17km^2 based on the 1997 census.

Marracuene

Marracuene is a riparian area around 32km north of Maputo City, located at the mouth of the Inkomati River. The 2006 projections for population size in the Marracuene district estimates figures at 50,263, with a population density of 67 people/km^2. There are 45 public schools in the district and 8 health posts. There are several markets in Marracuene where it is possible to buy domestic products. Concrete houses with gardens were constructed in Mumemo after the devastating floods of 2000 to rehouse, both locals and people from other areas. There are both small and large landholdings in Marracuene as well as a significant fishing community which totals 6% of the entire district population2. The majority of local household food production (crops, livestock, and fish products) is for sale in local markets as well as for domestic consumption. There are treated water supplies in Marracuene that cost around 20,000 MZM per month for the community pumps. There is a relatively small but important tourist industry in Marracuene including a ferry which goes to Macaneta beach several times a day. There are a number of cafés and pubs on the way to the ferry crossing.

Though the quality of the roads is highly variable, there is a good quality tarmac road into Marracuene from Maputo city and a mixture of tarmac and dirt roads within the district. There is a railway line and chapas to Maputo, but not many chapas travel locally within Marracuene. There are also small boats (12 people maximum) that transport people to Costa do Sol (approximately 10km from Maputo city) which are cheaper than the chapas.

Tenga

Tenga is a rural area located 40km north-east of Maputo City and 28km south-east of the district capital Moamba. There is a projected population size for Moamba of 36,460 people, with a population density of 10 people/km^2. There are 62 public schools in Moamba and 8 health posts. The majority of people in Tenga depend upon "traditional wells" known as xilovo (seasonal wetlands) for drinking water. There are some constructed wells, but these dry up as the dry season progresses. There is only one permanent water source in Tenga which retains water during the dry season, a xilovo around the course of the Rio Matola, which is around 6km from the village. Other options include getting water from Machava which is 24km away.

The area depends upon rain fed farming for subsistence, with most households having only small plots of land to cultivate. A minority of farmers in Tenga occasionally use supplementary irrigation but this is extremely limited due to a lack of water. In Tenga, most people are subsistence farmers who grow cassava and peanuts that are relatively tolerant of dry conditions. Other food crops grown are beans (including the leaves), onions, pumpkin, broccoli, and cashews. Many farmers also have a small number of domestic fowl (chickens, pigeons, and/or ducks) and/or goats, mainly for domestic consumption. There are a few wild fruit trees in Tenga, such as massala, tinsiva, and maphilwa that are consumed locally and occasionally taken to be sold in Machava or Maputo.

2 Based upon participants estimates

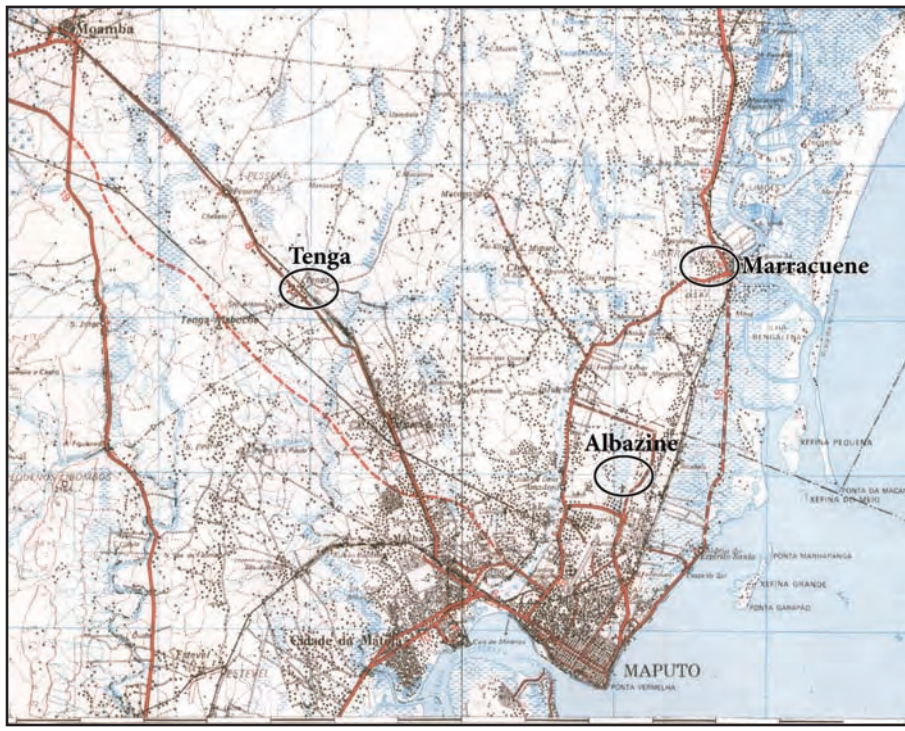

Figure 5: Map of Study Area

In terms of recreation, there is a small bar, and a cinema (a house with a TV) that costs 1,000 MZM (about 2p). The train stops daily (the Maputo – South Africa line) and buses come 3 to 4 times a day from Machava and Moamba. It costs around 9,500 MZM to get to Machava on the bus. The dirt road that leads into Tenga from Machava is severely eroded and impassable after heavy rain.

2.1 Findings

The majority of people involved in this study are chronically vulnerable to a range of stresses including climate risk. 70% of households are employed in the informal market and therefore have tenuous job/income security[3]. Only 15% of household members identified themselves as farmers though the vast majority of people interviewed either owned or had access to at least a small garden farm. Houses that are built with local materials are fragile and frequently damaged, and sometimes destroyed by heavy rains and tropical storms. This is especially the case for the rectangular houses that are less stable than round buildings. When it rains, thatched roofs leak. This is obviously very uncomfortable and prevents people from getting sufficient sleep. Such "low key" stress is clearly not a priority for intervention when food security issues prevail and need to be addressed, but nevertheless form a cumulative burden on vulnerable households. Houses built from local materials are less common in Albazine than in Guijá, Tenga and Marracuene.

Though the majority of households stated that a man was the head of the household, it was not specified whether this also includes families who are supported by migrant remittances. Gender divisions of labor within agriculture were not acknowledged by households in the study areas and

3 All quantitative statements are based upon surveys undertaken during September and December 2005.

initial observations did not contradict this perception. Children are expected to help with agricultural work when they are not at school, for example in the afternoons and/or weekends, though a minority of children do not attend primary school at all. Women and children are largely responsible for water collection. Women also hold almost sole responsibility for childcare, cooking, and health care within the family. Only one participant directly identified gender as an issue, because she did not know of any seasonal fluctuations in commodity prices since her husband controlled all of their money.

Malaria and gastro-intestinal diseases were the most common illnesses identified in all of the study areas.

There is dynamism as well as diversity in household composition in the study areas that may extend to include grandparents and other relatives at different points over the years. A third of households in all the study areas did not have personal possessions such as a radio, television, or bicycle. There was not a strong NGO presence perceived by the community in any of the study areas, though there is a food for work program in Tenga to build a road to Witbank (in South Africa). The majority of people in all the study areas identified the local church as the major community support institution, for example, in Mumemo and in Marracuene, the rehousing scheme is implemented by the local church. While there were public schools in each of the study areas, the vast majority of these catered only to grade 7 (primary level). In order to complete secondary education, families are obliged to send their children to travel great distances (from 16 to 40km).

Where banks or formal micro credit facilities exist in the study areas (there are none in Tenga), they are not used by the majority of people who either cannot open an account or cannot afford interest charges (even if they would be eligible for credit). Money may be borrowed from neighbors, friends, or family in exceptional cases such as illness or death of a family member. The only other circumstance in which someone would consider borrowing money would be to start up a small business. Xitique (estique in Portuguese) exists to a varying degree in all of the study areas. Xitique is the name given to a collective savings scheme between households. The xitique system requires that everyone in the scheme contributes a small amount of money each month and the sum of all these contributions goes to one member each month on a revolving basis. However, while most people agreed that it was present, the majority of people said they did not use xitique.

Common strategies employed to minimize climate risk were limited in all three study areas and included setting up small businesses to sell charcoal or other natural resource products (for example bamboo, thatch, wild fruits). This indicates that there are severely restricted opportunities to diversify income opportunities, particularly because these common strategies are employed simultaneously within the communities during periods of hardship (thus lowering the value of the products). Many older people in the study areas are able to interpret short-term weather patterns from cloud formations, and most people have access to the National Meteorological Institute radio broadcasts either directly or through neighbors. There was the perception, particularly from older people in Marracuene and Tenga that the predictability of the seasons is decreasing.

Albazine

In Albazine, the agricultural area covers both highland and lowland plots. Cash crops dominate in Albazine, including both large and small landholdings. However, when smaller producers go to Xiquelini (one of the local markets) business is not lucrative because there is strong competition with other producers (who come from as far away as Gaza province) who have larger volumes and higher quality products. Pests were identified as a major threat to agriculture in Albazine, and because pesticides are considered expensive, significant damage is often sustained.

Tropical storms were identified as a hazard for tall crops such as sugar cane and bananas. Flooding and waterlogging affect the lowland farm plots between January and March, which is significant because up to 20% of households have plots in the river basin. In Albazine, people identified xilo-

co as a coping mechanism to ameliorate the impacts of flooding. Xiloco is a system where people who have farms in the lowlands work on farms in the higher areas in return for food, clothes, or sometimes money. This is possible in Albazine because there is a relatively higher degree of socio-economic stratification (compared with Tenga for example), and therefore the xiloco system is important in maintaining local livelihoods. The last floods witnessed in Albazine were in 2002, although people did not require assistance to cope with this hazard.

Albazine is the only location where the majority of households surveyed possess 2 bedrooms, and almost half of the households surveyed had possessions such as a radio, television, bicycle, and/or sewing machines. Almost everyone who participated in the study considered that domestic water quality was good enough for drinking and cooking, and almost half of the respondents were able to collect water in an under 15 minute roundtrip from their homes. A small percentage of households receive both water and electricity. Charcoal is the most common fuel, though wood is sometimes used. Despite the relatively good transport network in Albazine, the majority of people surveyed do not use transport. The general perception of residents in Albazine was that there are hardly any opportunities for jobs outside agriculture or that the local wages are extremely low.

Guijá

The majority of the population of Guijá are women (43% are male), and typical family size is between 3 and 5 people. Almost 90% of families have built their own homes, which have 1 or 2 bedrooms. Approximately half of these are built using locally available materials. Houses made with wood and zinc, are more common than those built with blocks or bricks. Almost all households surveyed use gathered firewood to cook, and over 70% of households use paraffin for lighting. There are 150 boreholes with hand pumping systems in Guijá (110 are operational), and the majority of people get water from local wells or boreholes on a daily basis. The water is usually good for consumption, though more than half of households surveyed harvest rainwater for domestic purposes. Most households have access to a toilet or latrine, with 30% of households reliant upon going to the bushes instead of a latrine. Malaria and diarrhea are the most common diseases in Guijá. Most households prefer to go to hospital if possible when sick, though a minority mentioned the use of medicinal plants/local remedies.

Almost all families in Guijá practice agriculture, the vast majority of which is rainfed. Up to 30% of farms have an irrigation system. The main crops include maize, beans vegetables, cassava and peanuts. Only around 10% of families have access to animals or tractors for their farms, and almost 70% of people practice mixed cropping. Crops are perceived to be extremely susceptible to pest damage, with maize being identified as the most vulnerable crop.

At the time of the survey, households were buying seed stock because their stock was damaged by drought. Seed fairs had been established to assist in restocking, but these were not regulated. This creates serious sustainability issues because traders were coming from the Northern provinces and selling seeds very cheaply relative to local prices. Besides damaging the local economy, these cheap seeds are not particularly adapted to local environmental conditions. This means the cheap seeds are likely to cause a further failed harvest. Droughts started in 2001 and got worse in 2005. Local indicators of drought include ants, elephants, and the birth of more boys. Up to 80% of people required food aid during the 2005 drought. During times of scarcity, there are very limited options for economic diversification. Selling firewood in the informal sector, seeking wage employment on farms with irrigation systems, or migration to South Africa were the only stated options.

Almost half of the households surveyed live near the Limpopo River although there is no fishing industry in Guijá. Almost half of households had farms in the lowlands. Up to 30% of households were reached by the 2000 floods, which dominate local memories. Up to 80% of people required assistance with food and clothing, the vast majority of which was provided by NGOs and religious

organizations. Almost everyone (90%) said they didn't have any advance warning of the floods, and many households lost livelihood assets such as housing, farm production, and livestock. Traditionally, good harvests on Marula trees are a sign of rains, but in the case of the 2000 floods, the opening of water control systems in the Republic of South Africa as well as heavy rains were attributed to be the cause of the floods.

Marracuene

The 2000 floods devastated large parts of Marracuene and there have subsequently been several rehabilitation activities, including the construction of houses and relocation of some people to Mumemo. There were major floods witnessed in Marracuene by older residents in the 1970s but the 2000 floods were the worst in living memory. They destroyed livelihoods, including houses, farms, livestock and tools, as well as rendering the roads useless for many months. The river is reported to be wider following the floods and is encroaching upon the land. Some people from Maputo city were relocated to Mumemo after the floods, and those who participated in this study commented that although there was no crime in Marracuene, transport was a problem.

There are several markets in Marracuene including an indoor market in Mumemo and a large outdoor market (around 150 vendors) on a Tuesday and Saturday at Mucauline. There is a small daily market down the hill on the way to Macaneta, adjacent to some local building suppliers. There are both small and large landholdings in Marracuene, with the smaller plots generally used mainly for household consumption. A risk management strategy identified by older people in Marracuene is to have more than one plot of land (for example one in the higher land and one in the riparian zone or another district) so that if crops fail due to flooding or lack of water, the other plot provides a level of insurance. However, this is not a strategy that can be readily employed by the whole community due to both financial and labor constraints.

Because of the proximity to the Inkomati River, floods can destroy agricultural production, though droughts are not considered to be a problem by the majority of households in Marracuene. However, a local shopkeeper commented that her business noticeably drops between March and July because there are not many crops in the fields, and people have no money to buy her products. There used to be a factory in Marracuene but this closed some years ago. There are some South Africans with businesses who offer local people jobs, but only on short term, temporary contracts. Opportunities for young people revolve around agriculture, fishing, cutting bamboo, or working at the local markets unless they have the resources and desire to migrate to other areas. A typical working day for a young woman begins at 04.00 when she buys bread and sets up her market stall that is open until 16.00 when she goes home to do chores, prepare the family meal and spend time with her children. Her father works on the farm during the week and she goes to the fields on a Sunday.

The majority of households have to purchase fuel, including firewood, whereas water can be obtained both from treated community pumps and charcos (seasonal wetlands). Over half the people surveyed can collect water from within a 30 minute roundtrip from their home, and three quarters of these consider the water quality good enough to drink. The majority of people surveyed do not use transport in Marracuene. If people need to travel locally, it is sometimes possible to get a lift for a small fee. Despite the significant fishing community, the majority of people are engaged in agriculture in Marracuene. This is partially explained by the fact that fishing is extremely dependent upon suitable weather conditions, and requires a fallow period from January to February, so many fishing households also have farms (which include cattle if they are prosperous), as well as engaging in other activities like seasonal building labor for example. Tropical storms are the biggest climate risk for the fishing industry in Marracuene.

Much of the fish products are sold to vendors who come from as far as Maputo and Manica to obtain fish and sea produce. One fisherman we spoke to has developed a business relationship with his buyers where they will take the fish to sell for three weeks and return at the end of the month to divide the profits. This has been sustainable for the past 5 years. It is not viable for the fishing

community to sell only to local people who can usually only afford to buy small amounts. However, fish products are consumed by the family as well as sold. There was a fishing assistance fund set up by the government after the 2000 floods which loans money and/or equipment to fishermen so that they can rebuild their livelihoods. Not everyone is eligible for this fund, and those who utilize it repay 200,000MZM per month. Other fishermen have started to organize an association to discuss issues that affect everyone. For example because there are not many other job opportunities, some people continue to fish during the fallow period which will affect fish stocks.

Tenga

The quality of life in Tenga was defined entirely in relation to the rain because the vast majority of households are dependent upon rainfed agriculture. The only good thing people had to say about Tenga was that they could grow their own food. There is no sustainable source of drinking water and crops can fail due to a lack of rain, as well as due to flooding in the wet season. Xiloco was not identified as a coping mechanism by people in Tenga, because the majority of households in Tenga are too poor to maintain this system. A compounding factor is that the vast majority of farmers have relatively small plots of land and limited income generating opportunities. Most farmers had small livestock, although we observed four cows and one donkey during fieldwork. A local resident explained that in the past, people used to have cows, but during the post-liberation civil war the Renamo soldiers ate their livestock and most people still cannot afford to replace them. Most farmers said that the soils were good and only needed to be cleared in order to cultivate.

No households in Tenga have electricity or water connections to their houses, and the public wells are neither reliable nor sustainable sources of water. Collecting water is at least an hour roundtrip for most people in Tenga and only around half of the people surveyed consider that the water is of a good enough quality to drink. There is a local health post in the village where it is possible to buy chlorine to treat drinking water but this obviously depends upon the income of households as well as the availability of the stock[4]. Two years ago, UNICEF brought tankers of water to Tenga because of a chronic lack of water. Wood fuel is gathered locally, though charcoal and candles are purchased. It is difficult to obtain wood (that will light) if the rains are heavy. This is compounded by the fact that the road from Machava is impassable after a day's heavy rain, which is an obstacle to sourcing charcoal or kerosene.

Discussion on Vulnerability

The majority of the people within all the study areas are vulnerable to a range of climate risks. Chronic poverty erodes the resilience of communities to external pressures, which is further exacerbated by climate hazards. The key climate hazards that impact upon the three study areas are floods, tropical storms, and drought. Floods impede agricultural production and other employment opportunities and activities. Tropical storms damage houses and crops, and halts fishing activities. Drought contributes to both food and water insecurity in Tenga, while in Guijá there are serious "maladaptive" recovery mechanisms that contribute further to food insecurity.

However, it is difficult to draw direct causal linkages between climate variability and the impacts on livelihoods perceived by the communities. For example, in Tenga, people said that life was bad when there was drought because they can't grow crops and so they go hungry. However, the main strategies to cope with a lack of food production in Tenga are based upon selling wood, charcoal, and to a much lesser extent, unprocessed wild fruits. This requires up to 25km travel to places such as Machava or Moamba which is either expensive or exhausting (or both!) and there is both strong competition and limited demand for these products. Other strategies include selling labor in the informal sector that provides limited opportunities for insecure and poorly paid work. So it is fair to conclude that a lack of opportunity for alternative seasonal employment, combined with drought conditions greatly affects food security in Tenga. Additionally, due to a general lack of agricultural inputs in the production systems, declining soil fertility may be a compounding factor in declining

4 According to several respondents, the health post does not always have medicines in stock which means they have to be obtained from Maputo

food security during the drought periods. Intensifying agricultural production and improving post harvest storage, as well as improving the regulation of seed fairs would increase food security in all areas.

Limited opportunities for employment exist outside of agriculture which increases vulnerability to climate risk throughout all study areas. The strategies identified in Albazine and Marracuene rely upon socio-economic stratification within the community, for example xiloco cannot work if everyone is poor, and clearly having more than one plot of land is not a strategy that can be employed by landless people. This strongly demonstrates that social capital is not a panacea and is in fact eroded by chronic poverty. There is varied NGO activity in Marracuene, partially in response to rehabilitation after the 2000 floods, and there is a food for work program in Tenga. However, the only long term formal "grass roots" institutions within all three study areas were the local churches. These institutions should therefore at least be considered as potential partners in building community resilience.

There are much greater opportunities for income diversification in Albazine and Marracuene than in Tenga or Guijá because of their close proximity to several thriving markets. The higher proportion of durable houses and roads in Marracuene and Albazine also indicates relatively higher resilience to climate risks in both financial and physical terms. Environmental sustainability may prove to be an issue in the near future, particularly relating to the wood sourced for charcoal production in all the study areas, and local fish stocks in the Inkomati River. However, the fishing community is already actively seeking ways to resolve this issue.

It is obvious that the health situation for the majority of people in the study areas is extremely precarious, given their insecure access to employment and in some cases food and water. Malaria and gastro-intestinal diseases were the main health problems in all of the study. It is not surprising that HIV/AIDS was not mentioned by most of the research participants because of the widespread stigma attached to the disease. For example we were informed that people actively discriminate against HIV positive community members in Mumemo, partially because they receive special assistance from the church. However, HIV/AIDS prevalence is estimated at 16% in Mozambique and is therefore a serious threat to people already suffering from poverty.

The presence of the railway link to all of the study areas theoretically provides access to bigger markets (including South Africa). However, in order for people to be able to access bigger markets, there would have to be substantial support to communities in order to develop the production of appropriate value-added products.

The majority of people in the study areas are surviving in the short term. There is high vulnerability to climate variability in the short term because of a lack of income diversification opportunities and a heavy reliance upon the informal sector. With the exception of extreme floods, it is not useful to attribute this vulnerability solely to climate risk.

3. Conclusion

Work in Mozambique was extremely rewarding although it was done from a low information base. It was also true that state, provincial and district administrative structures were very weak and frequently under resourced in terms of both people and equipment. Nevertheless, the focus on pre-disaster planning, linking across state structures from the MICOA has proved to be a useful exercise in capacity building.

At the level of physical science data, the country remains inadequately served and thus finds itself trying to draw conclusions from broader regional analyses. There are, however, lead individuals around state, parastatal and university institutions who have demonstrated capacity at international

and national level to complete the scientific requirements of UNFCCC reporting. Their ability goes beyond this formal reporting as demonstrated in this chapter. Their willingness to explore vulnerability as a key factor in the design of a local adaptation program offers hope for local solutions that address not only climate change but the broader challenge of poverty alleviation. There has been much to celebrate in Mozambique NCAP.