MOZAMBIQUE INITIAL NATIONAL COMMUNICATION TO THE UNFCCC

APRIL 2003

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ABBREVIATIONS

BR	Bulletin of the Republic
m^3/Seg	Cubic meters a second
GHG	Greenhouse effect gas
Km	Kilometre
Km^2	Square Kilometre
Gg	Gigagrams
GWh	Giga Watt hour
GPL	Gases of Liquefied Petroleum
DNE	National Directorate of Energy
INE	National institute of Statistics
CO_2	Carbon dioxide
CO	Carbon monoxide
CH_4	Methane
N_2O	Nitrous oxides
NOx	Nitrogen Oxides
^oC	Centigrade degrees
hl	Hectolitres
ha	Hectares
ton.	Tons
GDP	Gross domestic product
MW	Mega Watt
IPCC	Intergovernmental Panel on Climate Change
COP	Conference of the Parties
NMVOCs	Non-methane Volatile Organic Compounds
MICOA	Ministry for the Coordination of Environmental Affairs
DNT	National Directorate of Transports
DNA	National Directorate of Waters
DNDR	National Directorate of Rural Development

DINGA	National Directorate of Agriculture
DNGA	National Directorate of Environmental Management
INIA	National Institute of Agronomic Research
UGC	Coastal Zone Management Unit
PNUD	Program of the United Nations for the Development
PROAGRI	National Agricultural Support Programme
GEF	Global Fund for the environment
ONG's/NGO’s	Non-governmental organizations
DSSAT	Decision Support System Agrotechnology Transfer
USCSP	US Country Studies Programme
GCM	General Circulation Model
UKMO	United Kingdom Meteorological Office
GISS	Goddard Institute of Space Studies
AVVA	Aerial Videotape Assisted Vulnerability Analysis
GFDL	Geophysical Fluid Dynamics Laboratory

FOREWORD:

The Republic of Mozambique recognizes that the global nature of climate change requires the widest possible cooperation of all countries to respond to the challenge. All countries have common but differentiated responsibilities according to their social-economics conditions.

Mozambique ratified the United Nations Framework Convention on Climate Change on August 24th, 1994 through the Assembly of the Republic and became Party in 25th August 1995. By doing so Mozambique joined other Parties of the Convention, in the common objectives of stabilizing the greenhouse gas concentration in the atmosphere to a level that would impede dangerous anthropogenic interference with the climate system. Such a level should be reached in a time frame that allows the ecosystems to adapt naturally to climate change that, assures that the production of food is not threatened and that allows economic development to continue in a sustainable way.

The Republic of Mozambique is vulnerable to the effects of the climate change (occurrence of extreme events: tropical cyclones, floods, droughts) in the following ways: firstly because it is a developing country with scarce financial and technical resources to face these climate events and secondly because of its geographical location i.e. low-lying coastal areas in the global belt of arid and semi-arid areas of the world.

At the end of the civil war, in October of 1992, the Mozambican economy registered some notable economic growth. However, the recent floods and tropical cyclones that devastated the country constituted a living example of how vulnerable the country is to the occurrence of extreme climate events and its consequences, like demonstrated by the decline in the economic growth. In this context, it is urgent to adopt measures of adaptation to and/or mitigation of the adverse effects of the climate change as well as to increase the awareness and education of the population in matters related to climate change.

This Mozambique Initial National Communication intends to bring to the attention of the Conference of the Parties, through the UNFCCC Secretariat, the following:

i) National inventory of anthropogenic greenhouse gases emissions and their removals from the atmosphere by sinks, considering all the greenhouse gases not controlled by the Montreal Protocol;

ii) General description of the steps taken by the country to implement the Convention and

iii) Other information considered relevant and related to climate change in accordance with Article 12 of the Convention.

ACKNOWLEDGEMENTS:

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We would also like to thank the Government and academic institutions, the private sector and NGO's that directly or indirectly contributed to the development of the present report.

0 EXECUTIVE SUMMARY

0.1 National Circumstances

Mozambique is located on the Eastern coast of the African Continent, between the parallels 10º27´ and 26º52 South and the meridians 30^0 12´and 40º51´East.

The Mozambique territory covers a surface area of 799 380 km^2, with 786 380 km^2 constituting the land and the remaining 13 000 km^2 consisting of water bodies. It has a terrestrial border with 4 445 km long and a coastal line length of 2 515 km.

The climate is tropical with two seasons: one hot and rainy season, from October to April, and the other cold and dry, from May to September. The rainfall is more abundant in the North of the country, where the annual average varies between 800 and 1200 mm becoming exceptionally high, 1500 mm, in the Zambezi and Lichinga Plateaus. The centre and the whole coastal line receive rainfall amounts that vary between 800 and 1000 mm. In the mountainous areas of Gorongosa the precipitation exceeds 1500 mm and Tete province registries lower precipitation values (600 mm) . The South of Mozambique is generally drier with an average rainfall lower than 800 mm, decreasing to 300 mm in Pafuri District.

The countrys population is estimated, according to the 1997 census, in 15.28 million inhabitants. This population mainly relies on agriculture, which is the main land use. Agriculture occupies approximately 80% of the labour force, contributing to about 40% of the Gross Domestic Product (GDP) and generating almost 70% of the revenue in foreign currency.

In spite of the current economic recovery registered in the country, which was reflected into a GDP growth of 6.9%/year from 1993-96 and 12.4%/year in 1997, Mozambique continues among the poorest countries of the world.

0.2 GHG Inventories

Global climate change is attributed to the increase of CO_2 concentration in the atmosphere, chiefly due to anthropogenic actions, which results in the greenhouse effect. This is reflected through the increase of air temperatures, followed by other effects such as the melting of the polar glaciers, as well as rise in sea level. In addition, there are also changes in the rainfall regime, reduction of the availability of fresh water and of the capacity of absorption of nitrogen by plants and more frequent occurrence of extreme weather events, among others.

The total direct greenhouse gases emissions in Mozambique, in 1994, was approximately 9 265 Gg of CO_2, 272 Gg of CH_4, and 3 Gg of N_2O. When expressed in Global Warming Potential (GWP), these emissions amount to a CO_2 equivalent of 15 907 Gg. 58% of total emissions are CO_2 emissions, and 36% are CH_4 emissions. Indirect greenhouse gases consist of 94 Gg of NO_x, 4 762 Gg of CO and 8 Gg of NMVOCs.

0.3 Vulnerability and adaptation

For countries like Mozambique with a weak economic development and low institutional and reactive capacity, the impact of the climate change on living organisms, natural resources, the environment and consequently the national economy can be very severe. The major challenge therefore is the need to predict and/or project climate changes in the future, as well as its effects on the natural environment and resources. This knowledge will enable the adoption of strategies aimed at adapting and mitigating the effects of climate change.

In Mozambique the main sectors that are likely to be or are being impacted by climate change are:

- Agriculture;
- Forests and pastures;
- Livestock;
- Water resource;
- Coastal Areas and resources;
- Infrastructure
- Health and fishing

The impacts of climate change are particularly serious for Mozambique, where the effects of the doubling of the current concentration of CO_2 in the atmosphere is likely to have the following consequences:

- The increase of the mean air temperature by between 1.8 and 3.2 ºC;
- Reduction of rainfall by 2 to 9%;
- Increase of the solar radiation from 2 to 3%, and;
- Increase of the evapo-transpiration by between 9 to 13%.

Computer simulations already indicate that the coastal area resources, water resources, agriculture and forests would be negatively impacted.

Pastures seem to be the only sector where it would be possible to observe an increase of the foliage, but conversely, the reduction of the nutritional capacity due to the weak absorption of nitrogen, would counterbalance, in a negative way, the predicted increase in pastures.

Faced with the potential vulnerability of the sectors of the Mozambican economy of the environment, the adoption of measures based on predicted impacts is important in order to mitigate the following impacts:

- Inundation of the low coastal areas and aggravation of the coastal erosion;
- Reduction of the availability of fresh water;
- Reduction in the agricultural production;
- Reduction of the nutritional value of plants due to decrease of their nitrogen content with significant effects on livestock:

Specific adaptation measures for the identified problems include:

- Strengthen the country's socio-economic development, closely dependent on the integration of environmental issues with development efforts.
- Implement sustainable management of the country resources, in a multi-sectoral context, with harmonisation of plans and programmes and involvement of all the stakeholders implicated in the exploration and utilisation of natural resources.

This understanding is the basis for the process of review and formulation of pertinent environmental legislation for sustainable development in Mozambique, taking in consideration the main thrust of the Governmental development programmes, which are aimed at eradicating poverty, at the same time ensuring that there should be sustainable use of natural resources. Such pieces of legislation are: The National Environment Policy, the Energy policy, the National Environment Management Program, the National Land Policy and its Implementation Strategies, the National Policy and Strategy for Forests and Wild Life, the Environment Law and Framework, Legislation on Investments, Mines Law, Petrol Law, and Transport Law among others.

0.4 Systematic observation

The capacity to systematically observe the parameters of the climate system is still poor as a result of the internal conflict, which affected the country for more than 15 years and destroyed a large part of the observing infrastructure. This weakness is directly reflected in the lack of information for appropriate knowledge of the behaviour of the parameters of the climate system. This also brings about uncertainties in the climate studies that can be conducted in the country. In addition to that, the capacity to conduct relevant research is still poor.

These two factors jointly, make the understanding of the cause-effect mechanisms, as well as the magnitude and time of impact of the occurrence of climate change in Mozambique, uncertain. This endangers the process of adoption of strategies for adaptation and mitigation of such impacts. To correct this situation, all the support that can be provided to Mozambique will constitute a way forward for the establishment of foundations, which ensures a more appropriate future within these areas.

Taking in consideration the spirit and letter of the paragraph g) of the article 5 of the United Nations Framework Convention on Climate Change, Mozambique needs urgent assistance in the strengthening of the systematic observation systems and development of databases related to all the components of the climate system. The development of human and institutional skills necessary for the efficient use of these data in scientific, technological and socio-economic research is equally necessary and urgent.

In the light of these difficult, Mozambique’s needs are as follows:

- Scholarships for training and specialization of experts in various domains of climate change;
- Support for the establishment of technical conditions that enable the development of research activities at national level;
- Support for public awareness activities in matters related to climate change;
- Support for transfer of know-how through, namely, the participation of national experts in research activities of regional and international character;
- Support for the improvement and strengthening of the monitoring skills as well as for systematic observation of the parameters of the climate system and its interactions with the environment;

- Support in the processing of the existent data so that it can be easily accessed for research activities.

In spite of recent efforts in environmental education with particular emphasis on climate change, the level of perception and knowledge of the Mozambican society on these issues is still very limited, particularly in the rural areas. Improvement in education activities and information dissemination is still weak. There is a need for improvement in training skills in different institutions and organisations involved in public awareness activities.

There is also a need to introduce environmental issues in the school curricula at all levels as well as specific courses on environment at universities.

Given that the majority of the Mozambican population is illiterate, without access to formal education institutions, there ought to be a clear policy and programmes specifically aimed at raising the climate change awareness of the different communities**.**

1 NATIONAL CIRCUMSTANCES

1.1 Extent of the study

The Mozambique Government has committed himself to submit its Initial National Communication to the UNFCCC Secretariat, fulfilling its obligations to the Convention in accordance with Article 12.

The Ministry for the Coordination of Environmental Affairs is the national responsible institution in coordinating the implementation of the United Nations Framework Convention on Climate Change. In order to meet its UNFCCC obligations, the Mozambique Government created an inter-institutional climate change national group, with two sub-groups: one is reponsable for the inventories while other is concerned with vulnerability and adaptation studies. Technicians from the Government, NGO's and academic institutions contribute to these groups.

In its attempt to implement the Convention, the Government calculated two Greenhouse Gas (GHG) Inventories: the first one was released in 1998 and was based in 1990 data and the second, published in 2000, was the update of the previous. This became the second national GHG inventory. Apart from these inventories, Mozambique also conducted vulnerability and adaptation studies to assess the potential impact of climate change on the Mozambique economy.

The vulnerability and adaptation studies included the following sectors: agriculture (corn crop), forests and pastures, water resources and coastal zone.

Besides these studies, activities of public awareness related to climate change were conducted, considering the Convention and the Protocol. These activities consisted in seminars, television programs, letters and visits to organisations and institutions that work on matters related to legal and international instruments.

1.2 The Geography of Mozambique

Mozambique is situated on the Eastern coast of Southern Africa, between 10°27´ S and 26°52´ S latitudes and 30°12´ E and 40°51´ E longitudes (Figure 1). The total land area is 784,090 km^2. The country is divided into 11 provinces including Maputo city, which is also considered a province. About 70% of the country is covered by savanna and secondary forests. Approximately 45% of the territory has potential for agriculture. About 60% of the land is classified as managed land, including agriculture and permanent pasture lands. The maritime area is about 666 km^2. The shelf area up to 200 m depth and 104 km^2 and the total area of the Exclusive Economic Zone is 562 km^2.

The climate in the Northern region of the Zambezi River is under the influence of the equatorial low pressure zone with a NE monsoon in the warm season. The climate in the Southern area of Zambezi River is influenced by subtropical anti-cyclonic zone. In the North of Sofala, along the Zambezi River, lays a transitional zone with high rainfall figures (Saetre *et al.*, 1979).

In the North of Mozambique the winds in the are influenced by the monsoon system with NE winds during the southern summer and SW winds during the southern winter. Central and Southern Mozambique are dominated by the SE trade winds.

The average annual precipitation is about 1200 mm. The rainfall is mainly restricted to the warm season, November to April. According to the classification of Köppen, the Northern areas (Cabo Delgado, Niassa, Nampula and Zambezia) and the coastal region climate is classified as tropical rain savanna, whereas the climate of the upland areas of the interior is humid and temperate. Ocean currents, particularly the Mozambique warm current, may influence the rainfall.

Mozambique has more than 100 rivers. The major ones are: Rovuma, Lúrio and Zambezi in the North, Pungué, Buzi, Gorongosa and Save in the center and Limpopo, Incomati and Maputo in the South. These rivers drain about 208 km^3 of water rich in nutrients into the coastal waters. About 80% of this water enters the ocean from Sofala Bank, central Mozambique. Zambezi River, the largest river in Eastern Africa, alone, contributes with 67% of the total river discharge in the whole country (Seatre and Jorge da Silva, 1982).

The tidal range is about 2 m in the South, 3.1 m in the North and about 6.4 in the center. High range in the center is thought to be related to both the shallowness and channel effects. The tidal wave entering the Mozambique Channel through the South would, due to Coriolis, induce an increment in the tidal range in the Mozambican coast.

In terms of administrative divisions and, in accordance with Mozambican constitution, Mozambique is divided into eleven provinces, which are sub-divided into 128 districts, Administrative Post and urban centres, which have also a special political-administrative status.

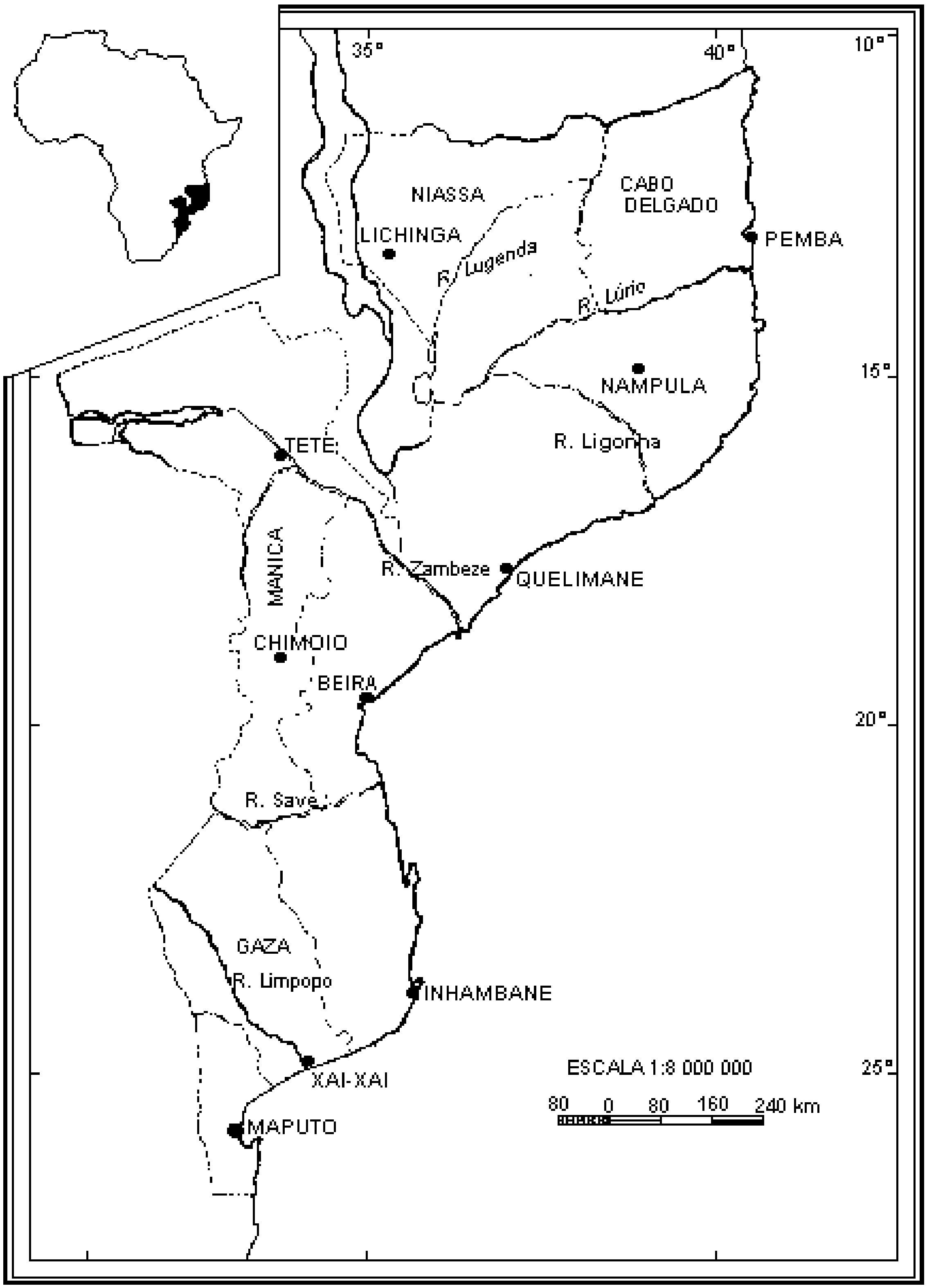


Figure 1-1. Location map, administrative regions (provinces) and their capitals. Some of the capitals were named after their respective provinces.

1.3 Demography

The current population of Mozambique is estimated at more than 17 million. It is expected to grow at an annual rate of 2.5%, and in the year 2025 it is estimated to be about 35 millions (Figure 2). About 40%-45% of the population is composed by the youth and children (<15 years old). The working or active population (between age 15 and 65) constitute about 50% of the total population, which resultes in the dependency of half of the population. Urban population is quite representative and shows a considerable increase from year to year: in 1950 urban population represented only 5.4% of the total, having increased about 33%, until 1995.

The fertility rate is likely to drop in the future as the family planning programmes become more effective and implemented in rural areas, the status of women in the society improves and the poverty diminishes. Further, it is more likely that the mortality rate would decrease and the life expectancy would increase in the future as medical cares will become more accessible to people and status of living of the population improves. The major causes of death in Mozambique are infectious and parasitic diseases, as in other developing countries.

About 2/3 of the Mozambican population lives in the coastal zone, for security reasons: since this areas were relatively safer during the war (UNCED, 1992). Other reasons are related to the easier access to food and employment facilities: most of the infrastructures such as large cities, tourism, industry, commerce and harbors are located in the coastal zone. The average population density in the coastal area is about 120 inhabitants per km^2, against overall population density of 2 inhabitants per km^2.

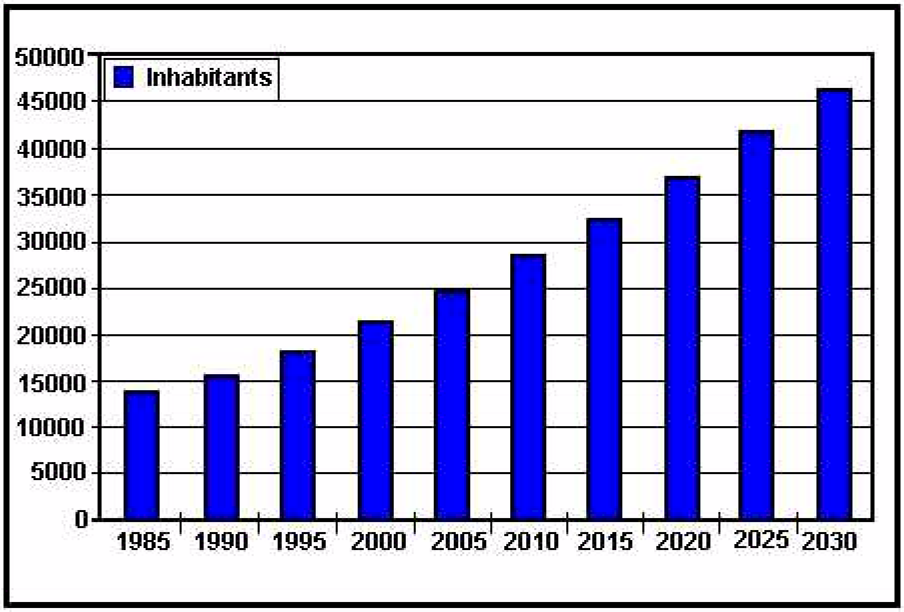


Figure 1-2. Prediction of the growth of population in Mozambique (in thousands of people). Source: World Bank, 1992/93.

Poverty in Mozambique is multi-faceted and its causes can be traced back to a number of historical factors. A set of key determinants have been singled out, including: (1) low rate of economic growth throughout the early nineties; (2) poor education levels, especially among women; (3) high household dependency rates; (4) low agricultural productivity, namely in the small-holder sector; (5) lack of employment opportunities and (6) infrastructure constraints, particularly in rural areas, where the incidence of poverty is higher (about 71%).

The incidence of diseases amongst the populations is the fundamental cause of human suffering and increase in absolute poverty. Preliminary data analysis on the main epidemic diseases shows that malaria affects the whole country, with greater incidence in the Southern region (in terms of the percentage of affected population) especially in Gaza Province (Figure 1.3).

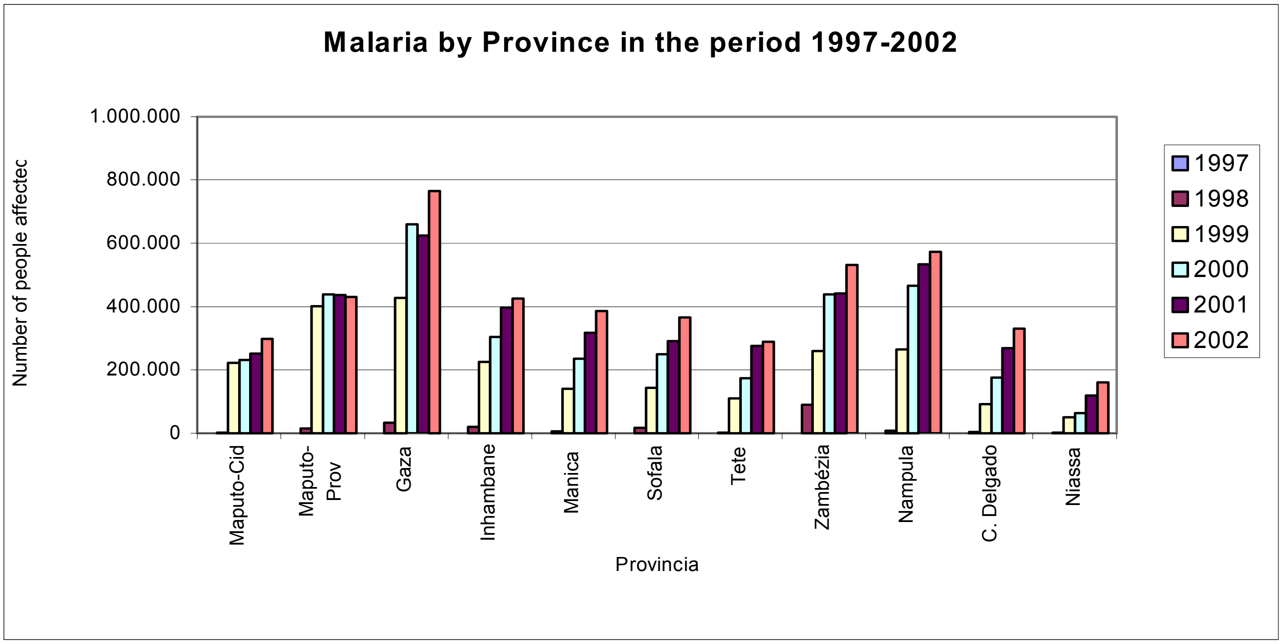


Figure 1-3. Number of people with Malaria per Province in the period 1997-2002

The second most frequent epidemic disease, which impacts the whole country and a considerable number of people, is Diarrhoea. Contrary to Malaria, Diarrhoea has larger incidence in the Center and Southern regions such as Maputo city (Figure 1.4). In general, these two epidemics (Figure 1.3 and 1.4) show a tendency of increasement in the number of cases observed every year. Apparently, this scenario contradicts the efforts made by the Health authorities in the combat and control of these diseases. On the other hand, this tendency may be reflecting the improvement in the methodology of data collection as well as in the increasement in the areas covered.

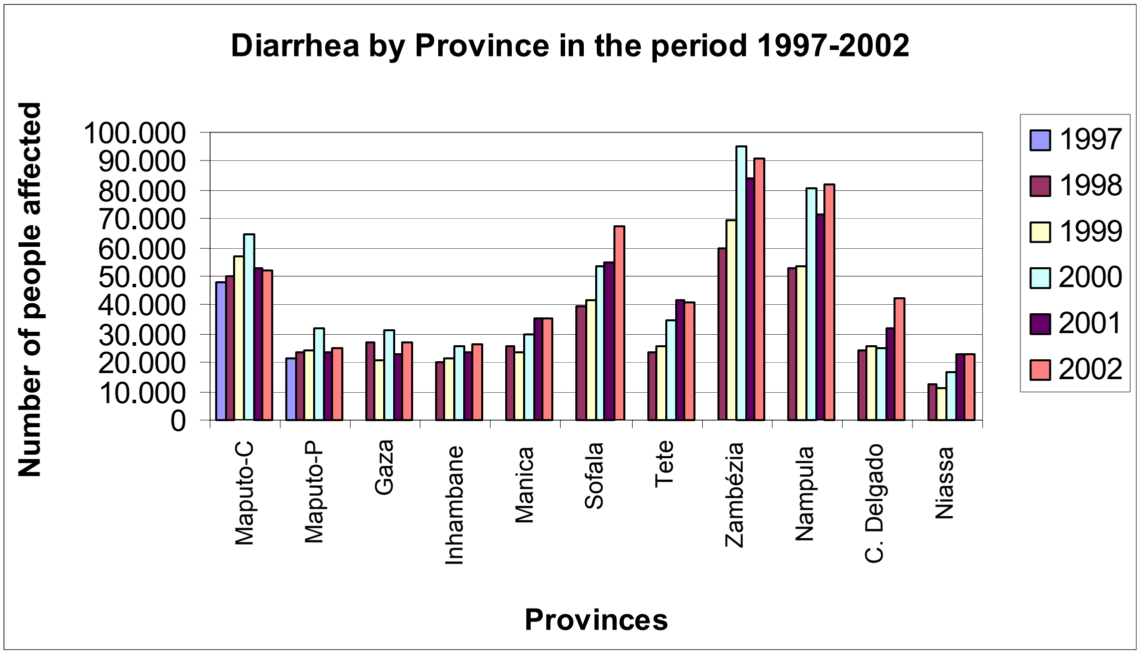


Figure 1-4. Number of people affected by Diarrhea by Province in the period 1997-2002

Another epidemic that should me mentioned is Cholera, with largest incidence in the Center (Sofala and Zambézia) and Northern regions (Nampula and Cabo Delgado) (Figure 1.5). In the Southern region the city of Maputo has also high incidence and the remaining Provinces of this region show picks in the year 2000, probably due to the occurrence of the worst floods in the last 50 years.

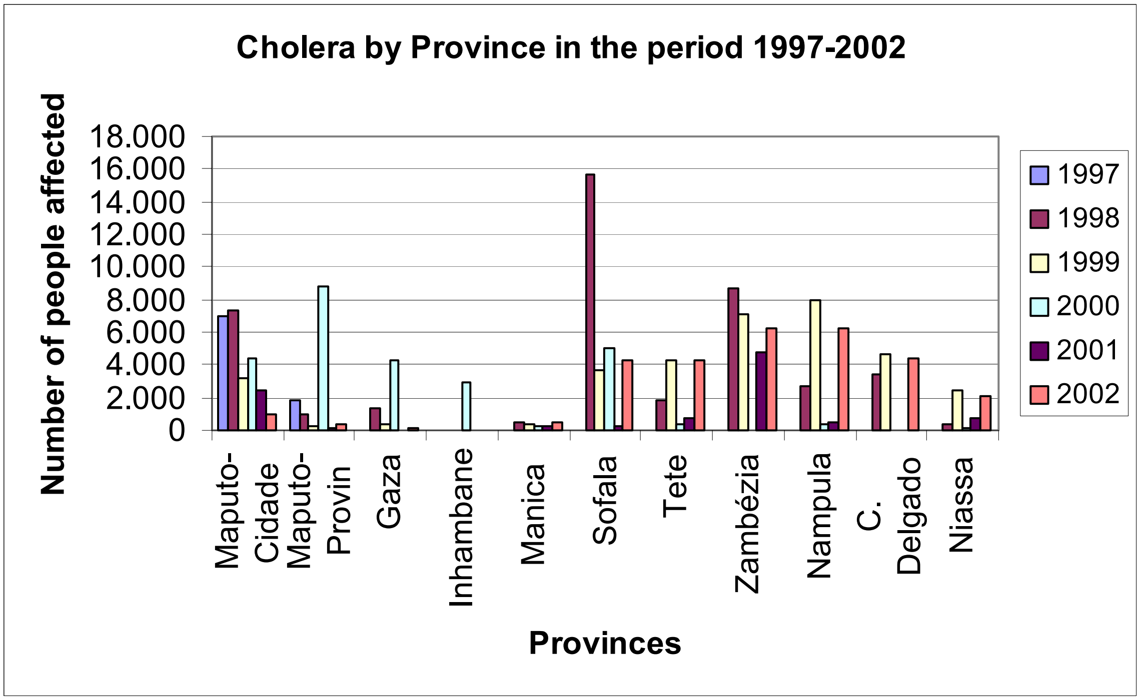


Figure 1-5. Number of people affected by Cholera by Province in the period 1997-2002

1.3.1 Nutritional Indicators

Physical growth can be defined as an increase in an individual's size measured by alterations in his weight and/or in his height. The food that provides the necessary nutrients for physical growth constitutes an essential environmental factor of growth and development, mainly during childhood, when an integral part of the psychosocial development occurs.

A poor environment, for instance, that supplies inadequate nutrition, can hinder a child from reaching its total genetic potential, not only in terms of height, weight and strength, but also relating tol other contemporary indicators, like in terms of mental development.

One of the parameters used for nutritional surveillance is the insufficient growth. One evidence of this abnormally is the lack of weight gains observed between two consecutive passages (in an interval of 1 to 3 months). If it becomes persistent it can lead to malnutrition. A classification of the population by the percentage of insufficient growth (C.I.) indicates that about 16% to 30% should be considered in an alarming situation and more than 30 % in a serious situation (Ministry of Health, 1997).

Published data, in the bulletin of nutrition number 32 by thr Ministry of Health, shows that in the 2nd semester of 1997 the northern region of the country presented focus of C.I., with larger incidence in the North of the Niassa province, particularly in the Mecula district, and in Nampula province, in the the Mongicual district, where the situation was classified as serious. In the center region of the country, in the North and the South of Sofala province, namely the districts of Gorongosa and Chibabava, presented an alarming situation and in Manica province, in Macossa district, the situation was serious. In the Southern region of the districts of Mabote, in Inhambane and Guijá and in Gaza, the situation of C.I. was considered alarming.

The data analysis of C. I. considering the period between 1997 and 2002, indicate a significant nutritional improvement in the whole country. However, in the Northern region, the province of Niassa in the Mecula, still presents an alarming situation. In the center of the country in Sofala province, Gorongosa district registered an increase of C. I. between 1997 and 2000, following by a significant decrease towards 2002; continuing meantime to present an alarming situation.

The Southern region of the country has registered a significant improvement, dispite the appearance of a new located focus in the district of Inhassoro, showing an alarming situation in 2000 that quickly normalized again in 2002. In general in the Southern region of the country, the districts of Mabote, Inhassoro (Inhambane) and Guijá (Gaza) need continuous monitoring.

The scenario illustrated by the information above reveals a positive example of the effort endeavored by the Mozambican Government and other partners, in combating what has been one of the main morbidity and mortality causes.

1.3.2 Impact of HIV/AIDS in Mozambique

HIV/AIDS is the epidemic that, at the present, worries all the humanity due to its negative effects on the population and on socio-economic development. These effects have already started to be well known in Mozambican's daily life. In the future, it can be worse if all of us do not take the adequate precautions to avoid its contamination and propagation.

According to studies about HIV (Ministry of Health, 2000), conducted in 20 health centers, 11 urban and 9 rural, distributed with 7 health centers in the Noth, 8 in the center and e in the South, the incidence of HIV in adults (15-49 years) indicate high rates in the center of the country (16,5%), followed by the Southern and Northern areas (13,2% and 5,7%, respectively).

Considering the HIV prevalence, the provinces that stand out are Manica (21.1%) and Tete (19.8 %), in the center, Gaza (16.0 %) and Maputo (14,3%), in the South and Niassa (6.8%) and Cabo Delgado (6.4%), in the South. These rates aggregate to an average of 12,2% at national level. As for the incidence by sex, women present a higher rate in relation to men. The same study reveals that although the number of infections by HIV/AIDS will continue to rise until 2008, it is presumed to stabilize after reaching a national rate of 16 %.

HIV/AIDS is still an epidemic without cure, which causes deaths, resulting in the reduction of life expectancy, as well as social upsets of several orders. These facts are going to increase the level of poverty of the population, contradicting all the efforts that are being endeavored by the Government in the combat to absolute poverty.

1.4 Topography

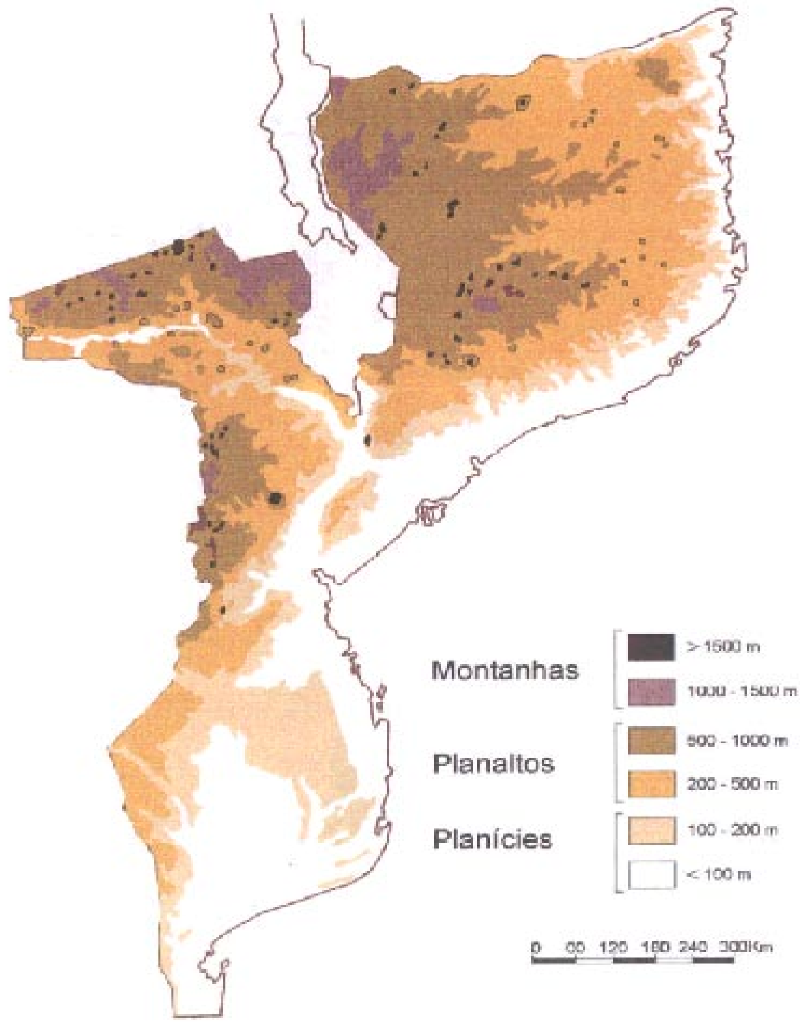


Figure 1-6. Topography of Mozambique.

The surface of Mozambique is not homogeneous. The main topographical features are:

- The plateau region that covers much of the North and North-West of the country in the Niassa, Zambezia, Tete and Manica provinces, with an elevation of up to 2 436 m (MSL) at Binga;
- The valley region, which occurs between the plateau and the coast, and goes along the entire Eastern side of the country from Rovuma, Southwards to the border with

Swaziland. However, it is progressively wider in the Southern part of the country, where altitude ranges between 100 to 200 meters above mean sea level.

- The coastal region forms the Eastern boundary of the country and varies in elevation from 0 to 100 m (MSL).

1.5 Economy

Mozambique is among the 8 poorest countries in the world. The country debt was around 1 billion of US$ in the beginning of 1990's and about 5 billion of US$. in 1996.

Several causes had contributed for the observed critical economy situation in Mozambique. The country inherited destroyed infrastructures from Portuguese, at independence in 1975, and soon after Mozambique had to apply economy sanctions to the Rhodesian Regime. On the other hand, South Africa reduced the use of Mozambique harbors and of the Mozambican migrant workers in the mines. Besides that facts there was the collapse of the production and exportation levels, as a result of sabotage to the economy, the destruction of social and economic infrastructure by the civil war, the over centralized planning and management of the economy adopted in the first decade of independenceand the long term drought which affect the Southern Africa in 80´s. As a result of these factors the Gross Domestic Product fell dramatically, the external trade balance deficit worsened, and public expenditures rose alarmingly.

Nevertheless, Mozambique's geographical position and resource´s potentialities offered ample space for the country's rapid social and economic development. Mozambique is located in the sea side and, that way, offers harbor and transportation facilities to the neighboring countries. It has a variety of natural resources including marine and coastal, large fertile areas, several forests, rich wildlife, minerals, water bodies and high potential for hydroelectric power production.

In order to reverse the negative economy development, the Mozambican Government initiated in 1987 the Structural Adjustment Program (UNCED, 1992) aimed at reducing state control over the economy, promoting the family sector in agriculture, improving the marketing of agriculture products, adjusting the internal and external imbalances, improving resource distribution and expanding the responsibility of the private sector in the economy activities. As consequence of this economic reform policy, most of the industries owned by the government were privatized or associated with the private sector.

The new government policy, coupled with the political and social stability, has rendered positive results: from 1986 to 1989 the GDP growth increased from 0.9% to 5.3% and consumption per capita gradually increased from 0.8% to 1% in 1988, stabilizizing at about 2% in 1989 and 1990. Between 1986 and 1989, forest and wood land increased by 7.7%, the production of cereals increased 5%, pig production increased about 27%, marine catch increased by 28% and exportations increased 16%. The Government has worked hard to bring down the inflation and stabilize the local currency: between 1987 and 1990 the inflation fell from 170% to 40%. In the beginning of 1997 it was 18% and it was expected to drop below 10% in the following years. The debt relief exceeded 100 millions of US$ for the first time in 1995. It was expected to exceed 300 millions of US$, which means 15% of the GDP, by the year 1999. In spite of these economic achievements, the foreign debt is still high compared with the GDP and the foreign earning. The Mozambican Government has been negotiating with its creditors in order to reschedule the foreign debt.

Table 1-1. Mozambique's GDP change (1996-2000)

Description	1996	1997	1998	1999	2000
Percent change (1996=100)					
GDP	6.8	11.1	12.6	7.5	1.5
GDP per capita (in US$)	186	217	241	243	218
Population	1.7	2.3	2.3	2.4	2.4

Source: Contas Nacionais 1999-INE

1.6 Water resources

Mozambique shares all its main rivers with other countrie, being the lowest riparian. The regime of these rivers is characterized as torrential, with high flows during the wet season, from November to March, and relatively low flows in the dry season, from April to October. In average 60% to 80% of the mean annual flow occur in few months of the year. The river water is highly restricted in the upstream countries, hence the flow observed in Mozambique is about 1.5 times lower than that observed in the upper riparian countries

Fresh water plays an important role in the country's socio-economic development. Water is used mainly for irrigation of crops, energy production, domestic and public supply, fish production and in tourism industry. Agriculture is the major water consumer: in 1992 the amount of water used in agriculture was about 540 Mm^3, while urban and rural used 25 Mm^3 and 28 Mm^3, respectively. The industry and public services expended about 10 Mm^3 in 1992.

The water demand varies with time and the water use infrastructures' state of development. Water demand is expected to increase in the future, as the population increases and agriculture and industry develop.

1.7 Fisheries

Most of fisheries resources are located in two major shelfs: the Sofala Bank, in the center, and Delagoa Bight, in the South, and in the bays. Major fisheries' resources include: shallow water shrimp, in Sofala Bank, deep water crustacean on the slope, scad and mackerel, in Sofala Bank and Delagoa Bight and the demersal fish, in the Southern and Northern regions. In coastal zones there are intensive artisanal fisheries, with the capture mollusks,, which are the basis of subsistence of several local populations.

The fisheries sector employs between 50,000 to 60,000 people and its contribution to the economy is substantial, representing about 40% of the total export earning. The estimated potential of fish in Mozambique is about 310,000 tons. Recorded amounts of marine fish at the landings were about 32,000 tons in 1980, about 80,000 tons in 1980, and about 120,000 tons in 1992. The artisanal and semi-industrial methods contribute with more than 50% of the total fish production. The most valuable fishery resource is the shallow water shrimp and its bycatch, deepwater shrimp, scad and mackerel. These resources represented about 54% of the total exportation in 1993. The shallow water shrimp resource alone contributed with about US$20 million in 1979-80.

The current production of shallow water shrimp is almost 7,000 tons per year. Unfortunately, in spite of the restriction in the fishing effort, this resource shows signs of overexploitation in Sofala Bank, where most of this resource is located. The catch yields are decreasing due to environmental factors such as the artificial Zambezi flow regime brought by the Cahora Bassa dam activity, that may contribute for the reduction in the availability of the shrimp in Sofala Bank (Hoguane, 1997).

Other resources that are overexploited are those located in the bays of Maputo and Inhambane. The government policy is encouraging the capture of other resources apart from traditional fishing area. Examples are scad and mackerel since their capture was stopped in 1990, due to the fall of the major fishing company owned jointly by Mozambique and former Soviet Union governments. As consequence, this resource is under-exploited and, so, available for fishing licensing.

The central Mozambique offers excellent conditions for prawn culture as well as Maputo, which is another area where it is possible to develop shrimp culture. This activity is being promoted for investment.

The fresh water resources are mostly located in Lake Niassa and in the Cahora Bassa reservoir. The annual registered catches have been reaching 30,000 tons, although the estimated potential is 90,000 tons.

1.8 Agriculture

Agriculture is one of the most important sectors in Mozambique and is mostly carried out by peasants. More than 80% of the country's population gains its livelihood from the agricultural sector. It contributes by about 40% of the country's exportations value. The mechanized agriculture is still very localized and possessed by few farmers.

The climate and soil fertility are the two factors that more influence the agricultural production. Based in this, the country can be divided in two large regions: (i) South and (ii) North of the Save River. In the Southern region the soil is relatively fertile but the climate conditions are highly interannually variable. On the other hand, the climate in the Northern region of the Save River is favorable, in most part of the year, for agriculture but the soils, in big part of the places, are normally deficient in nitrogen, phosphorous, sulfur and, occasionally, potassium. The most fertile areas are located along the river valleys but coastal zones and higher lands are less fertile.

They are seven main alimentary cultures in Mozambique: cassava, corn, peanut, rice, bean, mapira and mexoeira. These cultures are produced by two sectors: the business sector (that is composed by the private, cooperative and state sectors) and the familiar sector. According to data of the total agricultural production of the main alimentary cultures (DINA), between 1995 and 2002, the familiar sector contributed with the larger percentage (98%), while the business sector contributes with only 2 % of the total.

Apart from the alimentary cultures, the country also produces income cultures. These are defined as cultures that are produced with a commercial end, as for instance, tobacco, sugar cane, cotton, cashew, tea, sisal and copra.

The familiar sector is predominantly dependent of the availability of rain and, hence, highly vulnerable to climate changes. This factor is important since, for instance,almost all the cashew trees and 60% of coconut palms in Mozambique belong to the familiar sector. This sector also contributes with 52% of the national cotton harvest.

The commercial (mechanized) farming occupies only 250,000 ha, with annual and perennial crops being irrigated, either for all needs or as a supplement and fertilized with agro-chemicals.

1.9 Manufacturing industry

The Mozambique industry is not developed and is mainly devoted to food processing, petroleum refinery and production of other goods to export. Most of these industries, about 80%, are located in the two major cities, Maputo/Matola and Beira, the capital and the second larger city, respectively. The most important industries include: Mozambican Foundry Aluminium (MOZAL), cement manufacture, dairy plants, glass manufacture, textiles, pulp and paper products, wood processing, beer and soft drinks manufacture, tyre production, sugar and salt production and food processing, including cashew nut processing. Most of these plants are old, and they directly discharge the industrial waste into the sea.

The Mozambique industry suffered the effects of the civil war. The independence caused a period of steep decline in production, which was followed by a slowly recover until 1981, afollowed by a collapse that reached about 40% of the production capacity in 1985. Production rose again in subsequent years: 2.8% in 1986, 21.5% in 1987, and 10.8% in 1989. Currently, the Government is making efforts to develop industry to its full operational capacity, at the same time that it is encouraging foreign investments in new industrial areas. As mentioned before, profound reforms related to privatisation should be put in place for the development of industry.

It is worth mentioning that Mozambique is becoming one of the most important producters of tea, chestnuts and copra, in the world. These economic activities were paralysed by the long civil war in the rural areas where these agricultural activities took place. However, there was also the aging of the cashew and coconut trees, which is a negative factor to the production of these products.

1.10 Ports and harbors

There are three large ports in Mozambique: Maputo, Beira and Nacala; and several small ports like Inhambane, Quelimane, Pebane, Angoche and Pemba. Mozambican harbors provide services not only for national customers but also, and mostly, for the neighboring countries. Perhaps most of the foreign services provided by Mozambique are through its harbors.

Mozambique harbors handle annually several tons of cargo to and from Swaziland, South Africa, Zimbabwe, Zambia and Malawi. Some of the cargo to and from Congo is also handled in Mozambique ports.

Both the road and railways networks are built to facilitate regional trade rather than the national economy integration of the country. The transport sector used to be an important foreign exchange earner from the transit facilities offered to the neighboring countries. As a result of the war this has dramatically declined. The transport sector accounted for 12.7% of the GDP in 1975. It dropped to 8.8% of the GDP in 1989. One of the priorities of the Government policy, now that the war is over, is to revitalize and rehabilitate the infrastructures (harbors, roads and railways) that were destroyed during the war.

1.11 Minerals

The predominant minerals in Mozambique may be grouped in three categories, as follows: (i) energetic (coal, natural gas and petroleum), (ii) metallic (gold, iron, copper) and (iii) non-metallic minerals (marble and precious stones).

The delta of the Zambezi River accumulates large amounts of heavy-minerals deposits such as ilmentite, rutile and zircon. Similar situation is observed around the estuaries and deltas of other major Mozambican rivers, such as Limpopo, Save, Ligonha, Lurio and Rovuma. Accumulations of heavy mineral can also be found either on beaches or in sand dunes. The most promising deposits are those located between Quelimane and Quinga. These are being currently exploited.

In spite of the recognition of the potential of the mineral resources in Mozambique, the mineral industry still does not play a major role in the country's economy. Its contribution is only 2% of the GDP. Reasons for the weak development of the mineral industry are associated with, among others, the abandonment of the property by the owners during the independence and the destruction during the civil war.

Among the mineral resources mentioned above the coal has the largest potential. In the province of Tete the estimated reserve is about 10 billions of tons. In 1989 there were extracted about 62,000 tons. The extraction capacity is about 9 millions of tones per year.

The national exploitation of minerals is still done by rudimentary techniques and most of the minerals extracted are exported. Major projects in gold, coal, natural gas and heavy minerals are at advance stage of implementation, including modest projects in graphite, diatomite earth, marble, bauxite and bentonite.

1.12 Recreational parks and tourism

Tourism offers an important future economic potential for the country. Historically, Mozambique had a thriving tourism industry, mainly in the center and South of the country, with Rhodesia and South Africa providing the potential markets. Now the opportunity exists to tap both these historical markets as well as the Northern tourism markets. Soon after the war stopped, development plans were put forward. Mozambique has excellent potentials for both the coastal and wildlife based tourism.

Coastal tourism is well developed in the Southern part of the country, in the South of Save River. Beautiful sandy beaches and extensive corals characterize this region. This type of tourism expanded rapidly after the end of the civil war in 1992. Many areas in the Southern Mozambique are now experiencing touristic pressure due, in part, to uncontrolled tourism activity. Some of the tourism activities include beach sailing and game fishing. Several game fishing competitions take place every year in Bazaruto, Inhambane, Maputo and Ponta do Ouro.

Wildlife based tourism offers good prospects for economy. There are two forms of land based tourism: (i) photo-safaris and (ii) hunting safaris. Photo-safaris were very little significant in the past two decade. Safari companies were unable to attract this kind of clients due to the civil war. Hunting safaris contributed considerably for the country's economy. Between 1965 and 1970 about 1,310 tourists hunted in Mozambique. The resulting revenue was about US$87,000 per year for the government (licenses and administrative fees) and US$642,000 per year for the safari companies.

Sea level rise would certainly affect the coastal structures. On the land, wildlife is much associated with availability of forest, and this is very much dependent on climate. Hence, tourism would very much be affected by global climate changes.

2 GREENHOUSE GASES INVENTORY

2.1 Introduction

The ultimate objective of the Convention is the stabilisation of greenhouse gases' (GHG) concentration in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. The Convention also calls for all Parties to commit themselves to the following objectives:

- To develop, update periodically, publish and make available to the Conference of the Parties (COP) their national inventories of anthropogenic emissions by sources and removal by sinks, of all GHGs not controlled by the Montreal Protocol;
- To use comparable methodologies for inventories of GHG emissions and removals, to be agreed upon by the COP.

Accordingly, Mozambique prepared its First National Greenhouse Gas Inventory in 1998 using data from 1990. The inventory was updated in 2000, to the Second National Greenhouse Gas Inventory, ,using data from 1994.

The 1996 IPCC Revised Guidelines for National Greenhouse Gas Inventories (Revised Guidelines), which provide methodologies to prepare national greenhouse gas inventories, were used to estimate anthropogenic emissions by sources and removals by sinks.

The main gases considered within the 1996 IPCC Revised Guidelines are (a) *direct GHG*, namely carbon dioxide (CO_2), methane (CH_4) and nitrous oxides (N_2O), and (b) *indirect GHG*, particularly carbon monoxide (CO), nitrogen oxides (NOx) and non-methane volatile organic compounds (NMVOC). The estimation of the emissions of these GHG were dependent on data availability, such as activity data, carbon content and emission factors.

The present document reports all estimated GHG emissions by sources and removals by sinks from Mozambique, considering the methodologies described in the 1996 IPCC Revised Guidelines, limited by the data available at the time.

2.2 Data Collection

The data required to estimate GHG emissions, related to the various activities, was collected from different public, governmental and private entities. For the energy sector the data sources were: the National Directorate of Energy (Ministry of Mineral Resources and Energy), Carbomoc (the coal mining company) and Electricidade de Moçambique (the national electricity utility) as well as the Ministry of Agriculture and Fisheries provided information about agriculture, forestry, fisheries and livestock. On the other hand, the National Institute of Statistics provided diversified data, namely, on importations and exportations, agriculture, livestock, traffic; the Ministry of Industry, Trade and Tourism provided information related mainly with the industrial processes; the Maputo Department of Drainage made available information regarding the waste's sector, the National Directorate for Marine Transports provided data about fuel consumption from marine transports and the National Directorate of Water, Directorate of Urban Services of the City of Maputo, Coca-Cola Company, Cement of Mozambique Company and the National Institute for Agronomic Research, the National Airports Company as well as the petrol distributors companies (as BP, Shell, Petromoc, Mobil) were also important data sources for assessing the level of GHG activities.

During data collection the following problems were noted:

- Lack of trustable official information in some sectors (e.g.: transport, domestic, commercial and industrial wastewater);
- Poor institutional capacity, despite of the ongoing reforms in the country;
- Some companies' historical data series couldn't be provided, due to changes on their ownership, onwing to the privatisation process;
- Uncertainties and/or lack of liability in some annual reports produced by different sectors;

- Lack of systematic updates of the information of some of the sectors considered in the study (for instance manufacturing and construction industries and, agriculture/forests/fisheries and livestock).

In some cases, there was no consistency within the data obtained from different institutions. This required the team to discuss with the data providers (institutions) in a bid for coming up with technically sound data. For example:

- Fuel consumption data obtained from the national fuel supplier companies (PETROMOC, BP, MOBIL, TOTAL, etc.) was different from the information provided by the National Directorate of Energy;
- Some industrial production data supplied by the 1994 Mozambique Statistical Yearbook did not match with the information provided by 1994 Industrial Statistics;
- Data provided by some companies was different from those provided by Mozambique Statistical Yearbook.

2.3 Inventoried sectors

The national inventory was organised in five sectors as proposed by 1996 IPCC Revised Guidelines (excluding Paints and Solvents):

- Energy,
- Industrial processes,
- Agriculture,
- Land-Use Change and Forestry and
- Waste.

Specific aspects of each sector including related sub-sectors are discussed within the sector.

2.3.1 Energy Sector

The GHG emissions from the energy sector in Mozambique emanate from the combustion of carbon based fuels (fossil and biomass). Carbon dioxide (CO_2) and carbon monoxide (CO) are the main gases released from energy activities. Methane (CH_4), nitrogen oxides (NOx) and Non Methanic Volatile Organic Compounds (NMVOC) are also emitted in the combustion of carbon fuels in negligible quantities.

In accordance with the IPCC methodology, the energy sector is subdivided into the following sub-sectors:

- Energy industries;
- Manufacturing industries and construction;
- Transports (including national and international bunkers);
- Commercial and Institutional sector;
- Residential sector;
- Agriculture/forestry/fishery.

a) Emissions from Fuel Combustion

The GHG emissions are mainly originated in the combustion of two types of fuels: liquids and solids. Liquid fuels are gasoline, diesel, liquefied petroleum gas (LPG) and lubricants and solid fuels are coal and woodfuels. These last are the most common solid fuels used in Mozambique, chiefly to meet household energy demand.

b) Fugitive emissions

In Mozambique, fugitive emissions occur as a result of the exploration, handling, transportation and storage of mineral coal, basically at the Carbomoc Coal mines, located in the Central part of the country (Moatize, Tete Province).

In 1994 (reference year for this inventory) there was no significant exploration of coal within the country and, therefore, the fugitive emissions resulting from mining, handling and storage of coal are negligible. Default IPCC values have been used to determinate fugitive emissions.

c) Emission from Biomass burning

Biomass fuels constitute about 80% of the primary energy sources for the Mozambican population. Apart from a small percentage of the population that has access to paraffin (kerosene) and other conventional sources of energy (electricity), biomass is used for cooking, lighting and water heating, especially in the rural communities.

Data on the sub-sectors within the energy sector:

Energy Industries – Although some manufacturing industries produce their own power to supply the manufacturing process, in the present report only the diesel used by the "Electricidade of Mozambique" (the national energy utility) is considered as well as the natural gas used by "Empresa Nacional de Hidrocarbonetos" in the NG field at Vilankulos, in the Southern part of the country.

Transports - emissions estimates from national and international transport are based on the data collected as well as on the methodology given.

There are no consistent statistical data for road transport consumption. So, this data were derived by subtracting the fuel used in domestic aviation (AA), railways (RW) and national navigation (MN) from the total quantity of fuel supplied to the national transport sector (FT). Then it was assumed that the difference was used in the road transport (RT).

$$RT = FT - (AA+RW+MN)$$

For the international marine bunkers, the diesel and residual fuel consumptions were estimated as 2,297 tons and 200 tons respectively, while for the international aviation bunkers, the consumption was 22,664.31 tons of jet kerosene and of 876.96 tons of AVGAS.

Commercial and Institutional Sector – the transport's sub-sector is the main consumer of diesel, gasoline and lubricants. So, the consumption from the commercial and institutional sector was considered within the road transport consumption. The same procedure was applied for manufacturing and construction industries, except for diesel. The GHG emissions from commercial and institutional sector were estimated based on LPG consumption, since it is the principal commercial and institutional fuel used for purposes other than transportation.

Residential Sector – GHG emissions of this sub-sector are due to the consumption of paraffin, also known as kerosene (12,712.69 tons), LPG (1,954 tons) and woodfuels.

The consumption of diesel, gasoline or lubricants reported here was also considered in the road transport sub-sector.

Agriculture/Forestry/Fisheries – in this sub-sector only emissions from mobile sources were considered. After consultation with stakeholders, it was assumed that the fuel consumption in this sub-sector occured due to fishing enterprises supply or to energy generation for the sector.

2.3.2 Industrial processes

The most important industrial processes, whose activity data seem to be reported consistently, are the sugarcane, margarine and cooking oil, alcoholic beverages, paper, cement, glass, steel and biscuits. From the national statistics yearbook (1994), the following activity data is given (Table 2.1):

Table 2-1 Products Manufactured under Industrial Processes

Industry	Production (tons)	Industry	Production (tons)
Sugar	**20 901**	Cement	**63 669**
Margarine/cooking oils	**733**	Glass	**1 580 200**
Alcoholics drinks	**156 335**	Steel	**952**
Paper Kraft	**946**	Cookies	**3 443**

Source: Mozambique Statistical Yearbook, 1994

2.3.3 Agriculture

Agriculture is the most important sector in the Mozambique's economy. The country produces a wide range of agricultural products and has different categories of livestock.

The agricultural products, whose data is considered for this inventory, are corn, wheat, soya, tobacco, cashew nuts and coconuts. Data related to other products is not considered due to the lack of emission factors available for such crop, what unables the estimation of the related emissions.

The livestock types considered in the present inventory include dairy cattle, non-dairy cattle, buffalos, sheeps, goats, swine and poultry.

There are five sources of greenhouse gases emissions in agriculture sector:

- Enteric Fermentation and Manure Management**;**
- Rice Cultivation: Flooded Rice Fields;
- Agricultural soils;
- Prescribed Burning of Savannas and
- Field Burning of Agricultural Residues

a) Enteric Fermentation and Manure Management

The livestock's population used to estimate the GHG emissions is shown in the table below (Table 2.2):

Table 2-2. Livestock population (1994) and correspondent Default Emission Factors

Animal type Domestic	Number of animals (x1000)	Emission Factor for enteric fermentation (kg/head/year)	Emission Factor for manure management (kg/head/year)
Dairy Cattle	4	36	1
Non-dairy Cattle	235	32	1
Buffalos	1	55	
Sheep	30	5	0,21
Goats	240	5	0,22
Swine	144	10	2
Poultry	855	1	0,023

Source: Animal population from the National Directorate of Livestock (1994) and Emission factors from the IPCC (1996)

b) Rice Cultivation

According to the available data, the harvested rice area in 1994 was equivalent to 174,000 ha, with 121 cropping days. To estimate GHG emissions the annual average temperature of 24^{o}C and the emission factor of 5.56 kg/ha.day (IPCC) were considered.

c) Burning of Savannas

In Mozambique, burning of savannas is a cyclic occurrence that takes place yearly between August and September. There are a number of different reasons given for such a strange occurrence. The main reason seems to be the practice of hunting.

Indeed, in many cases, people burn forests and savannas as a technique for hunting different wild animals that are part of their diet.

Some other reasons without relevance, but also contributing to the uncontrolled burning of savannas, are forests clearing for agriculture and for woodfuels collecting.

Data related to the areas burnt annually is not well known due to the difficulty in monitoring the real situation from the fields. The estimation of GHG emissions from this activity is calculated based on the available statistics from the Ministry of Agriculture and Fisheries.

d) Field Burning of Agricultural Residues

There is no data on burning of agricultural residues that occur in the agricultural fields. In fact, the extension of familiar agriculture activities is not well known.

Additionally, the balance of CO_2 emissions from this activity is taken as zero since it is assumed that the carbon released into the atmosphere is reabsorbed during the following growing season. However, other non-CO_2 gases have to be considered in the calculation of GHG emissions.

2.3.4 Land-Use Changes and Forestry

The major portion of Mozambique's vegetation is classified as tropical savanna, woodland and forests. The Annual Growth rate of natural forests in Mozambique ranges from 0.19 to 1.04 m^3/ha.year [Saket, 1995][1].

The average rate of deforestation from 1972 to 1990 was 4.27%. This corresponds to 2.74 million hectares. In terms of vegetation loss, it corresponds to about 150 000 ha/year. During the decade of 1980-1990, the annual average rate was found to be around 135 000 ha/year.

The main reasons for forest clearing were excessive removal of vegetation for agricultural purposes, wild fires (particularly late in the season), excessive cutting for fuelwood and charcoal and cutting for timber and among others.

It is known that during the civil war, people in the rural areas moved to safer zones, i.e., the urban and peri-urban areas. This resulted in the reforestation in these unsafe areas but there is no data on it.

2.3.5 Waste (solids and liquids)

In 1994, Mozambique had a population of about 15 091 356 inhabitants and the consumption of proteins per capita was 11.06 kg (Ministry of Health, Department of Nutrition).

a) Solid waste

In the whole country, especially in the urban areas, there are specific waste disposal areas where the urban solid waste is dumped. There is no data on the amounts of waste daily dumped in these areas. According to the Directorate of the Urban Services of the City of Maputo, 60% of the solid waste generated in this city is collected and deposited in the

[1] Regarding data from 1990

landfills. This is a common waste disposal practice in the remaining cities over the country. These areas are controlled by Municipal Services.

The waste collected is managed in three forms:

- Part is incinerated in open ovens,
- Another part goes through decomposition processes during the storage time and
- Solid wastes consisting of paper and glass are recycled.

b) Domestic and industrial wastewaters

In Maputo, the domestic wastewater includes all sewage from commercial buildings (hotels and restaurants) and residential buildings. Maputo City has a wastewater treatment plant consisting of two series of lagoons where the BOD is reduced from 150 to 50 mg/l before the wastewater is discharged into Maputo Bay through the Infulene Valley.

In Mozambique, particularly in Maputo, the sewage grid is not differentiated, since residential and industrial areas are quite mixed, with some exception (e.g., Matola industrial park). On the other hand, very few plants have their own wastewater treatment systems, whose performance is not well monitored leading to a situation in which no one knows what goes out from such treatment plants.
The common practice is to drain the wastewater straight into lagoons, rivers or the sea.

2.4 GHG Emissions per sector

2.4.1 Energy

Fuel Combustion: The most significant GHG emitted from energy sector are CO_2 and CO, totalising 1 534Gg and 1 360Gg, respectively. Other gases, such as N_2O (1 Gg) and NOx (36 Gg) are emitted in traces levels. These amounts of CO_2 result from Energy Industries, Manufacturing Industries and Construction, Transports and Other sectors, namely residential, commercial/institutional and fisheries/agriculture/forestry.

Energy industries: GHG emissions from energy industries are basically related to the diesel used to generate electricity, in some cities where hydropower or electricity from the national grid is still not available. According to Mozambique 1994 Yearbook the power supplier/distributor company "Electricidade de Moçambique" used about 7 410 tons of diesel to generate electricity, which combustion emitted about 23 360 tons of CO_2, Natural gas was also used to generate electricity. For this purpose, 122 000 tons of natural gas were consumed, emitting 311 210 tons of CO_2.

These processes emitted 910 ton of NO_x (Table 2.3).

Table 2-3 Consumption and Emissions for the Energy Sector

Type of Fuel	**Consumption (Tons)**	**Emissions (Gg)**					
		CO_2	**CH_4**	**CO**	**N_2O**	**NO_x**	**NMVOC**
Diesel	7 409.4	23.36	0	0	0	0.07	0
Natural gas	122 000	311.21	0	0	0	0.84	0
TOTAL		**334.57**	**0**	**0**	**0**	**0.91**	**0**

- Sub-sector of Manufacturing Industries and Construction

The total amount of CO_2 emitted in 1994, due to the burning of different fuels in the manufacturing industries and construction, was 94 000 tons. The total amount of GHG emitted by each type of fuel consumed in this sub-sector are given in Table 2.4 below.

Table 2-4 Fuel Consumption and GHG emissions from Manufacturing Industries and Construction

Type of Fuel	Consumption (tons)	Emissions (Gg)					
		CO_2	CH_4	CO	N_2O	NOx	NMVOC
Gasoline	1324.8	4.090	-	-	-	-	-
Diesel	8466	26.690	-	-	-	-	-
Residual fuel oil	6768	22.290	-	-	-	-	-
GPL	682	2.010	-	-	-	-	-
Lubricants	7.95	0.020	-	-	-	-	-
Coking Coal	70.9	0.18	-	-	-	-	-
Kerosene	10 000	31.84	-	-	-	-	-
Patent Fuel	241.4	0.87	-	-	-	-	-
Coal Sub-bituminous	1 644	6.19	-	-	-	-	-
TOTAL		**94.19**	**0**	**0**	**0**	**0**	**0**

- Sub-sector of Transports

Several means of transport classes were considered for the determination of emissions.

- The international marine transport (international bunkers) generated 7 860 tons of CO_2 as a result of consuming 2 297 tons of diesel, which generated 7 240 tons of CO_2, and 200 tons of residual fuel oil, which generated 620 tons of CO_2;
- The international aviation contributed with about 75 090 tons of CO_2, as a result of the consumption of 22 664.31 tons of Jet kerosene, which generated 72 200 tons of CO_2, and the use of 876.96 tons of AVGAS, that produced 2 890 tons of CO_2;
- Road transport emitted about 687 490 ton of CO_2, 21 520 ton of CO and 70 ton of CH_4, as a result of the consumption, during 1994, of 38 998.69 ton of gasoline, 173 963.55 ton of diesel oil and 6 396.81 ton of lubricants;
- Railways transport emitted 68 870 ton of CO_2 and 440 ton of CO as a consequence of a consumption of 10 321.05 ton of diesel and 11 857.16 of residual fuel oil in 1994**;**
- The total amount of CO_2 emitted from national navigation was 8 400 ton and 110 ton of CO. These amounts were derived from the use of 12.25 tons of gasoline, 2 624.56

ton of diesel and 56.78 ton of lubricants. These fuels generated the CO_2 emissions of 40 tons, 8 280 tons and 80 tons, respectively.

Table 2-5 Consumption and Emissions for the sub-sector of National Transport

Class Transport	Type of fuel	Consumption(ton)	Emissions (Gg)		
			CO_2	CO	CH_4
Domestic Aviation	Gasoline	960.48	**2.970**	**0.13**	**-**
	Jet Kerosene	26 034.45	**82.93**		
	AVGAS	804.04	**2.650**		
Road	Gasoline	38 998.69	**120.400**	**21.52**	**0.07**
	Diesel	173 963.55	**548.510**		
	Lubricants	6 396.81	**18.580**		
Railways	Diesel	10 321.05	**32.540**	**0.44**	**-**
	Residual fuel oil	11 857.16	**36.330**		
	Lubricants	-	**-**	**-**	**-**
National Navigation	Gasoline	12.25	**0.040**	**0.11**	**-**
	Diesel	2 624.56	**8.280**		**-**
	Lubricants	56.78	**0.080**		**-**
TOTAL			**853.30**		-

Table 2-6 International Transport: fuel consumption and emissions

Class Transport	Type of Fuel	Consumption (ton)	Emissions (Gg)					
			CO_2	CH_4	CO	N_2O	NO_x	NMVOC
International Bunkers	Diesel	2 297	**7.240**	-	-	-	-	-
	Fuel oil	200	**0.620**	-	-	-	-	-
International Aviation	Jet Kerosene	22 664.31	**72.200**	-	-	-	-	-
	AVGAS	876.96	**2.890**	-	-	-	-	-
TOTAL			**82.950**	-	-	-	-	-

(e) Residential Sub-sector

The following types of fuels were supplied to this sub-sector:

- Kerosene: 45 981,49 ton,
- LPG: 1 954 ton,
- Firewood: 10 000 000 ton and
- Charcoal: 200 000 ton.

As a result, the sub-sector emitted the amounts of GHG listed in Table 2.7.

Table 2-7 Fuel Consumption and GHG emissions from residential sub-sector

Type of Combustible	Consumption (ton)	Emissions (Gg)					
		CO_2	CH_4	CO	N_2O	NOx	NMVOC
Kerosene	45 981.49	**147.220**	**0**	**0**	**0**	**0**	**-**
GPL	1 954.00	**5.760**	**0**	**0**	**0**	**0**	**-**
Firewood	10 000 000	**27 280. 590**	**0**	**133 640**	**1.040**	**0.520**	**-**
Charcoal	200 000	**558.690**	**0**		**0.005**	**26.00**	**-**
TOTAL		**27 992.260**	**0**	**133 640**	**1.045**	**26.520**	**-**

N.B.: As CO_2 from woodfuels does not count for GHG emissions, the balance of this sub-sector is 152.98 Gg of CO_2.

(f) Sub-sector of the Agriculture, Forestry and Fisheries

Table 2-8 Consumption and emissions for the sub-sector of the Agriculture, Forestry and Fisheries

Type of Combustible	Consumption (ton)	Emissions (Gg)					
		CO_2	CH_4	CO	N_2O	NOx	NMVOCs
Gasoline	151.200	**0.470**	**-**	**-**	**-**	**-**	**-**
Kerosene	2.690	**0.010**	**-**	**-**	**-**	**-**	**-**
Diesel	30 115.720	**94.960**	**0.1**	**1.29**	**0**	**0**	**-**
Residual Fuel Oil	2.840	**0.010**	**-**	**-**	**-**	**-**	**-**
Lubricants	23.160	**0.070**	**-**	**-**	**-**	**-**	**-**
TOTAL		**95.52**	**0.1**	**1.29**	**0**	**0**	**-**

As can be seen in the table above, diesel oil was the most important GHG emitter from this sub-sector.

(g) Sub-sector Commercial and Institutional

As mentioned in section 3.3.1, only LPG was considered in this sub-sector, with a consumption of about 1254.0 tons, which resulted in the 3 680 tons of CO_2.

2.4.2 Fugitive emissions

According to data provided by National Directorate of Coal and Hidrocarbon, fugitive emissions were originated in the processing, handling and utilisation of coal mined. Both internal consumption and export contributed to 20 392.94 tons of coal. This resulted in 20 tons of to CH_4 using the 1996 IPCC Revised Guidelines (default EF=1.2 m^3/ton).

- **Emissions from biomass burning**

GHG from biomass do not include CO_2 emitted by woodfuels as it, theoretically, balances with the amount of CO_2 reabsorbed by the growing plants (biomass). Thus, the table bellow just summarises other GHG rather than CO_2.

Table 2-9 GHG Emissions from burning Biomass in 1994

Type of Fuel (Biomass)	**Consumption (ton)**	**Emissions (Gg)**				
		CO	**CH_4**	**NO_x**	**N_2O**	**NMVOC**
Firewood	10 000 000	133 640	-	0.520	1.040	-
Charcoal	200 000		-	26.00	0.005	-
TOTAL		**133 640**	-	**26.52**	**1.045**	-

2.4.3 Industrial Processes

Industrial processes were responsible for the emission of about 51.350 Gg of CO_2 and 7.110 Gg of NMVOC. The CO_2 was emitted by the mineral's production industry, exclusively, while the NMVOC were originated in glass container industry.

As mentioned in paragraph 2.3.1, in this group GHG emissions estimated resulted from production processes, excluding power generation (Table 2.10).

Table 2-10 CO_2 emissions due to Industrial Production in 1994

Production	Amount (tons)	Emissions of CO_2 (Gg)
Cement	**63 669**	**31.740**
Limestone	**9 938**	**4.370**
Iron and steel	**5 770**	**14.430**
Road surface (paving)	**170**	**0.05**
Soda ash (used)	**721.66**	**0.300**
Ferroalloys	**127.35**	**0.460**
TOTAL		**51.350**

Production of glass container emitted 7.110 Gg of NMVOC.

2.4.4 Agriculture

- **Emissions from Domestic Livestock Enteric Fermentation and Manure Management**

CH_4 emissions from domestic livestock enteric fermentation and manure management produced in country in 1994 were 11 371.91 tons and 605.98 ton, respectively.

To estimate the emissions from this sub-sector, the default emission factors provided by the 1996 IPCC Revised Guidelines were used (for developing countries and warm regions).

Table 2-11 Methane Emissions from Enteric Fermentation Management

Domestic animal category	Number of animals	Emissions from Enteric Fermentation (tons CH_4)	Emissions from manure management (tons CH_4)	Total annual emissions (Gg)
Dairy Cattle	3783	136.19	3.784	0.14
Non-dairy Cattle	235 186	7 525.95	235.19	7.76
Buffaloes	1 208	66.44	0.0	0.07
Sheep	29 897	149.49	6.28	0.16
Goats	239 359	1 196.80	52.66	1.25
Swine	144 206	1 442.06	288.44	1.73
Poultry	854 979	854.98	19.66	0.87
TOTAL		**11 371.91**	**605.98**	**11.98**

- **Rice Cultivation**

To estimate the amount of CH_4 emitted from rice cultivation it is necessary to know the annual harvested area, 174 000 ha in 1994, the number of cropping seasons per year.1, and the period of irrigation water management, 121 days. In this exercise, the average annual temperature for Mozambique of 24^{o}C was taken into account.

In 1994, the total amount of CH_4 emitted from rice fields was of 54.360 Gg. This value is attributed to two rice cultivation categories grown in Mozambique. The rice cultivation in intermittently flooded areas (single aeration) contributed with 2.200Gg of CH_4 emissions, while the flood prone areas emitted 52.160Gg of CH_4 emissions.

- **Burning of savannas**

The fractions of GHG emissions from savanna burning are conventionally estimated considering the area of savannas burned yearly, the average biomass density and default values of emissions factors as recommended by 1996 IPCC Revised Guidelines.

In 1994, the estimated GHG emissions derived from uncontrolled fires (burning of savannas) were of approximately 128 670 ton of CH_4, 1 590 ton of N_2O, 57 550 ton of

NO_x and 3 377 520 ton of CO. As observed, the most significant GHG emmited from savanna burning is CO followed by CH_4.

These emissions resulted from the burning of the areas and type of vegetation shown in Table 2.12:

Table 2-12 Areas and categories of vegetation burnt (savanna burning)

Type of vegetation	Area burnt (ha)
Low Forest HD	**696 299**
Low Forest MD	**1 362 266**
Low Forest LD	**3 415 330**
Thicket	**6 140 663**
Medium & Low thicket	**4 562 176**
Wooded Grassland	**4 562 176**
Grassland	**1 036 572**

Emissions from agricultural fields were confined to nitrous oxide which accounted for 110 ton.

- **Land Use Changes and Forestry**

In this sector, the most relevant GHG released was CO_2 which resulted from forest and grassland conversion activities (8 983 240 ton) and partially removed through changes in forest and other woody biomass activities (1 303 700 ton),. This sector emitted 7 679 540 ton of CO_2.

- **Changes in Forest and Other Woody Biomass**

Changes in forest and woody biomass' emissions resulted from the harvesting, for commercial purposes, of 47 480 m^3 of round wood from tropical thickets, corresponding to 13 618 700 ton of dry matter. This dry matter (biomass) stock exchange was responsible for a carbon uptake of 1 303 700 ton of CO_2, acting as an important carbon sink.

The changes were a direct consequence of plantation of *Eucalyptus spp* (18 300 ha), *Pinnus spp* (21 450 ha), or stock exchange of *moist forest* (6 526 000 ha), *dry forest* (10 065 440 ha), *thickets* (14 765 680 ha), *shrubs* (7 877 640 ha) and *montane forest* (189 360 ha) as well as commercial harvest of *tropical thickets* equivalent to 118 700 ton of dry matter.

- **Forest and Grassland Conversion**

The forest and grassland conversion emitted about 8 983 240 ton of CO_2 as a result of:

- An annually converted area of 133 900 ha, corresponding to a loss of 6 423 500 ton of dry matter through clearing activities;
- 177 710 ton of carbon released from the biomass that was burned on site;
- 666 390 ton of carbon burned off site; and,
- 1 605 880 ton of carbon released from decay of aboveground biomass.

Apart from the emission of 8 983 240 ton of CO_2, 2 840 ton of CH_4, 710 ton of NO_x, 24 880 ton of CO and 20 ton of N_2O, were also emitted from this subsector.

- **Wastes (solids and liquids)**

According to information provided by the Directorate of the Urban Services of City of Maputo, the rate of solid waste generation per capita in the urban areas is about 1 kg /head.day. This resulted in 1 574 280 tons of solid waste generated in 1994.

The registered urban population in Mozambique in 1994 was about 4 313 077 inhabitants, resulting in a total of CH_4 emissions of 74 190 tons. It should also be noted that 60% of the solid waste was disposed on the land.

According to the Maputo Drainage Cabinet only half of wastewater generated by urban population was sent to a unit of conversion in the Wastewater Treatment Plant (ETAR), located in Infulene.

Due to the lack of data abaout the quantity of wastewater treated, IPCC default factors for developing countries were used to estimate CH_4 emissions in this sector. According to the

National Directorate of Waters in Maputo City, 13 497 066 m^3 of water were supplied. It is estimated that 674 853 m^3 were drained to the ETAR.

With respect to industrial wastewater (referred in the paragraph 2.3.5. b), the emissions of methane are negligible.

The indirect emissions of nitrous oxide (N_2O) from human waste, due to the consumption of proteins (11,06 kg proteins/head.year), were estimated to be 420 tons of N_2O.

- ***Summary of GHG emissions in Mozambique***

Table 2-13 Summary of GHG Emissions in Mozambique in 1994

Sources of greenhouse gases		Emissions (Gg)					
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC
National total emissions		*9 265*	*272*	*3*	*94*	*4 762*	*8*
1. Energy	**Reference approach**	**1 522**	-	-	-	-	-
	Sectoral approach	**1 534**	-	**1**	**36**	**1 360**	-
A. Fuel Combustion activities		**1 534**	-	**1**	**36**	**1 360**	-
B Fugitive Emissions from Fuels		-	-	-	-	-	-
2. Industrial Processes		**51**	-	**0**	**0**	**0**	**8**
3. Agriculture		-	**195**	**2**	**58**	**3 378**	-
Enteric Fermentation		-	**11**	-	-	-	-
Manure Management		-	**1**	-	-	-	-
Rice Cultivation		-	**54**	-	-	-	-
Prescribed Burning of Savanna		-	**129**	**2**	**58**	**3 378**	-
4. Land Use Change and Forestry		**7 680**	**3**	**0**	**1**	**25**	-
Changes'n Forest & other woody biomass		**-1304**	-	-	-	-	-
Forest & Grassland Conversion		**8 983**	**3**		**1**	**25**	-
5. Waste			**74**	**1**	**0**	**0**	**0**
Memo Items:		-	-	-	-	-	--
International Bunkers		*83*	-	-	-	-	-
Aviation		*75*	-	-	-	-	-
Marine		*8*	-	-	-	-	-
CO_2 Emissions from Biomass		*27 839*	-	-	-	-	-

Table 2-14 Summary of the GHG emissions per sector

Sector	Emissions (Gg)					
	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
1. Energy	1 534	0	1	36	1 360	
2. Industrial process	51	-	-	-	-	8
3. Agriculture	-	195	2	58	3 378	
4. Land Use Change and Forestry	7 680	3	-	1	25	-
5. Waste		74	-	-	-	-
Total	**9 265**	**272**	**3**	**94**	**4 762**	**8**

The figures have been rounded by excess.

Table 2-15 Summary of the emissions of GHG: percentage contribution per sector

Sector	Percentage of the Emissions (%)					
	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
1. Energy	**16.56**	**0**	**33.33**	**37.81**	**28.56**	
2. Industrial process	**0.55**					**100**
3. Agriculture	**0**	**71.69**	**66.67**	**61.22**	**70.94**	
4. Land Use Change and Forestry	**82.89**	**1.10**		**0.97**	**0.50**	
5. Waste	**0**	**27.21**				
TOTAL	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

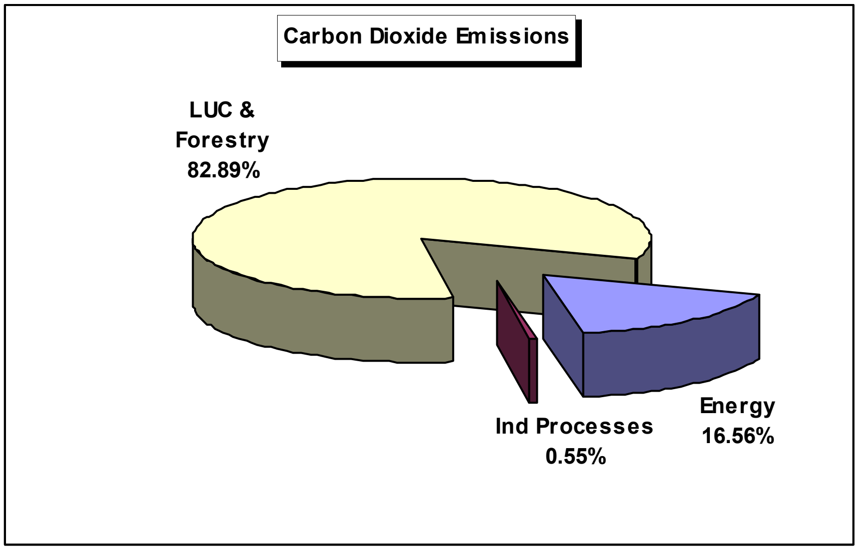


Figure 2-1. Graphic of Carbon Dioxide emission, 1994 National GHG Inventory

The figures show that, in terms of quantities emitted to the atmosphere, CO_2 was the GHG majorly emitted (9 265 Gg), followed by CO (4 762 Gg) and CH4 (272 Gg). At last come NOx (94 Gg), NMVOC (8 Gg) and N2O (3 Gg).

- **CO_2 emissions**

CO_2 is the GHG emitted in larger quantities among all other GHG. From the table 15 (and the figure 2.1) it's clear that the major contributors to direct CO_2 emissions are Land Use Change & Forestry (82.89%) and energy activities (16.56%). On the other hand, it is noticeable that only 3 sectors have contributed to CO_2 emissions, the ones refered before plus Industrial Processes.

- **CH_4 Emissions**

CH_4 is the third most abundant gas in GHG emissions from Mozambique, accounting for 272 Gg. It is emitted from three main sources: Agriculture (195 Gg), Waste (74 Gg) and Land Use Change & Forestry (3 Gg).

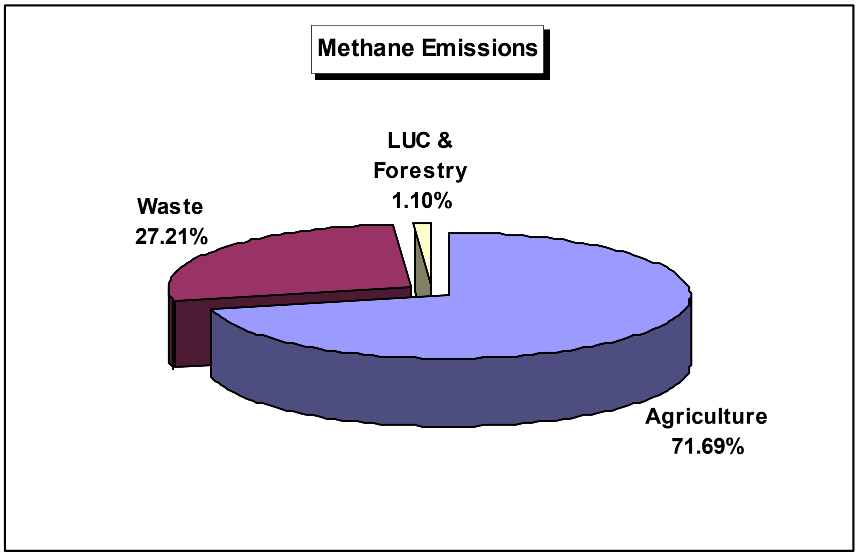


Figure 2-2. Graphic of Methane emission, 1994 National GHG Inventory

CH_4 from agriculture is released from prescribed burning of savannas (129 Gg), rice cultivation fields (54 Gg) and livestock (enteric fermentation released11 Gg and manure management 1 Gg).

Agriculture is, by far, the main source of methane emitted in the country: it emits about 72% of the total amount of methane within the country.

- **Nitrogen Oxides Emissions**

The country emitted, in 1994, about 94 000 ton of NO_x. Nitrogen oxides are emitted from Agriculture (57 550 ton, 61.22%), Energy (35 540 ton, 37.81%) and Land Use Change & Forestry (710 ton, 0.91%).

The contribution from energy sector can be splitted as follows:

i. Energy Industries: 910 ton;
ii. Transport: 380 ton (domestic aviation), 7 040 ton (Road), 530 ton (Railways), 170 ton (national Navigation); and,
iii. Residential: 26 520 ton.

The NOx emissions from agriculture are almost exclusively coming from savanna burning while emissions from Land Use Change & Forestry result from Forest and Grassland Conversion (biomass burning).

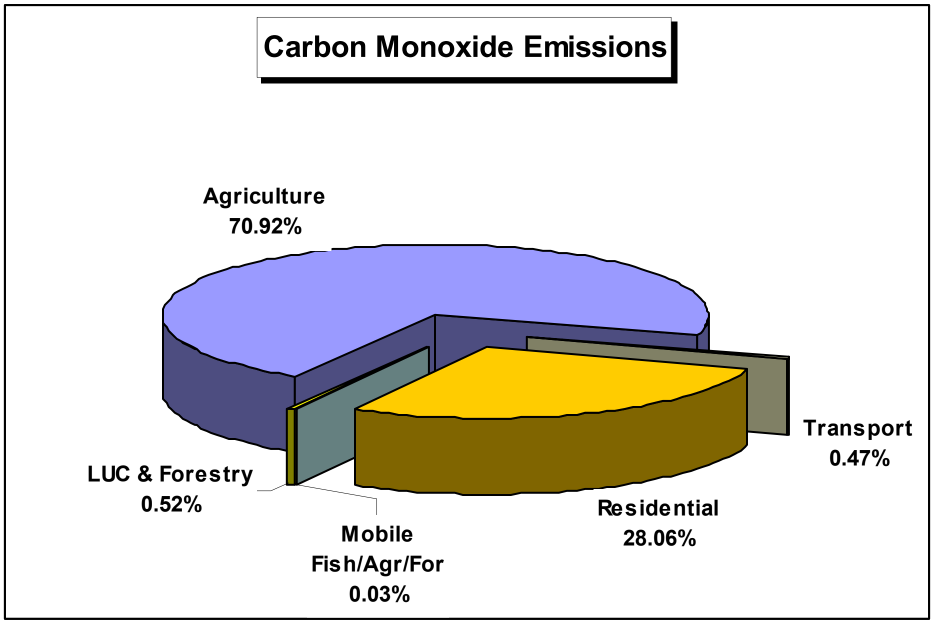


Figure 2-3. Graphic of Carbon Monoxide emission, 1994 National GHG Inventory

- **CO Emissions**

About 4 762 Gg of CO were released from different activities during 1994. The largest fraction of it was emitted by the Agriculture Sector (3 378 Gg) thorough savannah burning practices. The second largest quantity of CO emission resulted from the sector of Energy (1 360 Gg), especially from Transport (22.1 Gg), Residential (1 336.4 Gg) and Mobile Agriculture/Forestry and Fishery activities (1.29 Gg).

CO from Transport activities is affected as follows:

- 130 ton from Domestic Aviation;
- 21 520 ton from Road Transport;
- 440 ton from Railways; and,
- 110 from National navigation.

- **Nitrous oxide and Non-Methane Volatile Compounds Emissions**

Nitrous oxide emissions were mostly released from livestock enteric fermentation (66.67%) under Agriculture Sector, being the remaining released from Residential activities (33.33%) under the Energy Sector. The total N2O emissions during 1994 were 3 000 ton.

On the other and, NMVOC emissions are due to the Industrial Processes sector, specifically from Mineral Products, such as Glass Industry (7 110 ton) and Road Surface Paving (50 ton), Alcoholic Beverages (20 ton), Meat, Fish and Poultry (10 ton), Sugar cane (210 ton), Margarine and Solid cooking oils (10 ton) and Bread (370 ton).

2.5 Emissions from 1990 versus 1994

Given the fact that there has been a lot of changes within the country, from 1990 to 1994, the data collected for GHG national inventories for these two reference years are not easily comparable. In fact, in 1990, the country was still under the civil war and facing a lot of security restrictions for economic activities. On the other hand, data acquisition was a big problem and the liability of the few data available was very questionable. Additionally, some of the plants and other economic infra-structure were either converted to another activity or simply closed, as a result of the transition from an centralised economy (where a great portion of economic units were parastatal) to an open market guided economy (through privatisation of the former parastatal plants and activities).
Agriculture activities in 1990 were almost confined in a radius of 20-50 km around cities, almost all over the country.

Given this background, this chapter will only make comparisons of CO_2, CO, N_2O and NOx emissions, just to bring up the changes that had occurred since then.

Table 2-16 Summary of the Emissions of GHG for Sector in 1990

Sector	Emissions (10^3 tons)					
	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
1. Energy	1 043	59	0.5	11	596	
2. Industrial processes	40					
3. Agriculture		158	1.8	65	3 810	
4. Land Use Change and Forestry	1 769	4		1	32	
5. Waste		20				
Total	2 852	241	2.3	77	4 438	

Source: National Inventory of Greenhouse Gases of 1990 (Mozambique)

Table 2-17 Summary of the GHG emissions by sector in 1994

Sector	Emissions (Gg)					
	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
1. Energy	1 534	0	1	36	1 360	
2. Industrial process	51	-	-	-	-	8
3. Agriculture	-	195	2	58	3 378	
4. Land Use Change and Forestry	7 680	3	-	1	25	-
5. Waste		74	-	-	-	-
Total	**9 265**	**272**	**3**	**94**	**4 762**	**8**

Comparing these two tables it can be easily found that there has been some changes, being the biggest the one concerning CO_2 emissions, which almost has doubled during this period.

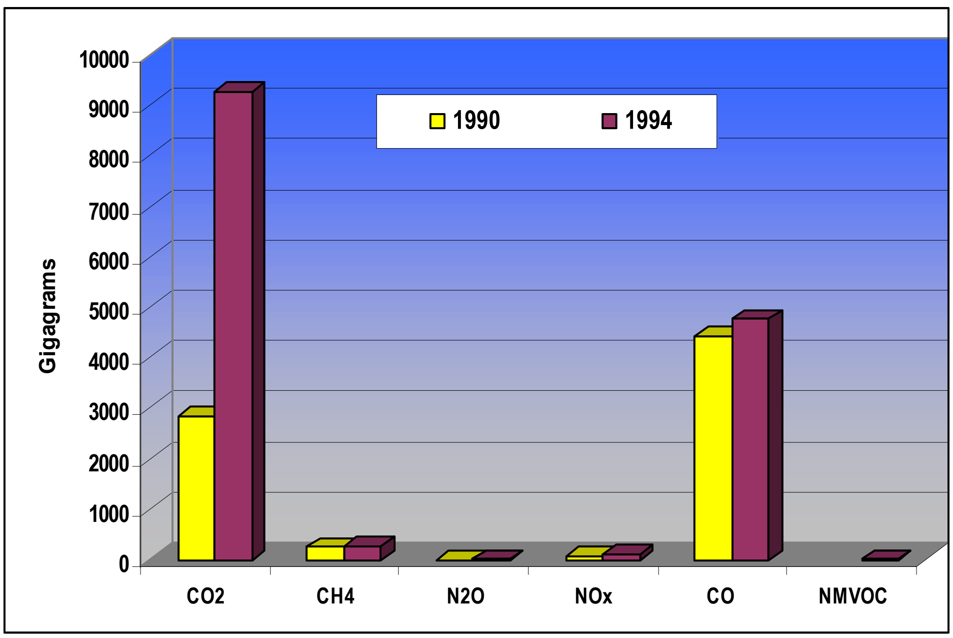


Figure 2-4. Graphic of comparison between emission of 1990 and 1994.

All the emissions have risen from 1990 to 1994. Indeed, only CO has registered slight changes (in about 7.3%). It is also to notice that in 1990 the NMVOC were not estimated due to difficulties to use the methodology (IPCC 1996). In fact, only for 1994's inventory the 1996 IPCC Revised methodologies were used.

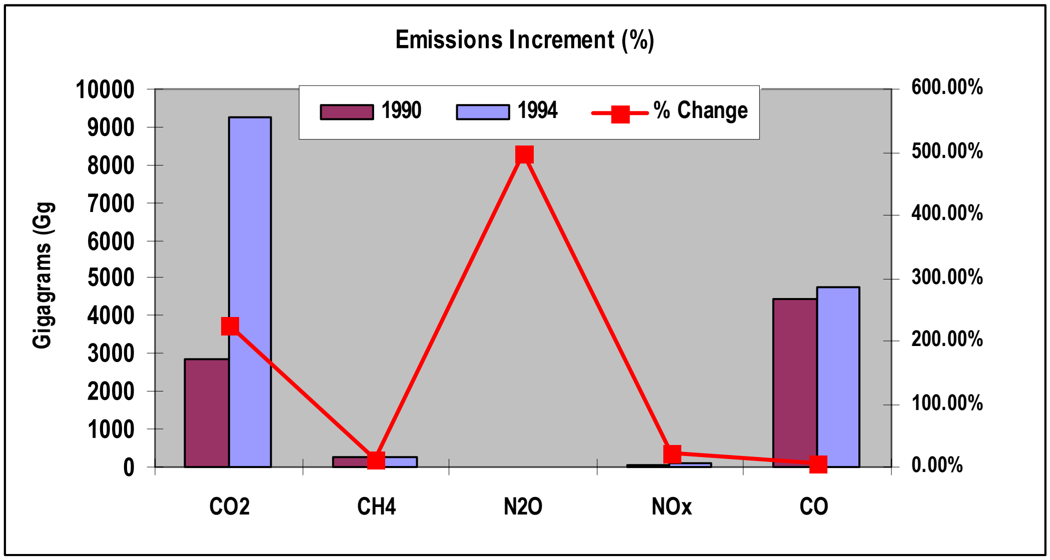


Figure 2-5. Graphic of emission increment

In terms of CO_2 equivalent, the direct GHG effect contributors in 1990 have totalised 8 628 Gg. This amount has risen to 15 907 Gg in 1994, which represents an increase of 84.41% concerning 1990.

2.6 Conclusions

It should taken into account that for 1990 there have been enormous difficulties to find data on sectoral activities, comparing to 1994, due to the facts that had been discussed before.

In Mozambique, the anthropogenic emissions of GHG by sources are mainly dictated by the burning of the savannah aimed at preparing new fields for agriculture and pest control, as well as for hunting. Motor vehicles and industries also contribute for such emissions. In fact, it has to be emphasised that, as happened in 1990, in 1994 the GHG emissions were due to the same sector activities.

		1990		1994		
	GWP	Gg	Gg CO2e	Gg	Gg CO2e	Change (%)
Carbon Dioxide	1	2852	2852	9265	9265	224.86%
Methane	21	241	5061	272	5712	12.86%
Nitrous Oxide	310	2.3	713	3	930	30.43%
Total			8626		15907	84.41%

Figure 2-6. Comparison of the main GHG emissions

While in 1990, the major contributor to GHG effect was CH_4 (58.67% of direct CO_2 equivalent), in 1994 it was CO_2 (58.24%). The minor contributor in 1990 was N_2O (8.27%) as well in 1994 (5.85%).

According to these figures, controlling the wild fires that yearly occur as well as switching to less emitting fuels or/and renewable energy sources, would help the country to reduce significantly its GHG emissions.

In fact, dissemination and promotion of the use of renewable sources of energy as prescribed in the energy strategy and policy and the improvement of the efficiency of combustion systems, can allow the country to deal, in a long term, with greenhouse gases reduction in Mozambique, which will help the country to comply with the United Nations Framework Convention on Climate Change ultimate objective.

On the other hand, there is a need to develop, through applied research, local GHG emissions factors and other characteristics that are important to effectively estimate the GHG emissions, as well as to conduct periodic surveys on the emissions, in order to monitor the GHG emissions trend in Mozambique. This would allow the GHG inventory team to assess with some liability the effects of the rapid growth and changes that the country is experiencing.

Industrial plants, transport and another relevant sectors should be encouraged to create accurate and updated records of their activities in such a way that they could provide the national environmental authorities with the information needed to estimate the GHG emissions related to their activities. This should be done by issuing any kind of regulation to report these figures to a sort of data bank officially created under UNFCCC national commitment.

Table 2-18 Detailed summary of the national emissions and removals of GHG in 1990 (in Gg)

GHG source and sink categories	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC
Total National Emissions and Removals (Gg)	*2 852*		*241*	*2.3*	*77*	*4 438*	
1. Energy	**1 043.4**		**59.6**	**0.5**	**11**	**596.3**	
A. Fuel Combustion (Sect approach)	**1 043.4**		**59.6**	**0.5**	**11.04**	**596.3**	
B.Fugitive Fuel Emissions from Fuels	**0**		**0.03**				
2. Industrial Processes	**39.72**						
A. Mineral Products	**39.72**						
B. Chemical Industry	**0**						
C. Metal Production	**0**						
D. Other Production	**0**						
3. Solvents and Other Product Use	**-**						
4. Agriculture			**158.1**	**1.8**	**65**	**3 809**	
A. Enteric Fermentation			**3.5**				
B. Manure management			**0.4**				
C. Rice Cultivation			**9.1**				
D. Agricultural Soils							
E. Prescribed Burning of Savanna			**144.8**	**1.8**	**64.7**	**3 799.8**	
D. Field Burning of Agricultural Residues			**0.3**	**0.01**	**0.2**	**8.9**	
5. Land Use Change and Forestry	**1 768.7**		**3.7**		**0.9**	**32.3**	
A. Changes in Forest and Other Woody Biomass Stocks	**0**	**-2 537.7**					
B Forest and Grassland Conversion	**4 306.4**		**3.7**	**0.03**	**0.9**	**32.3**	
C. Abandonment of Managed Lands							
D. CO2 Emissions and Removals from Soils	**0**						
6. Waste			**19.6**				
A. Solid Waste Disposal on Land			**19.4**				
B. Wastewater handling			**0.2**				
C. Waste Incineration							
Memo Items							
International Bunkers	**18**						
Marine	**-**						
Aviation	**18**						
CO2 from Biomass	**23 334.7**						

Table 2-19 Detailed summary of the national emissions and removals of GHG in 1994 (in Gg)

GHG source and sink categories	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC
Total National Emissions and Removals (Gg)	*9 625*		*272*	*3*	*94*	*4 762*	*8*
1. Energy	1 534			1	36	1 360	
A. Fuel Combustion (Sect approach)	1 534			1	36	1 360	
B.Fugitive Fuel Emissions from Fuels	0						
2. Industrial Processes	51				0		8
A. Mineral Products	36						7
B. Chemical Industry	0						
C. Metal Production	15						
D. Other Production	0						1
3. Solvents and Other Product Use	-						
4. Agriculture			195	2	58	3 378	
A. Enteric Fermentation			11				
B. Manure management			1				
C. Rice Cultivation			54				
D. Agricultural Soils							
E. Prescribed Burning of Savanna			129	2	58	3 378	
D. Field Burning of Agricultural Residues							
5. Land Use Change and Forestry	7 680		3		1	25	
A. Changes in Forest and Other Woody Biomass Stocks	0	-1 304					
B Forest and Grassland Conversion	8 983		3		1	25	
C. Abandonment of Managed Lands							
D. CO2 Emissions and Removals from Soils	0						
6. Waste			74				
A. Solid Waste Disposal on Land			74				
B. Wastewater handling			0				
C. Waste Incineration							
			0				
Memo Items							
International Bunkers	83						
Marine	8						
Aviation	75						
CO2 from Biomass	27 839						

3 VULNERABILITY

3.1 Introduction

Climate change is attributed to the increase of the global mean air temperature due to GHG anthropogenic emissions. Some human activities such as burning of fossil fuels, land use change and forestry, solid waste management, among others contribute significantly to the increase of the concentration of GHGs in the atmosphere.

As a consequence of this additional increase of the mean temperature of the global atmosphere due to the greenhouse gas effect, the following phenomena are likely to be observed:

- Melting of the polar glaciers and consequent sea level rise,
- Displacement of the climate and agricultural areas – it is foreseen that the latitudinal average displacement is about 150 to 550 Km for each 1 to 3.5^{o}C increase;
- Greater intensity and frequency of occurrence of extreme wheather events (droughts, floods and tropical cyclones) will cause large losses of human lives and goods, destruction of infrastructures and degradation of the environment; and
- Change in the precipitation patterns and consequently reduction of available water.

The predictable climate change will be particularly serious for Mozambique, owing to mainly to two decisive factors: weak socio-economic infrastructure and geographical location of the country (along the Indian Ocean Coast with some areas with low altitude, existence of arid and semi-arid areas, etc).

The main adverse extreme wheather events related to climate change in Mozambique are: Drought, Floods and Tropical Cyclones. These phenomenons happen generally allover the country, with drought having a larger incidence in the southern areas; floods are more frequent in the Center and South and Tropical cyclones in the coastal zone. Regarding the duration, the drought can prevail for long periods of time (3 to 4 years); the floods can last for some months, while the cyclones just few days.

The phenomenon of El Niño (warming of the waters of Equatorial Pacific) and La Niña (cooling of the waters of Equatorial Pacific) bring about floods and droughts in this area of Southern Africa. In this regard, the drought phenomenon experienced in the years 1972-1973, 1982-1983, 1991-1992 and 1994-1995 are linked to occurrence of El Niño and the drought of the years 2000 and 2001 are related to La Niña occurrence in Equatorial Pacific.

The experience shows that the drought has negative impact in different areas of activities, causing different effects such as:

- Loss of cultures
- Drought of water bodies
- Reduction of pastures
- Increase of prices of the agricultural products and of first need
- Increase of food import
- Increase in requests for international aid
- Loss of human and animal lives
- Appearance of diseases
- Loss of Biodiversity

The floods are probably the most vulgar events of the natural disasters. In Mozambique episodes of floods happen more frequently in the Center and South regions, mainly along the rivers basins, declined areas and zones with inadequate drainage system.

The floods in the country are caused not only by the intense precipitation but also by the drainage of waters coming from the dams' discharges in the neighbouring countries located upstream. Most of the torrential rains that cause floods have been associated to the tropical cyclones that affect the country mainly during the summer time.

The negative effects of floods are well known both at world level and in Mozambique, bringing the following consequences:

- Losses of lives and properties

- Loss of cultures
- Diseases
- Displacement of people
- Loss of Biodiversity
- Rupture of the normal activities

Tropical cyclones are the stronger and most destructive events among the global meteorological systems. They bring strong winds, torrential rains and storms that can cause floods, land slides, and erosion in the coastal area as well as in the interior. Many of them cause social and economic recession, losses of lives, human suffering, destruction of properties, degradation of the environment and rupture of the normal activities. However these extreme events can contribute to the supply of water in drought areas and redistribution of the flora and fauna.

Therefore, the impacts of the climate change on the living organisms, natural resources, and on environment and consequently on the national economy are severe. It is therefore important to evaluate Mozambique's vulnerability to climate change particularly on its economy.

Knowledge of these facts will enable the country to adopt possible adaptation measures and mitigation options, against climate change, in the following sectors/areas:

- Human health;
- Agriculture and food safety;
- Biological diversity and ecosystems;
- Water Resources;
- Coastal resources and areas; and
- Infrastructures and services

Mozambique was part of those countries that benefit from the assistance of US Country Study Program for Vulnerability and Adaptation Assessment, in this study the vulnerability of the following resources were assessed: water, coastal zones, agriculture, forestry, rangelands and livestock. The agricultural analyses focussed on crop production, specifically maize. Other sectors like human health, fishing and frequency of occurrence of extreme events were not covered due to lack of resources.

3.2 Scenarios of Climate change

Daily observed meteorological data for a period of thirty years (1951 - 1980), from eleven meteorological stations of Mozambique were used (Table 3.1) to set the baseline climate scenario. The stations chosen are located in the ten capitals of the provinces of Mozambique, and in Chókwé, where the agricultural analysis was conducted. The data consisted of air temperature, precipitation, wind speed, relative humidity and solar radiation. The data was kindly supplied by the Mozambican National Meteorological Institute (INAM).

Table 3-1. List of station used for the baseline climate

Station Name	Latitude	Longitude	Station Designation
Maputo	25° 58' S	32° 36' E	MP009001
Xai-Xai	25° 03' S	33° 38' E	GZ008032
Chokwe	24° 53' S	33° 00' E	GZ008050
Inhambane	23° 52' S	35° 23' E	IB007003
Beira	19° 48' S	34° 54' E	SF006053
Chimoio	19° 07' S	33° 28' E	MN005015
Tete	16° 11' S	33° 35' E	TT003002
Nampula	15° 06' S	39° 17' E	MP002051
Quelimane	17° 53' S	36° 53' E	ZB004001
Pemba	12° 59' S	40° 32' E	CD000034
Lichinga	13° 18' S	35° 14' E	NS001003

Table 3.2 shows the mean monthly values, average of all the meteorological stations presented in table 3.1, and over 29 years (1951-1980) period. These data describe the mean seasonal variations, and were used as baseline climate scenario.

Table 3-2. Parameters representative for the country baseline climate (1951-1980)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Tmean-[C]	26.2	26.0	25.6	24.3	22.5	20.1	17.8	20.8	22.7	23.8	25.4	25.9
Tmax-[C]	30.5	30.2	30.0	28.9	27.3	25.4	25.1	26.2	28.2	29.2	30.3	30.4
Tmin-[C]	21.8	21.8	21.3	19.7	17.2	14.9	14.5	15.4	17.3	18.6	20.6	22.5
Rainfall-[mm/day]	6.18	6.79	4.98	2.39	1.19	0.77	0.79	0.54	0.61	1.33	2.48	5.24
Wind-[Km/h]	8.45	8.28	8.41	7.72	7.70	8.20	8.36	9.04	10.09	10.24	9.78	9.22
RH- [%]	79.1	80.1	80.0	77.3	72.9	70.8	67.9	65.5	64.2	66.0	71.0	77.3
Insulation-[h]	227	198	227	236	250	234	236	254	248	249	206	196

The atmospheric concentration of CO_2 were set to be 330 parts per million (ppm), this was the average value observed in the 1970s. The predictions indicated that the concentration of CO_2 in 2075 would be about 540 – 580 ppm. Therefore, in prediction of the future climate scenarios it was, considered the double of the present concentration of CO_2.

Simulated scenarios on climate change for the century 1975-2075 are based on six General Circulation Models. The models were run to obtain "outputs" of air temperature, precipitation and solar radiation, forcing concentration of carbon dioxide ($1xCO_2$) and for the doubling of current CO_2 concentration ($2xCO_2$). Comparisons of the results of the simulation of the models and the meteorological parameters for the simulated periods, obtained on the bases of linear regression models, indicate that the models reasonably reproduce the seasonal variation of the climate of Mozambique, with a correlation coefficient (r^2) of 0.7 on average.

The model GFDL-R3, represented the seasonal variations of the climate best, with a coefficient of determination of 0.96 for the air temperature and 0.94 for the precipitation. The model that represents second best the climate of Mozambique is UKMO. However, it should be noticed that this model seems to underestimate the precipitation during the months of December and January when corn is grown. The results of the models GFDL-R3, UKMO, UK98, GENESIS and GISS were used for the vulnerability studies.

Scenarios based on different GCMs for the region over Mozambique indicate that doubling in the global concentration of CO_2 in the atmosphere may affect local climate as follows:

The mean temperature are estimated to increase by 2.8 ^oC according to UKMO, 1.8 ^oC with Genesis, 3.1 ^oC according to GFDL R30 and 3.1 ^oC with UK89;
The precipitation would decrease by 9% according to UKMO and UK89, by 2% according to Genesis, and 11% according to GFDL-R30;
For solar radiation UKMO and UK89 models indicated an increase by 3%, while GFDL-R30 shows an increase by 2%.

The increase in mean temperature is a reflection of the increase in the maximum air temperatures, for the minimum air temperature does not show significant long term trend. This may be particularly specific to this region, for normally, on a normal global climate change scenario one would expect trends in both the minimum and maximum temperatures to be proportional.

3.3 Vulnerability

3.3.1 Coastal Areas and Coastal Resources.

The Mozambique coastline, 2 700 km long, is the third longest in Africa and is characterised by a diversity of physical features such as sandy beaches, sand dunes, coral reefs, estuarine systems, bays, mangroves and sea grass beds. It is one of the country's most valuable natural assets.

The coastal resources are under pressure of both human and natural activities. From human activities, the major problems are:

i) Conflicting utilisation of natural resources (tourism, local communities, protected areas, industry, agricultural, sewage disposal, etc);
ii) High population density leading to over-utilisation of some coastal resources (over-fishing in estuaries and beach rocks, etc);

iii) Degradation of some fragile and important ecosystems, such as mangroves, coral reefs and sea grass beds.

From the point of view of the impacts of the sea-level rise the coasts of Mozambique can be subdivided into three regions as follows:

Region of bays:	Less vulnerable
Region of rivers:	high risk (inundation and erosion)
Region of Lagoons:	Moderate (erosion)

The region of bays is about 670 km long and lies between the mouth of river Rovuma to Mozambique Island. The coast consists mainly of sedimentary bedrock (calcarenites, limestone, and sandstone) and coral reefs, and therefore is relatively stable.

The region of rivers lies between Mozambique Island and the Bazaruto Island and is about 900 km long. This region is characterized by rivers that drain into sea through estuarine systems and deltas, where some major and secondary harbors are located. The coastline in this region is very unstable due to the position of material brought by rivers and erosion of the river edges by strong currents towards the mouth. The rivers meander into the sea through unstable bars and change their course with time, eroding or depositing material modifying the coastline shape. There are locations where the coastline has retreated or advanced as much as up to 1 m per year in the last 40 years, as for exempla Chinde (Zambezi Delta). Erosion has been identified as a serious problem in some regions including, particularly, the city of Beira where many property and infrastructure (e.g. roads) have been already lost.

The region of Lagoons extends from Bazaruto Island to Ponta de Ouro and is characterized by densely vegetated dunes. Some major towns, including the capital and many beautiful holiday resorts are located there. In many coastal cities roads built along the shore are restricting the ability of the shore to shift and adjust under the action of strong winds and waves, giving rise to unbalanced displacement and distribution of sand. But erosion and accretion occur mainly as a consequence of man-made structures.

In the south, cemented interior dunes of Pleistocene age and lagoonal/marsh zone, enclosed by sub-recent to recent exterior dunes, characterize the coastal zone, as a whole. Recent large and small dunes are restricted to a narrow North-South belt, from Ponta de Ouro through the eastern coast of Inhaca and Portuguese Island up to the north.

Preservation of these dunes was attained during high sea level stand and the consequent infiltration and precipitation of carbonates from marine waters resulting in the formation of beach rock that forms the ridges at several places in south (e.g. Inhaca Island). Erosion is moderate and is mostly restricted to the main headlands due to the wave action and along shore currents.

High risk area

The result from the Aerial Videotape Assisted Vulnerability Analysis (AVVA) indicated Beira, in the central Mozambique, as the most vulnerable site to the effect of sea level rise.

Beira is a low-lying harbor town of strategic importance for Mozambique and for the hinterland. It is the nearest natural port for Malawi, Zambia, Zimbabwe and other land locked countries in Southern Africa. The design of the port was upgraded in 1998 in order to receive larger vessels up to around 60,000 tons and it can handle million of tons of cargo per year, from containers, bulk and crude oil.

Around the harbor, a city has developed to become the second largest city of Mozambique and is home for more than 200,000 people according to 1980 census. The current population is thought to be far in excess of this figure. Most of the town is below high water level and several channels have been built to drain water and reduce the impact of fast rising and high range tides, and of heavy river floods.

Beira is located at center-east of Mozambique at the mouth of Pungoe River, which discharges huge amounts of sediment into the fore-lying bay. It is a flat physiographic unit consisting of old beaches ridges, cuspate spit, marshes and wetland.

The bay has semi-diurnal tides with a daily inequality of 0.4 m. The mean spring and mean neap tidal ranges are about 5.7 m and 1.7 m, respectively. The currents are very strong reaching up to 5 knots in the dredged channels.

Sea level rise estimates were taken from the first IPCC and ICC/FAR evaluation report (1990) that indicates different estimates for the sea level rise for the year 2100, namely, 0.5m, 1.0m and 2.0m. An evaluation of the impact of these estimates for the coast of Mozambique was made with the aid of the AVVA method, i.e., Aerial Vulnerability Analysis Assisted by Video, to identify coastal areas, which are more vulnerable to sea level rise.

Beira coast, as mentioned, was identified as being the most vulnerable coastal area to sea level rise in Mozambique. For this area, erosion and floods are the most critical processes identified by the model for the year 2075.

The impacts of sea level rise would be characterized by increase in frequency and intensity of over-wash, flooding of the low relief features, erosion of the existing beach ridge beyond the sea wall and sometimes severe inundation, to an extent of about 42.5 km^2 along coastline, during high water of the spring tides. These would result, in considerable environmental and human health problems. Navigation channels would severely be affected as a direct consequence of changes in water circulation and sediment distribution.

Another eminent danger for the coastal areas and their resources is the increase of the temperature of the sea along the canal of Mozambique as a result of the El Niño phenomenon. This increase can have negative impacts on corals, which are part of the Mozambican marine ecosystem. In addition, it also affects the resurgence processes responsible for transporting nutrients from the deep layer of oceans to the surface for feeding the fish - thus determining the abundance or scarcity of fish.

3.3.2 Water resources

The framework for assessing the impacts of climate change on national water resources and analysing potential adaptation options is made up of four distinct components: Supply, demand, vulnerability, and adaptation (Figure 9). Mozambique possesses a reasonable number of river basins, and they were not fully assessed under the V&A study, the first logical step was to identify those that are expected to be most vulnerable to climate change. The river basins in the southern and central Mozambique were selected because coupled with the harsh and erratic climatic conditions, there is a considerable increase in water demand against decrease in water supply. In addition, anthropogenic interference is high, through building dams, channels and deviation of water from one basin to the other, to account for the increasing development projects.

Mozambique river basins, which were considered for V&A assessment were in southern region (Limpopo, Umbeluzi, Incomati), in center (Pungoe) and north (Zambezi).

To study the impact of climate change on water resources, the WATBAL model was used. This integrates factors resulting from climate change, as well as the increase in the search for water due to the increase of population and industrial development in the coming years. Results show a general reduction of the surface water flow due to (i) the reduction of rainfall and increase of evapo-transpiration and (ii) increase of the search for water for domestic and industrial needs.

The impact of climate change on water resources will be manifested through irregularities in temporal and spatial distribution of rainfall and by the increase of the temperature and solar radiation, which in turn will increase evaporation levels. GCM’s predict a reduction in the amount of rainfall, which can vary between 2 to 9%, and an increase of the evapo-transpiration between 9 to 13% contributing to the global reduction of the amount of available water.

The agriculture sector is a major water user in Mozambique. The table below, presents the present and future needs of water in Mozambique.

Table 3-3. Present and Future Needs of Fresh Water in Mozambique

Need	**1992** (10 m3/yr)	**2002** (10 m3/yr)	**2017** (10 m3/yr)
Urban	25	56	183
Rural	28	58	147
No-domestic	12	20	55
Agriculture	540	1,180	2,100
Total	605	1,314	2,485

Source: Provincial Town Studies DHV Consult (1993)

3.3.3 Agriculture

Agriculture is the most important sector for the Mozambican economy. Agricultural production is mainly controlled by two major factors, namely, the climate and soil fertility, resulting in two subdivisions i.e. (i) North of Save River and the regions along the coast and (ii) South of Save.

North of the Save River along the coastal areas, the climate is favourable for the practice of agriculture through most of the year, but the soil in certain areas is deficient in nutrients such as nitrogen, phosphorus, sulphates and occasionally potassium. Most fertile lands can be found along river valleys. In the South, the soil is relatively fertile, but climatic conditions are a major hindrance due to the large annual variability of rainfall.

Climate change can affect agricultural production in Mozambique through the resulting changes in the air temperature, rainfall, atmospheric humidity and radiation. These are fundamental elements for the production of organic matter and for the basic activities of plants, such as photosynthesis, growth and development. Changes in soil humidity resulting from the reduction of rainfall and increase of evaporation can significantly affect the rates of plant transpiration and thus the supplement of nutrients such as nitrogen, phosphorus and potassium for the plants.

The evaluation of the impact of climate change in the agriculture in Mozambique was made on maize of the *ZEA MAYS* species and pastures, using Chokwe region as a case study. Version 3 of the DSSAT model and the SPUR2 model were used for maize and pastures respectively.

Considering the results of the climate scenario simulations, it was estimated that a reduction in the absorption of nitrogen from 6 to 50% according to the type of plants would occur. The content of nitrogen in the biomass and in the grains may vary between 1.5% to -5.6% and from 9% to -9% respectively. The reduction in the content of nitrogen in the biomass and in the grains implies the reduction in their nutritional capacity. The model also shows a reduction in the biomass from 7.5% to 5.9% and in the maize crops from 6% to 12%. For the pastures, an increase of the foliage from about 5% to 16% is expected

The occurrence of extreme events such as floods, droughts and tropical cyclones has negatively affected the agriculture sector, through the disruption of routine practices, infrastructures and the erosion of the soils. Another phenomenon that has been contributing negatively to soil empoverishment and consequently to the reduction of the agricultural income, is the practice of burning that is done at the beginning of the agricultural season.

3.3.4 Forests

Similar to agricultural production and pastures, forest production would be affected by the absorption of nutrients by plants, as well as by the rainfall and thermal regimes. For the preliminary evaluation of the impact of climate change in the forest production of four selected species: Ajoh, Aqua, Mexe, Cpen and Knya2, the Holdrige and the Forest Gap model (Beniof at al. 1994) models were used to classify the forests. Results show that the whole country would have the potential to retain some kind of tropical rain forests. Top biomass and height would increase between 12% and 13% for the majority of species, except Cpen for which the models predict a reduction of the biomass from 14% to 28%.

3.4 Conclusions

The danger of climate change is serious for Mozambique under the doubling of the current CO_2 concentration. Such a scenario would bring the following results:

- An increase of the air temperature between 1.8 and 3.2ºC;
- Reduction of the rainfall from 2 to 9%;
- Increase of the solar radiation from 2 to 3%; and
- Increase of the evapo-transpiration between 9 to 13%.

The impacts of these changes are still uncertain, but simulations already clearly show that coastal areas and resources, as well as hydro resources, agriculture and forests would be negatively affected.

Pastures seem to be the only sector where it was possible to notice an increase of the foliage area, but conversely, the reduction of the nutritional capacity due to the weak absorption of nitrogen would negatively counterbalance the predicted increase in the pastures.

4 ADAPTATION

4.1 Introduction

Mozambique is prone to extreme weather events and these alternate between drought and floods with some years of normal weather in between. Between 1965 and 1998, twelve major floods, nine droughts and four typhoons occurred. Floods in 1971 and 1977 were comparable in magnitude and destructive force to the floods that occurred in 2000, which resulted in 300 deaths, and affected half a million people. Droughts and famine in 1980, 1983, 1985 and 1992, resulted in 100 000 deaths and affected over 17 million people.

The effects of drought take place over a long period whereas the effects and loss of life from flood is immediate. However, both phenomena have devastating effects on the environment since they reinforce each other. For instance, during drought the vegetation dies and the land cover is reduced thus making the land more susceptible to erosion. During the floods, the topsoil is washed away making it less fertile hence vegetation growth is reduced. The net result is a degradation of the environment leading to a reduction in natural resources. The reduction of natural resources has implications on the economy, employment facilities and reduces the capacity for local communities to meet their needs.

According to the Inter-Governmental Panel on Climate Change (IPCC) the global temperatures are rising. Most of the droughts in Southern Africa are linked to the El Nino/Southern Oscillation (ENSO) and the floods are caused by cyclones and typhoons generated in the Indian Ocean. As rising temperatures in the sea also trigger these events, this means that the intensity and frequency of droughts will increase as global temperature increases. This will accelerate the environmental degradation - thus causing more suffering to Mozambique, especially to the poor who depend on natural resources for their livelihood. There is a great need for the country to adapt to extreme weather events caused *inter alia,* by climate change.

The impacts of floods and droughts are cross-cutting and diverse, with severe impacts on agriculture and natural vegetation besides the indirect effects on health and economy.

These effects are compounded by environmental degradation, including soil erosion, water pollution and deforestation.

Major environmental issues associated with floods in Mozambique are: water pollution, degradation of coastal and marine ecosystems, loss of critical habitat (mangrove, coral, sea beds, wetlands), loss of biodiversity, threat to endangered species and threat of movement due to land mines.

It is relevant to point out that the adoption and implementation of counter measures also imply the existence of financial and technical resources to face challenges from climate change.

The studies and efforts on adaptation to extreme weather events in SADC (Southern Africa Development Countries) region, which includes Mozambique, have focussed on droughts, with very little work on floods. This can be seen through the establishment of Drought Monitoring Center, such as the SADC drought-monitoring center in Harare. There is no such center for monitoring floods. In order to reduce vulnerability, from extreme weather events there is an urgent need to adopt disaster management programmes which incorporate both floods and droughts.

This chapter tries to elaborate on what can be done for Mozambique in this regard in as far it relates to climate change.

4.2 Coastal and resources

The occurrence of coastal degradation in Mozambique is related to unsustainable human activities, such as agriculture, forestry, fishing, tourism and urbanisation. This results in coastal erosion, habitat destruction of mangroves, beaches, sea-grass beds and reefs, biodiversity loss, land degradation and depletion of fish stock.

Coastal erosion (e.g. in the city centre of Beira) is mainly caused by building structures too close to the shoreline and lack of maintenance of protection structures. In the southern part of the country, uncontrolled tourist activities are exerting pressure on the natural resources base. Such examples are: tourism without proper planning which in turn cause destruction of coastal habitats (mangroves, beaches, dunes, reefs and other sensitive environments) and adversely affects the social and cultural life of local communities. There is, therefore, an urgent need for action to combat developments that undermine the livelihood of coastal communities, in terms of their dependence on fish protein, agriculture and other natural resources upon which these communities depend.

As already mentioned above Mozambique's coastal strip is characterized by multiple and conflicting human activities such as rural and urban settlement, agriculture, forest exploitation and fisheries. Tourism and transportation activities are also playing a growing and significant rule.

On the other hand the coastal areas are made of complex ecosystems of great value as habitats of tremendous variety in biodiversity. The fragileness and the ecological importance of some of these areas together with the economy value have led the authorities to seek legal protection of some these areas. However, this effort has often been undermined by the lack of enforcement and the unplanned occupation. Population pressure lead to the disorganized land use and the exploitation of natural resources far above their currying capacity. Consequently, negative processes such as soil erosion, mangrove depletion and loss of biodiversity occur in an accelerated way.

Having into consideration the main constraints pointed out in relation to the issues of coastal zone management, some priority measures are herein proposed, both to solve institutional organization problems as well as the gaps in the legal framework. Some of these issues will go a long way in providing the required environmental for definition and implementation of sealevel rise adaptation measures.

4.2.1 Inventory of the coastal zone and development of a data centre

Data and information are the key precursors to every aspect of development planning. Based on this notion it is necessary that the inventory of the coastal zone of Mozambique be undertaken and data center and data bank be created to keep data and information on the coastal zone. An intersectoral working group was created and is led by MICOA. This group is now in the process of collecting data to build up a coastal profile, which will be used in the coastal zone planning. This activity should continue and be expanded to the whole coastal zone. The process will include the zoning of the coast based on ecological sensitivity (wetlands, sand dunes, pressured ecosystems, vulnerability to climate change…) and the definition of priorities.

Some of the steps towards characterization of the coastal zone of Mozambique have been taken. A micro-diagnosis of the coast was produced with financial support from NORAD (Norwegian Agency for Development Co-operation) and IUCN. The output of the micro-diagnosis, apart from the comprehensive collection of the existing data and the production of a data bank, would be the identification of the following:

- Identification of gaps in the data sets and information
- Definition of priority areas for action, and
- Extension of the coastal zone

The next step is actual zoning and planning for the priority areas, whereby action plans and specific projects for each area will be defined. This useful process should be continued until the coastal zone is fully characterized.

4.2.2 Strengthening the institutional and legal framework in the coastal areas

Presently a number of institutions have sectorial competencies in coastal zone management, but their mandates are either unclear, full of gaps, conflicting and/or overlapping. These are, among others, the Ministry of the Co-ordination of Environmental Affairs (Coastal/Marine Environments), The Ministry of Transports and Communications (Coastal Shipping), The Ministry of agriculture and Fisheries (Fisheries, coastal parks and coastal agriculture), The Ministry of Industry, Commerce and Tourism (industrial effluents and tourism), The Ministry of Public Works and Housing (coastal construction), the cities and local municipalities (multiple powers and responsibilities).

It is, therefore, necessary to clearly define the management and coordinating roles of these various institutions and to mandate and strengthen MICOA to take the full responsibility of being the main coordinating arm of government in all environmental matters, particularly in the coastal zone. The implementation of the legal framework should be monitored and evaluated on a regular basis to identify and close loopholes in the implementation and enforcement of the various acts.

4.2.3 Establishment of coastal zone management centre

Current knowledge on the status of the coastal resources and their potential and development is rather scanty and sectoral (Forestry Department dealing with mangroves and reserves, Fisheries Research Institute with commercial fisheries). In order to build the capacity for training, research and monitoring of the coast, the establishment of coastal zone management centers should be considered high priority. The ideal situation would be to establish three centers: one in the southern, one the central and the other in the northern parts of the country. This arrangement would comply with the geomorphologic division of the Mozambique coastline. The coastal zone management centre for the southern part of the country has been created and is based in Xai-Xai. Still to be created are the centers for central and northern Mozambique.

The main duty of these centres would be to conduct activities such as research, survey and monitoring, to provide technical assistance to local governments, to promote and implement public awareness campaigns, to carry out short term training courses on natural resources management, to conduct environmental impact assessment of development activities, to promote and implement experimental and demonstration activities in the field of coastal and natural resources management and sustainable development.

The Xai-Xai center has been operating on experimental basis since January 1997 with funding from DANIDA (Danish International Agency). Funds from the European Union, UNEP and SIDA/SAREC (Swedish International Development Agency) have been pledged and shall be available in the short term, and are intended to support development and good practice pilot-projects, demonstration projects, research and training.

Building capacity for research and monitoring should also form part of the major activities of these centers. There is a need to study, at the micro-level, the complex interface existing between the population, environmental and development aspects in each region. This means that there is a need to know, on the one hand, the ecological structure of a region and the resources existing in it, and on the other hand, its carrying capacity and resulting consequences from human activities.

Having all this in mind, research activities in the coastal area must be developed starting with the definition of priority areas of investigation. This investigation will constitute the basis for future action plans that MICOA must promote.

4.2.4 Integrated coastal Zone Management

In June 1994, the government of Mozambique approved the National Environmental Management Programme (NEMP), which is the master plan for the environment in Mozambique. It contains a national environment policy, environmental umbrella legislation, and environmental strategy. The NEMP is also a programme of sectoral plans, containing projections for the medium and long term, aiming to lead the country to sustainable socio-economy development. The Ministry for Co-ordination of Environmental Affairs has taken the lead for environmental management in Mozambique (MICOA, 1995a).

The NEMP defines three priority areas of action: urban, rural and coastal areas. As far as coastal areas are concerned, the NEMP establishes the integrated coastal zone management (ICZM) as the correct approach. Specifically, the programme states that the coastal zone management will be based on the co-ordination between the relevant stakeholders (institutions and communities) and on a programme, which should be designed and approved by them. The main issues for this programme are: (i) fisheries, (ii) coastal and marine ecosystem management, (iii) coastal and marine protection, (iv) marine parks and (v) tourism. The programme also defines, for each of these issues, the strategy and the activities for the short, medium and long term. For instance, as far as coastal and marine protection is concerned, one short-term activity is the assessment of critical habitats and the development of protection measures and contingency plans.

The department responsible for coastal areas within MICOA, the CZM Unit, is composed of a team of professionals from different disciplines and is responsible for all the activities related to coastal area management, including studies, planning, programme management and co-ordination (MICOA, 1995b). This unit is presently coordinating a multi-sectoral technical committee bringing together the different institutions dealing with the coastal zone (e.g. the maritime authority, the local administration, research institutions, tourism, fisheries).

The planning shall address issues of social and economy development (e.g. tourism, ports and harbours), measures to protect threatened areas and rehabilitation of those already degraded (erosion, deforestation).

Land use planning came as the first step for the ICZM, in which three different components should be taken into consideration, namely:

- the geographical scope,
- the current situation of coastal natural resources and their potential use, including the local communities, and
- the institutional framework and legislation for coastal management.

The involvement of local community in this programme is of fundamental importance. Among the projects already being implemented there are at least three projects on coastal resources management by local communities involving funds from donors and local communities (one in the north, and two in south). Other projects refer to the improvement of management practices on coastal-urban areas (e.g. Mozambique Island). Some projects were designed and wait for funding. These are expected to address specific issues in different parts of the coast, e.g. management of mangroves, rehabilitation of coastal areas affected by erosion, e.g. Beira and Nacala.

Public awareness campaigns on the negative consequences that occur due to the unsustainable use of resources and coastal areas with respect to climate change should be mounted so as to:

- Involve the local communities in the elaboration of the programs of management and use of natural resources;
- Create alternative sources of income for the communities;
- Allow local communities to benefit from the results of the exploitation of the resources so as to elevate their standard of living;
- Adoption of strategies to face the impact of the sea level rise in the Beira area, with the help of legal, institutional, environmental and engineering approaches.
- At the institutional and legal level, measures should include the integrated management and local community participation in finding solutions to these problems on the basis of the "bottom-up approach" that develops the local communities from the point of view human and institutional capacities.

Engineering solutions should include the construction of dikes, walls and structures of coastal protection.

Environmental measures could include the use of local means and appropriate ecologically sustainable frameworks for the fixation and stabilization of the coastal dunes as protection against erosion.

Measures to put in the necessary environmental infrastructure usually require a long time for effective implementation. However, this route is usually advisable since it offers stable and durable solutions with minimum secondary effects apart from being cheap when compared to engineering solutions. The long time required for these infrastructures to be in place is not critical since sea level rise is a long-term process.

4.3 Water resources

Water is considered as a good with economic and social value. It is important for the economical development and for the improvement of sanitary conditions. This precious liquid is a limited resource, thus, it should be managed through combined actions at national, regional and international level. In Mozambique the largest water consumer is the irrigation, following by the supply to the urban areas, industries and lastly the rural areas (DNA, 1999).

On the implementation of the National Water Policy, elaborated by the Government of Republic of Mozambique in 1995, there are in course several activities and programs that will allow for a better management of water resources in a close future. On a short term perspective, this policy emphasizes the recovery and expansion of hidrometeorologic network that was seriously damaged during the civil war period, introduction of modern technologies of collection, transmission and data processing and regular and systematic exchange of information with the neighboring countries. Another short term step is the establishment of agreements on shared courses of river basins in more critical situation, like Incomati, Limpopo, Save and Pungue. The country also commits to engage strongly in the search of the necessary adjustments and improvements of SADC protocols on the systems of courses shared as well as in the ratification and regional implementation of the United Nation Convention about the Non Navigation in shared courses. In the medium and long terms, the Mozambican authorities, particularly DNA, is in the process of elaboration of a national strategy for water resources. In this strategy the component of the institutional capacity building will be very important.

Mozambique possesses few dams; therefore an effort will be necessary to build these infrastructures with the purpose of controlling drainage and production of energy. It is foreseen for a brief future the construction of a new hydroelectric dam on Zambeze river

(Mepanda Uncua) upstream of Cahora Bassa. On the other hand there is a perspective of constructing new dams in the following places:

- Moamba in Incomati river, for irrigation and water supply to Maputo city;
- Bue Maria in Pungue river, for irrigation and water supply to Beira city;
- Mapai in Limpopo river, for irrigation;
- Alto Malema in Malema river; for production of electric energy;
- Monapo in Monapo river, for irrigation and water supply to Nampula city.

Mozambique just as most of the SADC countries is not rich in water resources. Therefore a good management of this irreplaceable resource, which many times generates conflicts, its fundamental in order to guarantee a socio-economic development that the country desires, in an environmentally sustainable base.

4.4 Agriculture.

The adaptation measures for this sector could include: changing the type of farming activities, change of the cultivation periods and change of the geographical location of production activities. The introduction of an intensive agriculture, with rational use of fertilizers and irrigation is also an attractive measure.

The National Agricultural Support Programme (PROAGRI) launched in 1998 and being implemented by the Ministry of Agriculture and Rural Development, is expected to produce an impact in food security and poverty reduction. PROAGRI foresees three main areas of action: sustainable natural resources management (including forestry, fauna management, land tenure, land-use and irrigation), the provision of agricultural services and institutional development, focusing on capacity building at institutional and individual level.

According to the agricultural policy in Mozambique the Ministry of Agriculture and Rural Development (MADER), setup the following main objectives: Guarantee the food security, balanced diet and surplus production to respond the demand from the industries and overseas (Ministry of the Agriculture, 1992). The areas of seeds, research and technologies and support services are considered fundamental to reach the objectives mentioned above.

Among the strategies of MADER, in the scope of adaptation actions to climate change the following ones were outstanding:

- Maintenance and multiplication of pre-basic and basic seeds of the improved varieties in quantity that satisfy gradually the national production of essential seeds;
- Development of the national industry of seeds, with the capacity to produce seed with quality and in quantity in a long term, in order to cover the needs of the several social sectors of production;
- Development of research of alternative technological packages appropriate to the several social sectors of production with emphasis for low cost technologies and adaptation of the technical recommendations to the agriculture-ecological areas and the usual practices of the producers in those areas;
- Rehabilitation of the network stations, research and agrarian experimentation points in order to cover the main agriculture-ecological areas, production systems and production areas in the light of prioritising the basic alimentary agricultural products;
- Promotion of cultural practices that contribute to the reposition and conservation of soils fertility and avoid its salinization and erosion;
- Development of technologies that allow the reduction of the derived risks from the drought;
- Promotion of cultural practices that compete for the prevention and reduction of curses and diseases incidence and of powder-crops losses.

In the Livestock area the objectives are oriented for the recovery of bovine herds, promote the creation of animals of small species and small ruminants. The following priority areas are identified:

- Bovine for meat;
- Bovine for milk;
- Small ruminant and
- Swine.

Among the several strategies that MADER has elaborated for the livestock sector the following are the ones that were considered to be the most relevant for this study.

Relatively to the bovine of cut, it is foreseen the improvement and increase of the effective through the recovery of the cattle infrastructures of support to the family sector; import of improved reproducers and adaptable to the several ecological areas of the country.

For bovine milk dairy, it is necessary to define areas of milk production, considering the aptitude and occupational agriculture-livestock, promoting milk dairy production, commercialisation possibility and collection of milk. Regarding the small ruminants it stands out the acquisition and movement of animals with reproductive potential for new areas, making fairs in the most populated areas, or taking advantage of the existing commercialisation infrastructures; creation of regional centers of multiplication of reproducers of local races for the distribution.

In relation to swine, to promote development of swine at the family or cooperative level, in the most suitable areas for agricultural production, as in the central area of the country; and where it doesn't exist any serious limitation of sanitary order; local production of food susceptible for the swine, namely, cassava, beet forager and the use of vegetables; definition and advocating food models the base of dominant products in each area and the knowledge of their nutritional value, price and periods of availability.

4.5 Forests

Adaptation measures include intensive and extensive reforestation through the introduction of new forest species that are compatible with projected climates.

MADER has a general objective for the forest area, to promote the sustainable use and permanent valorisation of the forest resources, including the following areas:
a) forest inheritance

b) forest exploration

c) forest destruction

d) industrial forest

e) export

f) fuels and construction materials

g) reforestation

Among the areas mentioned above, there is a need to emphasize strategies on the following areas: forest destruction, fuels and construction materials and reforestation.

Regarding forest destruction, the aim is to progressively reduce the itinerant traditional agriculture into forestry of high wood productivity, or in forests ecologically more sensitive, motivated additionally by the compensation for reforestation. In the consumption of fuels and construction materials, it is highlighted the reduction of fuels consumption from natural forest by the urban population while alternative programs of energy supply are introduced. Regarding reforestation, several actions should be impelled, namely creating in the population the sense for plantation of trees through a larger education and participation in planting programs.

The subject of the reforestation should deserve special attention and due priority, because in Mozambique, there is serious desertification risk as well as erosion. This situation calls for urgent counter measures.

For these measures to be effective, there is a need for urban and rural populations to have access to other sources of energy, because it has been found that major deforestation activities are due to clearing of the land for agricultural purposes as well as production of vegetable coal and firewood to feed the urban and rural populations.

Mozambique is reinforcing its involvement in the regional arena, also participating in Trans-frontier Projects for forest and fauna management. This project seeks the creation of great areas of biodiversity conservation, based in local communities' development;

creation of investment opportunities for private sector and partnership among the Governments shared resources. The following are part of the Trans-frontier project:

- The Limpopo National Park (Mozambique, South Africa and Zimbabwe);
- Chimanimani Park (Mozambique and Zimbabwe), and
- Maputo Reserve (Mozambique, South Africa and Swaziland) as partners

Among them the renown Gaza-Kruger-Gorongosa, officially launched by the Governments of Mozambique, South Africa and Zimbabwe in 2002, today the world's largest conservation area with over 20,000 sq Km.

The sustainable use of the energy resources constitutes one of the main priorities of the country, given the form how they contribute to the development of economic and social activities, especially the accomplishment of investments in the industry providing an increase of the rhythm of the economy growth, as it is the case of the mega project of aluminium swelter MOZAL.

The strategy for the energy sector approved by the Mozambican Government, is framed in the eradication of absolute poverty, asymmetry reduction in the country development and the increase of the national business community in the area of energy.

Measures to improve the access to services of energy in the urban and rural areas include:

- implementation of sustainable framework of community management of forest resources;
- Interventions in the extent of the use of substitution fuels, like petroleum and liquid gas (GPL);
- Introduction of services on the use of renewable energies, including the needed training for installation, monitoring and maintenance of the equipments;
- Promotion of the use of the natural gas for the energy supply in areas which are close to the fields production or transport facilities;
- Involvement of the private sector in the production and marketing of improved stoves and other means of replacing fuels;

- Implementation at low cost of a national program of electrification to the districts which have no access to electricity.

Table 4-1. Adaptation Measures identified in the V&A studies

Sector	Proposed Adaptation Measures	Comprised area
Agriculture (Crop maize)	Adjustment in management practices such as changes in crop types, season and location of farming or development of intensified and mechanised farming; Promotion of drought tolerant crop varieties and livestock in drought vulnerable areas; development of infrastructures for irrigated agriculture; Monitoring and control of migratory and seasonal pests and diseases; Promotion of yield increasing technologies e.g. manure and other crop.	Chokwe
Water resources	Development of integrated water master plan for each river basin; Construction of small dams; Public awareness campaign in water conservation; Rehabilitation of flood forecasting and warning systems and Mapping of flood and drought prone areas.	Limpopo Incomati, Pungue, and Zambezi Rivers
Coastal Resource	Inventory of the coastal zone and development of a data centre; Strengthening the institutional and legal framework in coastal areas; Establishment of coastal zone management centre; integrated coastal zone management	Beira
Grassland	Alternative grazing systems; Changes in stocking rates; Changes in the timing of the grazing period; Changes in the genotype of the livestock and Farming of improved animal feeding grass	Chokwe
Forest	Extensive and intensive forestation, using species compatible with the foreseen climate	Chokwe
Meteorology/ Hydrology	Strengthen capacity in long-term climate forecasting; Promote the uptake and use of meteorological information and warnings especially in disaster prone areas.	

4.6 Perspectives

To face the environmental crisis caused by climate change, it is necessary to integrate both national and international efforts to make sure that anthropogenic activities do not endanger human survival. Such efforts should have the following objectives:

(i) To elevate the standard of living of the population;
(ii) To mitigate the negative effects of the impacts of the climate change;
(iii) To continue to mitigate the regional emissions of greenhouse gases ;
(iv) To create adaptation mechanisms to the impacts of the climate change; and
(v) To enhance local and national capacity to face to the possibility of occurrence of extreme events.

4.7 Mitigation

The Maputo, Gaza, Inhambane and Sofala provinces are prone to flooding. Despite the high risk of floods, the inhabitants of the floodplains insist on living there. The 2000 floods are the worst in living memory and the community lost everything they owned including cattle used to plough land. Even with all the suffering, the communities insist on returning to the flood plain. The only solution is to assist them to continue staying in the plains by adopting preparedness and mitigation measures for future floods. The focus would be on practical approaches to disaster management stressing prepared techniques.

Decision-makers, professionals and the public need awareness rising in issues of climate change. The disaster management mechanism in Mozambique need strengthening particularly at local levels, which is where lives can be saved and environmental degradation minimized. Unnecessary damage to property and environment can be prevented by, identification of risks, adoption of vulnerability reduction strategies, specific training for emergency response planning involving communities, local authorities, and industries in the concerned areas.

In order to effectively prepare for future disaster situations, a clear understanding of the flood characteristics, topography of the basin and the vulnerability created by various land uses is essential. This understanding can only be gained through a comprehensive and detailed assessment of a risk/hazard/vulnerability profile of every land use system within the river basin. Environmentally sensitive/vulnerable areas will be identified and assessed, in combination with the overall risk assessment. For the maps and plans to be useful there should be reliable means of forecasting events. The current flood warning equipment used for forecasting floods in Mozambique is old and needs updating.

Probability of occurrence of floods can be used for hazard mapping so as to enhance disaster preparedness. This technique can reveal safe areas, areas frequently and infrequently flooded and areas susceptible to landslides. The map can be prepared at a suitable scale to facilitate the activities of emergency response teams.

Taking into consideration the commitment of the Republic of Mozambique at regional and international level in the environmental context, the mitigation measures should be based on the need of the country to reach industrial and social development guaranteeing the sustainable use of the natural resources as follows:

(i) Raise the level of international awareness for greenhouse gas concentration in the atmosphere;

(ii) Increase the efficiency of removal of the carbon dioxide of the atmosphere or the capacity of drainage natural through the maintenance of forests.

Concrete actions such that they can be adapted for different sectors such as:

- Regulation of the emissions of greenhouse gases and the creation of legal mechanisms for the respective implementation;
- To ensure that any actions geared towards industrial development are preceded by environmental impact studies;
- To ensure that the industrial technologies that are introduced by the industries do not harm the environment;
- To promote the reforestation and protection of Mozambican forests;
- To promote measures that help the population to adapt to styles of life that are compatible with the environment;
- To promote the scientific research with the objective of understanding the environmental problems and to seek appropriate technological solutions; and
- To promote the use of renewable energies

4.8 Conclusions

The adaptation measures should be based on the foreseen impacts for the different sectors that can be summarized as follows:

- Flooding of the low coastal areas and aggravation of the coastal erosion;
- Reduction of the fresh water supplies;

- Reduction in the agricultural production; Reduction of the nutritional value of plants due to reduction of their nitrogen content; this affects livestock negatively;

Specific adaptation measures include:

- Protection of coastal areas against erosion and floods through the use of engineering and/or ecological adaptation measures;
- Construction of reservoirs and dams for the conservation of the water and increased efficiency in its distribution;
- Promotion of the intensive agriculture and improvement of irrigation techniques;
- Research of new practical technologies in agriculture, including experiments with different species of plants for the determination of their adaptation potential;
- Reinforcement of the national capacity to respond to the possibility of occurrence of extreme events;
- To promote the participation of the different players in environmental subjects in matters linked to climate change;
- To diversify the national economy, so that it becomes less depend on agriculture;
- To promote the sustainable use of the natural resources;
- To increase the education level and public conscientization on subjects related to climate change;

Although Mozambique has not yet completed comprehensive studies on mitigation of GHG emissions, some general guidelines on the way forward can be proposed in the following way:

Table 4-2. Summary of proposed of measures to mitigate the emissions of GHG and the institutions involved

Sector	Measure Proposal	Results	Institution Involved
Forests	Combat uncontrolled burning	Reduction of emissions	DNFFB, MICOA, NGO`s,
	Promote the administration and community management of forest resources		DNFFB, MICOA, ONG'S
	Promote reforestation		DNGA, DNFFB
Industry of Energy	Substitution of the use of fossil combustion for natural gas in the thermal industries	Reduction of import and consumption of diesel	DNE, UEM and private Sector
	Promote the use of efficient technologies of energy, including renewable energies		DNE, DNFFB
	Rural Electrification using alternative sources of energy (wind and solar)		
Transport	Reinforce the capacity of the responsible institutions for the implementation of the enforcement laws on the import of second-hand vehicles.		DNT, ÂLFANDEGAS
	Promote and motivate the use of natural gas in vehicles.		DNE, UEM, DNT
	Promote the efficient use of the transport systems		DNT
	Create legal mechanisms that track the vehicles in circulation		MTC AND MICOA
	Develop efficient public transportation.		DNT
Energy: manufacturing industry and construction	Ensure that any activities for industrial development is preceded by Environmental Impact Assessment;		DNI, DINAIA AND UEM
	Ensure that the technologies to be introduced by the industrialization are environmentally friendly		DNI, DINAIA and Clean CDT
	Promote the conservation and the efficient use of energy		DNE, UEM
Energy: Domestic and	Promote the use of improved stoves;	Reduction of the biomass consumption	DNE, UEM, ONG'S, DNHC,

Institutional and Commercial			ENH
	Expand the use of gas;		DNE,
	Promote the conservation and efficient use of energy.		

5 POLICIES AND MEASURES TO ENSURE THE FULFILMENT OF THE UNFCCC OBJECTIVES

5.1 Introduction

The 1990 Constitution of the Republic of Mozambique in its Articles 37 and 72 stipulate that:

- "The State promotes initiatives to guarantee the ecological balance, conservation and preservation of the environment, aimed at improving the quality of life of its citizens"; and
- "All the citizens have the right to live in a balanced environment and are obliged to protect it".

These postulates are the result of the understanding that the Government of Mozambique has on the fact that, in the long run, the possibilities for the country's socio-economic development relies on the integration of environmental aspects in economic development. The capacity for national sustainable management of the resources available in the country needs a multisectoral approach in the harmonisation of plans and programmes from all stakeholders so as to have effective management policies.

This understanding is the basis of the process for the review and elaboration of legislation that is pertinent to the environment and sustainable development in Mozambique. It should take into account the major initiatives of the government's development programme that are aimed at eradicating poverty, ensuring, at the same time, that there is no undue pressure on the natural resources.

The Environmental Management Unit established in 1982 at the Physical Planning Institute was the realisation of the importance of the environment in Mozambique. In 1991, the Unit was transformed into the Environment Division, which on July 3rd 1992 became the National Environment Commission (CNA).

CNA showed Mozambique's interest in the UN Conference on Environment and Development that was held in July 1992 in Rio de Janeiro, Brazil. CNA established the basis for the constitution in December 1994 of the Ministry for the Co-ordination of Environment (MICOA), the body responsible for the implementation of the UN Convention on Climate Change in Mozambique.

MICOA emerged as a way of promoting a larger and more efficient co-ordination of all activity sectors as well as encouraging appropriate planning and use of the country's natural resources. It was also a tool for the realisation of the postulates in the Articles 37 and 72 of the Republic's Constitution. MICOA was also a product of the constitution for a Multiparty State, after the 1994 democratic elections. Its basis were founded on the development policy enshrined in sustainability principles.

5.2 Existing policies:

Apart from MICOA as an institutional tool, Mozambique today has various relevant policies in the context of climate change:

i. The 1995 National Environment Policy recognised that many key natural resources were under pressure, poverty being one of the factors behind environmental degradation. Building capacity for better environmental management and sustainable development was also part of a number of other sectoral policies.

ii. The 1995 National Policy on Water, which main objective is to promote the integrated and sustainable management of water resources in Mozambique in order to meet the water needs of the people now and in future

iii. The 1995 Energy Policy, which aims, on the one hand, to increase the feasibility and access to low cost supply of several forms of energy, and on the other hand, foresees the development of conservation technologies and environmental beneficial use of energy. The policy stipulates also the reduction in the consumption of wooden fuels

iv. The National Land Policy and it's Implementation Strategies approved in 1996 and the Land Law, which ensure that the population have access to the resources and participate in the management of such resources, for their sustainability and socially equitable use;

v. The National Policy on Forest and Wild Life, adopted by the Government in 1997 aimed at the management of forest and wild life resources, underlining the need for their sustainable use;

vi. The 1997 Environmental Law forms a tool that guides the integration of environmental aspects into development;

vii. The 1999 Policy on Disaster Management defines as its objective the elimination of poverty and establishment of a contingency plan in view of the recurring occurrence in Mozambique of calamities of different causes and the negative effects of which affect the country's social and economic development;

viii. The Action Plan for the Reduction of Extreme Poverty for 2001/2005 (known as PARPA) – that represents the government's strategic vision for reduction of poverty, the main objectives and the key actions to be pursed. This document which also serves as the Mozambique's Poverty Reduction Strategy Paper (PRSP), is based on the Government Program for the 2000-2004 period, the plans, policies and sectoral strategies developed by the government. It targets an overall reduction in absolute poverty levels from 70% in 1997 to 60% in 2005 or less by the end of the first decade of 2000. The Plan comprises a national multi-sectoral vision comprehending important policies from basically all sectors, inter alia, environment, agriculture, mining, industry, fisheries, tourism and disaster vulnerability reduction;

ix. The 1996 National Environment Programme, which defines the national environment priorities, establishes policies and environmental strategies for the environment management; it promotes sector co-ordination, elaboration of a global sustainability concept and the development of an environmental conscience and culture in Mozambique;

x. The 1997 Environment Frame Law is a tool that guides the national progress in systematically integrating environmental aspects in development. It is also targeted at defining the legal basis for the use and correct management of environment and its components aimed at materialising the country's sustainable development. Within the framework of this law, the National Sustainable Development Council (CNDS) was established to be the consultative body on environmental issues in the country at the level of the Council of Ministers;

xi. Legislation on investments in Mozambique regulates aspects linked to investments in Mozambique and stipulates that investment proposals should be followed by evaluation studies on environmental impacts.

Other policies and laws adopted include:

Industrial Policy;

Mines Law;

Petrol Law;
Transport Law, among others.

The existing environmental laws in Mozambique have some gaps, which is hoped will be covered with the introduction of the legal reform programme, whose environmental benefits are being supported by UNEP.

MICOA is currently leading the process of elaborating the country's Environmental Strategy for Sustainable Development through a consultative process. The Strategy builds on a discussion of scenarios and links issues to action at local, regional and international level; the National Directorate of Water Affairs is drafting the National Strategy for Water Resource Management, which will consider all aspects for conservation and use.

5.3 Conventions

Mozambique acknowledges and adheres to international efforts aimed at ensuring the environmental sustainability, which can only be achieved if environmental problems are seen as a responsibility of all those who inhabit this planet.

Thus, Mozambique adhered and ratified the following conventions and protocols:

- Vienna Convention on the protection of the ozone layer;
- Montreal Protocol on the substances that destroy the ozone layer and the respective London and Copenhagen amendments;
- Convention on Biological Diversity;
- Convention on Drought and Combating Desertification;
- Nairobi Convention for the protection, management and development of the East African marine and coastal areas;
- Basel Convention on the control of trans-border movements of dangerous residuals and their elimination; and
- Bamako Convention on the prohibition of importation of dangerous waste and the control of trans-border movements of such waste in Africa.

5.4 Measures taken for the implementation of the UN Convention on Climate changes

Mozambique ratified the UN Framework Convention on Climate change on 25 August 1995. Within the frame of the implementation of the Convention, MICOA also has the responsibility for monitoring compliance with obligations under the UNFCCC and other international conventions such as the Convention on Biological Diversity (CBD), United Nations Convention to Combat Desertification. In respect of these conventions, MICOA works closely with the Ministry of Agriculture and Rural Development (MARD), in particular, and with other relevant Ministries. MARD is to be the Ministry responsible for the Convention on International Trade in Endangered Species (CITES).

Within MICOA, it is the National Directorate of Environmental Management (DNGA), which deals with the three Rio Conventions (UNFCCC, CBD and CCD), so the DNGA has responsibility to co-ordinate with other institutions the implementation of these conventions.

To prepare the Initial National Communication an inter-institutional group for climate change led by MICOA was set up. This inter-institutional group is composed of two sub-groups; one for inventories and another for vulnerability and adaptation assessment. The composition of the V&A team is multi-disciplinary and was based on the consideration of the sectors most likely to be impacted by climate change. These sectors include agriculture, coastal resources, water resources, forest and rangelands and livestock. Due to a lack of financial resources it was not possible to consider other also important sectors, such as health and fisheries during the V&A studies.

Academic and research institutions such as Department of Chemical Engineering (Faculty of Engineering) compiled the GHG inventories and an expert from Faculty of Agronomic and Forest Engineering, elaborated the forest section on V&A. These two faculties are part of Eduardo Mondlane University. There was an expert from Department of Physics and Mathematics, Faculty of Science, Pedagogic University who built scenarios. Finally an expert from National Institute of Agronomic Research who was responsible for agriculture (crop maize).

NGOs such as Environmental Working Group (GTA) are also involved in the V&A sub-group. However, in the elaboration and implementation of the NAPA more NGOs will be involved.

This working group will be the nucleus for the formulation of the National Adaptation Programme of Action (NAPA) in Mozambique. However, the National Institute of Natural Disaster Management (INGC) is a relevant institution to be included in the NAPA team due to their mandate of coordinating all action related to disaster management including prevention, mitigation, emergency assistance and rehabilitation and reconstructions after emergency and also those sectors that were not possible to consider in V&A studies such as human health and fisheries.

Several technical seminars were held aimed at training and informing experts and population in general about aspects related to climate change in Mozambique.

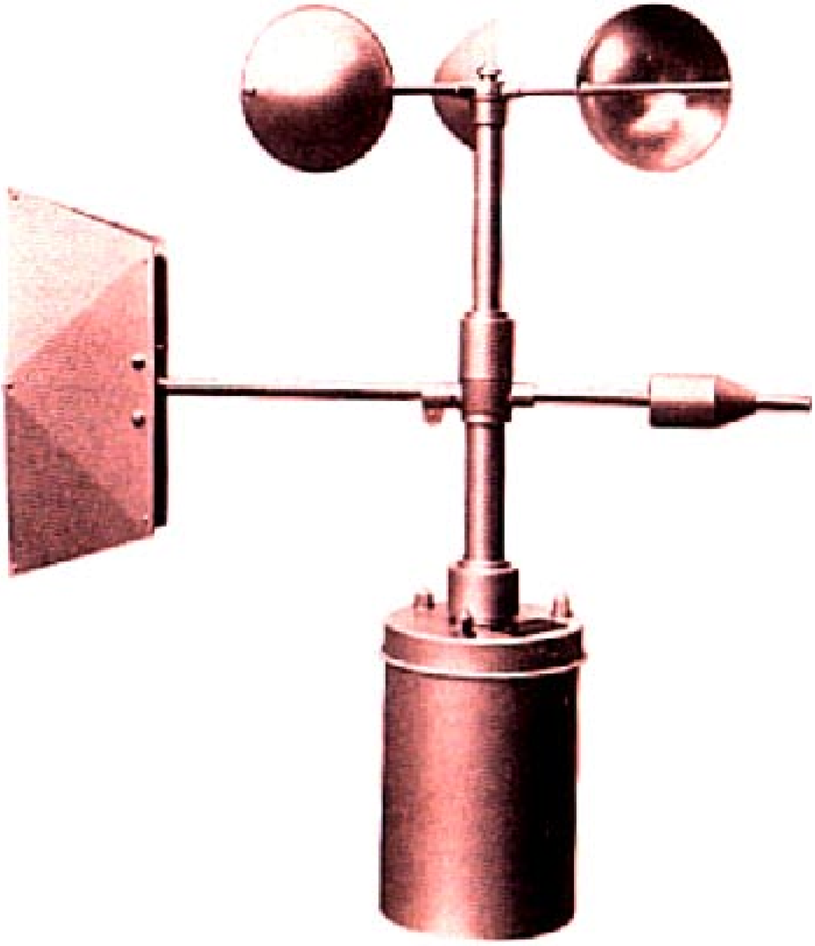
5.5 Conclusions

The adoption and promulgation of environmental policies are very recent practices in Mozambique. This was more pronounced after 1994 as a way to establish the legal basis for the implementation of the government's development programme for the period 1995-1999, which is characterised by sustainability principles.

Before independence, there were laws that dealt with specific environmental aspects, which in the current context need changing.

The legislation adopted since 1995, despite not being exhaustive in relation to various aspects of environmental problems serves as a compelling reference, particularly to the environment framework law. More legislation will be promulgated and reviewed within the context of this law.

6 SYSTEMATIC OBSERVATIONS AND RESEARCH



6.1 Introduction

The 15 year internal conflict that affected Mozambique after the independence in 1975 has considerably affected all public services and, in particular, the infrastructure of hydro-meteorological services that was almost completely destroyed in the areas outside the cities.

The National Meteorological Institute (INAM), which is responsible, among others, to record, collect, file, process and publish the result of observations, had about 180 meteorological stations and 670 rainy gauge posts spread out across the country, before independence. Besides those, there were about 128 climatic centres and 390 rainy gauge posts operated by the Portuguese administration and the private sector. INAM's current network consists in 48 stations. Upper air observations, which in the past were conducted at three stations in Maputo, Beira and Nampula, are not currently in operation. This includes ozone-observing stations as well.

Besides INAM, State institutions such as the National Directorate for Water (DNA) and the National Institute for Agronomic Investigation (INIA), from the Ministry of Agriculture and Fishing, operate observation networks whose data is sent to INAM for filing purposes.

Until 1975, DNA used to operate about 600 pluviometers located in the basins of the major rivers in the country. Currently, a little over 80 pluviometers are operated. INIA has about 10 agro-meteorological stations. Apart from these stations, the Ministry of Agriculture and Fishing has pluviometers spread out in the majority of the country's districts.

6.2 Databases

Availability of data is crucial to understand the processes and mechanisms of climate change. Data enables the monitoring of the behaviour of physical parameters and investigation activities for the determination of cause-effect mechanisms, magnitude and impact of climate change.

Mozambique has climate databases, which date back to 1951. These series of data, however, suffered some considerable discontinuity in the 80s as a result of the war that destroyed a great part of the infrastructures of the national observation network. Apart from these data, there are images of the Normalised Difference Vegetation Index (NDVI) obtained from the satellite NOAA, from 1980 to the current date, as well as images of the Cold Cloud Duration (CCD) from the satellite METEOSAT, from 1988 to the present.

Satellite images represent an excellent tool for the understanding of the temporal and spatial distribution of meteorological parameters, particularly for Mozambique, where the distribution of the conventional observation network is very sparse.

The climate database is archived at INAM. Data are computerised and kept in archives using the CLICOM software from the World Meteorological Organisation. Thereafter, these data are exported in various formats for different applications.

The National Hydrographic and Navigation Institute (INAHINA) have an oceanographic database, which is relevant to climate change assets.

Table 6-1. Existing Data Bases in Mozambique

Institution	Type of data	Period
INAM	- Meteorological - Temperature - Rainfall - Wind - Pressure - Relative Humidity - Radiation - Evaporation - Satellite Images - NDVI - CCD	1951-1999 1980-1999
INIA	- Meteorological[1] - Temperature - Rainfall - Wind - Pressure - Relative Humidity - Radiation - Evaporation - Agronomic - Phenological - Soils	1951-1999
DNA	- Hydrometeorological - Rainfall[2] - River streams	1951-1999
INAHINA	- Oceanographic[3] - Sea deepness - Maritime currents	1990-1999

[1] The stations' network is maintained by INAM
[2] Climatic Posts are explored by INAM, Udometric Posts explored by DNA

	- Tides	

6.3 *Investigation/Research*

In Mozambique, various institutions conduct research activities in areas inherent to climate change, each one dealing with the components relevant to its area of specialisation. From these institutions, the following can be noted:

- The National Meteorological Institute is responsible for studying agro-climatology, climate and human comfort and climatic conditions;
- The National Institute for Agronomic Investigation is related to the study and improvement of agricultural species;
- The Eduardo Mondlane University conducts academic research relevant to climate studies; and
- The Universidade Pedagogica is concerned with simulation and adaptation studies, as well as environmental education.

In spite of the existence of various activities, research in Mozambique is still in its infancy, particularly in the domain of climate changes. Research activities are still fragmented and lack inter-institutional co-ordination. Very often the research results lose their relevance as they are considered confidential or have restricted circulation. The insufficient publication of the research results contributes to the limited knowledge of the country's status with respect to climate change. Factors that contribute to the weak investigation' capacity include:

- Lack of qualified staff in the institutions;
- Lack of resources for the development of research activities;
- Lack of an effective inter-institutional co-operation;
- Insufficient territorial coverage of the data related to the necessary parameters;
- Lack of linkages between relatively new research areas and the curricula in the country's academic institutions; and
- Lack of dissemination or publication of the research results.

[3] There are data from the colonial period, though discontinuous

6.4 Necessary assistance

Taking into account the spirit and statement of line g) Article 4 of the UN Framework Convention on Climate Change, Mozambique urgently needs assistance in the strengthening of systematic observations and in the development of databases related to all the components of the climatic regime. The development of human and institutional capacities to efficiently use these data in scientific research studies, as well as technological and socio-economic applications is equally necessary and urgent.

Specifically, Mozambique needs:

- Scholarships for training and specialisation of technical staff in various domains of the climate system;
- Support for the establishment of technical conditions that would enable the development of investigation activities at the national level;
- Support in the transfer of know how through the exposure or participation of national technical staff in research activities of regional and international character;
- Support in the improvement and strengthening of the monitoring capacity as well as in systematic observation of the parameters related to the climate system and its interactions with the environment;
- Support in the processing of existing data so that it could be easily accessible for research activities.

6.5 Conclusions

The climate observing system is still weak due to the 15 year internal conflict, which destroyed a large part of the observation network. This state of affairs results in the lack of data and information for monitoring the behaviour of the climate parameters.

These two factors make the understanding of cause-effect mechanisms, the magnitude and time of the impact of the occurrence of climate changes very uncertain, putting at risk the process of adaptation and mitigation of the impacts of climate change. To reverse this situation, all the support that can be given to Mozambique will constitute a way forward for the establishment of a basis that ensures a more suitable future in those areas.

7 PUBLIC EDUCATION AND AWARENESS-RAISING

7.1 Introduction

The success of any strategy depends, on a large scale, on the understanding of those who are responsible for its implementation or execution. In this context, education is seen as one of the foundations for the effective implementation of the Convention on Climate Change in Mozambique.

Education can be introduced at the formal and informal levels:

7.2 Formal Education

In Mozambique there is no specific training on environmental issues. These issues are reflected in some teaching programmes in a limited and diffuse way in certain courses that have an environmental component. It is, therefore, necessary and urgent to establish strategies for environmental education encompassing all levels of instruction and all activity sectors.

Children, in particular, should constitute a special target because they are the majority of the population and have the country's destiny in their hands. On the other hand, universities should introduce courses on environmental sciences and environmental management.

At teaching institutions' level, the universities should introduce initiatives aimed at conducting a curricular review, in order to improve environmental components. However, to complement the curricular revision, there will be need for training courses as well as for capacity building for teachers on environmental issues, so that they can efficiently teach environmental contents that are new for most of them.

7.3 Informal Education

A key principle in education relies on the development of an environmental conscience in the population to enable their participation in the rational management of environment and, on the other hand, to acknowledge and value the local communities' traditional knowledge on environment management. This principle has been the basis for non-formal education practised in Mozambique, giving the opportunity for the rise of public awareness about environmental problems, using various tools such as seminars, workshops, social communication means as well as audio-visuals.

It is known that, traditionally, communities acknowledge the value of natural resources and the need to preserve them. This knowledge is traditionally passed on from generation to generation. Nevertheless, with the social disruption experienced in recent years due to the war, survival imperatives brought about irrational practises that are incompatible with the conservation principles. For many, poverty left few alternatives, leading to the irrational use of resources.

In face of the framework of these problems, there is a need to encourage the spirit of environmental conservation, taking as a reference, whenever possible, the scant traditional knowledge.

"MoçAmbiente", MICOA's newspaper, which is related to environment issues and sustainable development, has been an efficient vehicle for raising people's awareness on environmental problems and issues, despite its limited distribution in major urban centres.

7.4 Other Relevant Information

Mozambique is one of the least developed countries. Therefore, in order to meet its UNFCCC obligations, it needs financial and technological assistance as reflected in Articles 4.8 and 4.9 of the Convention.

Accordingly, the country needs to receive technical and financial support, in order to create capacity to elaborate climate change studies and, thus, to contribute to its sustainable development.

Therefore, support is requested in order to:

- Strengthen and assist the identified institutions for the implementation of the Climate Change Convention in the country;
- Conduct the technical and the technological training necessary for the implementation of the Convention and the Kyoto Protocol. This will also assist in the conduction and

development of vulnerability and adaptation studies, compilation of GHG inventories and other related activities

- Create familiarity with the climate change issues, as well as to develop pilot projects in the area of climate change, and
- To publish and conscientise the public on climate change issues.

As a way forward, we present a table with proposed activities/projects aimed at meeting the specific needs of the country.

Table 7-1. Proposed activities/projects aiming to meet specific needs of the Country

Objective	Results/Activities	Participants
Strengthening and institutional training	Result Creation of institutional capacity Activities i) Installation of equipments (computers, software adapted, printer, data-show, etc.); ii) Creation and maintenance of a homepage in the national internet on climate change; iii) Dissemination of the national activities and other relevant information to the community.	MICOA and MICOA Inter-Institutional National Climate Change Group
Technical training needs	Results Qualified national technicians involved in the related subjects to climate change. Activities i) Training courses in related matters the vulnerability evaluation and adaptation options; ii) Training in the related matters to the negotiations; and iii) Seminar on evaluation of the technological needs of the country and their transfer	
Pilot Projects of	Results	

demonstration in the extent of the climate changes	(a) Reduction of GHG emissions; (b) Reduction of the resulting impacts of the occurrence of extreme climatic events (floods) <u>Project</u> i) Installation and use of sources of renewable energies in the system of wells for drinking water, in the arid and semi-arid areas ii) Projects on the use of stoves have improved in the urban and rural areas; iii) Projects for the protection of the coastal area against floods and erosion; iv) Projects of electrification of the rural areas v) Investigation of seeds and drought and diseases tolerant practices so as to derive income for food procurement; vi) Recovery of degraded lands; vii) Reassessment of the population affected by floods and droughts; identification of the basic needs of this population, aiming at the restoration of standards of living, before they were affected by the catastrophe. viii) Programs of rural and urban sanitation	UEM, DNE, DNA, DNGA, NGO'S UEM, DNE, NGO'S UGC, INAHINA, UEM, NGO'S UEM, DNE INIA, DNDR, DINA MICOA, DNA, INIA MADER, UEM MICOA, INGC, MOPH, NGO’s, Municipalities. MISAU, NGO´S

7.5 Conclusions

In spite of efforts made on environmental education, the level of perception and the knowledge of climate change of the Mozambican society are still very limited. Improvements on the area of education and its dissemination are also dependent on the rising of the institutional capacities of the different institutions and organisations involved.

There is a need to introduce environmental contents in school's curricula at all levels, as well as the creation of specific courses on environment, at university level.

Given that the majority of the Mozambican population is illiterate, without access to formal education institutions, the raising of communities' awareness should be improved through a clear policy and specific programmes, which would take into account the specific conditions of the different communities.

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APPENDIX 1

Data of the river basins considered in the study of vulnerability of the sector of water resources.

1: UMBELUZI RIVER BASIN (Shared basin)

Geographical Data
Source:
Swaziland next to the border with South Africa
Altitude:
1,800 m
Total length**:**

Drainage Area:
5,600 Km^2 (2,300 km^2 in Mozambique)
Countries Traversed:
Swaziland
Major tributaries:
White Umbeluzi, Calichane, Movene
Discharge to:
Indian Ocean – Maputo Bay
Volume Discharge at mouth :
No information
Flow regime:

Special features:
Several reservoirs including Pequenos Libombos
and M'njoli reservoirs.

2: INCOMATI RIVER (Shared basin**)**

Geographical Data
Source:
Near Breyten, South Africa
Altitude:
1,832 m
Total Length:
714 km total (265 km in Mozambique)
Drainage area:
46,246 km^2 (14,925 km^2 in Mozambique)
Countries Traversed:
Mozambique, Swaziland, South Africa
Major Tributaries:
Sabie, Crocodile
Discharge to:
Indian Ocean (25 49 S ; 32 44 E)

Volume of discharge at mouth :
2.3 m^3/yr
Flood regime:
Unimodal flood peaking in January – February
Special features:
Several reservoirs including Harbeespoort and Sand
river; Flood – plain in lower course lake Chuali (28
km^2) and several smaller Lakes.

3: LIMPOPO RIVER BASIN (Shared Basin)

Geographical Data

Source:
Witwatersrand, South Africa
Altitude:
1,732 m
Total Length:
1,680 km
Discharge area:
358,000 Km^2 total (79,600 Km^2 in Mozambique)
Countries traversed:
Botswana, Zimbabwe, Mozambique, and South
Africa
Major tributaries:
Elefantes/Olifants, Nuanetsi, Umzingwani,
Shashi, Changane
Discharge to:
Indian Ocean (25 12 S; 33 31 E)
Volume of Discharge at mouth:

5.33 m^3/yr

Special features:

Numerous dams/reservoirs on tributaries, including

Massingir (151 km^2) flood plain along lower course

with numerous lakes, including lake Gondeza, Pave

(km2), Chinanga (5 km^2) Bambene and Linguazi (4

km^2 combined), and Nhangul.

4: PUNGOE RIVER (Shared Basin)

Geographical Data

Source:

Near Watsomba, Zimbabwe

Altitude:

2,033 m

Total Length:

300 km (40 km in Zimbabwe)

Drainage area

29,000 km^2 total

Countries traversed:

Mozambique, Zimbabwe

Major tributaries:

Urema, Vunduzi, Nhazonia

Discharge to:

Indian Ocean (19 51 S; 34 48 E)

Volume of discharge at mouth:

3.08 km^3/yr

Special features:

Flood plain on lower course and Urema tributaty,

5: ZAMBEZI RIVER (Shared Basin)

Geographical Data

Source:

Northwest Zambia and eastern Angola

Altitude:

1,600 m

Total Length:

2,574 km

Drainage area:

1,300,000 km^2

Countries traversed:

Angola, Mozambique, Zambia, Botswana,

Namibia, Zimbabwe

Major tributaries:

Cuando, Kafue, Luangwa, Shire, The Zambezi system also Communicates with the Okovango system via Chobe river.

Discharge to:

Volume of Discharge at mouth:

7,0780 m^3/sec

Flood regime:

December to July , maximum in March

Special features:

Barotse flood plain (700 – 9 000 Km^2), Kafue flats (200 – 7,000 km^2), Lukanga swamps (3,000 – 8,000 Km^2) Kariba and Cahora Bassa dams/reservoirs.

Indian Ocean (18 47 S, 36

APPENDIX 2

DEMONSTRATION PROJECT FOR INTEGRATED COASTAL ZONE MANAGEMENT PLAN IN THE BUZI RIVER BASIN AND DISTRICT

Background

The Mozambican coastal zone has variety of natural resources (coral reefs, lagoons, estuaries and mangrove forest) with recognised value and several infrastructures, is experiencing deep morphological changes that are also aggravated by rapid population growth in coastal areas. This development comes at the expense of natural environment, increased pollution, and often requires protection against erosion and/or coastal flooding during storm surges.

Coastal erosion has already manifested itself as another stress on the natural and human ecosystem, and accelerate sea level rise due to the projected climate change will exacerbate this situation. Hence, there is the need to take the issue into account within the planning framework. Redirecting growth away from sensitive lands and toward less vulnerable areas is one option to reduce the risk associated with a sea-level rise and also, to reduce vulnerability to severe coastal storms that happen with current climate conditions.

The Mozambican coastal zone is divided into the following three main regions:

a) The northern region, from Rovuma River on the border with Tanzania to Zambezi River in the south. The coastal zone is characterised by numerous small islands that form Quirimba Archipelago. This zone is dominated by coral reefs;
b) The central region between the Zambezi and the Save rivers is classified as a swampy coast. Many rivers discharge into the Indian Ocean along this region, each with an estuary supporting well-established mangroves. The coastal waters are shallow and this combined with the sediment loading from the rivers, increases the incidence of flooding;
c) The southern region, from Save River to Ponta do Ouro on the border with South Africa is characterised by high dunes and barrier lakes and marked by patchy coral reefs.

Project Rationale

The Vulnerability and Adaptation Assessment Report of Mozambique has identified the central region as highly vulnerable to flooding and erosion, particularly the Sofala province. Both economic development and impact of climate change will negatively affect coastal and water resources causing erosion, flooding and pollution of water in this region. These problems are exacerbated by some human-induced activities such as destruction of important ecosystem (depletion of mangroves, coral reefs, sea-grass beds, vegetation over sand dunes), over-exploitation of marine resources, utilisation of fertilisers in agriculture in areas near the Buzi River, etc.

So there is a need to assess both climate change vulnerability and impacts of anthropogenic activities in the region and develop an integrated coastal zone and water resources management plan, which will consider activities to protect stressed ecosystems, identifying and creating new income activities for local communities that will help reducing poverty and will contribute to a better way of using coastal and water resources.

This proposed project will be located in Buzi District, which is one of the Sofala's coastal area and has one of the international rivers, the Buzi River, passing through the district before discharging into the Indian Ocean. According to the 1997 population census, the Buzi District has 143,152 inhabitants and is estimated to increase to 147,300 in 2010. The Buzi River has 320 Km of length within the country and is one of the main international watersheds shared with neighbouring countries.

Buzi district and Buzi Basin River will be subject of the proposed integrated coastal and water resources management project and particular emphases will be given to Administrative Posts of Buzi (with 87. 095 inhabitants) and Nova Sofala (with 25.837 inhabitants). These Administrative Posts have been chosen because they have similar environmental problems.

The main problems identified in these Administrative Posts are:

a) Overexploitation of mangrove forest as biomass that negatively affect the existence of other marine resource such as crab, fish, prawn, etc;
b) Erosion in the mouth of Buzi River;
c) Seawater intrusion into the freshwater estuarine zone;
d) Degradation and loss of important ecosystems (wetland, mangrove, etc).

Objectives of the Project

a) To assess the vulnerability of the coastal and water resources of the Buzi River and the entire Buzi District to climate change and climate variability;
b) Based on the assessed vulnerability of the coastal and water resources, infer the potential effects on food security, ecosystems and sustainable livelihood of humans and biodiversity;
c) Elaborate an integrated an adaptation plan of action across scales for the Buzi River Basin and District;
d) Develop the capacity of national experts in the identification of long-term measures to adapt and mitigate climate change.

Activities

a) Elaboration and conduction of environmental profiles for Buzi River Basin and coastal surrounding area.
b) Participatory assessment of vulnerability to current climate change variability and extreme weather events and associated risk;
c) Identification of key climate change adaptation and mitigation measures;
d) Elaboration of a draft Strategic Plan of Action (SPA) for the area natural resources to adapt and mitigate the impacts of climate change and associated risk;
e) Discussion of draft of SPA with relevant stakeholders (governmental institutions, private sectors and local communities) involved in use and conservation of natural resources existing in the area;
f) Printing and publishment of final SPA.
g) Implementation and monitoring of strategic plan

Project Outputs

a) Level of vulnerability of the coastal and water resources of the Buzi River and the entire Buzi District to climate change and climate variability have been assessed and determined;
b) Profiles of the potential effects on food security, ecosystems and sustainable livelihood of humans and biodiversity are inferred from vulnerability of the coastal and water resources of the Buzi River and District;
c) An integrated adaptation plan of action is elaborated for the Buzi River Basin and District;
d) Throughout the process, the capacity of national experts to identify and develop long-term measures to adapt and mitigate climate change is developed and enhanced; and
e) A profile of the stressed natural ecosystems is developed and conservation and protection strategy developed.

Budget

Activity	**Budget in US dollar**
Data gathering	20,000
Participatory vulnerability assessment and identification of key adaptations measures	70,000
Preparation, review and finalization of strategic plan of action	50,000
TOTAL	***140,000***

Creation of Public Awareness and strengthening the National Climate Change Team

Project rationale

Mozambique prepared its Initial National Communication, consisting of a National Inventory of Greenhouse Gas Emissions and Vulnerability and Adaptation Assessment, which covered agriculture crop (maize in Chokwé), water resource (four international river basins), forestry, grassland (Chokwé) and coastal resource (Beira).

To carry out the activities listed above we created a National Climate Change team (NCCT), which is composed of National Institute of Agronomic Research, National Institute of Meteorology, National Directorate of Water, Pedagogic University and Forest Department of Eduardo Mondlane University and Ministry for Coordination of Environmental Affairs as a focal point institution. This Team is active only during project implementation and because of financial and technical constrains it is not possible to maintain and expand the NCCT to cover other important sectors.

Project objectives

a) Create climate change awareness at all levels of the public;
b) Enhance the capacity of the Technical Team through training in assessment of vulnerability and adaptation, training in the analysis and evaluation of mitigation and adaptation projects that will qualify for funding from the various flexible mechanisms; and
c) Create synergy between Climate Change and other multilateral environmental conventions such as biodiversity and desertification.

Expected outcomes

(a) A population that is aware of the science, impacts and response measures related to climate change
(b) A NCCT that is strengthened and capable of conducting vulnerability and adaptation assessment, identifying and analysing mitigation and adaptation options, elaborating and

implementing National Adaptations Program of Action (NAPAs), and participating in national and international climate change research activities;

(c) Sufficient synergy is developed between the Multilateral Environment Agreements of Climate Change, Biological Diversity and Desertification.

Planned activity to achieve outcomes: To achieve the above outcomes, we proposed:

(a) Develop public awareness and educational materials and programmes

(b) Conduct public awareness workshops and meetings to disseminate climate change information and educational materials;

(c) Disseminate public awareness and educational materials through national printing and broadcasting media;

(d) Implement educational and public awareness programmes on climate change and its effects;

(e) Train national experts through workshops on the assessment of vulnerability, identification and evaluation of adaptation and mitigation options and identification and elaboration of mitigation and adaptation projects that could qualify for funding under the flexible mechanisms.

Budget

Expert Team Training workshops	$18,000 US
Eleven Provincial public awareness workshops	$66,000 US
Preparation and publishing climate change materials (booklet, pamphlets, etc) for public awareness through print and broadcasting media	$45,000 US
Total	**$129,000 US**