REPUBLIC OF MOZAMBIQUE

Mozambique Second National Communication to the United Nations Framework Convention on Climate Change

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PREFACE

It is with immense honor and satisfaction that I present the Second National Communication (NC2) of Mozambique to the United Nations Framework Convention on Climate Change (UNFCCC). This Communication outlines the latest information on the country's progress in addressing climate change through specific actions and interventions.

The ongoing and expected impacts of climate change in Mozambique do not show substantial differences when compared to other countries in the world particularly, with those on the African continent. Mozambique is one of the African countries most exposed to climate-related risks that are being and will continue to be exacerbated by climate change. Extremely dangerous and destructive events have been recurrent and often resulting in disasters, characterized by high socioeconomic impacts that threaten and delay the development gains that the country has achieved in the recent past. During 2019, the central and northern regions of Mozambique were devastated by Tropical Cyclones IDA/ and KENNETH, which rank among the most intense and destructive events ever occurred in the history of southern Africa.

The latest world scientific reports indicate that events of this type will become more common and dangerous and, therefore, pose an additional challenge for the country on its way to achieving the various sustainable development goals, including other national goals. Despite the challenges we face, Mozambique is committed to reduce vulnerability to climate change and improving the well-being of its people through the implementation of concrete measures to adapt and reduce climate risks, promoting mitigation and development with the active participation of actors from the social, environmental and economic sectors.

Until now, Mozambique has been responding to climate change through the implementation of various climate actions, observing their alignment with key plans, policies, strategies and other relevant instruments.

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Executive Summary

1. Introduction

Mozambique joined by ratifying the United Nations Framework Convention on Climate Change (UNFCCC), the global efforts to combat climate change and, consequently, assumed the commitment to integrate in its policies, strategies, action plans and programs development, adaptation and mitigation actions to climate change. The country also assumed the obligation to communicate to the Conference of the Parties (COP) relevant information on the implementation of the Convention. Such information includes emissions by sources and removals by sinks of Greenhouse Gases (GHG) occurring in the country, in a given period and actions to reduce them, as well as adaptation and means of implementation such as financial, technological and capacity building.

Thus, this is the second communication that Mozambique submits to the COP containing information on its vulnerability and the adverse impacts of climate change, which occurred between 2000 and 2018; the estimates of emissions and removals occurred in the period from 1995 to 2004; the actions implemented and/or programmed, aimed at implementing the Convention, including the financial and technological constraints and capacity building needs for the effective implementation of the Convention, as well as the documents formulated and submitted to the Convention, in response to the decisions adopted at the Conferences of the Parties, highlighting the NAPA, the Technological Plan and the Intended Nationally Determined Contributions (INDCs) of Mozambique 2020 – 2025.

This communication also includes information on the process of integrating climate change into national development policies, laws, strategies, plans and programs and into national, local and sectoral planning implemented under the National Adaptation and Mitigation Strategy 2013 – 2025 and respective Action Plan 2013 – 2014, of which the implementation was extended until 2019, as well as the Nationally Determined Contribution of Mozambique 2020 – 2025 and respective Operational Plan of NDC 2020 – 2025 and the Partnership Plan of NDC 2018 – 2021 approved by the Council of Ministers , in December 2018, and which is being adjusted to the decisions adopted in Katowice, on transparency, in December 2018.

This document comprises six chapters namely: Chapter 1 – National Circumstances, Chapter 2 – National GHG Inventories, Chapter 3 – Vulnerability and Adaptation Measures, Chapter 4 – Mitigation Options, Chapter 5 – Other information relevant to the Convention and Chapter 6 - Constraints and gaps, and related to financial, technical and capacity needs.

There is an evolution when comparing the 1NC and SCN, both in terms of areas/sectors covered, as well as the contents. Some key improvements from the first National Communication submitted in 2003 to the SNC include the description of all sectors/areas covered in the document particularly on national circumstances chapter, the identification of key categories in the inventories; the inclusion of information about the impacts of extreme weather events that affected the country in the period covered, the inclusion of emission reduction estimates resulting from mitigation measures and the description of initiatives carried out in the country that contribute to the achievement of the fundamental objective of the UNFCCC.

The country is finalizing the formulation of the following documents: Nationally Determined Contribution Implementation Plan of Mozambique 2020 – 2021, Mozambique Low Emissions Long-Term Development Strategy 2020 – 2050, National Adaptation Plan and Action Plan of the National Strategy for Adaptation and Mitigation of Climate Change 2020 - 2025.

This Second National Communication is accompanied by the First Biennial Update Report – PBUR which includes relevant summaries of the information contained in this SNC, as well as the REDD+ Technical Annex.

1.1. National Circumstances

Chapter 1 provides an overview of national circumstances in terms of geographic and demographic profile of the country, the evolution of macroeconomic indicators, climate and its variability, climate trends and future climate projections. It describes several sectors sensitive to climate change, such as agriculture, forestry, fisheries, energy, industry and other relevant ones, namely biodiversity, health and tourism. This chapter also presents the profile of disasters and their trends, national priorities and institutional arrangements.

Mozambique is located on the east coast of Africa and borders Tanzania to the north, Malawi, Zambia and Zimbabwe to the west, and South Africa and Eswatini to the south. The country has an area of 799,380 km^2, of which about 13,000 km^2 is maritime and 78,380 km^2 correspond to the land part, and has a coastal strip to the east of the territory that is bathed by the Indian Ocean, in an extension of 2,700 km.

The country is divided into 10 provinces, however, the municipality of Maputo city (capital of the country) has the province status, which brings the number to 11 provinces.

It currently has 154 districts (26 more than the previous 128) which, in turn, are divided into 419 Administrative Posts and the latter are made up of 1,052 localities. In addition to the above-reported subdivisions, 53 municipal autarchies are added, 33 were created in 1998, another 10 established in 2008 and another 10 in 2013.

The Mozambican population has been growing at a rate of 2.4% per year. According to the 2017 population census, it was estimated at 27,909,798 inhabitants, of which 48% were men and 52% were women. The distribution by age group is about 45% between 0-14 years old, 52% between 15-64 years old and 3% over 64 years old. INE's population projections indicate that by 2030 the country will have around 30 million inhabitants, which presupposes that development interventions should ensure that Mozambique is prepared to meet the needs of this number.

Regarding to the economy, Mozambique experienced GDP growth from 2008 to 2014 and then a decrease, driven by several factors, including the armed insurgency in Cabo delgado. Agriculture in this country is the pillar of the national economy. This sector employs 90% of the country's female workforce and 70% of the male workforce, that is, 80% of the

Mozambican working population works in the agrarian sector (PEDSA, 2011). The agrarian sector has an average share of GDP above 20% of the total. After agriculture, the sectors of manufacturing industry and commerce are those that registered a relevant contribution to the national GDP. Although Mozambique has large reserves of coal and natural gas, the exploration of these resources is at an early stage and, consequently, the contribution of the extractive industry to the national GDP remains lower than the three sectors mentioned above, but with a tendency to grow annually.

According to the Köppen-Geiger classification, the climate of Mozambique is generally of A-w type (humid and dry tropical) and with pockets of BSh (warm semi-arid climate), with two very distinct seasons; one hot and rainy, from October to April, and the other cold and dry, from May to September (Gelcer et al. 2018). Other manifestations of climates like As, Cfa and Cwa can be found in isolation.

The period of greatest precipitation in Mozambique corresponds to the summer in the southern hemisphere, between October and April. During the rainy season, the highest precipitation values occur in the months of January, February and March.

Average temperature trends show positive variations (increase in average temperature) in most parts of the country. Studies indicate that the average annual temperature increased by 0.6°C between 1960 – 2006, at an average rate of 0.13°C per decade, for most seasons of the year (INGC, 2009). Observed precipitation trends in Mozambique are not significant due to the large inter-annual precipitation variability in different seasons.

In Mozambique, the average annual temperature is projected to increase between 1.0 to 2.8 °C by 2060 and between 1.4 to 4.6 °C by 2090 (INGC, 2009; Mcsweeney et al., 2010). The projected rate of warming will be faster in the interior regions of the country than in areas closer to the coast.

As for the relief, there are three main forms in the country, namely: plains, plateaus and mountains. Thus, in general, the Mozambican relief has a stairway format, as when walking from the coast to the interior of the country, we have three steps. The first is located along the coast and is formed by plains, the second is located in the intermediate zone and is formed by plateaus, and the third step is inland, formed by mountains.

However, climate-induced disasters have been the most significant manifestation of climate variability and change in Mozambique. From 1980 to 2019, the country was affected by 21 tropical cyclones, 20 flood events and 12 droughts. This means that on average Mozambique is affected by a tropical cyclone or a flood event every 2 years and a drought event every 3 years. Tropical cyclones and flood events represent about 77% of the total events that occurred in the period under review.

The consequences of the observed impacts of climate change in the country include the loss of human lives, destruction of socioeconomic infrastructure and properties, loss of crops and environmental degradation, with emphasis on erosion and saltwater intrusion, with impacts on communities and the national economy (MITADER, 2018).

The floods that occurred between 2000 and 2015 affected about 4,629,000 people, caused 1,204 deaths and affected 1,176,000 homes, of which 628,700 were destroyed, including water storage and flood protection infrastructure, with a greater emphasis on the dikes Licungo in Nante and Limpopo in Chókwè, Guijá and Xai-Xai and rail and port infrastructure. The cost of these events was estimated at 1,355.9 million USD.

The damages recorded on the roads between 2011 and 2015 include 130 aqueducts, 119 bridges and 41 drifts destroyed or affected, 15,512 km of impassable roads, with an estimated value of destruction of around 13,316,443,530 MT, corresponding to around 333 million USD.

The occurrence of extreme events in the country, in the period from 2005 to 2014 have led to crop losses of 1,199,762.91 ha. In the southern and central zones losses resulting from severe droughts occurred with 70.01%, being 368.91 ha in 2005; in 2007 droughts were moderate, with 102,000 ha lost; droughts and floods occurred in 2009, with significant losses of 715,696ha.

Saltwater intrusion intrusion represents a problem on the Umbeluzi, Incomati, Limpopo, Save, Púngue, Buzi and Zambezi rivers, where irrigation is well developed.

In 2012, the Government of Mozambique (GovM) approved the National Climate Change Adaptation and Mitigation Strategy (NCCAMS) 2012-2025, of which the general objective is to "establish guidelines for action to build resilience, including the reduction of climate risks, in communities and in the national economy and promote low carbon development and the green economy, through its integration in the sectoral and local planning process" (MICOA, 2012). The specific objectives of NCCAMS are:

that Mozambique becomes resilient to the impacts of CC, reducing climate risks to people and property to a minimum, and restoring and ensuring the rational use and the protection of natural and physical capital;

identify and make use of opportunities to reduce GHG emissions that simultaneously contribute to the sustainable use of natural resources and access to financial and technological resources at affordable prices, and reduce pollution and environmental degradation, promoting low-carbon development; and

build institutional and human capacity, as well as explore opportunities to access technological and financial resources, for the implementation of the NCCAMS (MICOA,2012).

The Strategy defines adaptation and climate risk reduction as a national priority, while recognizing the need to take advantage of the opportunities that the country has, without jeopardizing the development actions, in reducing the impacts of CC, through a set of mitigation and low carbon development (MICOA, 2012).

Additionally, in recognition of the need to adjust policies and adapt institutions, build capacities for implementation at all levels, generate knowledge and disseminate it to society at large, with a view to scientifically and technically informed decision-making, a set of cross-cutting strategic actions are considered and put into practice of which the implementation of this Strategy will be facilitated (MICOA, 2012).

The overall coordination of actions on climate change in Mozambique is under the responsibility of the Ministry of Land and Environment (MTA), through the National Directorate of Climate Change (DMC) which, at the same time, acts as a focal point for the Convention.

Likewise, the DMC is responsible for coordinating the Interinstitutional Group on Climate Change (GIIMC), which is composed by representatives of Ministries/Institutions of which the mandates cover areas and/or sectors relevant to climate change and representatives of non-governmental actors, private sector, civil society, academia and Social Communication.

However, there are still challenges to strengthen the climate change coordination mechanism in Mozambique, to ensure that the country responds in an effective and timely manner, to the assumed commitments, as well as to explore financial, technology transfer and capacity building opportunities.

1.2 National Greenhouse Gas Inventories

Greenhouse gas emissions

The GHG emissions inventory included in this Second National Communication covers the period from 1990 to 2016 for the following sectors: (1) Energy; (2) Industrial Processes and Use of Products (IPPU), (3) Agriculture; (4) Land-Use Change and Forestry; and (5) Waste.

The GHG inventory used the IPCC 2006 Guide (2006 IPCC guidelines for national greenhouse gas inventories), the respective Software, and the 2000 Guide to Good Practices (GPG) and Management of Uncertainty in National Greenhouse Gas Inventories (IPCC, 2000). The inventory covers sources of GHG emissions from anthropogenic activities for direct GHG, including carbon dioxide (CO_2) and their removals by sinks. Methane (CH_4), and nitrous oxide (N_2O) emissions from fires on Land remained in the same category, conversions to other land use and non-methane volatile organic compounds (NMVOC).

In 2016, net anthropogenic emissions of greenhouse gases were estimated at 15,902 Gg CO_2eq for Energy (19% of the total emission), 2,798 CO_2eq (5%) for Industrial processes, 1,882 GgCO_2eq (3%) for Agriculture, 33,721 GgCO_2eq (61%) for LULUCF, and 1,194 GgCO_2eq (2%) for Waste. Between 2005 and 2016, total CO_2eq emissions of Energy, Industrial processes, Agriculture, LULUCF and Waste increased by 222%, 66%, 16%, 36% and 330%, respectively. Broadly, LULUCF contribute to 61% of total emission in 2016, the remaining small contribution if from Energy with 29%, Industrial processes with 5%, Agriculture with 3% and Waste with 2%.

Mozambique's total emission without LULUCF in 2016 is about 21,776 GgCO_2eq representing to 39% of total emission.

With increasing emissions from the energy, industry and waste sectors, their proportional contribution has consistently increased throughout the period of analysis, but they are still much lower than the overall per capita GHG emissions. The country has an emission without LULUCF of well below 1tCO_2eq per capita and with LULUCF of about 2 tCO_2eq per capita. The total emissions from the data series can be compared in the following graphs of total national emissions with and without LULUCF.

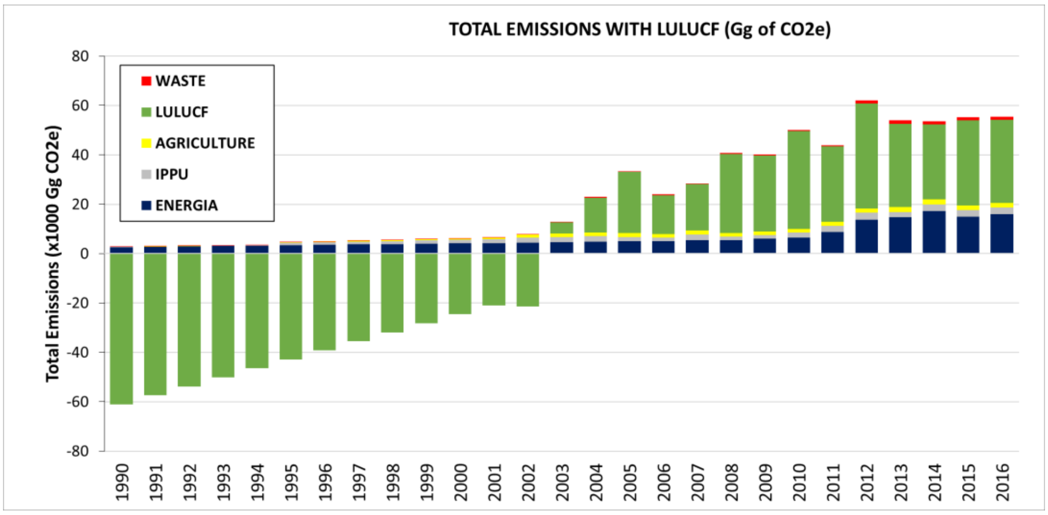

Figure 1.1: CO_2 emissions trends with LULUCF

1.3 Vulnerability and Adaptation Measures

Mozambique is vulnerable to climate change due to its geographic location in the inter-tropical convergence zone and downstream of shared river basins, its long coastline and the existence of extensive areas with an altitude below current sea level. On the other hand, the high level of poverty, limited investments in advanced technology, and the fragility of infrastructure and health services contribute to its vulnerability and low adaptive capacity. Extreme weather events such as droughts, floods and tropical cyclones affect different regions of the country every year. Consequences include loss of human life, loss of agricultural crops, domestic animals, destruction of social and economic infrastructure, increased dependence on international aid, rising prices for agricultural products and deteriorating human health. Climate change thus represents a setback in the efforts of the Government and its partners to fight poverty and achieve the Sustainable Development Goals.

Thus, it is considered a priority to assess the vulnerability of the most important social and economic sectors and identify adaptation measures. This chapter presents the results of the vulnerability and adaptation assessment study carried out in preparation for the SNC in 2011, in the sectors/areas of: coastal zones, water resources, fisheries, agriculture, pastures and livestock and health, as well as adaptation and climate risk reduction contained in the NCCAMS 2013 – 2025 and its Action Plan 2013 - 2014, approved at the 39th Session of the Council of Ministers, held on 13 November 2012, of which general objective is to “establish the action guidelines to build resilience, including the reduction of climate risks, in communities and in the national economy and to promote low carbon development and the green economy, through its integration in the sectoral and local planning process".

The adaptation and risk reduction pillar of the Strategy, of which the objective is that "Mozambique becomes resilient to the impacts of CC, reducing climate risks to people and property to a minimum, and restoring and ensuring the rational use and the protection of natural and physical capital", was defined based on the results of the studies carried out at the SNC. It should be noted that the strategic adaptation and risk reduction actions of the Strategy are part of the adaptation component of the NDC and are better defined in the country Operational Plan of the NDC 2020 – 2025.

Thus, the adaptation chapter also includes strategic actions from the adaptation and risk reduction pillar of the Strategy, namely:

(i) Strengthen the early warning system;
(ii) Ensure preparedness for an effective response to climate risks;
(iii) Increase water resources management capacity;
(iv) Increase access and capacity of water harvesting, storage, treatment and distribution;
(v) Increase the resilience of agriculture and livestock;
(vi) Increase fishing resilience;
(vii) Ensure adequate levels of food and nutrition security;
(viii) Increase the adaptive capacity of vulnerable people;
(ix) Reduce people's vulnerability to climate change vector-born disease transmission;
(x) Ensure and protect biodiversity;
(xi) Promote tree planting mechanisms and establishment of forests for local use;
(xii) Develop resilience mechanisms for urban areas and other settlements;
(xiii) Adapt the development of resort and coastal areas to reduce the impacts of climate change.

However, the Operational Plan of the NDC 2020 – 2025 organizes the climate risk reduction and adaptation component into:

(i) Communication, education, training and awareness;
(ii) Climate risk reduction;
(iii) Water resources;
(iv) Agriculture, forest, fisheries, food and nutrition security;
(v) Social protection;
(vi) Health;
(vii) Biodiversity;
(viii) Infrastructure, urban areas, settlement and resort & coastal areas.

This Plan aims to operationalize the country's contribution pursuing efforts to keep the commitments assumed under the Paris Agreement.

Below are the summaries of the vulnerability assessment studies carried out in the context of the preparation of the SNC and respective adaptation measures, as well as the adaptation and risk reduction measures contained in the NCCAMS and those the country intends to implement as part of its contribution to achieve the purposes of the Paris Agreement, relating to "increasing the capacity to adapt to the adverse effects of climate change and promoting climate resilience in a development of low GHG emissions, so that food production is not compromised".

Agriculture

Agriculture is the sector on which most of the Mozambican population depends for income and food security. It is one of the sectors most affected by climate change. For the assessment of vulnerability and adaptation, the maize crop produced in rainfed, in the district of Chókwè, Gaza province, was selected. Projections of climatic variables indicate that in the period 2011-2030 there will be an increase in temperature, reduced average annual precipitation and high variability. Yields from rainfed maize may decline over the next 20 years, with consequences for food security and household income. Measures to reduce vulnerability include promotion of conservation agriculture (CA); implementation of small-scale irrigation systems; management of agricultural practices; propagation of drought resistant crops; use of adaptable varieties for each agro-ecological region; improvement of early warning systems in cases of floods, droughts and cyclones and training of extensionists on issues related to climate change adaptation.

Based on the aforementioned results, NCCAMS classifies as high the impacts of changes in precipitation patterns and atmospheric temperature, floods, droughts and tropical cyclones; moderate impacts from rising sea levels and low impacts from rising sea water temperatures.

The Strategy recognizes that adaptation measures in the agriculture sector must be one of vulnerability. The Strategy recognizes that adaptation measures in the agricultural sector should be given higher priority in reducing vulnerability to CC. It also recognizes the relevant role of resilient infrastructure in both flood and drought protection of crops (for irrigation, drainage, post-harvest operations and road access), the use of groundwater and the need to protect crops from extremes events, such as tropical cyclones, and establishes that the promotion of CA must be a goal, as well as the promotion of resilient crops throughout the country.

Agriculture is one of the two sectors considered in the adaptation component of the TNA process. The three priority technologies for this sector are: conservation agriculture, of which the implementation cost is estimated at USD 8 358 200; harvesting and conservation of rainwater with an estimated cost of USD 134,696,050; and, seed production and promotion of low-cost storage systems estimated to cost around USD5,216,400 to be implemented.

Grazing and Livestock

The vulnerability and adaptation of natural grazing and livestock were analyzed in the Limpopo River Basin, due to the importance of cattle raising in the economy and livelihood of local communities. Due to the lack of data needed for modelling, the assessment of grazing vulnerability was based on a systematic review of studies carried out in areas with environmental attributes and similar grazing management practices for cattle. Possible impacts of climate change in this sector include the lengthening of the dry season which is a period of food shortage and scarcity of water for livestock consumption due to reduced flow and dryness of natural water sources.

These impacts may result in reduced levels of livestock production due to increased livestock mortality and reduced average weight gain and milk production, aggravating food shortages and food insecurity in rural communities dependent on cattle raising. Proposed adaptation measures include rainwater harvesting; improving the management and regulation of community grazing management practices; identification of livestock promotion zones, i.e., where livestock is less impacted by climate change and has comparative advantages for subsistence and family income; shift to sustainable and integrated methods of animal production; and dissemination of forage conservation methods.

Health

To assess the vulnerability of the health sector, malaria and cholera were considered as both are diseases that most concern the sector in terms of the number of admissions and deaths to the health units. After the evaluation study carried out within the scope of the first version of the SNC, prepared in 2011, the MISAU, with the support of WHO, started the assessment of the Vulnerability and Climate Change Adaptation in the Health Sector in Mozambique. This study included the assessment of the impact of climate change on two climate-sensitive diseases in the country: malaria and acute diarrhea.

This is the first study in Mozambique that calculates the vulnerability index of a sector (the health sector), including the vulnerability index to drought, floods and tropical cyclones. The Study followed the approach recommended by the IPCC and WHO. The results show that in general, the vulnerability of the health sector is high. In a total of 85 districts covered by the study, corresponding to 59.6% of the national territory and 48.9% of the population, the vulnerability index is either high or very high.

The Study included vulnerability analysis for each type of extreme event. Thus, the IVS for all districts in the country for droughts, floods and cyclones was calculated. The analysis results indicate that:

(i) 11 Districts (Panda, Mabote, Funhalouro, Govuro, Marromeu, Massingir, Inhassoro, Homoíne, Chokwe, Massinga and Nacaroa), corresponding to 9.3% of the national territory and 4.2% of the population, are very vulnerable to drought events;

(ii) 12 Districts (Nhamatanda, Mopeia, Caia, Mutarara, Morrumbala, Machanga, Maganja da Costa, Xai-xai, Cahora Bassa, Magoe, Buzi and Guijà), corresponding to 8.2% of the territory and 7.2% of the population, have a very high rate vulnerability to floods;

(iii) 4 Districts (Larde, Moma, Massinga and Nhamatanda), corresponding to 2.2% of the territory and 3.5% of the population have a very high rate of cyclones.

The same study pointed the following conclusions:

Climate change poses a serious challenge for the health sector which will be translated into additional pressures. The changes over time of the main climatic parameters and their influence on the transmission patterns of water-born related diseases, together with the occurrence of extreme climatic events such as droughts, floods and cyclones, make it necessary to increase preparedness for effective response of the health sector to deal with this scenario.

Adaptation measures to reduce the vulnerability of the health sector include:

1) Health education in the most vulnerable communities;
2) Impregnated mosquito nets for distribution to the population;
3) Provision of medications;
4) Leverage mosquito control activities;
5) Increased access to clean water;
6) Training of technicians.

Water resources

In the water resources sector, the Maputo river basin was selected for vulnerability assessment and identification of adaptation measures. This basin is of high economic importance in the district of Matutuine, providing around 50% of water for agriculture, 35% for human consumption and 15% for industry. For vulnerability analysis, data on daily evaporation and precipitation obtained from seven global climate models (ECHAM, GFDL, IPSL, CCCMA, CNRM, CSIRO and GISS) within the hydrological model Geospatial Stream Flow Model (GeoSFM) were used to simulate the conditions of soil moisture and subsequent generation of future daily flows.

The models predict probability of occurrence of normal precipitation, with some tendency for occurrence of above normal precipitation in the Maputo River basin. Analysis of future flow fluctuations shows that this basin will receive much more water in the future and there may be frequent floods, while analysis of dry flows shows that droughts will be more severe. Measures proposed to adapt to frequent floods and droughts include the implementation of water management measures, such as the use of natural lakes and ponds, collection of rainwater in buildings, storage of water in dams and dams, and the implementation of protective measures to prevent saltwater intrusion in the Maputo basin delta.

However, NCCAMS considers water resources to have a high impact on atmospheric patterns changes namely, temperature, precipitation, droughts, floods and tropical cyclones; moderate rise in sea level and low rise in the average sea temperature. In order to face these impacts, NCCAMS presents the following strategic actions: “Increase the capacity to manage water resources”; and “Increase access to and capacity for water harvesting, storage, treatment and distribution”. These actions are also included in the adaptation component of the water resources sector.

Coastal Zones

Mozambique has the third longest coastline in Africa, with more than 2700 km in length, characterized by diverse ecosystems that include beaches, mangroves, sand dunes, coral reefs, seagrass beds, lagoons and estuarine systems, which represents a large heritage and natural asset for the country. NCCAMS indicates that floods, tropical cyclones and rising sea levels have a high impact on coastal areas; the increase in the average temperature of the sea water has a moderate impact; and droughts and changing patterns of atmospheric temperature and precipitation have a low impact.

Sea level rise could cause the coastline of Mozambique to retreat significantly in some areas, with consequences such as coastal erosion, destruction of social and economic infrastructure and coastal ecosystems. The increased intensity of tropical cyclones will exacerbate wave and tidal activity, affecting the sedimentation rate which in turn will negatively influence coastal ecosystems. On the other hand, the sedimentation rate is linked to the availability of sediments in the upstream areas. Taking into account that several rivers flow in the central region of the Mozambican coast, of which the basins are shared by several countries in the interior, the environmental problems of the Mozambican coast take both national and regional concerns.

Considering the importance of the Mozambique coastal coastal resources for the national economy and social development, as well as their vulnerability to climate change, the coastal zone and insfrastructures was one of the selected areas for the technological needs assessment process, which culminated in the preparation of the Technological Action Plan – For the Transfer of Technologies for Climate Change Adaptation in Mozambique – Coastal Zones. The Plan identifies:

(1) The flood early warning system; (2) The beach nourishment; e (3) The restoration of mangroves, a priority technology for reducing the vulnerability of communities, and infrastructure in Mozambique.

For the implementation of these actions, there is a need to consider: (1) The establishment of Technical Training Programs, and (2) The preparation of technical, environmental, economic and financial feasibility studies, as actions that should be incorporated into the technological action plan for the adaptation of Mozambique's coastal zones to climate change. Thus, the estimated costs for creating a favorable environment for the massification of SAP technologies for Floods and Mapping, Mangrove Restoration, and Beach Feedback correspond to approximately 6,786,000.00USD, 1,346,120USD and 2,798,000USD, respectively. If these values are included the costs of implementing pilot projects and the costs of transferring or massifying the technology in Mozambique, the values (for the three technologies) corresponded to: 6,786,000.00USD, 2,546,120.00USD and 102,798,000.00USD, respectively.

If these values are included in the costs of implementing pilot projects and the costs for transferring or massifying the technology in Mozambique, the total costs (for the three technologies) will correspond to: 6,786,000.00USD, 2,546,120.00USD and 102,798,000.00USD, respectively. It should be noted that NCCAMS and Mozambique's NDC include other adaptation measures for coastal zones and resources that are described in the Adaptation Chapter.

Fisheries

In the fisheries sector, the vulnerability to climate change of the shrimp in the Sofala Bank was considered for assessment. This was selected for the study as it is the main fishing groung in the country, with more than 80% of the national fishing fleet and more than 25% of the population of artisanal fishermen, representing a high contribution to GDP, particularly through the export of shrimp. The methodology used, applies integrated ecological and socio-economic aspects of the shrimp to identify and assess the level of risk or vulnerability to climate change. The analysis reveals the high levels of vulnerability to climate change, as follows:

- The predicted reduction in precipitation will decrease shrimp recruitment rates due to increased salinity in estuaries;
- The predicted increase in seawater temperature will significantly increase shrimp mortality;
- Changes in the coastal zone caused mainly by rising sea levels and mangrove destruction could reduce shrimp recruitment;
- Frequent and high intensity cyclones will reduce fishing effort by destroying fishing boats and infrastructure.

These impacts will result in a decline in the shrimp population, a reduction in fishery income, a reduction in the volume of exports and a reduction in the income of coastal families dependent on fishing. Adaptation measures proposed to maintain the benefits of fishing activity, in a high-risk scenario, include:

- Comply with fisheries legislation and implement precautionary fisheries management to reduce the risk of overexploitation;
- Fund innovative research and integrated fisheries management within coastal and open ocean ecosystems;
- Expand integrated monitoring systems in the most productive areas in order to obtain systematic information on hydrophysical, hydrochemical and hydrobiological processes;
- Preserving and restoring wetlands, estuaries and habitats essential to fisheries resources;
- Expand aquaculture in closed systems;

- Develop fisheries in deeper waters where temperature variability may be less pronounced;
- Build fisheries support infrastructure (eg ports) and maintain vessels in areas less affected by tropical cyclones and tsunamis.

The measures proposed above are integrated in the strategic action - Increase the resilience of fisheries of NCCAMS and also in the adaptation component of the NDC in Mozambique.

1.4 Mitigation Options

Despite its low GHG emissions, Mozambique recognizes the potential for mitigating and promoting low-carbon development in certain areas, which provide an opportunity to guide sustainable development from the start, and to access additional sources of funding for initiatives oriented towards sustainable development (MICOA, 2012).

NCCAMS establishes that mitigation actions and low carbon development should not impede development actions, and these will be implemented when it is verified that they represent the best option for development. It is in this context that NCCAMS 's mitigation objective is to "identify and implement opportunities to reduce GHG emissions that contribute to the sustainable use of natural resources and access to financial and technological resources at affordable prices and the reduction of pollution and degradation environment, promoting low-carbon development".

It is in this context that NCCAMS identifies 4 sectors with the potential to reduce emissions by sources and/or increase carbon sequestration capacity. The sectors identified are:

7) Energy;

8) Industrial Processes and Product Use;

9) Agriculture, Forests and Other Land Uses;

10) Waste.

Additionally, the Strategy indicates that voluntary carbon management programs associated with carbon seals or certification processes may be promoted, capable of being implemented by any public or private agents.

The country also has the National Strategy for Reducing Emissions from Deforestation and Forest Degradation, Conservation of Forests and Enhancement of Carbon Reserves Through Forests (REDD+) 2016-2030. With this Strategy, the Government intends to promote integrated multi-sector interventions to reduce carbon emissions associated with the use and changes in land use and cover, through adherence to the principles of sustainable management of forest ecosystems (natural and planted), contributing to global efforts to mitigate and adapt to climate change and integrated and sustainable rural development. It is expected that with the implementation of REDD+ in the country, emissions of around 170 Mton of CO_2/year will be avoided by 2030, an average of 12 million TCO_2 per year. The 1NDC considered that approximately 40 $miTCO_2$ of emissions would be avoided from 2020 to 2025, equivalent to an average annual reduction of about 8 $miTCO_2$.

In response to decision 1/CP. 20 "Lima Call for Action" Mozambique submitted its INDC 2020 – 2030 in which it presents actions of policies and programs that implemented, the country hopes to reduce its emissions by 76.5 Mton of CO_2eq in the period from 2020 to 2030, of which 23 Mton of CO_2eq would be reduced by 2024. This target was revised in 2018 and 2021, with the update of the (NDC) of Mozambique 2020 – 2025, whose emission reduction estimates are around 40.48 Mton of CO_2eq by 2025.

The policy and program actions considered in Mozambique's 1NDC include measures covering the sectors of: Agriculture and Livestock and Sustainable Land Use, Waste Management, Energy Security and Industry Sustainability. Mozambique is recognized as one of the countries that has been most dedicated to and has developed national systems to increase emission reductions from deforestation and forest degradation and increase carbon sinks (REDD+).

The TNA process for mitigation covered the energy and waste sectors. The project ideas are proposed to be implemented by 2030. In the energy sector, the three priority technologies are: three photovoltaic solar plants, with a capacity of 150MW (each one). It is suggested that they be implemented in Niassa and Zambézia provinces and the cost is estimated at 1,000,000,000USD; natural gas combined cycle technology (five combined cycle gas power plants for electricity generation) with a capacity of 650MW and estimated at USD 5 billion; and, regular hydroelectric turbine technology (with a capacity of 500MW, proposed for the Zambezi River basin (Lupata).

For waste, the selected technologies are: landfill with garbage gas, with a capacity of 500Ton/day in Maputo; pyrolysis (pyrolytic treatment) with a capacity of 270 ton/day, proposed for the cities of Beira (+Dondo) and Nampula.

1.5 Other Information relevant to the achievement of the Convention's objectives

Mozambique submitted its First National Communication (1NC) in 2006. After the submission of the 1NC, the country registered milestones aimed at integrating climate change into the planning and budgeting process. Some examples include the creation of the climate change window in the Economic and Social Plan for the period 2009-2014, in which sectors planned climate change actions as a result of the Environment Sector Assistance Program (PASA).

It was also within the scope of PASA that the country formulated the NCCAMS (2012 – 2025) and the respective Action Plan (2013 – 2014), a document approved at the 39th Session of the Council of Ministers, held on the 13th November 2012. With the approval of NCCAMS, the process of integrating climate change into national and sectoral development policies, strategies, plans and programs was accelerated, including at the local level, with the formulation and implementation of Local Adaptation Plans in 98 districts by 2018. Within the scope of the implementation of NCCAMS, the following documents were also approved:

(i) National Climate Change Monitoring and Evaluation System (SNMAMC)
(ii) National Strategy for the Reduction of Emissions Resulting from Deforestation and Forest Degradation (REDD+) 2016 – 2030;
(iii) Disaster Management Law;
(iv) National Productive Social Action Program (PNASP);
(v) National Agricultural Sector Investment Plan (PNISA);
(vi) Strategic Plan for the Meteorology Sector;
(vii) National Adaptation Plan for the Agriculture Sector; and,

(viii) Pre-qualification documents for the establishment of the wind farm in Inhambane.

In the context of technology transfer, the country participated in Phase II of the Technology Needs Assessment Initiative. This process began in 2015 with the holding of a seminar where the sectors of agriculture and infrastructure and coastal areas were selected to assess the technological needs for adaptation in these sectors/areas, and energy and waste for mitigation. This process resulted in the formulation of three Technological Action Plans and Project Ideas, two for adaptation covering the sectors/areas of Agriculture and Infrastructure and Coastal Zone and the third, mitigation for Electricity Generation and Management and Treatment Technologies of Solid Urban Waste.

The costs of the Technological Action Plans are estimated at around 13,260,400,770USD, of which 260,400,770USD for adaptation being for agriculture with 148,270,650USD and 112,130,120USD for coastal zones and infrastructure; and, 13,000,000,000USD for mitigation, with 12,000,000,000USD for electricity generation and 1,000,000,000,000USD for management and treatment of urban solid waste.

Regarding to research and systematic observations, the country has higher education institutions and other state institutions that carry out the activities. However, research in the area of climate change remains incipient due to the scarcity of resources allocated for this purpose and the weak coordination between research institutions and the Ministry responsible for coordinating climate change. To overcome this difficulty, NCCAMS recommends accelerating the process of establishing the Knowledge Management Centre, to be hosted at the Mozambique Academy of Sciences, and with the function of producing, managing and disseminating information on climate change.

The Strategy also indicates the need to create multi-sectoral research teams - Climate Change Network - to be composed by thematic areas. The thematic areas will be coordinated by the Ministries of which the mandates cover the respective research areas and will integrate different specialized institutions, particularly the network of research institutions, higher education institutions and institutions for the systematic collection of climate and sectoral data and other entities that identify themselves as holders or producers of data and information that are identified as relevant.

As for systematic climate observations, these constitute the fundamental basis for a better understanding of the spatial and temporal behavior of climate. Although there are still no institutions dedicated in collecting data and specific information for monitoring climate change and impact assessment, the observations made by operational government institutions are contributing for a database creation on climate monitoring and assessment.

In Mozambique, systematic observations relevant for climate change are carried out by the National Institute of Meteorology of Mozambique (INAM); by the Regional Water Administrations (ARA - South, Centre, North Centre, North and Zambezi) and the National Directorate for Water Resources Management (DNGRH); by the Institute of Agricultural Research of Mozambique (IIAM), by the National Institute of Hydrography and Navigation (INAHINA); and by the National Institute of Fisheries Research (IIP).

These institutions have a network of observation instruments distributed throughout the national territory on land, but also by the sea. The effectiveness of the services provided by these institutions to society has been hampered by a series of challenges characterized by the low density of observation stations (most require rehabilitation and calibration) and different levels of technological solutions. For the most part, location of stations is limited to provincial and district headquarters, as well as strategic locations such as airports, agronomic experimental posts, ports and parts of the coast.

Regarding to education and training, climate change is addressed in isolation as part of a curricula subject in some educational institutions. Although the issue of climate change is already part of the national political and economic reality and with increasing coverage by the social media, the majority of the population still not have access to relevant information. Nevertheless, the occurrence of droughts, floods, tropical cyclones, as well as the increase in the intensity of extreme events, along with the consequences on ecological and economic systems, have drawn public attention to climate change. The perception is growing that the impact of climate change is one of the factors that contribute to the increase in the risks of natural disasters mentioned above. For example, the recent destructive impacts caused by tropical cyclones IDAI and Kenneth are perceived to as consequences of climate change. In addition, government efforts with cooperation partners have significantly contributed to education, training and increased public awareness of climate change.

Mozambique has hosted several initiatives that are part of the efforts on “Education, training (training) and public awareness” which contribute significantly to the achievement of the Convention's Objectives. Among several initiatives, the following should be highlighted:

The Pilot Program for Climate Resilience (PPCR) implemented in Mozambique, in the period 2014 – 2016, allowed, through its technical assistance project, the development of the first management platform content on climate change. This platform came to function as the Climate Change Knowledge Management Center - CGCMC (www.cgcmc.gov.mz) after its launch. Through this page, it was possible to disseminate information of public interest related to climate change, such as reports, publications, events, seminars, projects/programs, newsletters, policy briefs, including "averages" and virtual social networks (eg Facebook, etc.). However, the validity of this page was interrupted due its dependence on external funding and lack of internal sustainability.

USAID's Coastal Cities Adaptation Program (CCAP) in partnership with the Mozambican Academy of Sciences (ACM), developed an online platform to serve short-term training courses and subsequently implemented in 2018 a course on climate change adaptation and disaster risk reduction (DRR) for a significant number of beneficiaries countrywide.

The Project EBAC, CAOS - Borboletas e Sustentabilidade, Lda. I in partnership with the MTA (ex. MITADER) developed a manual on “Low Carbon Strategies – EBAC” with the aim of implementing capacity development actions that contribute to the adoption of a Low Carbon development, through strengthening institutional capacity in GHG MRV matters; identification and sectoral integration of INDC including education and awareness.

Several associations and activists have been engaged in public awareness campaigns on the need to preserve the environment and ecosystems in the face of ongoing and future climate change. In addition, on what could be the possible consequences if no action is taken. The national media with radio, television, newspapers and other "media" and social networks have played a very important role in the dissemination of climate change information since it became part of the national political and economic issue in the various public debates and discourses.

1.6 Constraints, Gaps and Needs Related to Finance, Technological and Technical

The country participated in the initiative – National Capacity Sel-Assessment (NCSA) – which produced the Capacity Needs Action Plan resulting from the National Self-Assessment. The most important constraints include the absolute poverty that characterizes most of the Mozambican population, weak human and institutional capacity, weak financial capacity, weak inter-institutional coordination. In order to overcome the identified constraints, eight objectives were identified, namely: (1) Strengthening MICOA's capacity to better coordinate the implementation of the Rio Conventions and other complementary ones; (2) Strengthening the capacity of ministries to better implement the Rio Conventions and other complementary ones; (3) Strengthening the capacity of business partners; (4) Strengthening national research and extension capacity; (5) Strengthening international cooperation (6) Strengthening the capacity for participation of communities and civil society; (7) Strengthening the capacity of the National Environment Fund; and, (8) Greater participation of the Government in the implementation of the conventions.

In addition to the NCSA, the country implemented several initiatives that identified technical-institutional capacity building needs to overcome the constraints and gaps that could negatively influence the achievement of its objectives. Such initiatives include the NAPA, TNA and, very recently, the NDC where the Implementation Plan was formulated that contains the needs for means of implementation.

The SCN formulation process also identified constraints, gaps and the need for capacity building so that the country can, in the future, improve information communications and present them in a timely manner. Next, the needs identified in the SCN preparation process are presented.

Need for capacity development to prepare national communications on a continuous basis

The roadmap on capacity development needs described below is prepared based on the findings obtained through the components of this communication, namely, national GHG inventories, mitigation options, vulnerability and adaptation and other relevant information (technology transfer; research and systematic observations; education, training and public awareness; and the need for capacity development). This survey is aimed at having a concrete idea of the technical and institutional capacity to introduce the necessary improvements, in order to implement the activities foreseen in the various components of the national communications, in a more effective way, to achieve the objectives of the Convention. The requirements for each component are summarized below:

Capacity development needs for carrying out greenhouse gas inventories:

- Strengthen the capacities of relevant sub-sectors to produce specific, reliable and consistent data and statistics;
- Create a modernized and updated multi-sector database to support research activities, systematic observation and monitoring and implementation of climate change adaptation and mitigation actions;
- Support training in methodologies for estimating deforestation and forest degradation; interpretation and quantification of data obtained via satellite with due precision; and management of forestry and agriculture databases (agrarian statistics);
- Support training for the characterization, quantification and registration of waste, effluents produced in the country and treatment technologies; creation of an effective database on the production, management and treatment of waste and effluents and for the development and management of Databases for the Mass and Energy Balances of the Sector;
- Support the training of HEIs and research institutions for the development of specific FE for Mozambique; in GHG inventory techniques, including the use of IPCC software for national GHG inventories (creation of a specialized inventory unit to advise sectors and lead national inventories).

Capacity development needs for vulnerability and adaptation:

- Support training in infrastructure climate resilience in the various sectors of activity; management, inspection and marketing of natural resources; monitoring of urbanization activities and occupation of urban land; integrated coastal zone management; quantification and monitoring of the sustainable use of water resources; skills in using holistic and integrated multifactor analysis tools;
- Support training in agricultural database management; outreach activities on climate-smart agriculture; research activities on the relationship between crop and animal productivity and climatic variables; conservation agriculture; pasture management and forage conservation; methodologies for estimating deforestation and forest degradation; and in good practices in fishing activity;
- Promote the inventory, management, monitoring, training and dissemination of data on waste produced at municipal and industrial level, including its standardized treatment.

Capacity development needs for mitigation options:

- Promote the development of a data infrastructure and its management for the Energy Balance;
- Promote training in the use of mitigation analysis tools such as Low Emissions Analysis Platform (LEAP) and Greenhouse Gas Abatement Cost Model (GACMO) among others;
- Support the strengthening of institutions/entities responsible for formulating different policies, strategies and legislative instruments for the sectors in the context of supporting activities to combat climate change;
- Support training in methodologies for estimating deforestation and forest degradation; forestry and agriculture database management; research in the waste sector, its collection, treatment and systematization and storage;

- Promote the participation of the private sector and civil society in the development of waste management projects;
- Support the capacity building of national technicians in the formulation and management of projects that contribute to the mobilization of climate funds and others; including its monitoring, reporting and verification (MRV).

Capacity development needs for other information relevant to the Convention:

- Improve the capacity of national technicians in the different technological options foreseen for the implementation of technologies in the sectors prioritized by the of technological needs assessment (TNAs);
- Strengthening of institutional capacity for the implementation of technologies in the various sectors of choice in the TNA;
- Establishment of an institutional mechanism with adequate technical and financial resources, which regulates and promotes, at national level, the practice and implementation of such technologies;
- Strengthen and promote the development of curricula in secondary, technical and higher education institutions that integrate in part or in full content relevant to climate change;
- Promote and increase a greater volume of projects for the installation of more systematic observation stations, including continuous training of personnel in various aspects, such as data processing and validation and mastery of instrumentation, to ensure its maintenance and operability; expand laboratory capacity in equipment for diagnosing climate-sensitive diseases;
- Promote continuous training in the field of instrumentation/observation and data collection; modeling and testing/operationalization of meteorological, hydrological, tidal and coastal flood forecasting models.

Acronyms

Acronym	Portuguese	English
ACM	Academia de Ciências de Moçambique	Academy of Sciences of Mozambique
ACMAD	Centro Africano de Aplicação Meteorológica para o Desenvolvimento	African Centre for Meteorological Applications for Development
AfDB	Banco Africano de Desenvolvimento	African Development Bank
AFOLU	Agricultura, Silvicultura e Outros Usos de Terra	Agriculture, Forestry and Other Land Use
AIFM	Avaliação Integrada de Florestas de Moçambique	Mozambique Integrated Forest Assessment Project
ALER	Associação Lusófona de Energias Renováveis	Lusophone Renewable Energy Association
ARAs	Administrações Regional de Águas	Regional Water Administrations
ARPAC	Instituto de Investigação sócio-cultural	Socio-cultural Research Institute
AVGAS	Gasolina de aviação	Aviation fuel
AWOS	Sistema Automatizado de Observação do Tempo	Automated Weather Observing System
AWS	Estação meteorológica automática	Automatic Weather Stations
BAEF	Barreiras e Identificação de Estrutura Favorável	Barriers and Identification of Favourable Structure
BP	Petróleo Britânico	British Petroleum
BUR	Relatório de Actualização Bienal	Biennial Update Report
CAP	Censo Agro-Pecuário	Agricultural and Livestock Census
CAs	Áreas de Conservação	Conservation Areas
CCAP	Projeto de adaptação das cidades costeiras	Coastal City Adaptation Project
CDB	Convenção sobre a Diversidade Biológica	Convention on Biological Diversity
CEAGRE	Centro de Estudos de Agricultura e Gestão de Recursos Naturais	Centre of Agriculture and Natural Resources Management Studies
CENACARTA	Centro Nacional de Cartografia e Teledetecção	National Center for Cartography and Remote Sensing
CENOE	Centro Nacional Operativo de Emergência	National Center for Emergency Operations
CEPAGRI	Centro de Promoção da Agricultura	Agriculture Promotion Center
CFM	Caminhos de Ferro de Moçambique	Mozambique Railways
CGCMC	Centro de Gestão de Conhecimento de	Climate Change Knowledge

Acronym	Portuguese	English
	Mudanças Climáticas	Management Center
CH_4	Metano	Methane
CISM	Centro de Investigação de Saúde da Manhiça	Manhiça Health Research Center
CM	Cimentos da Matola	Matola Cements
CO_2	Dióxido de carbono	Carbon dioxide
CO_{2eq}	Dióxido de carbono equivalente	Carbon dioxide equivalent
CONDES	Quadro Nacional de Monitoria e Avaliação das Mudanças Climáticas	National Framework for Monitoring and Assessing Climate Change
CONICET	Conselho Nacional de Pesquisa Científica e Técnica da Argentina	Argentina's National Council for Scientific and Technical Research
COP	Conferência das Partes	Conference of the Parties
CORDEX	Experiência de Regionalização Coordenada de Modelos Climáticos Regionais	Coordinated Regional Downscaling Experiment
CRDS	Centro Regional de Desenvolvimento Sanitário	Regional Health Development Center
CTD	Condutividade, Temperatura e Profundidade	Conductivity, Temperature and Depth
DFID	Departamento de Desenvolvimento Internacional	Department for International Development
DJF	Dezembro-Janeiro-Fevereiro	December-January-February
DMC	Direcção Nacional das Mudanças Climáticas	National Directorate of Climate Change
DNAS	Direcção Nacional da Agricultura e Florestas	National Directorate of Agriculture and Forestry
DNAV	Direcção Nacional de Veterinária	National Directorate of Veterinary
DNFFB	Direcção Nacional de Florestas Fauna Bravia	National Directorate of Forestry Wildlife
DNGM	Direcção Nacional de Geologia e Minas	National Directorate of Geology and Mines
DNGRH	Direcção Nacional de Gestão dos Recursos Hídricos	National Directorate of Water Resources Management
DNTF	Direcção Nacional de Terras e Florestas	National Directorate of Lands and Forests
DWA	Departamento dos Assuntos de Água da África do Sul/Eswatine	Department of Water Affairs of South Africa/ Eswatine
ECA	Estações Climáticas Automáticas	Automatic Climate Stations
ECTIM	Estratégia de Ciência, Tecnologia e Inovação de Moçambique	Mozambique's Science, Technology and Innovation Strategy
EDENR	Estratégia de Desenvolvimento de Energias Novas e Renováveis	New and Renewable Energy Development Strategy

Acronym	Portuguese	English
EDM	Electricidade de Mocambique	Electricity of Mozambique
ENDe	Estratégia Nacional de Desenvolvimento	National Development Strategy
ENH	Empresa Nacional de Hidrocarbonetos	National Hydrocarbon Company
ENSO	El-Niño Oscilação Sul	El-Niño Southern Oscillation
EWARS	Sistema de Aviso Prévio e Resposta	Early Warning, Alert and Response System
FAO	Organização para Alimentação e Agricultura	Food and Agriculture Organization
FAPESP	Fundação de Amparo à Pesquisa do Estado de São Paulo	São Paulo State Research Support Foundation
FNAC	Fórum Nacional de Antevisão Climática	National Forum on Climate Foresight
FNDS	Fundo Nacional de Desenvolvimento Sustentável	National Sustainable Development Fund
FNI	Fundo Nacional de Investigação	National Research Fund
FREL	Nível de emissões de referência florestais	Forest Reference Emissions Level
FUNAE	Fundo de Energia	Energy Fund
GCOS	Sistema de Observação Global do Cima	Global Observation System of Cima
GDP	Produto Interno Bruto	Gross Domestic Product
GEF	Fundo Global para o Meio Ambiente	Global Environment Facility
GGCA	Aliança Global de Gênero e Clima	Global Gender and Climate Alliance
GHG	Gases de efeito de Estufa	Greenhouse Gases
Gg	gigagrama	gigagram
$GgCO_2$	Gigagrama de dióxido de carbono	Gigagram of carbon dioxide
GIIMC	Grupo Interinstitucional de Mudanças Climáticas	Interinstitutional Group on Climate Change
GoM	Governo de Moçambique	Government of Mozambique
GTZ	Cooperação Técnica Alemã	German Technical Cooperation
GW	GigaWatt	GigaWatt
GWP	Potencial de Aquecimento Global	Global Warming Potential
Ha	hectare	hectare
HCB	Hidroeléctrica de Cahora Bassa	Cahora Bassa Hydropower
HEI	Instituições de Ensino Superior	Higher Education Institutions
HICD	Desenvolvimento de Capacidade Humana e Institucional	Human and Institutional Capacity Development
IDPPE	Instituto Nacional de Desenvolvimento da Pesca de Pequena Escala	Small Scale Fisheries Development Institute
IES	Instituições de Ensino Superior	Higher Education Institutions
IIAM	Instituto de Investigação Agrária de Moçambique	National Agricultural Research Institute
IIP	Instituto de Investigação Pesqueira	Fisheries Research Institute

Acronym	Portuguese	English
IMF	Fundo Monetário Internacional	International Monetary Fund
INAHINA	Instituto Nacional de Hidrografia e Navegação	National Institute of Hydrography and Navigation
INALCA	Indústria Alimentar de Carnes	Meat Food Industry
INAM	Instituto Nacional de Meteorologia	National Institute of Meteorology
INATER	Instituto Nacional de Transporte Terrestre	National Institute of Land Transport
INDC	Contribuição Intencional Nacionalmente Determinada	Intended Nationally Determined Contribution
INDE	Instituto Nacional de Desenvolvimento da Educação	National Institute for the Development of Education
INE	Instituto Nacional de Estatística	National Institute of Statistics
INGC	Instituto Nacional de Gestão de Calamides	National Institute for Disaster Management
INS	Instituto Nacional de Saúde	National Institute of Health
IOC	Comissão Oceanográfica Intergovernamental	The Intergovernmental Oceanographic Commission
IOM	Organização Internacional para Migração	International Organization for Migration
IPCC	Painel Intergovernamental sobre Mudanças Climáticas	Intergovernmental Panel on Climate Change
IPP's	Produtores Independentes de Energia	Independent Power Producers
IPPCTs	Institutos Públicos de Pesquisa Científica e Tecnológica	Public scientific and technological research institutes
IPPU	Processos e Uso de Produtos Industrias	Industrial Products Processes and Use
ISCTEM	Instituto Superior de Ciências e Tecnologia de Moçambique	Higher Institute of Science and Technology of Mozambique
ISPU	Instituto Superior Politécnico e Universitário	Higher Polytechnic and University Institute
ISRI	Instituto Superior de Relações Internacionais	Higher Institute of International Relations
ISUTC	Instituto Superior de Transportes e Comunicações	Higher Institute of Transport and Communications
ITCZ	Zona de Convergência Intertropical	Intertropical Convergence Zone
JICA	Agência Japonesa de Cooperação Internacional	Japan International Cooperation Agency
JJA	Junho-Julho-Agosto	June-July-August
km	Quilómetro	Kilometer
Km^2	Quilómetro quadrado	Square kilometer
LEM	Laboratório de Engenharia de Moçambique	Engineering Laboratory of Mozambique

Acronym	Portuguese	English
LEAP	Plataforma de Análise de Baixa Emissão	Low Emission Analysis Platform
LGC	Lei de Gestão de Calamidades	Disaster Management Law
LPG	Gás liquefeito de petróleo	Liquefied petroleum gas
LTS	Cenários de longo prazo	Long term scenarios
LULUCF	Usos da Terra, Mudanças no Uso da Terra e Silvicultura	Land Use, Land Use Change and Forestry
MADER	Ministério da Agricultura e Desenvolvimento Rural	Ministry of Agriculture and Rural Development
MAE	Ministério de Administração Estatal	Ministry of State Administration
MASA	Ministério da Agricultura e Segurança Alimentar	Ministry of Agriculture and Food Security
MC	Mudança Climática	Climate Change
MCA	Critério de Análise Múltipla	Multi-Criteria Analysis
MCTESTP	Ministério de Ciência e Tecnologia, Ensino Superior e Técnico-Profissional	Ministry of Science and Technology, Higher Education and Technical-Professional
ME	Ministério de Energia	Ministry of Energy
MEDH	Ministério da Educação e Desenvolvimento Humano	Ministry of Education and Human Development
MEF	Ministério da Economia e Finanças	Ministry of Economy and Finance
MGCAS	Ministério do Género, Criança e Acção Social	Ministry of Gender, Children and Social Action
MIC	Ministério da Industria e Comércio	Ministry of Industry and Commerce
MICOA	Ministério para a Coordenação da Acção Ambiental	Ministry for the Coordination of Environmental Action
MIMAIP	Ministério do Mar Aguas Interiores e Pescas	Ministry of Sea, Inland Waters and Fisheries
MINAG	Ministério da Agricultura	Ministry of Agriculture
MIREME	Ministério dos Recursos Minerais e Energia	Ministry of Mineral Resources and Energy
MISAU	Ministério da Saúde	Ministry of Health
MTA	Ministério da Terra e Ambiente	Ministry of Land and Environment
MITADER	Ministério da Terra, Ambiente e Desenvolvimento Rural	Ministry of Land, Environment and Rural Development
MITUR	Ministério de Turismo	Ministry of Tourism
MOPHRH	Ministério das Obras Públicas, Habitação e Recursos Hídricos	Ministry of Public Works, Housing and Water Resources
MOZAL	Indústria Metalúgica de Alumínio (MOZAL)	Mozambique Aluminium
MSW	Resíduos sólidos urbanos	Urban solid waste
MTA	Ministério da Terra e Ambiente	Ministry of Land and Environment

Acronym	Portuguese	English
MTC	Ministério dos Transportes e Comunicações	Ministry of Transport and Communications
$MtCO_2$	Megatonelada de dióxido de carbono	Megaton of carbon dioxide
MTCESTP	Ministério da Ciência e Tecnologia, Ensino Superior e Técnico Profissional	Ministry of Science & Technology, Higher and Professional Education
N_2O	Oxido Nitroso	Nitrous oxide
NAMAS	Acções de Mitigação Nacionalmente Apropriada	Nationally Appropriate Mitigation Actions
NAP	Plano Nacional de Adaptação	National Adaptation Plan
NAPA	Programa de Acção Nacional para a Adaptação às Mudanças Climáticas	National Adaptation Programme of Action
NCCAMS	Estratégia Nacional de Adaptação e Mitigação de Mudanças Climáticas	National Climate Change Adaptation and Mitigation Strategy
NDA	Autoridade Nacional Designada	Designated National Authority
NDC	Contribuição Nacionalmente Determinada	Nationally Determined Contribution
NDF	Fundo de Desenvolvimento Nórdico	Nordic Development Fund
NDVI	Índice de Vegetação por Diferença Normalizada	Normalized Difference Vegetation Index
NGO	Organização Não-Governamental	Non-Government Organization
NMVOC	Compostos Orgânicos Voláteis Não-Metânicos	Non-Metallic Volatile Organic Compounds
ODINAFRICA	Rede de dados e informações do oceano para a África	Ocean Data and Information Network for Africa
OIAS	Observatório Integrado Africano de Saúde	Integrated African Health Observatory
ONS	Observatório Nacional de Saúde	National Health Observatory
OPC	Cimento Portland Oridinário	Oridinary Portland Cement
PACE	Programa de Atenção Integral à Saúde do Idoso	Program of All-Inclusive Care for the Elderly
PARP	Plano de Acção de Redução da Pobreza	Poverty Reduction Action Plan
PDRRD	Plano Director de Redução do Risco de Desastres	Disaster Risk Reduction Master Plan
PEB	Política e Estratégia Nacional de Biocombustíveis	National Biofuels Policy and Strategy
PEDSA	Plano Estratégico para o Desenvolvimento do Sector Agrário	Strategic Plan For Agricultural Sector Development
PES	Plano Económico e Social	Economic and Social Plan
PETROMOC	Petróleos de Moçambique	Petroleum of Mozambique
PFCs	Perfluorcarbonetos	Perfluorocarbons
PHL	Perdas pós-colheita	Post-harvest losses

Acronym	Portuguese	English
PMEs	Pequenas e Médias empresas	Small and Medium Business
PNENR	Programa Nacional de Energias Novas renováveis	National Program for New Renewable Energy
PNISA	Plano Nacional de Investimento do Sector Agrário	National Investment Plan for the Agricultural Sector
PNUD	Programa das Nações Unidas para o Desenvolvimento	United Nations Development Program
POL	Laboratório Oceanográfico Proudman	Proudman Oceanographic Laboratory
PPAMC	Projecto de Pesca Artesanal de Adaptação às Mudanças Climáticas	Artisanal Fisheries Climate Change Adaptation Project
PPCR	Programa piloto de resiliência climática	Pilot Climate Resilience Program
PQG	Plano Quinquenal do Governo	Five Year Government Plan
QAO	Gabinete de Controlo de Qualidade	Quality Assurance Office
REDD+	Redução de Emissões de Desmatamento e Degradação florestal, conservação de florestas, maneio sustentável e aumento de reservas de carbono	Reducing Emissions from Deforestation and forest Degradation, conservation, sustainable management of forests, and enhancement of forest carbon stocks
ReNAPRI	Rede de Institutos de Pesquisa em Políticas Agrícolas	Network for Agricultural Policy Research Institutes
RSA	República da África do Sul	Republic of South Africa
SADC	Comunidade de Desenvolvimento da África Austral	Southern African Development Community
SANHO	Escritório hidrográfico da África do Sul	South African Hydrographic Office
SAPP	Grupo de Energia da África Austral	Southern African Power Pool
SARCOF	Fórum regional de Antevisão do Clima para África Austral	Southern Africa Regional Climate Forecast Forum
SASOL	Carvão e Óleo Sul-Africanos	Suid Afrikaanse Steenkool en Olie (orig.)
SAWS	Serviços Meteorológicos da África do Sul	South African Weather Services
SCN	Segunda Comunicação Nacional	Second National Communication
SDGs	Objectivos do Desenvolvimento Sustentável	Sustainable Development Goals
SETSAN	Secretariado Técnico para a Segurança Alimentar e Nutricional	Technical Secretariat for Food Security and Nutrition
SLR	Subida do Nível do Mar	Sea Level Rise
SON	Setembro-Outubro-Novembro	September-October-November

Acronym	Portuguese	English
TAP	Plano de Accão Tecnológico	Technological Action Plan
ToR	Termos de Referência	Termos of Reference
UCM	Universidade Católica de Moçambique	Catholic University of Mozambique
UDM	Universidade Técnica de Moçambique	Technical University of Mozambique
UEM	Universidade Eduardo Mondlane	University Eduardo Mondlane
UMC	Unidade das Mudanças Climáticas	Climate Change Unit
UN	Nações Unidas	United Nations
UNDCF	Fundo de Desenvolvimento de Capital das Nações Unidas	United Nations Capital Development Fund
UNDP	Programa das Nações Unidas para o Desenvolvimento	United Nations Development Programme
UNESCO	Organização das Nações Unidas para a Educação, a Ciência e a Cultura	United Nations Educational, Scientific and Cultural Organization
UNFCCC	Convenção Quadro das Nações Unidas sobre Mudanças Climáticas	United Nations Framework Convention on Climate Change
UniLúrio	Universidade Lúrio	University Lúrio
UniZambeze	Universidade Zambeze	University Zambeze
UNOPS	Escritório das Nações Unidas de Serviços para Projetos	United Nations Office for Project Services
USAID	Agência dos Estados Unidos para o Desenvolvimento Internacional	United States Agency for International Development
USGS	Pesquisa Geológica dos Estados Unidos	United States Geological Survey
WB	Banco Mundial	World Bank
WFP	Programa Mundial de Alimentação	World Food Programme
WHO	Organização Mundial da Saúde	World Health Organization
WIGOS	Sistema Integrado de Observação Global WMO	WMO Integrated Global Observing System
WMO	Organização Mundial da Meteorologia	World Meteorological Organization
WWTP	Estação de Tratamento de Águas Residuais	Wastewater Treatment Plant
ZAMCOM	Comissão do Curso do Zambeze	Zambezi Course Committee

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1. Chapter 1: National Circumstances

1.1. Geographic Profile

The Republic of Mozambique is located in the southern hemisphere, on the Southeast coast of the African continent, between latitudes 10°27’S and 26°52’S and the meridians of 30°12’E and 40°51’E. The country has an area of 801,590 km^2 of dry land and about 13,000 km² of inland waters. Along the eastern part lies the Indian Ocean, with a coastline extension of approximately 2,700 km. In its northern part, it is bordered by Tanzania; to the Northwest by Zambia, Malawi and Lake Niassa; Zimbabwe to the west; by South Africa, to the Southeast; and to the south, by Eswatini (formerly Swaziland), on an international land border line with a length of about 4,330 km. To the east, the country is bordered by the Indian Ocean and separated from Madagascar by the Mozambique Channel (Figure 1.1).

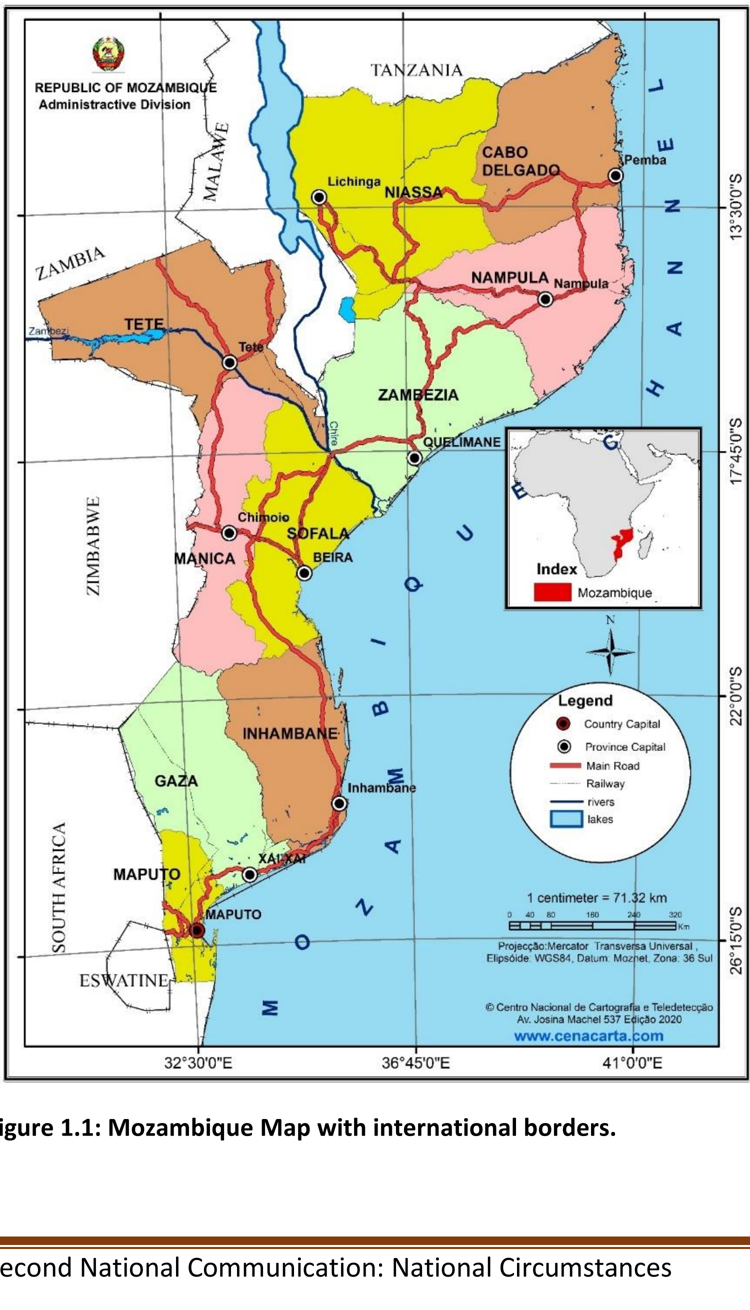


Figure 1.1: Mozambique Map with international borders.

Administratively, the country is divided into 10 provinces. However, the municipality of Maputo City (capital of the country) has the status of a province, bringing the number to 11. The provinces are currently divided into 154 districts (26 more districts from the previous 128) which, in turn, are divided into 419 local administrative districts, called Administrative Posts. The latter are made up of 1,052 Localities, the lowest level of administrative configuration in the Mozambican State. To the subdivisions reported above are added 53 municipal authorities, of which 33 were created in 1998, another 10 in 2008 and another 10 in 2013 (Figure 1.2).

Along the approximately 2,700 km of coastline there are numerous islands, including the Quirimbas archipelago, in Cabo Delgado Province, Mozambique Island and the Goa and Sena islands, in Nampula Province, the Bazaruto archipelago, in Inhambane, the islands of Inhaca, Portuguese and Xefina, in Maputo province.

Figure 1.2: Geographical location map of Mozambique with the administrative division by provinces.

1.2. Population

The Mozambican population is 27,909,798 inhabitants (INE 2017), with about 52% women and 48% men. The distribution by age group is about 45% for 0-14 years, 52% for 15-64 years and 3% for over 64 years (Figure 1.3). The most widely spoken national languages in the country include KiSwahili, EMakhuwa, CiSena, XiNdau, XiTsonga, XiTchope, Guitonga, CiNyungwe, EChwabo, EKoti, ELomwe, CiNyanja, CiYao, XiMakonde and KiMwane, out of more than 40 languages in the country. The language adopted as official is Portuguese, inherited from Portugal, the colonizing country from which Mozambique became independent on June 25, 1975.

Mozambique has experienced significant population growth with an average annual rate of 2.4% over the last ten years. Between 2007 and 2017 there was a growth of 8.4 million inhabitants, against 4.4 million between 1997 and 2007 (Figure 1.4). According to projections, the Mozambican population may exceed 50 million inhabitants by 2050. These data show how the demographic issue will play a very important role in the planning of the country's socioeconomic development and the potential challenges for the management of natural resources that is the main source for the majority of the population, as well as the environment.

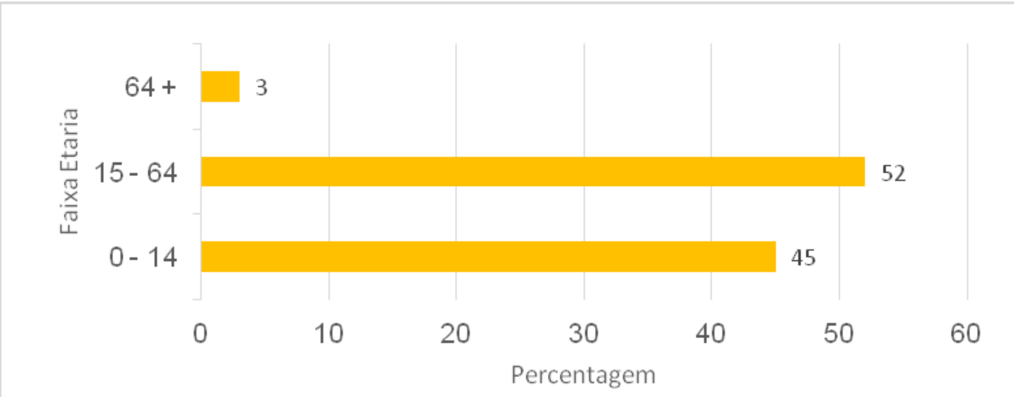


Figure 1.3: Population age structure (INE, 2017 census).

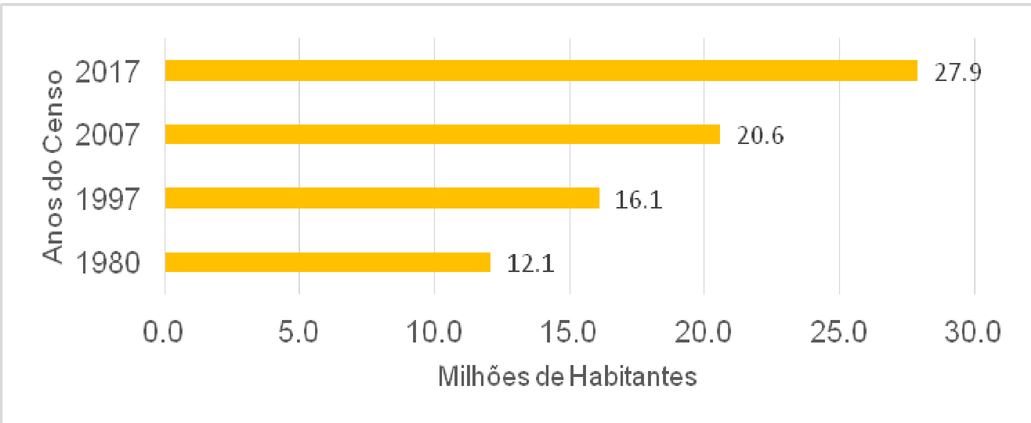


Figure 1.4: Population growth between 1980 – 2017.

Source: http://www.ine.gov.mz/estatisticas/estatisticas-demograficas-e-indicadores-sociais/populacao

Other demographic indicators are shown in Table 1.1. This table highlights the reduction in the maternal and child mortality rate, as well as the increase in life expectancy. The illiteracy rate has also decreased, although it is still high, particularly among women.

Table 1. 1: Evolution of demographic indicators in Mozambique between 1980 – 2017.

Indicator	1980	1997	2007	2017
Total population	12,130,000	16,075,708	20,632,434	27,909,798
Men	5,908,500	7,703,031	9,930,196	13,348,336
Women	6, 221,500	8,372,677	10,702,238	14,561,352
Population growth	12.1	16.1	20.6	27.9
Population Growth Rate	2.5	1.7	2.5	2.8
Gross Birth Rate	47.1	44.4	42	38
Gross Mortality Rate	20.7	21.2	13.8	11.8
Maternal Mortality Rate	-	-	500.1	451.6
Child mortality rate	159.0	145.7	93.6	67.3
Boys	172.0	152.9	97.2	70.9
Girls	146.0	137.8	89.9	637
Life expectancy	43.6	42.3	50.9	53.7
Men	42.1	40.6	48.8	51.0
Woman	45.0	44.0	52.9	56.5
Rural	86.80%	70.80%	-	66.60%
Urban	13.20%	29.20%	-	33.40%
Illiteracy rate	72.2	60.5	50.4	39.0
Men	58.0	44.6	34.6	27.2
Mulheres	84.6	74.1	64.2	49.4

1.3. *Economy*

Agriculture in Mozambique remains one the main pillar of the national economy. The sector employs 90% of the female workforce and 70% of the male workforce, that is, 80% of the Mozambican working population works in the agrarian sector (PEDSA, 2011). Agriculture has an average share of GDP above 20% of the total. The commerce and transport and communications services sectors contributed an average of 10% each (Table 1.2). The extractive industry sector has shown great performance in recent years, having gone from 2% in 2013 to just over 7% in 2018 (INE: National Accounts of Mozambique). The national economy has considerable potential in the primary sector, driven by the existence of natural resources, however, the main challenge is the development of industries that allow sustainable exploration and transformation of these resources. The diversification of the national economy is still a challenge for a more stable, comprehensive and sustainable growth. The Mozambican economy, after several years of growth of around 7% per year, has slowed down since 2016, due to various factors of the international and national situation (Table 1.3).

Table 1. 2: Contribution of sectors to GDP.

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Agriculture	19.8	19.9	23.6	23.5	23.4	22.64	21.8	21.0	22.5	21.8	21.7
Fisheries	1.7	1.4	1.4	1.4	1.42	1.41	-	-	-	1.5	1.4
Extractive Industry	1.1	1.1	1.2	1.3	1.7	2.11	3.2	3.7	6.2	6.9	7.3
Manufacturing Industry	13.4	12.2	12.4	11.9	11.67	10.86	8.8	9.0	8.7	8.0	7.8
Electricity and Water	4.6	4.8	4.8	4.8	4.37	4.08	2.8	2.9	2.7	2.9	2.7
Construction	3.5	3.5	3.4	3.3	3.40	3.54	2.0	2.1	2.1	1.8	1.7
Commerce	11.3	11.1	11.2	11.9	11.59	11.35	11.4	11.5	12.1	-	-
Transport and Communications	10.4	10.9	11.6	12	11.91	12.92	12.5	12.3	9.7	10.1	10.3
Financial services	5.0	5.6	5.4	5.4	5.6	-	5.7	5.7	4.9	5.1	5.2
Rental of Properties	4.5	6.7	6.5	6.2	5.8	-	7.1	7.2	5.3	-	-
Education and	5.1	5.3	-	-	-	-	7.0	7.0	8.1	7.6	7.4

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Health											
Public administration	-	-	-	-	-	-	5.6	6.0	6.4	6.5	6.4
Hotels and Restaurants	-	-	1.6	1.6	1.50	1.41	-	-	-	-	-
Others	-	34.6	16.8	17.6	17.4	-	3.7	3.4	4.5	5.6	5.7

Source : INE Mozambique National Accounts.

Table 1. 3: Evolution of Economic Indicators, 2008-2018.

Indicator	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Real GDP growth (%)	6.8	6.3	6.8	7.2	7.3	7.2	7.4	6.6	3.8	3.7	3.4
Inflation (%)	7.9	1.1	7.6	3.3	5.8	3.9	2.6	4.4	11.9	12.8	4.9
GDP per capita (USD)	468.9	439.2	422.8	579.7	608.1	626.6	645.2	547.2	391.5	441.6	490.0

Source: World Bank; Bank of Mozambique

1.4. Climate

According to the Köppen-Geiger classification, the climate of Mozambique is generally of the Aw type (humid and dry tropical) and with pockets of BSh (warm semi-arid climate), with two very distinct seasons, one hot and wet, from October to April, and the other cold and dry, from May to September (Gelcer et al. 2018). Other manifestations of climates of the As, Cfa and Cwa types can be found in isolation (Figure 1.5).

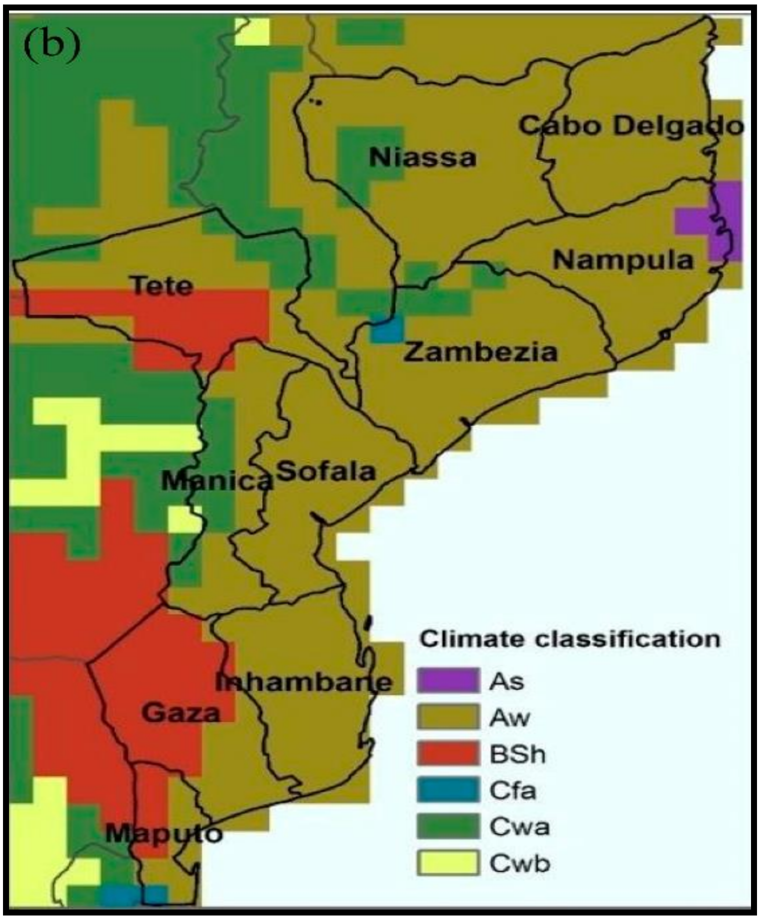


Figure 1.5: Climate in Mozambique, according to the Köppen-Geiger classification. As = rainy tropical climate; Aw = humid and dry tropical climate; BSh = hot semi-arid climate; Cfa = warm and humid temperate climate; Cwa = warm temperate climate with dry winter.

Source: Gelcer et al. (2018).

The atmospheric circulation in the country is characterized by zones of low equatorial pressures influence with NE monsoon winds during the summer. The winds in the south and central zone are predominantly SE trades, and in the north zone they are influenced by a monsoon regime with NE winds during the summer and SW during the winter. Mozambique's precipitation regime is influenced by tropical cyclones formed in the southwestern Indian Ocean basin during the summer, the Intertropical Convergence Zone (ITCZ), the Indian Monsoon, the low pressure systems over the continent, Atlantic and Atlantic Anticyclones. Indian Ocean, El Niño/Southern Oscillation (ENSO) and Cold Fronts (Macie, 2016).

The spatial distribution of precipitation varies widely across the country. Precipitation is most abundant in the northern zone, where the annual average varies between 800 and 1,200 mm, becoming exceptionally high, 1,500 mm, in the highlands of Zambezia, Niassa and mountainous areas of Gorongosa. Central Mozambique and the entire coastline receive amounts of rain ranging between 800 and 1,000 mm. However, in some regions of the province of Tete, the values of precipitation even decrease by up to 600 mm. The south of the country is generally drier, with an average rainfall of less than 800 mm, reaching values of 300 mm at the administrative post of Pafuri, in Gaza province (Figure 1.6).

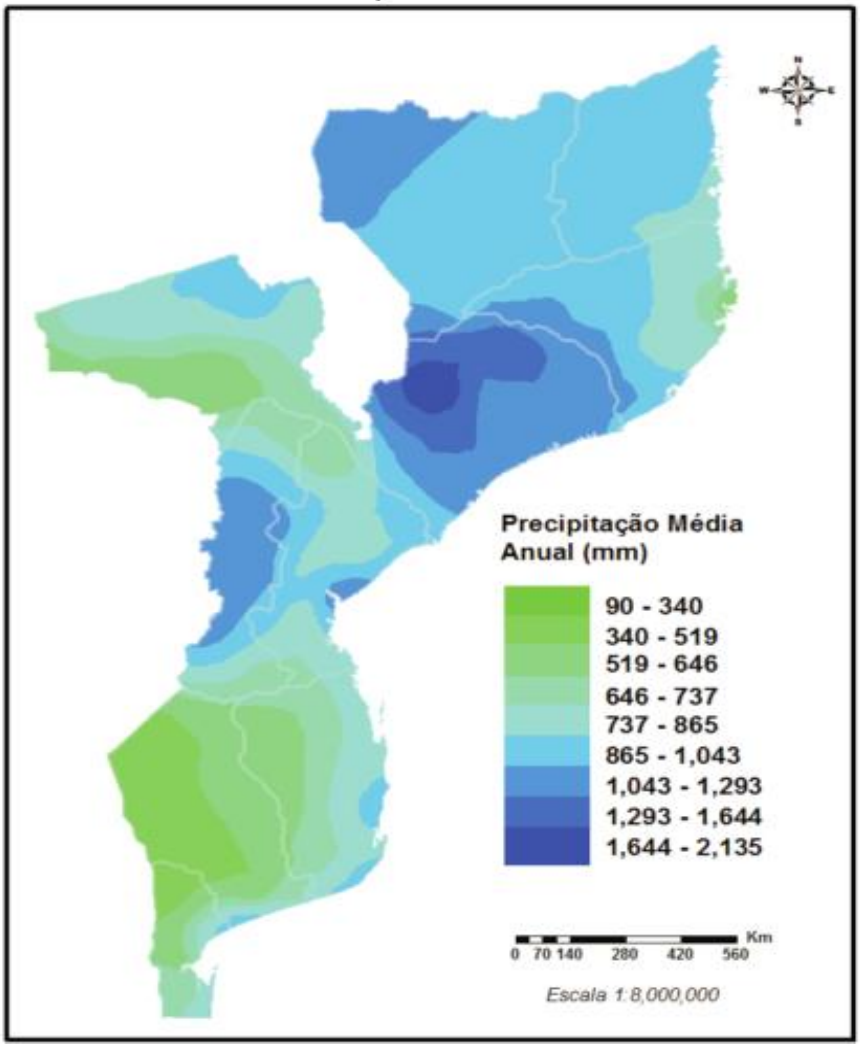


Figure 1.6: Spatial distribution of accumulated annual rainfall in Mozambique.

Source: Mozambique Rainfall Atlas, INAM (2012).

1.4.1. Seasonal Variation of Precipitation

The period of greatest precipitation in the country corresponds to the summer in the Southern Hemisphere, between October and April. During the rainy season, the highest precipitation values occur in the months of January, February and March (Figure 1.7), contributing about 45% of the total annual precipitation and is often associated with migration and Convergence Zone activity. Inter-Tropical (ITCZ).

In the northern region of the country, typical monthly precipitation values are 20 – 200 mm/month during the rainy season and 5 – 30 mm/month in the dry season. The central region registers between 30 – 200 mm/month in the rainy season and 20 – 40 mm/month in the dry season. The south of Mozambique, with the lowest precipitation values registers between 40 -130 mm/month in the rainy season and 20 - 40 mm/month in the dry season. It is mainly the southern region that is prone to drought and some southern parts of Tete province in the center of the country.

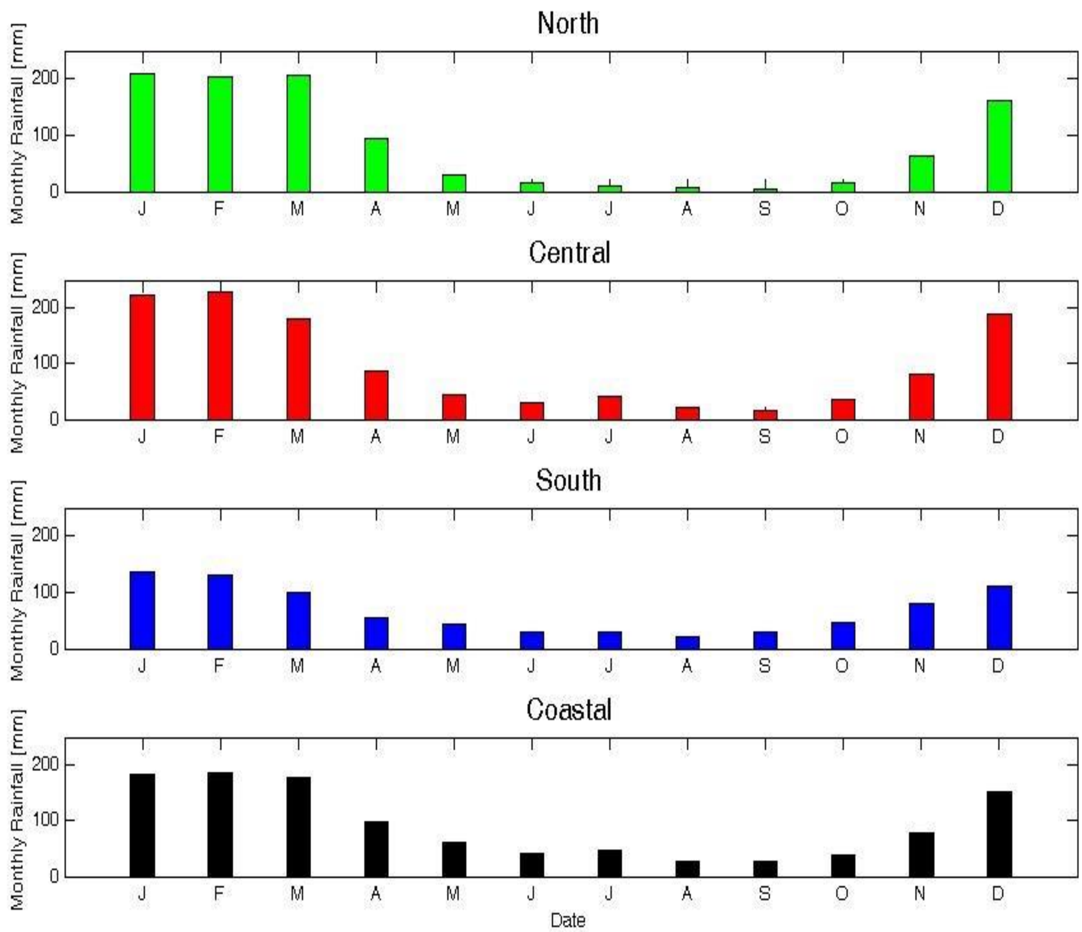


Figure 1.7: Seasonal variation of accumulated monthly precipitation in different regions of the country

Source: INGC (2009)

1.4.2. Inter-annual variation of precipitation

In Mozambique there is a very high inter-annual precipitation variability in the rainy season, particularly in the central and southern regions. This variability causes significant fluctuations in the annual amounts of precipitation, with years with an abundance of precipitation (with greater probability of inundations or floods) or precipitation deficit (with greater probability of droughts) being registered. Figure 1.8 shows precipitation deviations from the climatological mean in four geographic regions of the country, including the coastal region from 1960 to 2006. The best-documented cause of this variability is the southern oscillation and the El-Niño phenomenon (ENSO), which causes warmer and drier conditions on average; and relatively cooler and wetter conditions (La Niña) in the rainy season of eastern southern Africa. Evidence on the relationship between ENSO and precipitation in southern Africa can be found in several studies (Reason et al., 2000; Reason and Jagadheesha, 2005).

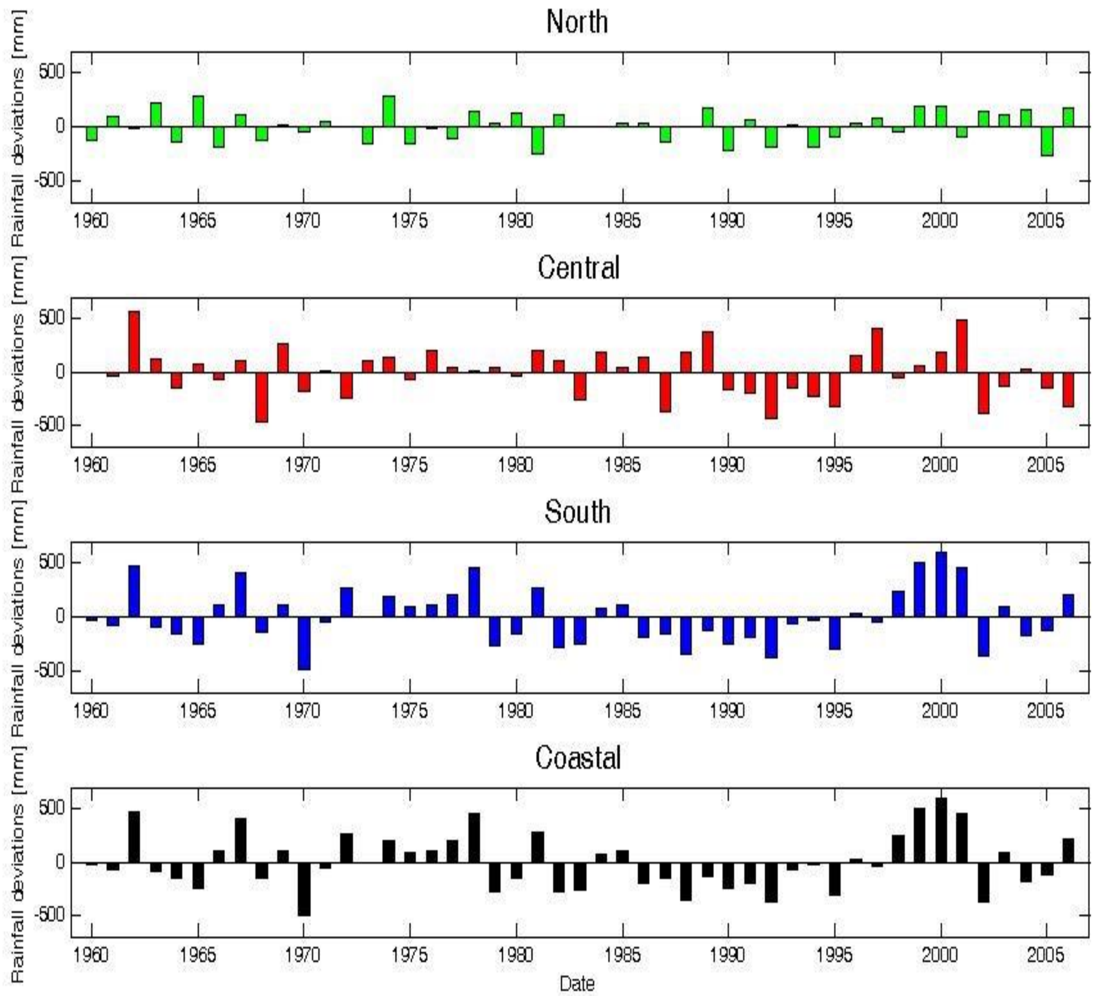


Figure 1.8: Precipitation deviations showing intra-annual variability and the probability of occurrence of floods and droughts in four regions of the country, north, center, south and coastal.

Source: INGC, (2009)

1.4.3. Average temperatures

In general, average temperatures in Mozambique range between 25 – 30 °C (average maximum temperatures) and between 15 – 21 °C (average minimum temperatures) (Figure 1.9). The highest mean maximum temperatures are recorded in the coastal area of the country, in the south of Tete province and in the western part of Gaza province (Figure 1.9 on the left). As for the average minimum temperatures, these have a decreasing pattern from the coast to the interior. The highest average minimum temperatures are recorded along the northern coast, while the lowest are found in Gaza province (WFP, 2018). In this region of Gaza, there is also the largest temperature range in the country.

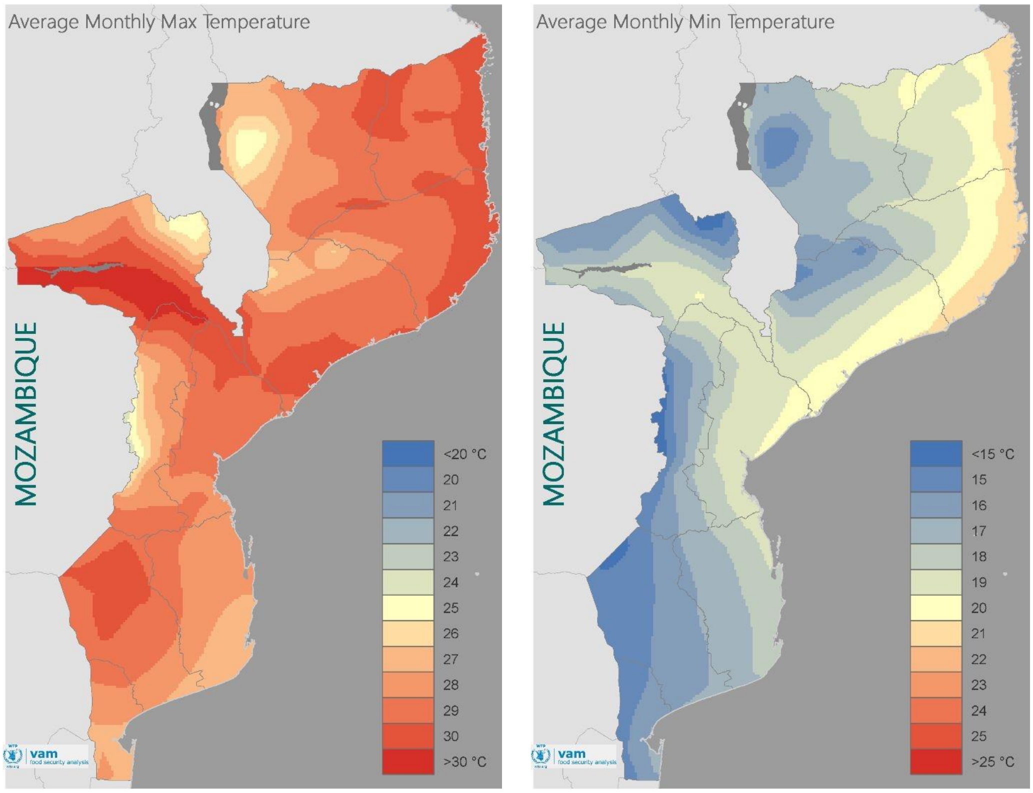


Figure 1.9: Spatial distribution of average maximum temperature (on the left) and average minimum temperature in Mozambique, calculated for the period 1982 - 2017.

Source: WFP (2018)

1.4.4. Historical trends

Average temperature trends show positive variations (increase in average temperature) in most parts of the country. Studies indicate that the average annual temperature increased by 0.6 °C between 1960 – 2006, at an average rate of 0.13 °C per decade for most seasons of the year (INGC, 2009). The study also points to an increase in the frequency of hot days and nights (days with a maximum temperature> 30 °C and nights with a minimum temperature> 20 °C respectively). The average number of "hot" days per year in Mozambique increased by 6.8% of days (~25 days) and the average number of "hot" nights per year increased by 8.4% of nights (~31 nights) during the same period of analysis (1960 and 2006).

Maximum and minimum temperatures

Trends in increasing maximum and minimum temperatures (warming) have not been uniform across the country. Increases in mean maximum temperature of greater magnitude were recorded in the North (0.76 – 1.16 °C), followed by central Mozambique between 1960 and 2006. Changes in average minimum temperatures in certain regions of the country are even greater, indicating such large increases between 1.12 - 1.62°C (in the central region of the country) during the same period under analysis (INGC, 2009). Tables 1.4 and 1.5 provide a summary of trends in average maximum and minimum temperatures for different regions of the country. They provide a summary of trends in maximum and minimum temperatures.

Table 1. 4: Change in mean maximum temperature (Tmax, °C) for each region, between 1960 and 2006 (Adapted: INGC, 2009).

Region	Trend	Magnitude (°C)
North	Increase	0.76 – 1.16
Centre	Increase	0.40 – 1.11
South	Increase	0.50 – 0.98
Coastal area	Increase	0.74 – 1.01

Table 1. 5: Change in the average minimum temperature (Tmin, °C) for each region, between 1960 and 2006 (Adapted: INGC, 2009).

Region	Trend	Magnitude (°C)
North	Increase	0.80 – 0.88
Centre	Increase	1.12 – 1.62
South	Increase	0.69 – 1.35
Coastal area	Increase	0.52 – 0.65

Precipitation trends

Precipitation trends in the country are not significantly observable, due to the great inter-annual variability in different seasons. However, the analysis of historical data made in several studies points to a late start of the rainy season in Mozambique, as well as an increase in the persistence of dry days.

The INGC report (2009), analyzing data between 1960 and 2006, indicates a delay in the start of the rainy season that can reach between 20 and 45 days in some places, as well as a more pronounced persistence of dry days in the Northeast of the country in the months from March to May and September to November.

The study by Mcsweeney et al. (2010) found that in the period between 1960 and 2006, the average annual precipitation in Mozambique decreased at an average rate of 3.1% per decade, in the period under review. On the other hand, despite the decreases observed in total precipitation, the amount of precipitation falling during heavy precipitation events increased at an average rate of 2.6% per decade, with these increases being more pronounced in the period from December to February (DJF).

1.4.5. Climate Projections

Future Temperature Projections

The Intergovernmental Panel on Climate Change (IPCC) in its Fifth Assessment Report (AR5) presents inequivocal evidence of climate change around the world: the atmosphere and oceans are warming, the extent and volume of snow and ice is decreasing, sea levels are rising and weather patterns are changing. The most optimistic scenario predicts an increase in the Earth's temperature of between 0.3°C and 1.7°C and, in the worst case scenario, the Earth's surface could warm between 2.6°C and 4.8 °C over this century by 2100 (IPCC, 2014). Paris Agreement approved in December 2015 under the United Nations Framework Convention on Climate Change (UNFCCC) established a global framework to reduce carbon dioxide (CO_2) emissions and noted that global warming should be limited to 1.5 °C According to the IPCC (2021) the increase in global warming of 1.5°C compared to the period 1850-1900 will be achieved by the middle of the 21st century (by 2040).

In Mozambique, some studies point to a significant increase in temperature, with the average annual temperature projected to increase between 1.0 to 2.8°C by 2060 and between 1.4° to 4.6°C by 2090 (INGC, 2009; Mcsweeney et al., 2010) (Figure 1.10). The projected rate of warming will be faster inland Mozambique than in areas closer to the coast. All projections indicate substantial increases in the frequency of days and nights considered "hot" in the present climate. This increase will be between 17 and 35% of days per year, around 2060 and between 20 and 53% of days per year in 2090. The same projections also indicate a reduction in the frequency of days and nights considered "cold" in the present climate.

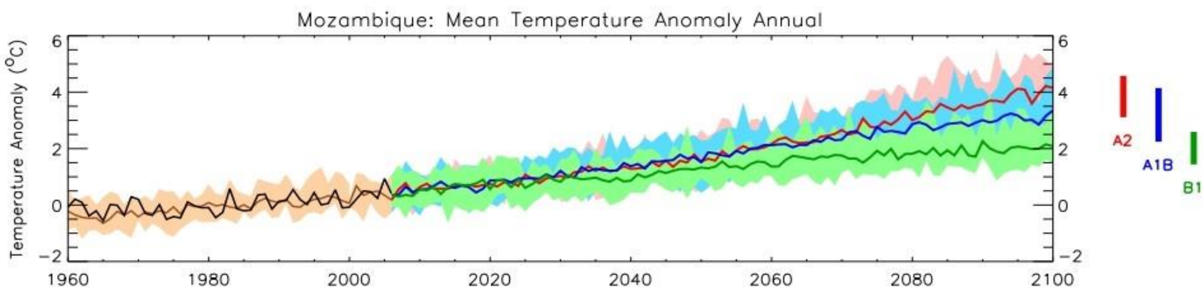


Figure 1.10: **Trends in annual average temperature in Mozambique between 1960 and 2006 (black line) and the projected future for three emission scenarios (colored lines). The colored bars on the right side indicate the different scenarios used in the simulations (A2, A1B and B1) as well as the uncertainty ranges in the average climate projections around 2090 – 2100 (Adapted from Mcsweeney *et al* ., 2010).**

Future Precipitation Projections

Precipitation variations are not as clear as temperature variations. The range of precipitation projections resulting from different models is large and encompasses both negative and positive changes. There are indications of variations between -15 to +20 mm per month, or -15% to +34% (Mcsweeney et al., 2010). However, the models show more consistency in seasonal projections, indicating a reduction in precipitation in the dry season, that is, in the period from June to August (JJA) and from September to November (SON). This reduction is partially offset by increased precipitation in the rainy season, from December to February (DJF), with greater expression in northern Mozambique (Mcsweeney et al., 2010). In general, precipitation projections do not indicate substantial changes in annual precipitation, but rather changes in precipitation patterns (Figure 1.11).

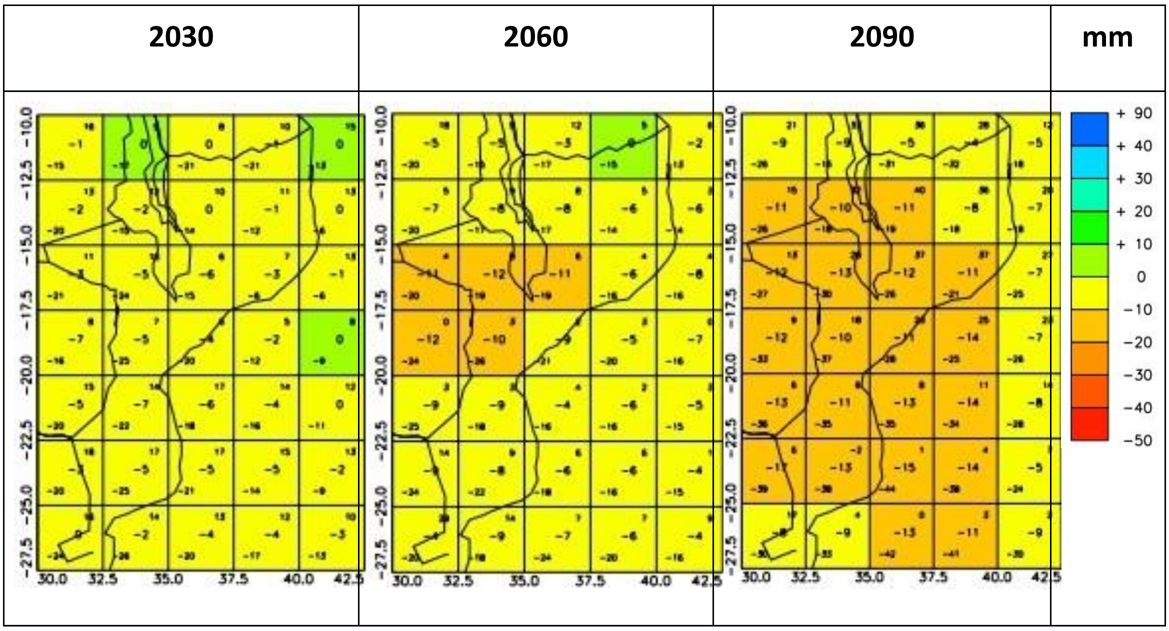


Figure 1.11: Spatial patterns of monthly average rainfall in the period September to November projected for the years 2030, 2060 and 2090 (Adapted from Mcsweeney et al., 2010).

1.5. Relief

The country's relief exihibits a mountainous area to the west, which descends in flat steps to the coastal plain, to the east. Thus, according to the altitude, plains, plateaus, mountains and depressions are identified in Mozambique. The coastal plain, with altitudes of up to 200 meters, extends along the entire coastal strip, narrowing from the mouth of the Rovuma river, to the Zambezi delta and extending in the southern part to the so-called great Mozambican plain, to Ponta de Ouro. It occupies 1/3 of the national territory. There are also the so-called low-pressure plains that extend along the valleys of the main rivers, eventually receiving the name of the respective hydrographic basins, such as: Incomáti Plain, Limpopo Plain, Save Plain, Búzi Plain, Lúrio Plain, Lugela Plain, Messalo Plain and Zambezi Plain.

The plateaus occur mainly in the Center and North regions of the country, where they are more expressive, especially in the provinces of Manica, Tete, Zambézia, Nampula, Niassa and Cabo Delgado, forming islands or "inselbergs".

In the southern region of the country, the plateaus occupy only a small strip in the western zone of the provinces of Maputo and Gaza in a mountainous alignment of approximately 900 km in length and 30 km in maximum width, close to the border with Swaziland, Republic of South Africa and Zimbabwe.

In some plateau areas, accumulation plains occur that result from excavations carried out in river valleys, such as the Zambezi, Messalo and Lugela river valleys (Viz. Figure 1.12).

Figure 1.12: Relief of Mozambique (Bila and Fondo 2010:32)

In the plateau area, the following are distinguished:

- Medium plateaus (200m - 600 m altitude).
- Highlands (600m – 1,000 m altitude).

The main plateaus are:

- **Mozambican Plateau:** located in the provinces of Zambézia and Nampula. In this region, the plateaus have altitudes ranging from 600 to 1,000 meters of altitude. The main characteristic of the Mozambican plateau is the occurrence of "inselbergs" called islands or residual mounds;
- **Niassa Plateau** - located in Niassa province, along Lake Niassa;

- **Mueda Plateau** – located in the province of Cabo Delgado;
- **Chimoio Plateau** – located in the province of Manica, close to the border with Zimbabwe;
- **Maravia Plateau** – located in the province of Tete, close to the border with Zambia; and,
- **Angónia Plateau** – is located in the province of Tete, next to the border with Malawi.

Mountain formations with altitudes equal to or greater than 1,000 meters are located at:

- **West of Niassa:** where the mountainous elevations have the shape of an Ipsilon (Y), constituting a chain or Maniamba-Amaramba system in which hills such as Jéci (1.836 m), Mitucuè (1.803 m), Sanga (1.79 m) stand out), Chitagalo (1,803 m), Chissindo (1,579 m) and Txingeia (1,787 m);
- **Northwest of Zambézia and Tete:** in Zambézia there are the Chire-Namúli formations with hills such as: Namúli (2.419 m), Chiperone (2.054 m), Inago (1.807 m), Mabu (1.646 m), Tumbine (1.542 m), Derre (1.417 m) and Mongue (1.043 m); and, in Tete, the hills (Plateaus of Maravia-Angónia) are in its northern part near the border with neighboring Malawi, the highlight goes to the hills: Domuè (2.096m) and Chiobuè (2.021 m);
- **West of Manica:** escarpment of the same name or Chimanimani massif near the border with Zimbabwe, this massif is where the highest mountain in the country, the Binga (2,436 m of altitude, in the district of Sussundenga), is located (35 km) of length and a width that varies from (8 to 10 km) and is distant from the city of Chimoio in about 80 km, Serra Choa (1,844 m). Also in this province, the Espungabera massif is located at an approximate altitude of 1,000m, separating Chimanimani from Serra da Gorongosa (Sofala) with a maximum altitude of 1,863m.

In the southern region of the country there are no mountain formations, per se, due to its altitude, however, we fall into an illusion when we look at the plateau chain of Libombos, as it is located in a predominantly flat region because, in fact, it is nothing more than an altiplanalto with just 802 m of altitude (Mount M'ponduíne) in Namaacha, close to the border with E-Swatini and South Africa.

1.6. Agriculture, Forestry and Fisheries

1.6.1. Agriculture

Agriculture in Mozambique is the basis for national development, constituting the most important source of income and subsistence for more than 80% of the population and with an average share of GDP above 20% of the total (INE: National Accounts, 2008 – 2018). The agriculture sector also plays an essential role for women's livelihoods, as 90% of the economically active female population earns a living from agriculture. Furthermore, women constitute 61% of the agricultural workforce. The country's agricultural potential is estimated at 62% of the total area, but only 7% of the area is currently cultivated (CIAT; World Bank. 2017). Of the 3 million hectares of land with potential for irrigated agriculture, only 118,000 hectares were equipped for irrigation in 2015 and only 62,000 ha (52%) were being used for irrigated agriculture (CIAT; World Bank. 2017). The country's National

Development Strategy (2015-2035), the Green Economy Action Plan (2013-2030), the National Climate Change Adaptation and Mitigation Strategy (2013-2025), identify the agriculture sector as essential for the reduction of poverty and to stimulate economic growth, as well as that which represents the greatest potential for adaptation and emission reduction, through the promotion of resilient production techniques and systems.

Basic food production is dominated by cereals such as maize, sorghum, millet and rice. Rice production has shown great expression in recent years with the expansion of national production on a commercial scale. In relation to cash crops, cotton, sugarcane and tobacco are the most expressive crops both in terms of covered area and production volume. Rice production is carried out in irrigated areas and floodplains. Rice is the third most important crop in the cereals group, having increased the cultivated area from 200 thousand hectares in 2006 to 300 thousand hectares in 2012, despite the national potential being around 900 thousand hectares.

Agriculture in Mozambique is mainly dominated by the family sector of wich the production is subsistence-oriented, rainfed, and highly vulnerable to climate variability. In terms of farm size, approximately 72% of the country's farmers work on parcels of land that do not exceed 2ha, using limited amounts of inputs and extensively practicing slash and burn (CIAT; World Bank. 2017). Livestock production and burning of savannas represent two main sources of greenhouse gas (GHG) emissions in the agricultural sector.

Livestock production is a relevant activity in the agricultural sector. Animal husbandry is a component of diversification of peasants' livelihoods, constitutes a source of income and an economic reserve, contributes to the balance of production systems, to increase agricultural production, with animal traction and manure, and for the food security of families, playing a social role in rural communities. Livestock production is mainly carried out by the family sector for subsistence (mainly small animals such as goats, rabbits, chickens, ducks), but large-scale production has been increasing in recent years, mainly livestock (beef, pig, goats and sheep), broiler chickens and egg production.

Although agriculture is the economic base of the majority of the population in the country, it is constrained by low soil productivity; biotic and abiotic factors, such as the high pressure of pests, diseases and weeds, and irregularity and scarcity of precipitation, respectively; low use of inputs (fertilizers, pesticides and improved seed) and low level of use of appropriate technologies. Other factors that also contribute to low productivity include poor agronomic practices and insufficient extension services due to low geographic coverage.

1.6.2. Forests

Mozambique has a considerable area of natural forests and other woody formations, mainly of the Miombo, Mecrusse and Mopane types. These dry tropical forests are subject to a high rate of deforestation and degradation, due to their fragility and high demand for goods and services to which they are subject and the fact that they are the main livelihood of the poorest population (MITADER, 2018).

The 2007 national forest inventory (Marzoli, 2007) estimated the country's forest cover at just over 50%, that is, just over 40 million hectares of forests and other woody formations. Of this area, about 67% (26.9 million hectares) correspond to productive forests. More recently, a new forest inventory (MITADER, 2018) verified a decrease of 21% in the total forest area and 36% in the productive forest area, compared to the 2007 inventory.

Although deforestation rates are variable, the pressure to convert forests to other uses has reduced by 30% from 2013 to 2018 (MITADER, 2018), and it is expected that reduced deforestation and increased afforestation will lead to larger areas of forests and greater carbon storage, allowing for increased wood production, employment and income.

Deforestation and forest degradation in Mozambique are estimated at 12 $MtCO_2$/year of CO_2 emissions in the period between 2000 and 2012 (CEAGRE & Winrock International, 2016). The main cause of deforestation, with about 7.8 $MtCO_2$/year (65% of total emissions) is the conversion of forests to shifting agriculture. The other important causes are urban expansion and infrastructure (1.4 $MtCO_2$/year; 12%), logging (0.9 $MtCO_2$/year; 8%) and firewood and charcoal (0.8 $MtCO_2$/year; 7%). Reforestation in Mozambique is still in its infancy, even recognizing its role in reducing pressure on natural forests. Although there is a potential area of around 7 million hectares for planting fast-growing exotic species, only close to 60,000 ha are planted, mainly with species of the Eucalyptus and Pinus genera (DNTF, 2015).

1.6.3. Fisheries

The Mozambican coastline has an extension of about 2,700 km, and several fishing resources can be identified. According to the Fisheries Master Plan (2010-2019), it is estimated that the potential of fishery products in Mozambique is around 332,000 tonnes, the main resources being shallow water shrimp (in the Sofala Bank and in the Maputo Bay), deep-sea crustaceans (in the continental slope of the central and southern zone), horse mackerel/carapau and king mackerel/cavalla (in the Sofala Bank) and demersal fish (in the southern and northern zone).

It is estimated that the fisheries sector contributes about 4% to GDP (MIMAIP, 2016) through the export of shrimp, prawns and other fishery products, with a global production of about 151,000 tons per year from fishing marine and inland waters (Ministerial Diploma No. 161/2014 of 1 October). Fisheries contribute to food security and especially by providing about 50% of the animal protein consumed in the country (MIMAIP, 2016). Therefore, a breakdown in fisheries-based ecosystems and resources will have severe socio-economic implications.

Climate change risks to marine and fisheries resources include increased temperature, precipitation and sea level, coastal storms and acidification of estuaries. This can deplete fish stocks, alter markets and influence tourism in the marine environment.

1.7. Energy

The energy sector has registered, over the last two decades, significant growth, both in terms of production and demand. Despite the consumption of modern energy sources showing a notable evolution, particularly the consumption of electricity and gas, biomass from forestry sources continues to be the most important source of energy used in the country (ME, 2012). Indeed, it is estimated that around 77% of Mozambican households depend on biomass, mainly charcoal and firewood, to meet their energy needs (Mahumane & Mulder, 2016).

This reality is due to the fact that the majority of the population in rural areas (estimated at around 70%) resort to the use of firewood to satisfy their cooking and water heating needs, while in the urban area, of which the population numbers come from growing at a fast pace, it uses charcoal for cooking, despite the rising price of this form of energy and the negative impacts associated with it. It should be noted that, according to the preliminary results of the last census carried out by the National Institute of Statistics, the urban population represents approximately 32% of the country's total (INE, 2018).

1.7.1. Electricity

In terms of electricity production, it should be noted that Mozambique has a generation capacity much higher than its domestic consumption. The Cahora Bassa Hydroelectric Power Plant (HCB), with an installed capacity of 2,075 MW, is the main source of electricity generation in the country. Of the total capacity of HCB, 500 MW is dedicated to the country, consisting of 300 MW of firm energy and 200 MW of non-firm energy. The rest of the capacity, around 1,500 MW, is destined for export to South Africa. The total capacity for national consumption is 1,045 MW, which represents the sum of the capacity allocated by HCB (500 MW) and other generation plants, while the total capacity for export to neighboring countries is 1,860 MW, which is the sum of the HCB capacity for export and that of other emerging sources, natural gas (ALER, 2017).

Regarding the electricity generation mix, 90% is from hydroelectric sources, with the remaining 10% coming mainly from natural gas. Figure 1.13, taken from the most recent strategy of the company Electricidade de Moçambique, illustrates the projection of the country's supply and demand; according to the firm, paradoxically, it is expected that the country will face an energy deficit around the year 2020 and that, according to the Integrated Master Plan for energy production, after 2021 there will be a surplus of electricity production that could be marketed at competitive prices in the regional market (EDM, 2018).

A recent study on the potential of renewable energy in Mozambique (Atlas de Energias Renováveis, 2014) indicates that the country has a huge potential for energy production, with an estimated capacity of around 23,000 GW of solar resources, followed by hydroelectric sources with 19 GW, wind potential with 5 GW and biomass resources estimated at 2 GW. From this potential, the government has identified priority projects for the exploitation of these resources, locally, including the possibility of injecting the energy generated into the national grid. In this context, the priority projects identified include the production capacity of 5,645 MW for hydroelectric sources, 600 MW for solar, 1,146 MW for wind, 128 MW for biomass and 20 MW for geothermal energy. The Atlas also highlights the need for adequate financing schemes for the effective implementation of these projects. Access to renewable energy represents an important contribution, especially for the socioeconomic development of communities that are far from the national electricity distribution grid, as well as in mitigating climate change, through the sustainable use of biomass resources.

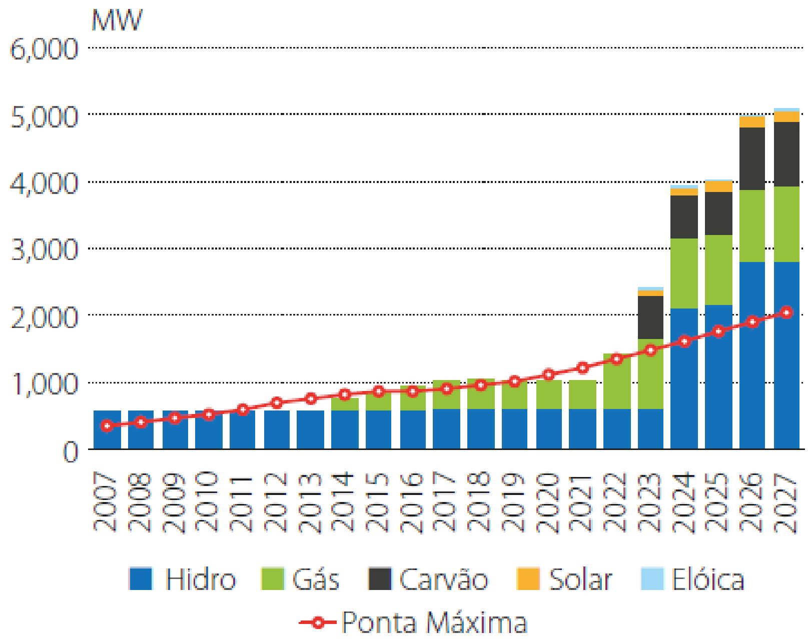


Figure 1.13:Projection of supply and demand (maximum tip) of Mozambique.

Source: EDM 2018.

Despite the remarkable efforts being carried out by Electricidade de Moçambique company, in the electrification domain across the country, with an average of around 120 thousand new connections made per year in the last 15 years, the current coverage is of only 25.9% (EDM, 2015). In fact, this is the average rate of access to electricity, which varies for each province, with the lowest rate in the provinces of Cabo Delgado, Niassa and Zambézia, with around 12% each and higher, in the city of Maputo, with a level of 92% (MIREME, 2018). The high level of dependence on biomass resources for energy purposes has serious implications for the health of the population and the environment. On the other hand, the current electrification rate represents a huge challenge for achieving the Sustainable Development Goals (SDGs), namely the seventh goal, according to which "until 2030, universal, reliable, modern and access must be ensured. affordable prices for energy services" (UN, 2015).

1.7.2. Oil and Gas

The consumption of liquid fuels grew at an average rate of 6% per year, and from 2009 it reached a growth rate of 15% per year, on average. The transport sector is responsible for the largest portion of this increase, followed by the industrial sector. The consumption of petroleum products almost doubled in the period 2000 - 2011. Natural gas production in Mozambique has grown on average by 5.3% per year since 2006. Around 95% of the natural gas produced is exported to South Africa.

Over the last decade, the energy sector has continued to grow significantly. With the increase in the exploration and consumption of natural gas in the country, new players emerged, especially from the private sector, in the area of electricity production, independent energy producers (IPP's) that have been expanding the national production capacity, which currently stands at 2,724 MW (EDM, 2018).

The approval of the Natural Gas Master Plan, by the Government, in 2014, aiming at the massification of the natural gas produced in the country, has boosted the increasing use of this resource, not only in the production of electricity, but also in the industrial sectors, services and road transport, although still at low levels. Natural gas also represents an opportunity to diversify the mix of energy forms used in Mozambique, making an important contribution to industrial and socio-economic development. In turn, the consumption of liquid fuels, diesel and gasoline has doubled, mainly due to the increase in the national car fleet which, with 287.951 vehicles in 2010, almost tripled in less than ten years to 782,757 vehicles in 2018 (INE, 2011 & 2018). It should be noted that part of these fuels is used in the extractive industry, which is an emerging sector with significant growth in electricity generation.

1.8. Industry

The industrial sector has played an important role in the Mozambican economy. Since national independence, this sector has contributed significantly to GDP. Based on this contribution, integrated industrialization is identified as one of the bets of the Mozambican government to promote national development (END, 2014).

It is important, however, to point out that the Mozambican industrial sector is mostly made up of micro-enterprises and by others of small dimension which, together, account for more than 90% of the industrial park. Micro-industries account for around 63% of the sector, small 31%, medium 3% and large 3% (PEI, 2016).

In terms of employment, large companies are the ones with the greatest weight with 71%, followed by small companies with 16%, medium companies with 8% and, lastly, micro-enterprises with 6%. Large companies are also the ones that move the largest volume of business with a total of 69%, followed by micro-enterprises with 21%. Medium and small companies only move turnover of around 5% and 4%, respectively.

Regarding the sectors that contribute the most to Mozambican industrial production, from the observation of Figure 1.14, it is noted that the metallurgical industry has the greatest weight with a 35% contribution, followed by the food industry with 25%, the beverage industry with 13 %, non-metallic minerals industry with 10%, tobacco industry with 8%, and other industries with 9%.

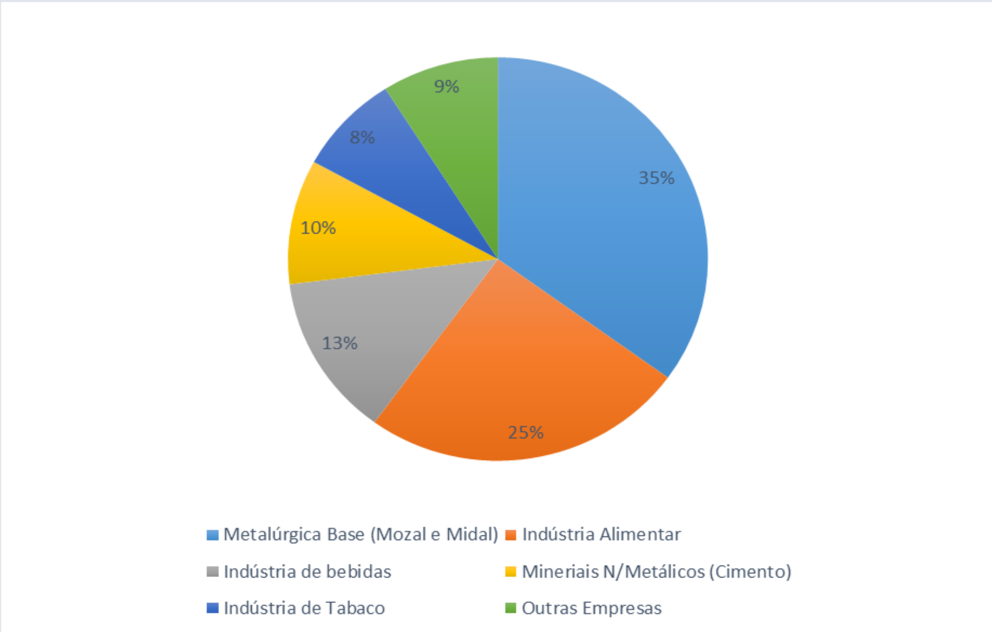


Figure 1.14: Main Industrial Sectors in Mozambique

Among the industrial products manufactured in the country, the top ten (10) with the greatest weight in the value of production in this sector are aluminum with a contribution of 31.7%, non-agglomerated coal (coal) with 25.1%, natural gas (8.2%), beer with alcohol (7.2%), sugar (5.6%), cement (5.5%), non-ferrous metal ores and concentrates (5.1%), wheat flour (3.6%), bars, non-alloy aluminum profiles (2.6%), and soft drinks (2.4%) (INE, 2017).

Although the industrial sector (including mining, construction, electricity, water and gas) contributed around 11% of GDP in 2014, it has shown remarkable growth in recent years, as illustrated in Figure 1.15 (Deloitte 2016). This growth has been thanks to the development and expansion of the industrial sector, which highlights the entry into operation of large and medium-sized companies, for example, in the production of cement (LIMAK - Maputo, Cimentos da Beira, Cimentos de Cabo Delgado, Maiaia Cements – Nacala); soft drinks (expansion of the Coca-Cola soft drink plant); meat processing (INALCA), in Maputo; wheat milling (Pembe Mozambique); manufacture of steel structures (Martifer) and Merec Nacala (wheat milling) in Nampula, G.S. Beverages (soft drinks and water) - Zambézia, ETG Group (processing pigeonpea and sesame) in Nampula and Sofala, and Espiga D'ouro (Breadmaker); Beauty (processing synthetic fiber to obtain artificial hair), Heineken (Beers) and Xinavane Sugar Refinery.

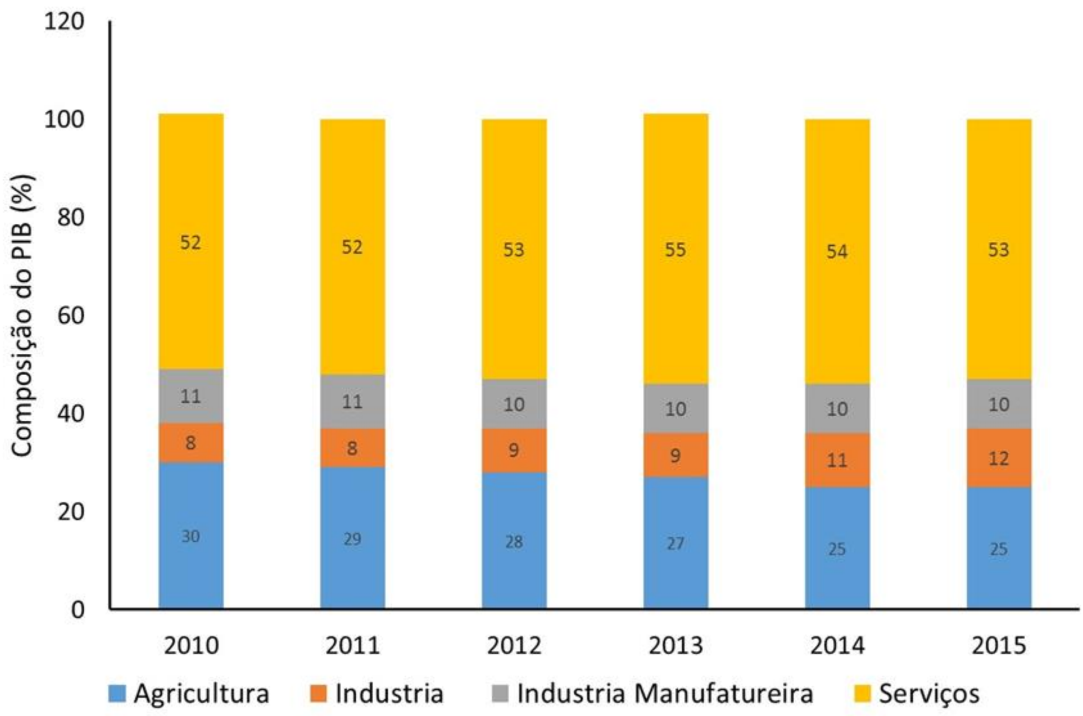


Figure 1.15: Contribution by sector of activity, 2010-2015

Source: Deloitte (2016)

Alongside the manufacturing industry, the extractive industry in Mozambique is also expected to experience substantial growth in the near future, as a result of the discovery of natural resources such as gas, coal, graphite, iron ore, limestone, ilmenite, rutile, graphite, zircon, among others. Among these products, those that present an immediate growth potential are coal, of which the production increase is projected for 2016 to 2025, natural gas projected for 2021 to 2028, as well as iron of which the mining starts in Tete, is also coming soon (USGS, 2015).

Given the great potential that industry, as a whole, represents for the national economy, during the preparation of the 2016-2025 Industrial Policy and Strategy, some sub-sectors were defined as priorities, namely, food and agro-industrial; clothing, textiles and footwear; non-metallic minerals; metallurgical and metal products manufacturing; wood and furniture processing; chemicals, rubber and plastics; paper and printing. However, to make this possible, it is important to develop activities or strategies, such as public-private partnerships, creation of industrial free zones, among other initiatives that, when articulated with the Government's Five-Year Programs, can promote industrial development in Mozambique.

1.9. Biodiversity

Mozambique is characterized by an abundance of natural resources and considerable biological diversity, which support a great diversity of species (flora and fauna). The country has four groups of important natural ecosystems: (i) terrestrial ecosystems, (ii) marine and coastal ecosystems, (iii) inland water ecosystems and (iv) coastal ecosystems. These encompass considerable biological diversity estimated at more than 6,000 plant species and 4,200 animal species (3,075 insects, 726 birds, 214 mammals, 171 reptiles and 85 amphibians). There is also a considerable agricultural and livestock production potential and diversity, which is distributed in 10 agro-ecological zones. In terms of coastal and marine biodiversity, 194 species of coral, 9 plant species of mangrove, 13 of marine meadows, 5 of turtles, 18 of marine mammals (seven species of dolphins, 8 of whales, 2 of seals and 1 species of sea) are recorded. dugong), 2,626 species of sea fish (800 species associated with coral reefs, 92 cartilaginous fish) and 1,363 species of molluscs. The biodiversity of inland waters is equally recognizable, notably Lake Niassa and the Zambezi Delta.

Recognizing the importance of biodiversity conservation, Mozambique ratified the Convention on Biological Diversity (CBD, Resolution No. 2/94) and signed the Cartagena Protocols on Biosafety on Genetically Modified Organisms (Resolution No. 11/2001) and the Nagoya on Access and Fair and Equitable Benefit Sharing, (Resolution No. 2/2014). The country's socioeconomic characteristics also give it a peculiar situation in terms of biodiversity conservation. In fact, more than half of the Mozambican population, estimated at 28 million inhabitants according to the results of the last census in 2017; 66.6% of the population of this country lives in rural areas (INE, 2019). Like other developing countries, the Mozambican population, especially the rural, depends on natural resources for their survival.

At the national level, in 2003, Mozambique embarked on the development and implementation of the National Strategy and Action Plan for the Conservation of Biological Diversity (2003-2010) and this was updated for the period 2015 – 2035. Given the transversal nature of conservation of biodiversity, the national legal framework is characterized by a diversity of instruments that govern activities related to biodiversity, including, among others, the Land Law (law 19/97), the Environment Law (Law nº 20/1997), the Fisheries Law, the Forests and Wildlife Law (Law 10/99) and the Conservation Law (Law 16/2014), in addition to a series of regulations associated with these laws (e.g. Regulation on Impact Assessment Environmental Regulation, Forestry and Wildlife Regulation and General Regulation of Maritime Fishing Activities). Although some of these instruments need to be improved, consolidated and their implementation strengthened, the existence of this diverse legal basis that contributes to the conservation of biodiversity is to be praised and valued.

For the materialization of the above mentioned instruments, the country has bet on conservation measures, mainly *in-situ*, which is demonstrated by the fact that 26% of the national territory is covered by Conservation Areas (CAs), being 13 terrestrial areas and 2 seascapes. In recent years, three National Reserves, a National Park and several wild and community farms have been created. Biodiversity is fundamental in Mozambique for economic development in general, as 90% of rural energy comes from firewood and charcoal and more than 80% of the population uses the goods and services offered by biodiversity for their survival. Biodiversity values can be analyzed within the following categories:

- Forest resources (timber and non-timber) and wildlife;
- Fishery resources;
- Agricultural and livestock resources
- Tourism resources
- Mineral resources.

The main threats to biodiversity in Mozambique are human activities, constituted mainly by land use change that results in loss or reduction of biodiversity and operate at various spatial scales. Among the various threats, those that are directly or indirectly linked to climate change (mitigation), due to deforestation stand out; forest fires, mining (coal and heavy sands), agriculture (mainly large-scale commercial), forests (forest plantations of exotic species and selective logging).

1.10. Health

The GovM is committed to the Sustainable Development Goals (SDGs) and Universal Health Coverage, defined as ensuring that all people have access to health services for the preventive, curative and rehabilitative reasons they need, sufficient quality to be effective, also ensuring that they are not exposed to financial difficulties when paying for these services. The right to health is embraced along with other human rights in the Mozambican legal framework. The Ministry of Health (MISAU) leads efforts to protect, promote and restore the health of the population, with an emphasis on ensuring that the health system is accessible to all, taking into account the elements of availability, accessibility, acceptability and quality.

Extreme weather events such as cyclones and floods are often associated with loss of human life, socioeconomic damage, isolation of communities, human suffering, loss of assets, destruction of critical infrastructure (eg, health facilities, schools, access roads, etc.) and other indirect losses. Additionally, these events have other negative health consequences, eg leaving health facilities without water, sanitation systems or energy; they can block access routes to health facilities; interrupt the cold chain of vaccines, reagents and some drugs; destruction of warehouses and containers for sanitary consumables; cause delays and absences of health personnel, etc.

Extreme climate-related events that frequently occur in Mozambique, such as tropical cyclones, floods and droughts, often cause epidemic outbreaks such as cholera, diarrhea and malaria; bringing enormous challenges to the health sector. Ongoing climate change has the potential to increase vector-borne diseases, food insecurity, hunger and malnutrition. However, the combined effects of biophysical and socio-economic factors on human health and disease and the capacity needed to manage and respond to these challenges are uncertain.

MISAU, in partnership with WHO, in 2019, conducted a country-wide assessment of the health sector's vulnerability and adaptation to climate change. The study has developed a district-scale vulnerability assessment methodology that can serve as the basis for a sustainable model for assessing and monitoring the vulnerability to climate change of the health sector in Mozambique that is regularly updated. This study will serve as a basis for the preparation of the Adaptation Plan for the Health Sector in the country.

1.11. Tourism

The country has a great diversity of natural resources, which are potentially attractive for tourism, especially the international level. Additionally, Mozambique has a coastline of about 2,700 km and this makes the tourism offer in the sun and beach tourism modality the greatest attraction from an international point of view and, somehow, domestic tourism also has a preference for this modality.

Mozambique is cyclically affected by floods and cyclones with severe impacts on the tourism sector. The floods mostly affect the lowland regions and some Mozambican cities are located in low-lying areas, putting at risk urban tourism, which is widely practiced due to the availability of infrastructure to support tourism in these cities (hotels, restaurants, nightclubs, meeting lounges and other similar events, communication, security, pharmacies, convenience stores, etc.). Tropical cyclones and sea level rise have been a major threat to the country's tourism infrastructure, with very high economic losses.

Therefore, the ongoing climate change imposes on tour operators, State institutions, firms, local communities, tourists and the world in general, increasingly demanding challenges in order to make the tourist activity more sustainable. All tourist activities should be planned taking into account the occurrence of extreme weather related events.

1.12. National priorities

Mozambique has established its long-term National Development Strategy (ENDe) for the period 2015-2035. The main objective of ENDe is to “improve the living conditions of the population through the structural transformation of the economy, expansion and diversification of the productive base”.

The following are priority areas for national development:

- Agriculture
- Fisheries
- Manufacturing industry;
- Mineral extractive industry; and,
- Tourism industry.

The development pattern adopted by ENDE assumes that the industrialization process plays a crucial role in boosting the economy “by boosting the development of the main sectors of activity (agriculture and fisheries).

1.13. Institutional Arrangements

The Institutional arrangement emerges as an approach for better coordination and articulation between the various institutions/sectors. It aims to assign hierarchical responsibilities and competences as well as define standards/criteria for the flow and sharing of information. As a result, it is expected that climate change adaptation and mitigation actions will be implemented effectively, transparently, coordinated, and reinforcing the planning processes of medium and long-term actions. The institutional arrangement is based on the National Strategy for Adaptation and Mitigation to Climate Change in Mozambique (MICOA, 2012) and the First Updated NDC of Mozambique 2020 - 2025 (MTA, 2021).

The institutional arrangement presented in Figure 1.16 was taken from the Mozambique PNDCA 2020 – 2025, launched on 1 November 2021, on the sidelines of COP 26, by His Excellency Prime Minister and developed within the scope of the Initiative for the Transparency of Climate Action – ICAT.

This institutional arrangement for the MRV has two main subsystems: (1) For Measurement and Reporting and (2) For Verification, both organized by the coordinating institution, which is currently the MTA, through the DMC. The institutional arrangement also includes the 17 sectors, the Private Sector, Civil Society, NGOs, GIIMC, Academy and Council of Ministers (MTA, 2021).

According to the Institutional Arrangement for Mozambique's MRV System, all sectors included in the Measurement and Reporting subsystem are responsible for measuring and reporting the implementation of mitigation and adaptation actions included in the ENAMMC, in particular the NDC, including the support needed and received. Still considering the Arrangement, the sectors are represented by the ministries and are responsible for collecting data on activities implemented internally and by other institutions, including the private sector, civil society and NGOs. Sectors may also use information published in statistical yearbooks, published by the institution responsible for national statistics. The private sector is composed of private companies, and civil society, includes associations, such as the Association of Municipalities, which have data for the calculation of GHG emissions and removals, are responsible for the implementation of ENAMMC's activities, in particular the actions of the NDC, thus having the data to monitor the actions of the NDC and/or to inform about the resources needed and received. NGOs include organizations that work with assessment of climate change activities and promote their implementation, so they also become primary data holders.

All sectors that are responsible for reporting on the implementation of activities provided for in ENAMMC, particularly NDC actions, GHG emissions and removals, necessary and received support and the Coordinating Institution will receive technical support from the academy. The academy is also responsible for supporting the elaboration of documents on climate change, providing technical support and training to sector specialists, as well as developing research to support the MRV System. The Coordinating Institution will be responsible for compiling the CNs, GHG Inventories, BUR that should be replaced by the BTR by the end of 2024. After compilation, the Coordinating Institution will send the reports to the Statistics Sector to verify the statistical procedures; and to the Academy to verify the methods for calculating emissions and removals and the indicators. The reports verified by the Statistics Sector and Academia shall be subsequently submitted for verification and validation by the GIIMC. Afterword, the Coordinating Institution will submit the reports to the decision-making bodies of the MTA, to CONDES and, finally, to the Council of Ministers for verification and approval before submission to the UNFCCC.

Then, the key institutions are listed, containing the description of roles and responsibilities, related to the functions of proposing policies, strategies and decision-making, coordination, advice and knowledge management, planning, communication, mobilization of support, implementation of actions as described in Table 1.6.

Figure 1.16: Institutional Arrangements for the Strengthened Framework for Climate Transparency, adapted from MTA (2021).

Table 1. 6: Key institutions relevant for Adaptation and Mitigation to climate change and their respective responsibilities

Ministry/Institution	Responsibilities
Ministry of Land and Environment (MTA): National Directorate of Climate Change (DMC)	The Ministry of Land and Environment (MTA) is responsible for developing proposals for the implementation of policies, legislation and strategic decisions in the environment sector, as well as the preservation of conservation areas considering climate change. In order to respond to its functions related to climate change, the Ministry has the following powers: (1) to promote and coordinate the implementation of activities that guarantee the fulfillment of the commitments assumed under the United Nations Convention on Climate Change; and (2) monitor, supervise and evaluate climate change adaptation and mitigation actions, as well as the support needed and received, and report to the government on the implementation of mitigation and adaptation actions. Among other directorates, the MTA has the National Directorate for Climate Change and the Directorate for Planning and Cooperation. The National Directorate of Climate Change is responsible for coordinating all activities related to climate change and the Directorate of Planning and Cooperation is responsible for making statistics and coordinating cooperation with other institutions. In addition, the MTA is a focal point for organizations and commitments made in the context of climate change, such as, (1) UNFCCC and IPCC, (2) GHG Inventories, (3) gender and climate change, (4) Political Focal Point and GEF Operational; and (5) National Entity for the Clean Development Mechanism of the Kyoto Protocol
Ministry of Mineral Resources and Energy (MIREME)	The Ministry of Mineral Resources and Energy has several attributions aimed at the development of the energy sector, the exploration and preservation of mineral resources relevant to the development of the institutional arrangement of the Robust National MRV System. These attributions include the development of policies and legislation for the sector, research and management of mineral resources, as well as the promotion and monitoring of the development of the sector. Among other directorates, the ministry has a Directorate of Planning and Cooperation, which is responsible for (1) monitoring the execution of investments, (2) organizing and updating statistics on the mineral resources, fuel and energy sector and communicating to interested parties, and (3) coordinate and follow up on negotiations, establishing agreements with other institutions.
National Institute of Meteorology (INAM)	The National Institute of Meteorology is responsible for making the weather forecast. The National Institute of Meteorology, together with the Regional Water Administrations, informs the National Institute of Disaster Management about the eminent Climatic Disasters.
Ministry of Public Works, Housing and Water Resources (MOPHRH)	The Ministry of Public Works, Housing and Water Resources is responsible for proposing, implementing, monitoring and supervising policies and strategies for infrastructure development and water resources management. The ministry also has a Planning and Cooperation Directorate, which is responsible for coordinating the preparation and dissemination of activity reports in the public works, housing and water resources sector.

Ministry/Institution	Responsibilities
National Institute for Disaster Risk Management and Reduction (INGD)	disaster prevention and management actions, through the National Institute for Disaster Management. The ministry also has a Planning and Cooperation Directorate responsible for (1) controlling and evaluating the execution of plans and programs and preparing the respective reports; and (2) participate, when requested, in the preparation of conventions and cooperation agreements.
Ministry of Economy and Finance (MEF)	The Ministry of Economy and Finance is responsible for the management of State assets and holdings. This ministry has three Directorates that can be used for the development and operationalization of the Robust National MRV System, the National Directorate of Planning and Budget, the Directorate of Cooperation and the National Directorate of Monitoring and Evaluation. In accordance with the responsibilities of the Ministry, these Directorates ensure the integration of the NDC's actions in the Economic and Social Plans and in the State Budget, including the monitoring and evaluation of these, as well as providing information on financial resources mobilized from international entities and allocated to the actions mitigation and adaptation to climate change. In addition, the MEF is the National Authority for the Green Climate Fund.
National Institute of Statistics (INE)	Develop statistical database on the impacts of climate events and vulnerability reduction.
Ministry of Health (MISAU)	The Ministry of Health is responsible for proposing, monitoring the implementation of policies and strategies for the health sector. The Ministry of Health also has a Planning and Cooperation Directorate that is responsible for conducting statistics, which include the collection, analysis and forecasting of data that can serve as a data source for the Robust National MRV System.
Ministry of Gender, Children and Social Action (MGCAS)	The Ministry of Gender, Children and Social Action is responsible for proposing, monitoring the implementation of policies, strategies to promote gender equality and equity in economic, social, political and cultural development, including social assistance to people and households in situations of poverty and vulnerability, namely, women, children, the elderly, people with disabilities and people with chronic degenerative diseases. The ministry has a Planning and Cooperation Directorate that is responsible for collecting, centralizing and systematizing statistical information on the sector's target groups and coordinating the assessment of the impacts of sectoral programs. The Planning and Cooperation Directorate is also responsible for coordinating cooperation with other institutions.
Ministry of the Sea, Inland Waters and Fisheries (MMAIP)	The Ministry of the Sea, Inland Waters and Fisheries is responsible for the management, operational supervision of Sea and Inland Water resources and ecosystem preservation. This Ministry has a Directorate of Studies and Planning which is responsible for planning, making statistics and studies. This direction has the Department of Monitoring and Statistics which is responsible for statistics that can be a source of data for the institutional arrangement of the Robust National MRV System.
Ministry of Science and Technology	The Ministry of Science, Technology and Higher Education is responsible for proposing, implementing, monitoring and supervising policies and strategies for the development of science and technology through research and higher education. As a coordinating

Ministry/Institution	Responsibilities
	institution for the development of research and higher education, it is responsible for including climate change content in teaching and promoting research on related subjects. MCTES is the national entity for the development and transfer of technologies, and is responsible for approving technology transfer projects related to climate change.
Ministry of Agriculture and Rural Development (MADER)	The Ministry of Agriculture and Rural Development of Mozambique (MADER), among other Directorates, has (1) Planning and Policy Directorate and (2) Cooperation and Markets Directorate. The mandate of the Directorate of Planning and Policies includes (1) identifying, formulating, monitoring and evaluating guidelines, policies, strategies, programs, plans, projects and preparing technical and economic feasibility opinions and (2) producing and publishing statistics that allow the evaluation of the implementation of agricultural and rural development activities. Meanwhile, the Cooperation and Markets Directorate includes in its responsibilities the responsibility of (1) ensuring the harmonization of sectoral policies, legislation and strategies within the national, regional and international frameworks. The Ministry of Agriculture and Rural Development of Mozambique (MADER), among other Directorates, it has (1) Planning and Policies Directorate and (2) Cooperation and Markets Directorate. The mandate of the Directorate of Planning and Policies includes (1) identifying, formulating, monitoring and evaluating guidelines, policies, strategies, programs, plans, projects and preparing technical and economic feasibility opinions and (2) producing and publishing statistics that allow the evaluation of the implementation of agricultural and rural development activities. While, the Cooperation and Markets Directorate includes in its responsibilities the responsibility of (1) ensuring the harmonization of sectoral policies, legislation and strategies within national, regional and international frameworks, (2) and participating in intergovernmental and non-governmental meetings at national and international level. In addition, MADER is the Political Focal Point of the GEF and its Operational Focal Point, through FNDS.al, (2) and participates in intergovernmental and non-governmental meetings at national and international levels. In addition, MADER is the Political Focal Point of the GEF and its Operational Focal Point, through the FNDS.
Ministry of Transport and Communications (MTC)	The Ministry of Transport and Communications is the central body of the State which, in accordance with the principles, objectives, priorities and tasks defined by the Government, directs, coordinates, plans and ensures the execution of policies, strategies and activity plans in the areas of transport. road, rail, waterway, air, port and airport infrastructure, communications and meteorology.
Ministry of Industry and Commerce (MIC)	The Ministry of Industry and Commerce is responsible for developing proposals and monitoring the implementation of policies and strategies aimed at the development of industry, commerce and services. The Ministry has a Planning and Studies Directorate that can facilitate the development of the institutional arrangement. Among other responsibilities, the Planning and Studies Directorate has to (1) lead the development of statistics, including: data collection, processing and forecasting; and (2) participate in defining the statistical indicators needed to monitor its activities.

Ministry/Institution	Responsibilities
National Sustainable Development Fund (FNDS)	Gather and manage funding that promotes sustainable development and climate resilience.
Ministry of State Administration and Public Service (MAEFP)	The Ministry of State Administration and Public Service (MAEFP) is the central body of the State apparatus which, in accordance with the principles, objectives and tasks defined by the Government, is responsible for the organization, operation and inspection of Public Administration, prevention and management of disasters, as well as the strategic management of the State's human resources

On the other hand, these entities play a key role in their contribution to:

- Harmonization of national actions and priorities considering the interests of different sectors and entities;
- Appreciation and technical approval of documents prepared in the country, in the context of the implementation of the Convention and other related instruments;
- Preparation of national and international climate reports; and,
- Development of local initiatives for adaptation and mitigation to climate change, as well as promotion and continuous establishment of capacities, through studies and development of relevant training courses.

1.14. Challenges

Despite the existence of a robust system of structuring coordination, the issue of institutional arrangements still presents some challenges:

i. Need to strengthen and institutionalize the climate change coordination mechanism in Mozambique (in particular the formalization of the GIIMC) to ensure that the country responds, in a timely and effective manner, to the commitments assumed as well as to explore financial opportunities, technology transfer and capacity building established by these instruments in the realization of national priorities;
ii. Limited engagement related to intersectoriality and articulation of different sectors;
iii. Need to improve understanding of common and general concepts/issues across sectors on climate change;
iv. Weakness in the production of reliable data inherent to climate change response challenges;
v. Lack of data and information with adequate frequency and scale which in turn represents a strong barrier to determine the real impacts of climate change;
vi. Lack of a common and accessible climate change database platform;
vii. Deficient production and statistical analysis of information;
viii. Lack of incentives and structural models for monitoring and supervising existing guiding instruments for the efficient and effective control of actions;
ix. Complex interaction between institutions/sectors that suggests duplication of efforts and dualism in the implementation of actions.

Currently, the country is benefiting from the Climate Action Transparency Initiative – ICAT, Phase 2, funded by UNEP – DTU aimed at establishing the legal institutional arrangement for transparency activities based on the Phase I roadmap and recommendations; and, ensure sustainable capacity development efforts in the country, through the formulation of training programs involving the Climate Change Network and focusing on monitoring NDC policies and actions and GHG inventories and reporting on received and required support.

1.15. Institutional arrangements for the preparation of the BUR and for REDD+

The overarching institutional arragements described above, including their strengthening towards the transition to the Enhanced Transparency Framework under the Paris Agreement, encompass and are complemented by specific arrangements made for the prepapration of the BUR and for monitoring, reporting and verifying the results of REDD+, in accordance with the respective modalities, procedures and guidelines (MPGs).

The information on domestic measurement, reporting and verification as requested by the MPGs for the elaboration of the BUR, can be found in Section 3 – Mitigation - of the First Biennial Update Report of Mozambique.

The description of the national forest monitoring system and the institutional roles and responsibilities for measuring, reporting and veryfing the results of REDD+, can be found in chapter 5 and in Annex 3 of the REDD+ Technical Annex to the first BUR.

2. Chapter 2: National Greenhouse Gas Inventories

2.1. Introduction

Mozambique submitted its First National Communication in 2006, including the First National Greenhouse Gas Inventory in 1998, using data from 1990. The First NC reported emissions by sources and removals by sinks, considering the methodologies described in the 1996 IPCC Revised Guidelines.

In 2018, intending to consolidate the process of REDD+, Mozambique submitted a proposal of Forest Reference Emissions Level (FREL) to the United Nations Framework Convention on Climate Change (UNFCCC), responding to decision 1/CP.16, referring to the requests of developing countries with intention to perform activities related to REDD+.

This 2NC GHG Inventories chapter contains estimates of anthropogenic emissions and removals by sinks of all GHGs not controlled by the Montreal Protocol that occurred in the country from 1990 to 2016. The process of preparation of the inventory Chapter is simultaneous with the other five chapters included in the structure of NC to the Convention (steps are in Figure 2.1)

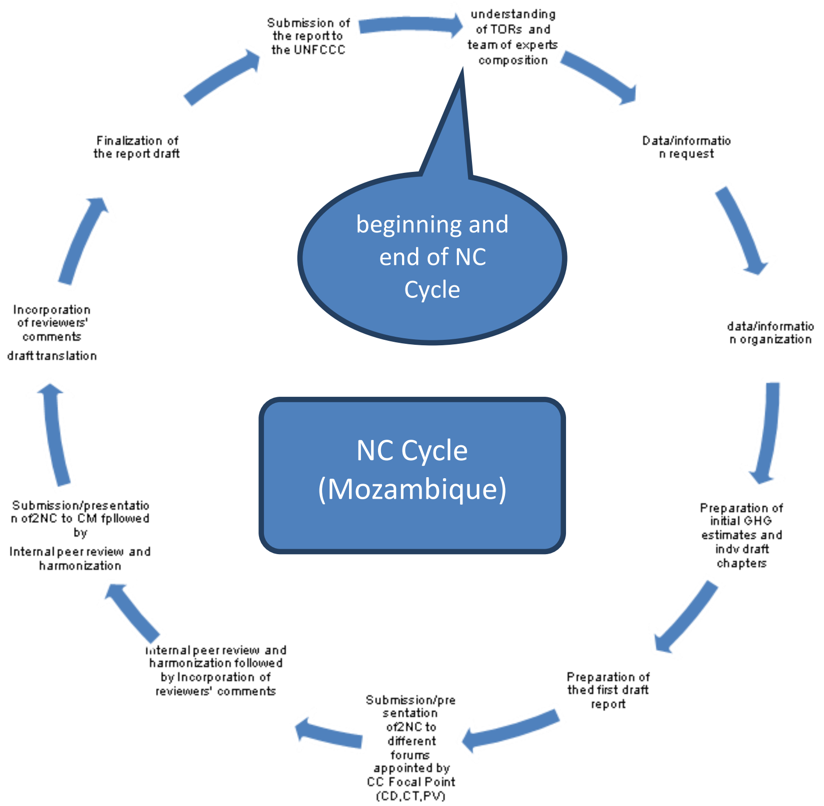


Figure 2.1: NC reporting cycle in Mozambique.

The GHG inventory used the IPCC 2006 Guide (2006 IPCC guidelines for national greenhouse gas inventories), the respective Software, and the 2000 Guide to Good Practices (GPG) and

Management of Uncertainty in National Greenhouse Gas Inventories (IPCC, 2000). The inventory covers sources of GHG emissions from anthropogenic activities for direct GHG, including carbon dioxide (CO_2) and their removals by sinks. Methane (CH_4), and nitrous oxide (N_2O) emissions from fires on Land remained in the same category, conversions to other land use and non-methane volatile organic compounds (NMVOC).

The First and Second National GHG Inventories were used as a basis for Activity Data (AD)information and were updated with additional information collected across sectors. For assessing GHG emissions and removals, the IPCC 2006 *Software was used.* Most of the Emission Factors (EF) used were the *default* by the IPCC 2006values (tier 1). Where there was room for choice, sector experts used their experience to make the best choice for Mozambique's conditions. In sectors or categories where national information on EF was available, Tier 2 were used, to improve the estimation of emissions and removals. Thus, the inventory results were a combination of Tier 1 and Tier 2 and reported in Giga-grams (thousand tons) of each specific gas. Emissions for each GHG have been presented in carbon dioxide equivalent (CO_2eq) terms using the 100-year Global Warming Potentials (GWPs) contained in the IPCC Second Assessment Report (Table 2.1).

Table 2.1: Global warming potential of the leading greenhouse gases

Gas	Symbol	Global Warming Potential (Gg CO_2eq.)
Carbon dioxide	CO_2	1
Methane	CH_4	21
Nitrous oxide	N_2O	310
perfluorocarbons	PFCs	6500/9500

Source: IPCC AR2

2.2. Sectors covered

Anthropogenic emissions of greenhouse gases occur in several activity sectors. Therefore, we estimated the emissions from the following sectors recommended by the IPCC guide: (1) Energy; (2) Industrial Processes and Use of Products (IPPU), (3) Agriculture; (4) Land-Use Change and Forestry; and (5) Waste.

Removals of greenhouse gases occur in the Land-Use Change and Forestry sector due to protected area management and reforestation activities and the abandonment of managed lands.

2.3. Data collection

Data collection was carried out in two phases, as indicated below:

Phase 1: Literature review and stakeholders' consultation

This phase comprised (i) literature review; and (ii) Consultation and data collection in the corresponding central Ministries, some NGOs and the private sector, which, due to their nature and type of work, provided some data that were deemed relevant for the exercise. For example, for industry, specific information was obtained from Mozal, Cimentos de Moçambique, and Cervejas de Moçambique, among others. In this phase, we identified relevant gaps, and corresponding data were analysed and modelled to ensure that each year of the analysis period (1990 to 2016) had some observation. It is worth mentioning that it was not always possible to find the complete information on the requested time series, and sometimes, the information was not in the desired format (units) or level of disaggregation. For example, the FOLU data were in a desirable configuration, as MITADER prepared them in the context of the elaboration of the FREL; however, they only covered the period from 2001 to 2016. When applicable, we performed interpolation and extrapolation in all cases to fill the data gap and ensure time series consistency.

On the other hand, in the case of the energy sector, the data on the use of liquid fuels did not distinguish the type of fuel (gasoline or diesel). Furthermore, despite indicating the sectors, the classification of the sectors was not in line with the sectoral classification for the preparation of the greenhouse gas inventories. In most cases, the data providers do not distinguish if the fuel is for transport, industry or agriculture. These and other constraints were the main challenges to overcome during the data collection process.

This phase culminated with the 1st Sectorial Seminar to share results, assess consistency, control quality, and identify additional data needed. In this process, we relied on expert opinion to reach a consensus on the details required by the IPCC *software.* We agreed with stakeholders on the fuel distribution by sector according to the fuel type. In addition, the proportion of waste type produced by the domestic sector was also discussed and agreed upon.

Phase 2: Field mission in every sectors

Fieldwork was carried out, which consisted of collecting missing data reported in the first phase to guarantee the updating of the results of the previous inventory based on the Revised Guide of the IPCC (1996)[1] to the current one recommended by the 2006 IPCC guide. A team of consultants coordinated the field methodology, and the survey was carried out by

[1] IPCC Revised Guidelines for National GHG Inventories

technicians from the respective sectors who supported the GHG inventory process. It should be noted that in many situations where there were no data, extrapolations and linear interpolations were carried out, as appropriate, to obtain the data necessary for the analysis, as recommended by the IPCC guide for GHG inventories.

This phase culminated with the 2nd Sectorial Seminar to share the results and their validation, estimate uncertainties and their sources, identify key emissions categories, and recalculate emissions applying the IPCC 2006 Guide. Where data gaps were identified, specific notes were made, in each sector, on the type of limitation and the improvement plan, with a focus on identifying and describing what is needed to improve the next Biennial Report using Tier 2 and 3.

2.4. Data analysis

Mozambique's GHG inventory was conducted using a series of steps and a range of data from diverse sources. The estimation of the emissions and removals used a combination of (a) country-specific methods and data, (b) IPCC methodologies, and (c) emission factors (EFs). The methods were consistent with the 2019 IPCC guidelines for national greenhouse gas inventories and are, to the extent possible, in line with international practice. IPCC methodology tiers 1, 2 and 3 were applied. In addition, for each sector (AFOLU, Energy, Waste and Industrial Processes and Use of Products), we performed quality assessment (QA) and quality control (QC) based on the IPCC (2006) AQ/CQ guide, as well as the evaluation of the precision or uncertainty of GHG estimates.

For this inventory, although the assessment covered the years 1990 to 2016, the detailed annual tables are presented for eight years (beginning: 1990; intermediate: 1994, 2000, 2005, 2010, 2012, and 2014; and final: 2016), covering only total emission of each category. The general evaluation for the entire period of analysis and the assessment of trends were presented in a graphic format, contemplating the annual results of each gas.

2.5. Energy Sector

Emission factors of Energy sector

In the absence of local emission factors for estimating emissions from the energy sector, standard emission factors (fuel combustion by source categories - Tier 1) were used, as recommended by the 2006 IPCC Guide. Table 2.2 shows the emission factors used to estimate energy sector emissions by subsector.

Table 2.2: Emission factors used to estimate energy sector emissions.

Type of fuel	Emission Factors (TJ/Unit)
Diesel	43
Gasoline	44.3
Lubricants	40.2
Kerosene	43.8
Jet Kerosene	44.1
Natural gas	44.2
Cooking gas (LPG)	47.3
Firewood/wood waste	15.6
Charcoal	29.5

Activity data of Energy sector

This section briefly describes the activity data used for recalculating GHG emissions for 2000-2004 and estimating emissions for 2005-2016, using the IPCC 2006 methodologies in both cases. The source of the activity data for the first period is the "Report of the National Inventory of Greenhouse Gas Emissions, 1995 – 2004" (MICOA, 2010). From 2005 onwards, we used a combination of data from the national energy statistics from 2000 - 2011 (ME, 2012) and energy balance data from the archive of the Ministry of Mineral Resources and Energy (MIREME) for the period between 2012 and 2016, a period not covered by the statistics mentioned above. MIREME prepares energy balances on an annual basis based on activity data provided by several institutions as the following stand out:

- The Electricity of Mozambique (EDM)
- National Petroleum Company of Mozambique (PETROMOC)
- Hidroeléctrica de Cahora Bassa, SA (HCB)
- National Petroleum Institute (INP)
- National Hydrocarbon Company (ENH)
- National Energy Fund (FUNAE)
- South African gas and oil company (SASOL)
- Matola Gas Company (MGC)
- Mozambican Oil Importer (IMOPETRO)
- Mining companies
- Petrogal SA (GALP)
- Ports and Railways of Mozambique
- Air transport operators
- Construction companies
- Cement companies
- Sugar companies
- Agrarian companies
- Commercial and banking institutions
- Among others
- VidaGas
- Autogas

Table 2.3 summarises the assumptions adopted in estimating the consumption of liquid fuels, namely diesel and gasoline, for the road transport, industry, construction, and agriculture subsectors. We break down the fuel consumption per fuel type to recalculate the emissions for 2000-2004. The emissions were calculated by fuel type: diesel and gasoline – and for the period from 2004 onward. The percentages assigned to each subcategory were kept constant for the entire analysis period, as agreed with sectors in the first Seminar. As this is the first BUR report, we expect these segmentation options to be verified against the data the sector may generate in the coming years. In all categories, there is a trend towards an increase in fuel consumption. The most steeped was gasoline consumption, which almost tripled between 2000 and 2016 due to the rise in second-hand vehicle imports.

Table 2.3: Assumptions adopted for estimating the consumption values of liquid fuels, units [kT]

FUEL	% SHARING	2000	2008	2016
DIESEL		278,734	358,872	675.077
Road transport	90.0	250,861	322,985	607,570
Agriculture (stationary)	0.8	2,230	2,871	5,401
Railways	2.4	6,690	8,613	16.202
Cabotage	0.9	2,509	3,230	6,076
Int.	1.0	2,787	3,589	6,751
Electricity generation	2.4	6,690	8,613	16.202
Industry and construction	2.5	0.44	8,972	16,877
GASOLINE		52,580	91,161	215.100
Road transport	95.0	49,951	86,603	204,345
Cabotage	1.5	0.789	1,367	3,227
Electricity generation	2.0	1.052	1,823	4,302
Agriculture (stationary)	1.5	0.789	1,367	3,227
LPG	-	7,766	13.013	18,658
JET A-1	-	24.22	48,706	21,653
AVGAS	-	0.43	1.074	2,274
FUEL OIL	-	15,466	0.672	3,547
LIGHTING OIL.	-	49,773	17,252	20,876
LUBRICANTS	-			

The "IPCC 2006 Guidelines Manual for Greenhouse Gas Inventories" recommends as a Good Practice the estimation of emissions from the energy sector using two approaches, namely, the sectoral and the reference. This practice allows a comparison of the estimated emissions between both methods. However, due to limited fuel data, it was impossible to calculate emissions using the baseline approach. This limitation consists of the lack of data, mainly on the variation in fuel reserves, non-energetic use of fuels (use as raw material) and information on the re-export of fuels to neighbouring countries. Improving the collection and treatment of this data by the sector will allow the estimation of GHGs using both approaches in future inventory processes.

2.6. *Industrial Processes and Product Use Sector (IPPU)*

We surveyed data in the different subsectors to estimate the emissions corresponding to the industrial processes and product use sector. The survey consisted of identifying the productive activities using the guidelines of the IPCC 2006 Guide. The activities occurred in three (3) of the eight (8) categories in the IPPU sector. We calculated clinker emissions in cement production (mining industry), aluminium in the metal industry, and food and beverages in the other category.

This inventory did not include many IPPU activities areas due to the lack of activity data and information on how the processes occur. The most critical points were the sections on non-energy products from using fuels and solvents. For example, the use of paraffin, solvents and lubricants), the electronics industry (e.g. integrated circuits and semiconductors and photovoltaic panels), the use of the product as substitutes for substances that deplete the ozone layer (refrigeration and air conditioning) and manufacture and use of other products (e.g. medical equipment and others).

Thus, to carry out this work, data from the National Inventory of Greenhouse Gas Emissions Report (1995 – 2004) were used, together with data from the National Institute of Statistics and those provided by some industries, such as from Cervejas de Moçambique, Mozal and AMOPÃO.

Emission factors of Industrial processes

For each activity, the respective emission factors were used (Table 2.4), according to the guidelines of the IPCC 2006 Guide, for the mining industry, the chemical industry, and the manufacture and use of other products, based on the emission factors predefined in the *Software* (Tier 1). Note that emissions from category 2H2: Food and beverage industry are Non-Methane Volatile Organic Compounds (NMVOCs), which are reported in the national GHG inventory but are not counted as CO_2 equivalents with potential for global warming, as described in the IPCC Guide (2006): Volume 1, Chapter 7, on Indirect and precursor emissions. In addition, the emission factor values for the food and beverage industry have been updated according to the European Union air pollutant emissions inventory guide (EMEP/EEA air pollutant emission inventory guidebook, 2019).

Table 2.4: Emission factors used in the IPPU.

Code	Category	Emission Factor factor	IPCC guide
2.A.1	Cement production	0.52 tonnes CO_2 /tonne clinker	V3_2_Ch2_Mineral_Industry
2.H.1	Pulp and Paper Industry		Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories
2.H.2	Food and Beverage Industry	Non-methane volatile organic components (NMVOCs)	Reference Manual (Volume 3) Values are in kg/ton (for bread,

	Sugar	10	sugar, fish and biscuits) and in kg/hectoliter for beer.
	Bread	4.5	
	Fish	0.3	
	Beer	0.035	
	Biscuits/Cookies	1	

Activity data of Industrial processes

For the IPPU sector, we applied data on the production of ordinary *Portland cement,* food and beverages such as fish, sugar, beer, cookies and crackers, bread (regular and wholemeal) (2000, 2008 and 2016), and aluminium production (2008 and 2016). Unfortunately, it was impossible to include data from other activities in this first phase. Therefore, the final report is expected to compile all other areas not included.

Data source of Industrial processes

The activity data were mainly from the "Report of the National Inventory of Greenhouse Gas Emissions, 1995 – 2004" (MICOA, 2010) combined with data extracted from the statistical yearbooks of the National Institute of Statistics (INE) and data provided by the sectors. Due to the scarcity of data to carry out a complete analysis of emissions in the IPPU sector, we used alternative data sources such as the United States Geological Survey (USGS), sector reports and individual data generated.

2.7. Agriculture Sector

Agriculture and livestock are critical economic activities in Mozambique. However, several processes result in greenhouse gas emissions in the agriculture sector, such as (i) enteric fermentation, (ii) manure management, and (iii) rice cultivation.

Emission Factors of Agriculture sector

Standard factors (Tier 1), according to the IPCC 2006 guide "2006 IPCC Guidelines for National Greenhouse Gas Inventories", were used for the emission estimates of the agriculture component since national emission factors developed for this purpose are not available.

Activity Data of Agriculture sector

Enteric fermentation and Manure management

Data from the First and Second National GHG Inventory for 1994 and 2004 were used as base data, on top of which data from more recent years were added. IPCC software, using the IPCC 2006 Guide to National Greenhouse Gas Inventories, was used for the recalculation of emissions for the past years, 1994 and 2004, as well as for the calculation of 2016 emissions. As a result, emissions results have been validated through comparison with the previous inventory and a seminar and review by the respective sectors. However, it is important to mention that there was a change in the calculation methodology from the Revised Guide of the IPCC 1996 to the Guide of the IPCC 2006.

The data collected cover information on livestock, areas cultivated with rice and production of the leading agricultural crops, mainly sugarcane, cotton, cassava, cereals (corn, sorghum, millet, and rice), and legumes (peanuts and beans). Cattle are raised in the extensive pasture (ruminant) or backyard systems, as it is dominated by small-scale smallholder operations (80%) and only 20% by medium-large processes (MASA, 2019). Data collection takes place through i) the Integrated National Agricultural Survey - INAS (called - Integrated Agricultural Survey), previously National Agricultural Survey (annual), which allows the production of the Agricultural Statistics Yearbook (called - Agricultural Statistics Yearbook); ii) the agricultural census (CAP).

The livestock numbers considered include cattle, goats, sheep and pigs, buffaloes, donkeys, and small animals from 2000 to 2016. In addition to livestock, for the calculation of emissions, data on manure and urine produced by domestic animals and waste management systems (MMS). The livestock sector, which could provide animal manure for fertilisation in various forms, is constrained by unconfined livestock systems. However, the sector's statistical systems do generally not record these data. Furthermore, we did not find the official records information on systems for the use and management of manure in the form of fertiliser or used for food, fuel, biogas production, or construction purposes. Thus, to estimate methane and nitrous oxide emissions from the management or management of animal waste, we relied on the knowledge of specialists in the sector to calculate the quantities of manure produced (depending on livestock numbers) and proportions by type of use and management (table 2.6).

Table 2.5: Data required for estimating emissions from the Agriculture sector

Category	Variable	Description	Unit
3A Enteric Fermentation and 3B Manure Management			
CH_4	AAP	Annual average population by type (meat and dairy cattle, buffalo, sheep, goats, horses, donkeys, rabbits and poultry)	Number
CH_4	NAPA	Number of animals produced annually by type	
3C7 Rice Cultivation			
CH_4	t_{ijk}	Growing period for rice and conditions	Day
	the $_{ijk}$	Rice area harvested annually	ha/year

To reduce disparities among data sources, we validated the data used in the current inventory with experts from the sectors involved in preparing the GHG inventory during Seminar 1 and Seminar 2. The collection of data at the producer level and systematised at the sector level about the use of fertilisers by crop and by area, use of liming or other products, use of animal manure and its management, and agricultural soils would be of great help for the enrichment of the emission estimates for the agriculture sector.

Rice Cultivation

The agricultural potential for rice production is estimated at around 900,000 ha, of which around 320,000 ha are cultivated. About 90% of the cultivated area is in Zambézia and Sofala provinces, 7% in the provinces of Nampula and Cabo Delgado and the remaining 3% in the province of Gaza (Irrigation of Chókwè and Xai-Xai).

Rice production is concentrated in six geographical areas and confined in *clusters*: Maputo, Gaza, Sofala, Zambézia, Nampula and Cabo Delgado. These *clusters* coincide with 4 PEDSA corridors and cover 20 districts.

These data sources were: statistical yearbooks, agricultural statistics (INE) and FAO statistics (FAOSTAT) for Agriculture sector data from 2000 to 2016. First, following the IPCC 2006 Guidelines, we applied an interpolation or extrapolation approach to fill the time series gap. After that, we validated with specialists from respective sectors, resulting in new data or amendement.

2.8. Land Use, Land Use Change and Forestry Sector

This sector includes the estimates of emissions and removals of greenhouse gases associated with the increase or decrease of carbon in biomass above and below ground as land-use change occurs, for example, in the conversion of a forest area to agriculture or livestock activity or when replacing Cropland by reforestation.

Carbon dioxide (CO_2) is the sector's predominant gas. Still, there are also emissions of other greenhouse gases such as CH_4 and N_2O from the imperfect burning of wood left in the field in case of forest conversion to other uses.

For the estimation of GHG emissions and removals for the Forest and Land Use Change Sector, Mozambique has followed the methodologies proposed in the 2019 IPCC guidelines, Volume 4, Chapter 2 "Generic Methodologies Applicable to Multiple Land-use Categories", for change in biomass carbon stocks (above-ground biomass, below-ground biomass) and non-CO_2 emissions from fires in forest lands. In addition, it includes the analysis of Land remaining in a land-use category and Forest lands converted to a new land-use category.

Emission Factors of Land Use Change and Forestry

For the Land Use, Land Use Change and Forestry (LULUCF) component, emission factors developed for national conditions (Tier 2) were used, which are reported and used in the FREL report. The Government of Mozambique submitted the FREL report to the UNFCCC Secretariat in 2018. As a result of the FREL, this sector presents more in-depth work and has a more reliable and well-documented estimate of the data quality, emission factors, and estimation error.

The table below summarises the methods and emission factors used for the AFOLU-GHG. This inventory uses mostly Tier 1 and Tier 2 methods (table 2.6).

Table 2.6: Methods and emission factor applied

Category	CO_2		N_2O		CH_4	
	Methods	EF	Methods	EF	Methods	EF
LULUCF						
A. Forest Lands	T3, T2, T1	CS, D	T2, T1	CS, D	T2, T1	CS, D
B. Croplands	T2, T1	CS, D		NE		NE
C. Grasslands	T2, T1	CS, D		NE		NE
D. Wetlands	T2, T1	CS, D		NE		NE
E. Settlements	T2, T1	CS, D		NE		NE

T1 – Tier 1, T2 – Tier 2, T3 –Tier 3, CS – Country specific, D – IPCC default, IE – Included Elsewhere; NA – Not Applicable; NE – Not Estimates; NO – Not Occurring

Activity data of Land Use Change and Forestry

Land Use Classes

Mozambique followed the 2006/2019 IPCC guidelines structure for the AFOLU sector, including the proposed Land uses such as Forest lands, Cropland, Grassland, Wetlands, Settlement, and other lands (Level 1). Therefore, the forest definition used in this GHG Inventory, and all land categories is the same as from FREL (table 2.7).

Table 2.7: Description of land use and Land cover category

Land categories (Level 2 and 3)	Definition
Forest Definition	In Mozambique, forests are defined as lands with trees with the potential to reach a height of 3 m at maturity, a canopy that covers equal to or greater than 30% and occupies at least 1 ha. This includes

Land categories (Level 2 and 3)	Definition
	temporarily cleared forest areas and areas where the continuity of land use would exceed the thresholds of the definition of forest or trees capable of reaching these limits in situ (Falcao and Noa, 2016).
Croplands	Cropped land, including rice fields and agroforestry systems where the vegetation structure falls below the thresholds used for the Forest Land category. 1 ha area with more than 20% cover of any planted crop but less than 30% cover of forest or 20% cover of infrastructure.
Grasslands	1 ha area dominated by grasses and shrubs or woodlands with less than 30% tree cover. Rangelands and pasturelands that are not considered Cropland, with less than 20% cover of crops or infrastructure. Also, systems with woody vegetation and other non-grass vegetation, such as herbs and brushes, that fall below the threshold values used in the Forest Land category.
Wetlands	1 ha area land covered or saturated by water for all or part of the year and does not fall into the Forest Land, Cropland, Grassland or Settlements categories. It includes reservoirs as a managed subdivisions and natural rivers and lakes as unmanaged subdivisions.
Settlements	1 ha area with at least 20% cover of infrastructure (houses, roads, etc), but less than 30% forest canopy cover.
Other lands	Bare area with less than 20% cover of grasses, shrubs, trees, wetland, crops or infrastructure Bare soil, rock, ice and all land areas that do not fall into any of the other five categories. It allows the total of identified land areas to match the national area where data are available. Mining areas bigger than 1hectare are classified as other land categories.

Area estimation

The approach to collecting activity data is a probabilistic sampling process, focusing on the fact that each land use class of the sampling units is representative of the sampling frame. Therefore, it is possible, from a sampling unit, to infer about the sampling frame. To generate estimates of land use class areas, it was necessary to apply expansion factors or weights to measure the representativeness of each land use class within the sampling frame.

The expansion factor is the factor that transforms the sample results to the sampling frame. In this case, it is the quotient between the province area by the number of its respective sample units. Thus, the area of each sample unit is represented by its respective provincial expansion factor. For more details, refer to the FREL (2018). Table 2.8 Expansion factor by province shows the expansion factors applied by province.

Table 2.8: Expansion factor by province

Province	Area (ha)	Nº of points	Expansion Factor (ha)
Cabo Delgado	8 027 338,9	4 872	1 647,6
Cidade de Maputo	38 758,8	25	1 550,4
Gaza	8 248 235,2	4 701	1 754,6
Inhambane	7 498 070,3	4 295	1 745,8
Manica	6 628 716,2	3 891	1 703,6
Maputo	2 590 492,1	1 455	1 780,4
Nampula	8 139 712,9	4 872	1 670,7
Niassa	12 648 287,9	7 962	1 588,6
Sofala	7 207 150,5	4 218	1 708,7
Tete	10 512 069,8	6 297	1 669,4
Zambézia	10 820 042,4	6 306	1 715,8

2.9. Waste Sector

As in other developing countries, solid waste management in Mozambique is a significant challenge in most cities and towns. This challenge is mainly related to the lack of financial, material, and human resources for safe and sustainable management. As a result, a considerable amount of Waste ends up in uncontrolled landfills, posing a severe risk to public health and the environment, particularly in urban areas.

Currently, the amount of solid Waste generated in the country is unknown. However, it is estimated to be around 2.5 million tons per year. Based on this estimate, in 2014, Carbon Africa calculated GHG emissions to be 776,546 tCO_2eq. According to this study, if nothing is done to reduce the Waste currently produced, it could double to around 1,369,721 tCO_2eq., in 2030. For this not to happen, a series of actions need to be taken, among which are: the separation of Waste at source, recycling, public awareness, and establishment of public-private partnerships for the collection and processing of Waste, among others.

Emission factors of Waste sector

The estimation of GHG emissions in the waste sector was made using the IPCC 2006 Guidelines for National Greenhouse Gas Inventories from the IPCC 2006 Guide, based on category 4A, using the level 1 approach (Tier 1). According to the IPCC 2006, this method considers only municipal solid and industrial Waste. It is assumed that the Waste's degradable organic component (DOC) slowly decays over a few decades releasing CH_4 and CO_2. However, if conditions are constant, the rate of CH_4 production depends exclusively on the amount of carbon remaining in the Waste. As a result, CH_4 emissions from Waste deposited at a disposal site are highest in the first few years after deposition. After that, it gradually decreases as the degradable carbon in the Waste is consumed by the bacteria responsible for decomposition.

This approach (Tier 1) resulted from the scarcity of complete and consistent data on characteristics and quantities of Waste generated over the study period (2000-2016). Furthermore, it is essential to note that this approach does not consider emissions from effluent handling in the emission calculations. Thus, despite consistent data on solid Waste generated in the country, resorts were made to their per capita production, composition, and default values for Africa.

Activity data of Waste sector

Data on the Mozambican population (total and urban) and the respective Gross Domestic Product were from the World Bank database (worldometer.info). The IPCC recommendation on Waste is to register since 1950 to cover slowly decomposing categories. However, for the conditions in Mozambique and based on the available data, the registration was made from 1970 onwards. Other information was from the statistical yearbooks produced by the National Institute of Statistics (INE), information submitted by the Ministry of Land and Environment sectors and direct sources. Most of the data were subjected to appropriate preliminary treatment before use.

In the absence of consistent data on the production of urban Waste in Mozambique, the default values for Africa were used, including parameters such as *per capita production* of solid Waste and the composition of Waste. In addition, we used figures from the National Communication of Angola as a proxy for the waste sector's emissions.

Hospital waste was estimated based on the total number of beds available in hospitals across the country. It was estimated, based on data from the World Health Organization, which indicate that, for each bed, 1.13 kg of hospital waste is generated per day. This data includes the Waste eventually generated also by outpatients. These wastes, roughly speaking, are incinerated in existing infrastructures in almost all health units and constitute the primary emissions from waste incineration. In addition, emissions from industrial wastewater treatment have been estimated based on production volumes from a limited number of industries, subject to data availability. Table 2.9 below summarises data on the population, nominal Gross Domestic Product (GDP), beds in the National Health Service and the estimated amount of hospital waste generated.

Table 2.9: Data used in estimating emissions from waste management.

Nº	Description	Year		
		2000	2008	2016
1	Population (number of inhabitants)	17,711,927	22,276,596	27,829,938
2	urban population	4,987,019	6,580,886	9,302,449
3	Nominal GDP (USD)	5,016,469,069	11,494,837,053	10,981,358,031
4	Beds in the National Health Service	15,008	17,341	21,510
5	Hospital waste (Ton)	16.96	19.60	24.31

The estimation of greenhouse gas emissions caused by the generation and management of Waste was structured into five categories, namely:

4A: Emissions from solid waste disposal (at controlled and uncontrolled waste disposal points);

4B: Emissions from biological treatment of Waste;

4C: Emissions from incineration and open burning of Waste;

4D: Emissions that occur in the treatment and disposal of Waste (treatment and disposal of domestic and industrial wastewater), and

4E: Emissions from other wastes.

Waste is responsible for emissions of methane (CH_4), carbon dioxide (CO_2), and nitrous oxide (N_2O), and in general, methane emissions are the most significant in this sector.

Waste Categories Covered

Despite the constraints mentioned above regarding the scarcity of data, it was possible to obtain data that allowed estimating the emissions of subcategories 4A, 4C and 4D. Regarding subcategory 4B (biological treatment of solid Waste), Mozambique has a very insignificant number of composting and anaerobic digestion plants. Those that exist are informal and operated non-continuously during the period covered by the study, with no record of the amounts or composition of the treated Waste in terms of moisture and organic material.

The country produces hazardous industrial Waste, and they are all channeled to the Mavoco Dumpster in Maputo, where they are pre-treated and stored. These wastes are not subjected to any treatment that could generate emissions.

Most solid and liquid domestic Waste is treated in drains, septic tanks and latrines, closed facilities. Therefore, according to the IPCC 2006 Guidelines for National Greenhouse Gas Inventories, their emissions are negligible.

2.10. Total Anthropogenic Emissions by Sources and Removals by Sinks of Greenhouse Gases in Mozambique

The result of total emission of all sectors are presented in the Table 2.10, Figure 2.2 to 2.5. The emission was also reported with and without LULUCF. All emissions are reported in $GgCO_2e$ (thousand tons of CO_2 equivalent) for each sector.

In 2016, net anthropogenic emissions of greenhouse gases were estimated at 15,902 Gg CO_2eq for Energy (19% of the total emission), 2,798 CO_2eq (5%) for Industrial processes, 1,882 $GgCO_2eq$ (3%) for Agriculture, 33,721 $GgCO_2eq$ (61%) for LULUCF, and 1,194 $GgCO_2eq$

(2%) for Waste. Between 2005 and 2016, total CO_2eq emissions of Energy, Industrial processes, Agriculture, LULUCF and Waste increased by 222%, 66%, 16%, 36% and 330%, respectively. Broadly, LULUCF contribute to 61% of total emission in 2016, the remaining small contribution if from Energy with 29%, Industrial processes with 5%, Agriculture with 3% and Waste with 2%.

Mozambique's total emission without LULUCF in 2016 is about 21,776 GgCO_2eq representing to 39% of total emission. With increasing emissions from the energy, industry and waste sectors, their proportional contribution has consistently increased throughout the period of analysis, but they are still much lower than the overall per capita GHG emissions. The country has an emission without LULUCF of well below 1tCO_2eq per capita and with LULUCF of about 2tCO_2eq per capita. The total emissions from the data series can be compared in the following graphs of total national emissions with and without LULUCF.

Table 2.10: CO_2eq emissions and removals

Sector	1990	1994	2000	2005	2010	2012	2014	2016
	Gg							
Energy	2,627	3,243	4,169	4,940	6,500	13,789	17,301	15,902
IPPU	40	51	1,414	1,687	2,047	2,737	2,570	2,798
Agriculture	55	131	560	1,628	1,516	1,796	2,049	1,882
LULUCF	- 61,054	- 46,473	- 24,602	24,866	39,584	42,410	30,438	33,721
Waste	3	24	162	278	446	1,400	1,262	1,194
TOTAL with LULUCF	- 58,331	- 43,024	- 18,297	33,398	50,093	62,132	53,620	55,498
TOTAL without LULUCF	2,724	3,449	6,305	8,532	10,508	19,722	23,182	21,776
Memo Items								
International Bunkers	83	83	83	83	83	83	83	83
CO_2 Emissions from Biomass	27,839	27,839	20,786	22,950	24,922	25,597	26,271	26,945

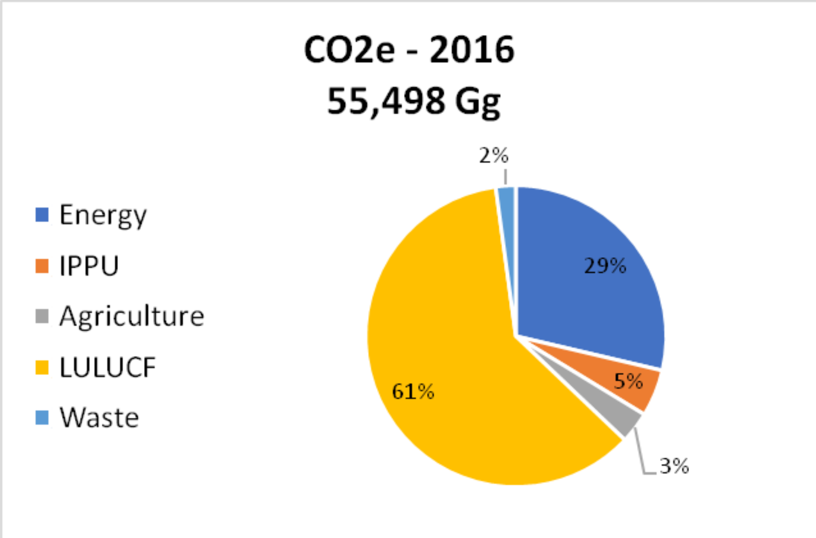


Figure 2.2: CO_2 emissions by sector with LULUCF in 2016[2]

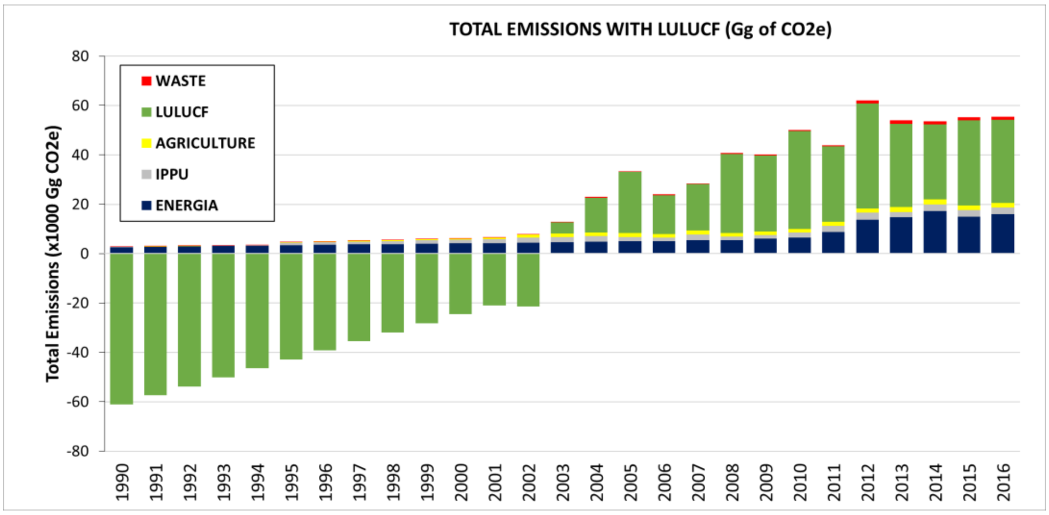


Figure 2.3: CO_2 Emissions Trend with LULUCF

[2] The corresponding chart for 2019 is not shown as the country presented negative emissions due to the large removals in LULUCF.

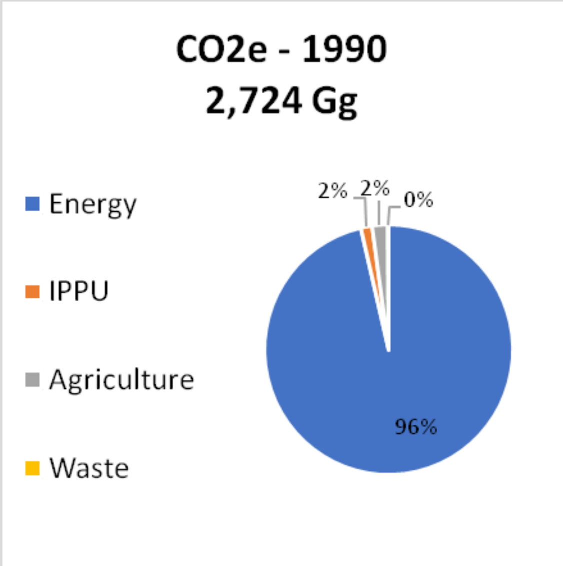


Figure 2.4: CO_2eq Emissions by Sector without LULUCF - 1990

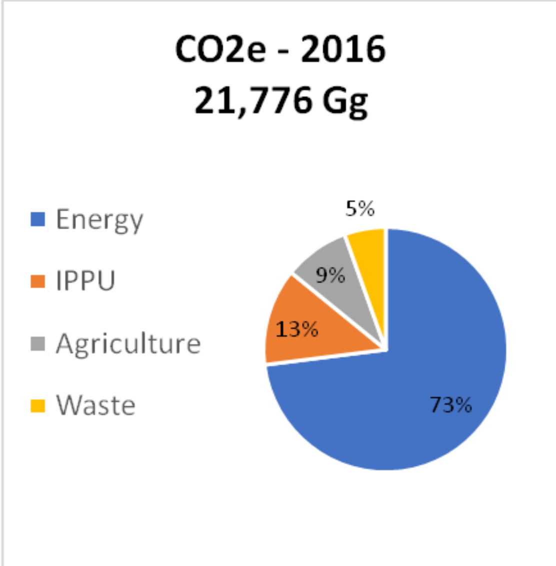


Figure 2.5: CO_2eq Emissions by Sector without LULUCF - 2016

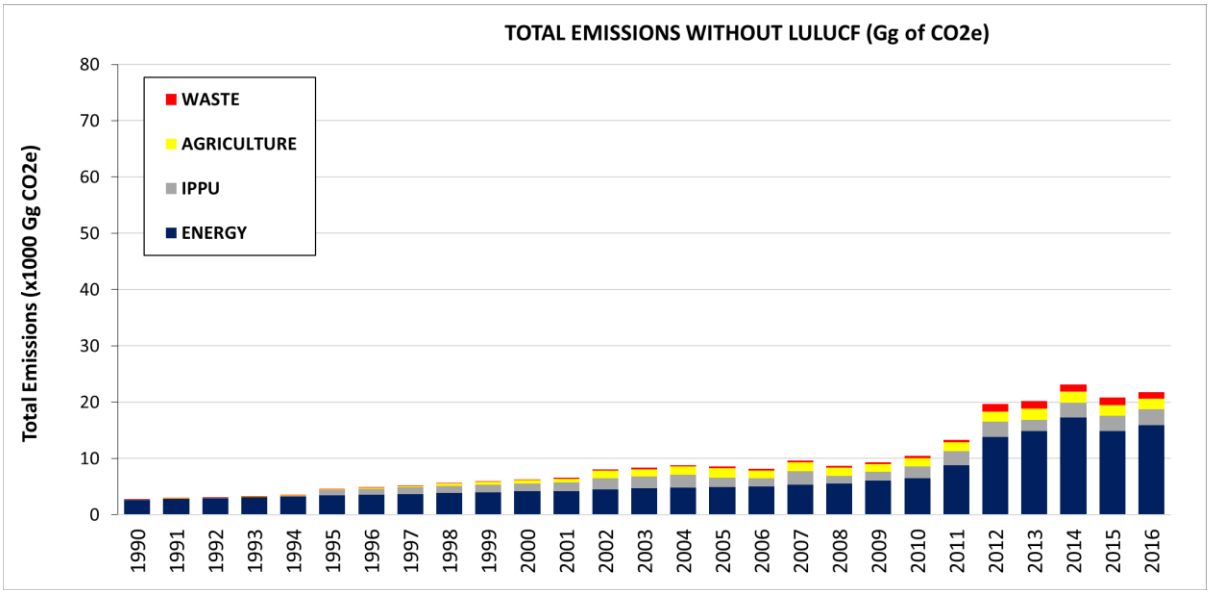


Figure 2.6: CO_2eq Emissions Trend without LULUCF

2.11. *Anthropogenic Emissions by Sources and Removal by Sinks of Greenhouse Gases by Gas*

In 2016, net anthropogenic emissions of greenhouse gases were estimated at 42,932 Gg CO_2; 506 Gg CH_4; 1.24 Gg N_2O; and 1.55 Gg PFC. Between 1990 and 2016, total emissions of CO_2, CH_4, N_2O and PFC increased by 3.29, 3.17, 12.4 and 56.6 times, respectively. Broadly, CO_2 contribute to 98% of total emission in 2016, the remaining small contribution if from CH_4 with 1.1%. The following sections presents the emissions by sector and by gas.

Carbon Dioxide Emissions

Table 2.11 and Figures 2.2and 2.7 summarise CO_2 emissions and removals in Mozambique, by sector. The Energy sector encompasses emissions from fossil fuel combustion and fugitive emissions. Fugitive emissions include the burning of oil and natural gas, solid fuels, and other emission from energy production. In 2016, CO_2 emissions from the Energy sector represented 18% of total CO_2 emissions, having increased 74 times more in comparison to 1990 emissions. The transport subsector alone was responsible for 58% of CO_2 emissions from the Energy sector.

Emissions from industrial processes represented 3% of total CO_2 emissions in 2016, with the aluminium production, lime production and food and beverages making up the greatest share of 51%, 25% and 23%, respectively. From 1990 to 2005, emissions from industrial processes increased by 95 times. The Land-Use Change and Forestry sector was responsible for the largest portion of CO_2 emissions and for all CO_2 removals, which include protected area management, tree plantations and regeneration of abandoned areas, with net emissions for the sector with a share of 79% of total CO_2 net emissions in 2016. Conversion of forests to other uses, especially agriculture, accounted for virtually all CO_2 emissions for the sector and the small remaining share was due to grassland.

The Waste sector's share of CO_2 emissions was small due to the open burning of Waste containing non-renewable carbon.

Table 2.11 CO_2 emissions and removals

Sector	1990	1994	2000	2005	2010	2012	2014	2016
	Gg							
Energy	105	130	1,888	2,223	3,233	6,858	8,605	7,909
IPPU	13	17	461	750	910	1,218	1,143	1,245
Agriculture	-	3	13	39	37	43	49	45
LULUCF	-61,054	-46,473	-24,602	24,866	39,584	42,410	30,438	33,721
Waste	0	0	2	3	4	14	13	12
TOTAL with LULUCF	-60,936	-46,324	-22,238	27,881	43,768	50,543	40,248	42,932
TOTAL without LULUCF	118	150	2,364	3,016	4,184	8,133	9,810	9,211
Memo Items9								

Sector	1990	1994	2000	2005	2010	2012	2014	2016
	Gg							
International Bunkers	83	83	83	83	83	83	83	83
CO_2 Emissions from Biomass	27,839	27,839	20,786	22,950	24,922	25,597	26,271	26,945

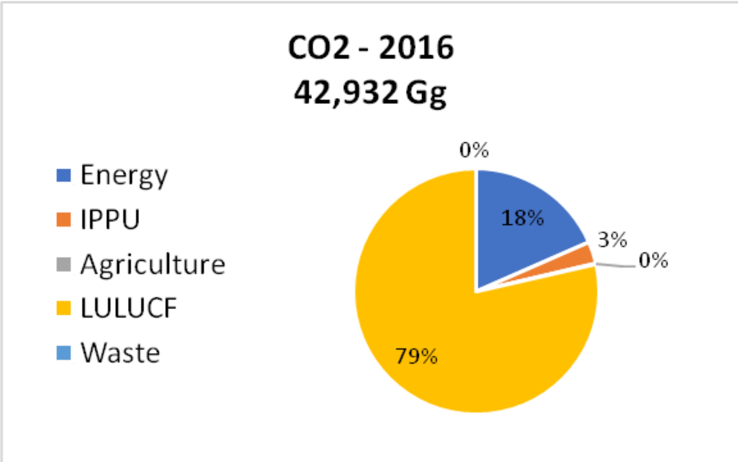


Figure 2.7: CO_2 emissions by sector - 2016[3]

Methane Emissions

Many activities from all sectors, such as Energy, Waste, Agriculture and LULUCF, represent the source of CH_4 emissions. Those activities include sanitary landfills, wastewater treatment, oil and natural gas production and processing systems, agriculture, coal mining and handling, fossil and biomass fuels combustion, conversion of forests to other uses and some industrial processes.

In Mozambique, the Energy sector is the most responsible for CH_4 emissions (74% in 2016), with 373 Gg, resulting primarily from residential (charcoal consumption). In 2016, CH_4 emissions associated with the Agriculture sector were estimated at 84 Gg, 16% of total CH_4 emissions in 2016. Managed disposal sites and domestic Waste were responsible for the remaining emissions in the Waste sector. The increase in CH_4 emissions predominantly occurred due to the rise in non-dairy cattle herd size in recent years (table 2.12 and figures 2.8 and 2.9).

[3] The corresponding chart for 2019 is not shown as the country presented negative emissions due to the large removals in LULUCF.

Table 2.12: CH_4 Emissions

Sector	1990	1994	2000	2005	2010	2012	2014	2016
	Gg							
Energy	119	147	107	127	152	323	406	373
IPPU	-	-	-	-	-	-	-	-
Agriculture	2	6	25	73	68	80	92	84
LULUCF	-	-	-	-	-	-	-	-
Waste	0.12	1	7	11	18	57	52	49
TOTAL	121	154	138	211	238	461	549	506

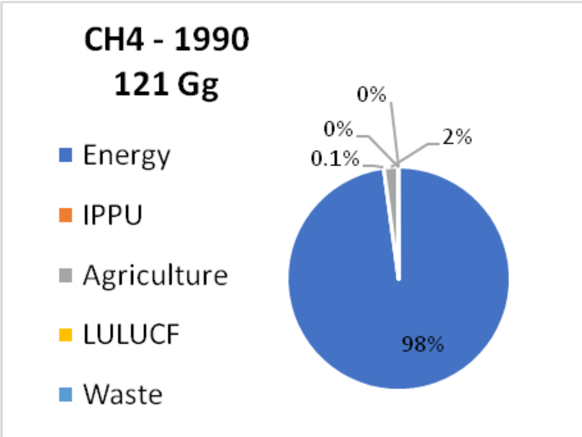


Figure 2.8: CH_4 Emissions by Sector - 1990

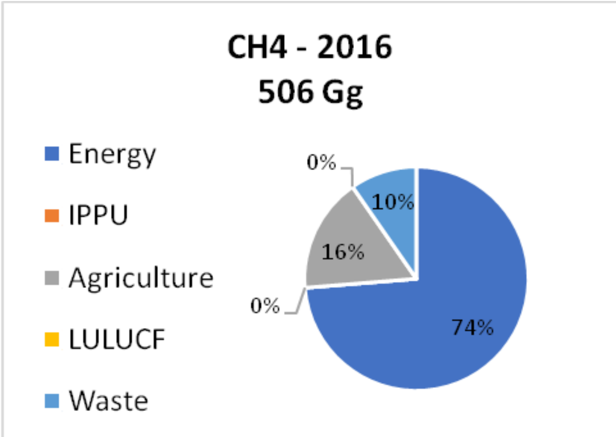


Figure 2.9: CH_4 Emissions by Sector – 2016

Nitrous Oxide Emissions

N_2O emissions result from diverse activities, including agriculture, industrial processes, fossil and biomass fuels combustion, and conversion of forests to other uses. In Mozambique, N_2O emissions predominantly occur in the Energy sector from fuel combustion following Agriculture sector from deposition of animal manure in pasture and application of fertiliser in cropland, and Waste sector from domestic Waste. Sectoral N_2O emissions grew 13 times between 1990 and 2016. N_2O emissions in the Energy sector represented just 41 % and Waste 40% of total N_2O emissions in 2016, resulting basically from the other sectors (charcoal), and domestic Waste, respectively. An additional small share comes from Agriculture with 18% of total N_2O emissions in 2016 from manure management (table 2.13 and figures 2.10 and 2.11).

Table 2.13: N_2O Emissions

Sector	1990	1994	2000	2005	2010	2012	2014	2016
	Gg							
Energy	0.08	0.10	0.13	0.16	0.21	0.44	0.56	0.51
IPPU	-	-	-	-	-	-	-	-
Agriculture	0.01	0.02	0.07	0.20	0.18	0.22	0.25	0.23
LULUCF	-	-	-	-	-	-	-	-
Waste	0.0013	0.01	0.07	0.12	0.19	0.59	0.53	0.50
TOTAL	0.09	0.13	0.27	0.47	0.58	1.25	1.34	1.24

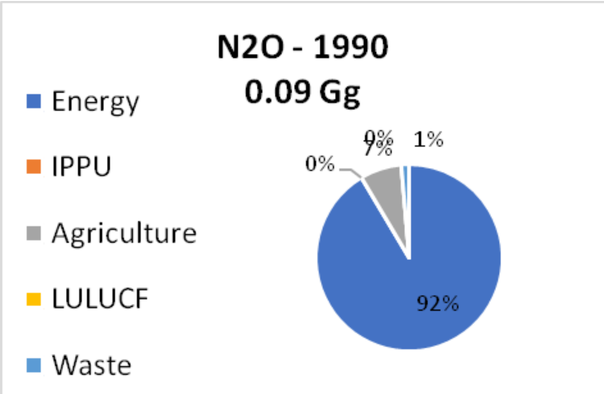


Figure 2.10: N_2O Emissions by Sector - 1990

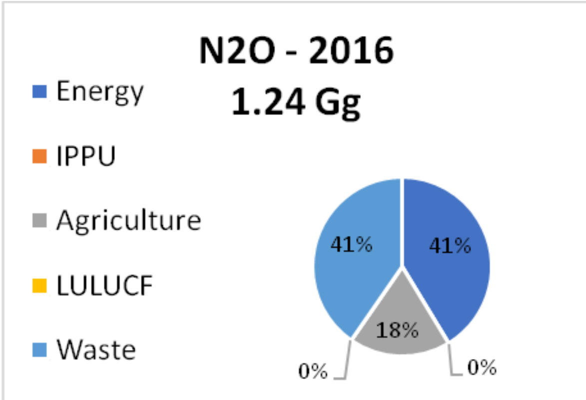


Figure 2.11: N_2O Emissions by Sector - 2016

Emissions of Hydrofluorocarbons, Perfluorocarbons and Sulfur Hexafluoride

HFC, PFC and SF_6 gases do not exist in nature, resulting exclusively from human activities. Mozambique does not produce HFCs and SFs. PFC emissions occur during aluminium production and result from the anode effect that occurs when the quantity of aluminium oxide diminishes in the processing vats. PFC emissions were estimated at 27 Gg in 1990, with a 57 times increase when compared to 1990 (table 2.14).

Table 2.14: PFC Emissions

Sector	1990	1994	2000	2005	2010	2012	2014	2016
	Gg							
Energy	NO	NO	NO	NO	NO	NO	NO	NO
IPPU	0.03	0.03	0.95	0.94	1.14	1.52	1.43	1.55
Agriculture	NO	NO	NO	NO	NO	NO	NO	NO
LULUCF	NO	NO	NO	NO	NO	NO	NO	NO
Waste	NO	NO	NO	NO	NO	NO	NO	NO
TOTAL	0.03	0.03	0.95	0.94	1.14	1.52	1.43	1.55

3. Chapter 3: Vulnerability and Adaptation Measures

3.1. Introduction

Mozambique is vulnerable to climate change due to its geographic location, low adaptive capacity as a result of poverty, limited investments in technology and weak infrastructure and social services. Climate change manifests itself through increased frequency and intensity of extreme events (droughts, floods, floods, event storms and tropical cyclones), rising sea levels, changes in temperature and precipitation patterns.

The consequences of climate change impacts include loss of human life, destruction of social and economic infrastructure, loss of domestic animals, loss of agricultural land and crops, rising prices of agricultural products, deterioration of human health, environmental degradation in particular for erosion and saltwater intrusion.

This chapter presents the results of the vulnerability assessment and adaptation measures carried out in 2010, which covered the following sectors/areas: agriculture (maize cultivation in Chokwé); pastures and livestock, in the Limpopo basin; water resources, the Maputo basin was considered; fishing, shrimp in the Sofala bank; the coastal zone; mopane forests; and, health considered malaria and cholera. In the process of updating the SNA that started in 2020, other relevant sectors/areas were included, namely, biodiversity, infrastructure, energy and social protection, for which a review of the existing literature was carried out. Information on the impact of extreme events in the country on the sectors/areas covered was also included, using the Balance Sheet Reports of the Rainy Seasons produced by INGD.

The information on the vulnerability of the health sector was updated based on the preliminary results of the study "Assessment of Vulnerability and Adaptation to Climate Change in the Health Sector in Mozambique", which includes the assessment of the impact of climate change on two climate-sensitive diseases. in Mozambique: Malaria and acute diarrhea, carried out by MISAU.

In addition to the vulnerability assessment mentioned above, this chapter includes summary information on the vulnerability of 98 districts (Table 3.2) in which Local Adaptation Plans (PLAs) were formulated and approved within the scope of the implementation of NCCAMS. For the formulation of the PLAs in the districts, at least two communities in the district that participate in the assessment of the climate vulnerability and adaptability of the communities are involved – Step 2 of the guide for the Formulation of Local Adaptation Plans. After the assessment with the communities, step 3 is followed, which is an assessment in the district. These two steps aim to determine the extent to which communities/districts are vulnerable to climate change, analyzing trends, threats, opportunities and adaptive capacity of communities/districts to climate change and determining adaptation measures to improve their resilience to climate changes.

The Guide for Formulating Local Adaptation Plans includes the Climate Vulnerability and Capabilities Analysis (CVCA) tools - developed by CARE and the Theory of Change (ToM). The PLAs are part of the short-term objectives defined by NCCAMS - increasing local resilience, fighting poverty and identifying opportunities for adaptation and low-carbon development at the community level, to be included in district planning.

3.2. Impact of Climate Change

3.2.1. Disasters

Historical data on extreme events show that three climate-related hazards are most likely to occur in Mozambique, namely tropical cyclones, floods and droughts. These events are often associated with socio-economic damage, translated into loss of human life, human suffering, loss of assets, destruction of critical infrastructure (eg health facilities, schools, access roads, etc.) and other indirect losses.

An analysis of data from 1980 to 2019 shows that Mozambique was affected by 21 tropical cyclones, 20 flood events and 12 droughts (Figure 3.1). This means that on average, the country is affected by a tropical cyclone or a flood event every two years and a drought event every three years. Tropical cyclones and flood events represent about 77% of the total events that occurred in the period under review.

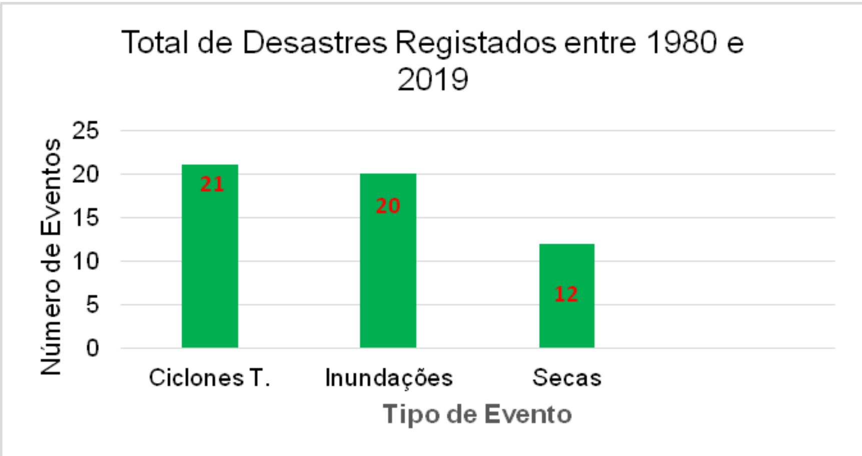


Figure 3.1: Total number of extreme events that occurred in Mozambique, between 1980 – 2019.

Source: Produced based on DeSinventar data and INGC wet season balance reports.

3.2.2. Historical trends of extreme events

One of the crucial questions today is whether there is any evidence of an increase in extreme disaster-causing events or not. Through an analysis of the trend of events registered in the last four decades (1980 – 2019), it is noted that the number of events that devastated the country increased significantly since the 2000s (Figure 3.2). From the decade (2000-2010) to the current, the number of cyclones competes with the number of flood events, despite the slowdown of drought events.

Taking into account that tropical cyclones are often associated with heavy precipitation events that can contribute a significant proportion of precipitation in a very short period which in turn cause flooding in various regions of the country, with serious implications for the health of communities, the aggravation of these phenomena in recent decades should deserve special attention from health authorities and beyond.

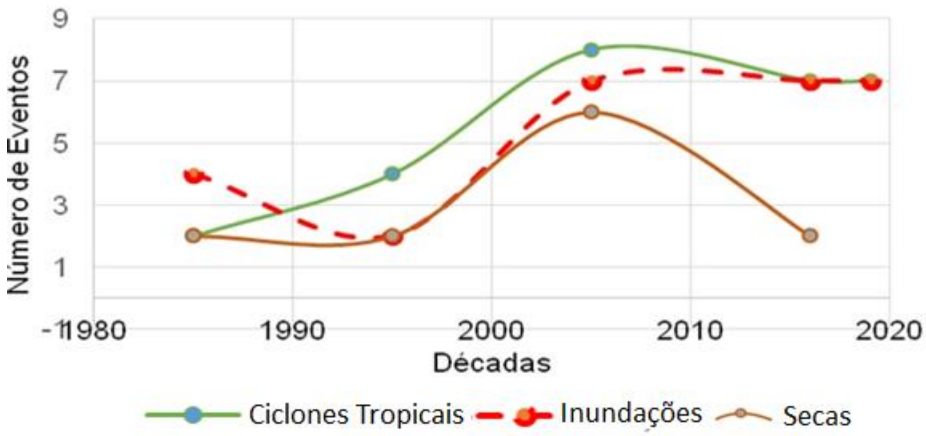


Figure 3.2: Trend in the number of extreme events that occurred between 1980 and 2019.

The direct impact of these events is often expressed by the number of losses of human life, people affected through loss of personal property and livelihoods, destruction of critical country infrastructure such as roads, bridges, water supply system, schools, hospitals, as well as the outbreak of waterborne diseases (e.g. malaria, cholera, diarrhea etc.). However, the lack of systematic and homogeneous records of events and their impacts and, on the one hand, the persistence in considering only large-scale and high-impact disasters in a short space of time, have hidden thousands of small and medium-scale disasters. that occur every year in the country. Consequently, Mozambique does not know the real value of direct and/or indirect economic losses associated with these events. The extreme weather events that occur in the rainy season from the years 2005 – 2018 and their impacts on human life are presented in Table 3.1. Table 3.1 presents the impact of climate change on the human dimension. Regarding the economic impacts, these are presented in the respective sectors where the vulnerability analysis is carried out.

Table 3. 1: Summary of the impacts of extreme events on the human dimension.

Rainy season	Event	Affected provinces	Affected		People			
			Families	People	Disappeared	Displaced	Injuried	Deaths
2005/6	Heavy precipitation	Nampula, Zambézia, Manica, Sofala, Inhambane, Gaza		24,984			5	16
	Floods	Tete, Sofala, Inhambane, Maputo Província		10,266				3
	Storm	Nampula, Gaza		1,060			12	2
	Strong winds	Maputo Província		12				1
2006/7	Tropical Cyclone Favio	Inhambane Sofala Manica		186,245				
	Strong winds	Niassa, C. Delgado, Nampula, Zambézia, Sofala, Tete, Manica, Inhambane, Gaza, Maputo		46,533				

Rainy season	Event	Affected provinces	Affected		People			
			Families	People	Disappeared	Displaced	Injuried	Deaths
		província						
2007/8	Strong winds, Heavy Precipitation and Floods	Niassa, C. Delgado, Nampula, Maputo	2,354	8,018				3
	Floods	C.Delgado, Niassa, Zambézia, Tete, Manica, Sofala, Inhambane	21,555	72,579				24
	Tropical Cyclone Jokwe	Nampula Zambézia	40,339	201,695			41	13
2008/9	Sem dados							
2009/10	Sem dados							
2010/11	Strong winds	Niassa, C.Delgado, Nampula, Zambézia, Tete, Manica, Inhambane, Gaza, Maputo província e		18,563			43	

Rainy season	Event	Affected provinces	Affected		People			
			Families	People	Disappeared	Displaced	Injuried	Deaths
		Maputo Cidade						
2011/12	Tropical Depression Dando,Tropical Cyclone Funso and Tropical storm Irina	C. Delgado, Nampula, Zambézia, Sofala, Inhambane, Gaza, Maputo província, Maputo Cidade	28,335	123,888			76	58
2012/13	Heavy precipitation and strong winds	Niassa, C.Delgado, Nampula, Zambézia, Tete, Manica, Inhambane, Gaza, Maputo província e Maputo Cidade		478,981				117
2013/14	Heavy precipitation, strong winds and thunderstorms	Niassa, C.Delgado, Nampula, Zambézia, Tete, Manica, Inhambane, Gaza, Maputo	18,555	92,775			76	30

Rainy season	Event	Affected provinces	Affected		People			
			Families	People	Disappeared	Displaced	Injuried	Deaths
		província e Maputo Cidade						
2014/15	Heavy precipitation and strong winds	Niassa, C.Delgado, Nampula, Zambézia, Tete, Manica, Inhambane, Gaza, Maputo província e Maputo Cidade	82,958	408,711				163
2015/16	Sem dados							
2016/17	Heavy precipitation and strong winds	Niassa, C.Delgado, Nampula, Zambézia, Tete, Manica, Inhambane, Gaza, Maputo província e Maputo Cidade	19,624	84,165				
2016/17	Lightning	Niassa, Nampula, Zambézia, Tete, Maputo Cidade	4	23			14	

Rainy season	Event	Affected provinces	Affected		People			
			Families	People	Disappeared	Displaced	Injuried	Deaths
	Floods and Inundation	C. Delgado, Sofala, Inhambane, Maputo Cidade	81,116	405,580				
	Tropical Cyclone Dineo	Inhambane	112,877	551,511				
2017/18	Heavy precipitation and strong winds	Niassa, C.Delgado, Nampula, Zambézia, Tete, Manica, Inhambane, Gaza, Maputo província e Maputo Cidade	32,382	158,062				66
	Lightning	Niassa, Nampula, Zambézia, Tete, Manica, Sofala, Gaza, Maputo Província	252	1,257				
TOTAL			**440,351**	**2,874,908**			**8,039**	**496**

Source: INGD data from the 2005/6 to 2017/18 Rainy Seasons.

Extreme weather events in Mozambique in 2000 and in the rainy seasons from 2005/6 to 2017/18 affected around 440,351 families, 2,874,908 people, caused injuries to 8,039 people and 496 deaths. It should be noted that tropical cyclones are events that cause greater impacts on the human dimension.

These impacts represent a setback in the process of poverty reduction, which is the priority of the Governments of developing countries, and increase their dependence on international aid. In this context, assessing the vulnerability of the most important social and economic sectors and identifying adaptation measures is of high priority.

This chapter presents the results of the vulnerability assessment and adaptation measures carried out in 2010, which covered the following sectors/areas: agriculture (maize cultivation in Chokwé); pastures and livestock (pastures in the Limpopo River basin); water resources (Maputo river basin); fishing (shrimp on the Sofala bank); the coastal zone; mopane forests; and, health (malaria and cholera). In the process of updating the SNA that began in 2020, other relevant sectors/areas were included, namely, biodiversity, infrastructure, energy and social protection, for which a review of the existing literature was carried out. Information on the impact of extreme events in the country on the sectors/areas covered was also included, using the Balance Sheet Reports of the Rainy Seasons produced by INGD.

Information on the vulnerability of the health sector was updated based on the preliminary results of the study "Assessment of the Vulnerability and Adaptation to Climate Change of the Health Sector in Mozambique" which includes the assessment of the impact of climate change on two climate-sensitive diseases in Mozambique: Malaria and Acute Diarrhea, carried out by MISAU.

In addition to the above-mentioned vulnerability assessment, this chapter includes summary information on the vulnerability of 98 districts (Table 3.2 and Table 3.3) in which Local Adaptation Plans (PLAs) were formulated and approved as part of the implementation of NCCAMS. By 2018, 61% of the total of 161 districts in the country, including the municipal districts of the city of Maputo, had PLAs prepared. For the formulation of the PLAs in the districts, at least two communities in the district are involved that participate in the assessment of the climate vulnerability and adaptability of the communities – Step 2 of the guide for the Formulation of Local Adaptation Plans. After the assessment with the communities, step 3 is followed, which is an assessment in the district. These two steps aim to determine the extent to which communities/districts are vulnerable to climate change, analyzing trends, threats, opportunities and adaptive capacity of communities/districts to climate change and determining adaptation measures to improve their resilience to climate changes.

The Guide for Formulating Local Adaptation Plans includes the Climate Vulnerability and Capabilities Analysis (CVCA) tools - developed by CARE and the Theory of Change (ToM). The PLAs are part of the short-term objectives defined by NCCAMS - increasing local resilience, fighting poverty and identifying opportunities for adaptation and low-carbon development at the community level, to be included in district planning.

Table 3. 2: PLAs prepared in the period from 2014 to 2018.

Year	Province	District
2014	Gaza (1)	chigubo
	Zambezia (2)	Mopeia and Morrumbala
	Nampula (4)	Angoche, Memba, Mogincual and Moma
2015	Maputo Province (1)	Magud
	Maputo City (1)	Ka Nhaca
	Gaza (3)	Chibuto, Guijá and Massingir
	Inhambane (3)	Massinga, Panda and Vilanculo
	Sofala (3)	Chibabava, Machanga and Nhamatanda
	Manica (3)	Machaze, Macossa and Tambara
	Cabo Delgado (3)	Macomia, Metuge and Mocimboa da Praia (M)
	Niassa (5)	Cuamba, Lago, Mecanhelas, Metarica and Sanga
2016	Maputo Province (4)	Manhiça, Marracuene, Matutuine and Namaacha
	Gaza (2)	Chicualacuala and Massangena
	Inhambane (1)	Funhalouro
	Sofala (1)	Chemba
	Manica (1)	Guru
	Tete (2)	Horn and Macanga
	Zambezia (5)	Chinde, Maganja da Costa (M), Maganja da Costa (D), Mocuba (D) and Pebane
	Cabo Delgado (4)	Mocimboa da Praia (D), Muidumbe, Pemba and Quissanga
	Niassa (1)	ass
2017	Maputo Province (1)	Moamba
	Gaza (6)	Chokwe, Chongoene, Limpopo, Mabalane, Manjacaze and Mapai
	Inhambane (5)	Govuro, Inhassoro, Mabote, Morrumbene and Zavala
	Sofala (4)	Búzi, Caia, Gorongosa and Maringue

Year	Province	District
	Manica (6)	Barue, Gondola, Macate, Manica, Sussundenga and Vanduzi
	Tete (4)	Angonia, Magoe, Mutarara and Tsangano
	Zambezia (2)	Upper Moloch and Gurue
	Nampula (3)	Larde, Liupo and Mossuril
	Niassa (1)	muembe
2018	Maputo Province (2)	Boane and Matola
	Gaza (1)	Bilene
	Inhambane (2)	Inharrime and Homoine
	Sofala (1)	marromeu
	Zambezia (6)	Dere, Lugela, Mocuba (M), Mocubela, Namaroi and Quelimane (M)
	Nampula (1)	Island of Mozambique (M)
	Cabo Delgado (1)	namuno
	Niassa (1)	mandimba

Table 3. 3: Number of districts with PLAs prepared in the period 2014 – 2018.

Province	Year					Total Nº of Districts with PLA	Total Nº of District	% of Districts with PLA
	2014	2015	2016	2017	2018			
Maputo City	0	1	0	0	0	1	7	14
Maputo Province	0	1	4	1	2	8	8	100
Gaza	1	3	2	6	1	13	14	93
Inhambane	0	3	1	5	2	11	14	79
Sofala	0	3	1	4	1	9	13	69
Manica	0	3	1	6	0	10	12	83
Tete	0	0	2	4	0	6	15	40
Zambézia	2	1	5	2	6	16	22	73
Nampula	4	0	0	3	1	8	23	35
Cabo Delgado	0	3	4	0	1	8	17	47
Niassa	0	5	1	1	1	8	16	50
TOTAL	**7**	**22**	**21**	**32**	**15**	**98**	**161**	**61**

The technical-institutional capacity strengthening, social and economic infrastructure, fisheries, agriculture, water, forestry and agriculture sectors were covered by the PLAs with the largest number of districts at the national level (Table 3.4)

Table 3. 4: Sectors covered by the PLAs with the largest number of districts at the national level.

Covered sectors	Nº of districts
Strengthening of Technical-Institutional Capacity	68
Social and economic infrastructure	57
Fisheries	49
Agriculture and livestock	47
Water	39
Forest	39
Agriculture	36
Business	31
Livestock	19
Social protection	13
Biodiversity	11
Land use planning	11
Risk management	11
Environmental Quality	10
Tourism	10
Energy	9
Green economy	8
Transfer and adoption of clean and climate-resilient technologies	7
Human health	5
Agroprocessing	3

At the national level, the most important threats indicated by communities and districts are grouped into droughts/drought, floods and floods, tropical cyclones/strong winds, uncontrolled pests and fires, rising sea levels, epidemics, heat waves and/ or cold, food insecurity, human conflict, wildlife and pests.

Table 3. 5: **Hazards identified in the PLAs at the national level.**

Hazard	Nº of districts
Drought/dryness	75
Floods/Inundation	71
Tropical Cyclone/Strong winds	71
Pests	52
Uncontrolled fires	35
Erosion	19
Conflict Man Fauna	11

Epidemics	9
food insecurity	4
Sea level rise	3
heat waves	2
Cold wave	1

In addition to the PLAs, sector plans and other relevant instruments were also formulated, including:

- The national action plan for expanding climate-resilient agriculture. This plan seeks to strengthen agricultural extension services to small farmers as well as knowledge management and sharing and strengthening in coordination with research and extension services;
- Ministerial approval of national climate-resilient road standards and maintenance approaches; and the ministerial approval of mandatory climate risk screening for new road investments.”;
- National Program for Productive Social Action (PNASP) through which households living in vulnerable districts are involved in public works activities in order to diversify their sources of income and, consequently, make them resilient.

3.3. Climate Scenarios

The vulnerability analysis carried out at the SNA considered the climate projections developed by INGC “Studies on the Impacts of Climate Change on Disaster Risk in Mozambique Synthesis Report – Second Version” in 2009.

The methodology of the INGC study was based on climatological modeling (temperature and precipitation) with the main purpose of understanding how Mozambique's climate may already be changing and how it can be expected to change in the future. This study details the observed changes in the country's seasonal climate during the period 1960 to 2005, in terms of temperatures and precipitation patterns (INGC, 2009).

Both historical trends and future projections were derived from daily temperatures (maximum and minimum) and precipitation values recorded since 1960, from 32 synoptic weather stations within Mozambique (INGC, 2009).

To project future scenarios in terms of the country's climate (temperature and precipitation), focusing on the mid-century (2046-2065) and late-century (2080-2100) periods, seven general circulation models were used: ECHAM, GFDL, IPSL, CCCMA, CNRM, CSIRO and GISS.

INGC projections (2009) anticipate that CC in Mozambique are mainly manifested in the following:

- Temperature patterns

- **Atmosphere** – with an average increase between 1.5ºC and 3.0°C in the period between 2046 and 2065 and recording of more hot days and fewer cold days, with an increase in the maximum and minimum temperature;
- **Oceans** – with rising mean sea heights and changes in the distribution and availability of fish stocks and effects on marine ecosystems (such as, for example, corals);

- Precipitation patterns
  - With irregular precipitation behavior in terms of onset and end times (heavy precipitation phenomena in a short period of time) and duration of the rainy season (drought), disfiguring the notions of "official onset" and "effective onset" of the campaign agricultural, which may result in some regions in a decrease in current potential yields in the order of 25%;
  - With a growing reduction in potential agricultural income levels of up to 20% in the main crops that constitute the basis of food security and an essential condition for improving the per capita income of mozambican families;
- Increased frequency and intensity of extreme events (droughts, floods and tropical cyclones);
  - Persistence of the situation of extraordinary floods in identifiable places in the country and which can be referred to as “risk zones”;
  - Cyclones and other strong winds;
  - Prolonged droughts;
- **Sea level rise:** 15 cm, 30 cm and 45 cm as a consequence of thermal expansion and 15 cm, 110 cm and 415 cm as a consequence of the reduction of continental ice caps in the years 2030, 2060 and 2100, respectively;
  - Identified areas with potential increased risk by the emergence of other adverse natural phenomena such as loss through submersion and erosion of coastal areas, intrusion of saline water, desertification;
  - Reduction of areas available for agricultural practice in green or low-lying areas;
  - Many of the country's main coastal urban centers, including Maputo, Beira and Quelimane, are already in a critical situation in terms of vulnerability (human lives, properties, social infrastructure, etc.) to the effects of climate change.

3.4. Agriculture

Agriculture is considered the basis for the development of Mozambique. This sector is made up of small, medium and large producers. The most predominant class is smallholders who use approximately 97% of the approximately five million arable lands currently used for agriculture (GovM - PAPA, 2008).

In 2010, agriculture contributed 23% to the GDP (INE). Furthermore, 80% of the country's working population is employed in the agrarian sector. Thus, this sector is fundamental for poverty reduction and income generation for rural families, since most of this population depends on agriculture for food, employment and income.

A critical factor in agricultural production is access to and distribution of water throughout the vegetative cycle of crops. Production and productivity levels are affected by changes in climatic parameters, in particular variations in precipitation, given that around 98% of farmers practice rainfed agriculture (CAP, 1999-2000).

According to the wet season balances, the agriculture sector is vulnerable to drought and drought events, floods and floods, strong winds, tropical cyclones including pests (see Table 3.6). These events result in crop areas affected and/or lost; death and/or disappearance of domestic animals, especially cattle, goats, pigs, sheep and birds; destruction of agricultural and animal husbandry infrastructures; loss of pasture areas, affecting farmers and their families.

Table 3. 6: Impact of climate change on agriculture.

Rainy season	Event	Location	Impact
	Heavy precipitation and floods		
2012-13	Inundation	Maputo city and province, Gaza, Inhambane, Manica, Sofala, Tete and Zambézia	• 229,470 ha of crops affected, of which 168,511 ha were lost; • Death by dragging 21 cattle, 2 donkeys and 4 heads of swine, in Inhambane.
	Drought	Maputo and Inhambane Provinces	• 37.228 ha of affected and lost crops.
	Pest	Tete	• 324ha of crops affected and lost.
	Floods, drought and pests	Maputo City and province, Gaza, Inhambane, Manica, Sofala, Tete and Zambézia.	• 182,281 producers affected.
2013-14	Precipitation	Maputo province, Gaza, Inhambane, Sofala, Zambézia, Niassa and Cabo Delgado.	• Affecting 24,989 families 45.689ha affected, corresponding to 1.1% of the sown area, and 14.495ha were lost. Affecting 24,989 families
2014-15	Irregular precipitation and drought	Sofala, Inhambane, Gaza e Maputo.	• 56,126 ha affected, corresponding to about 1% of the total area sown with different crops and about 38,000 producers.
	Excessive precipitation and floods	Niassa, Cabo Delgado, Nampula, Zambézia, Sofala, Manica, Tete, Gaza e Maputo	• 115,234 ha affected, corresponding to about 2% of the total area sown with different crops; • 07 Dams affected in Zambézia province; • Death of 138 cattle, 29 goats, 13 pigs and 132 birds; • Damaged several management infrastructures, namely 01 pigsty, 07 carracicide tanks, 01 cattle and goat corral, 03 aviaries and 1 warehouse. • Wetted extensive grazing areas thus reducing the ideal grazing area per animal.

Rainy season	Event	Location	Impact
2016-17	Inundation	Sofala, Inhambane, Manica, Gaza e Maputo,	• 47,755 ha of crops affected and a universe of 46,063 producers.
	Tropical cyclone Dineo	Inhambane	• 18,861 ha and 15,050 producers affected.
2017-18	Inundation		• 274,742 ha of crops affected
	Drought		223,502 ha of crops affected and lost
	Pests		• 41,975 ha of crops affected.

Source: Balances of the rainy seasons from 2011-12 to 2017-18

Weather events occurred in the country between the rainy seasons from 2011-12 to 2017-18 affected around 1,384,677 ha of crops, of which around 733,270 ha were lost. The events that affected the largest area of crops were the tropical depression Dando and the tropical cyclone Funso, which occurred in the 2011-12 rainy season, while the greatest loss of crops occurred following the floods of 2012-2013.

In addition to affected areas and/or lost crops, weather events in the country caused the death of 315 heads of cattle, 2,707 of goats, 254 pigs, 111 sheep and 132 birds. In terms of equipment, 9 dams and 113 pumps were damaged. These losses and destruction affected 278,394 producers and around 25 thousand families.

The events that cause the most losses and destruction in the agriculture sector are those related to excessive rains and floods and tropical cyclones. However, when there is a drought, normally, the affected area is the same as lost.

It is also important to emphasize that, in addition to the biophysical vulnerability associated with the occurrence of extreme weather events, the technology levels adopted by most producers do not correspond to the requirements of the selected varieties, due to the poor financial capacity for the acquisition of agricultural inputs, which also contributes for low production and productivity.

To assess the vulnerability to climate change in the agricultural sector, the maize crop produced in rainfed, in the district of Chókwé, Gaza province, was selected. The evaluation consisted of the analysis of the relationship between crop yield and climate variables (precipitation and temperature) and climate change projection and their possible impacts on yields.

3.4.1. Justification of the choice of maize crop and study area

In Mozambique, cereals occupy the largest cultivated area, around 1.8 million hectares, or 47% of the total cultivated area. Maize is the most produced food crop in the country, occupying around 1.3 million hectares, that is, 72% of the total area occupied by cereals. Corn supplies products used for human, animal and raw material for industry. This cereal is cultivated by about 79% of small and medium farms in a dry farming environment.

In the country, corn production per unit area still does not reflect the genetic potential of the materials recommended by the research, despite its great importance, the progressive evolution of the quantities produced and yields obtained. According to IIAM (2012), critical maize yields depend on the production system used, namely: (i) irrigation systems with two values, with 2,500 kg/ha in systems where the average use of inputs is recorded and 1,875 Kg/ha in those with low input use; (ii) 595.63 Kg/ha in drylandRainfed maize production experiences uncertainties, due to the irregularity of precipitation both related to variations in the beginning and end of the rainy season and the distribution of precipitation during the rainy season. Added to this are high temperatures and high levels of evapotranspiration.

Although the vulnerability of the agricultural sector to climate change is felt in many districts of the country, the district of Chókwé was selected for the study area for the following reasons:

i. Presence of an operational meteorological station that gathers enough data to carry out this work;
ii. Existence of favorable agro-ecological conditions for the practice of agriculture;
iii. Chókwé is part of the priority districts identified in the Action Plan for Food Production (PAPA) for maize production;
iv. About 80% of the population in the district practices rainfed agriculture in which maize is predominant and agriculture is also the main economic activity.

The District's climate is tropical dry, with an average annual temperature of 24˚C; the average annual rainfall ranges from 500 to 800mm, confirming the gradient from the coast to the interior, while the reference potential evapotranspiration (ETo) is around 1,400 to 1,500mm; and, the average annual relative humidity is between 60 to 65% (MITADER, 2017).

Low precipitation is combined with high temperatures, resulting in an accentuated shortage of water. The irregularity of the rain causes frequent droughts even in the rainy season (MITADER, 2017). In the agriculture sector, the number of households that practice this climate-resilient activity has been doubling since 2012, as a result of the expansion of extension services and the dissemination of good agricultural practices, within the scope of the implementation of projects and programs by the Government. and their partners.

MAE (2005) indicates that the total area cultivated by the family sector, in the District of Chókwé, is 10,000 hectares which represents 5% of the total area of the district. of intercropping, in some regions of the district, crops are made using animal traction and tractors.

Relevant climate variables for maize production

Temperature

Different plant species and varieties have different temperature requirements throughout the growing season. According to Malate (2015), some ideal conditions for the maize development cycle are:

- **Germination and emergence** - To ensure a good emergence, the soil temperature should be above 10°C and temperatures between 25°c and 30°C provide better conditions for seed germination and seedling emergence;
- **Growth and development phase** - air temperature should be around 25°C and be associated with good soil water availability;
- **Flowering and maturation** - Average daily temperatures above 26ºC can promote the acceleration of flowering and maturation, while temperatures below 15.5°C can delay them.

In order to reduce maize losses during harvest, it is necessary that this occurs in a predominantly dry period. The presence of organic residues on the soil is favorable in regions with excessively high temperatures, for example, tropical areas, in the hot season, as the residues help to conserve soil moisture and protect it from wind and water erosion (Costa, 1995).

- Precipitation

Precipitation, associated with soil fertility, determines the productivity of rainfed crops. In order to avoid water and nutritional deficiencies in the plant, the soil water flux density must be equal to or greater than the maximum transpiration of the crop, which is mainly dependent on climatic conditions (Fancelli et al. 2000).

Maize, despite being tolerant to drought, needs water to maximize yield, especially in the critical period. The most critical phases of water deficiency are emergence, flowering and seeding. Maize requires a minimum of 350-500mm of summer precipitation well distributed throughout the crop cycle for it to produce without the need for irrigation (Malate, 2015).

The sowing season, in general, is determined by the variation in temperature and precipitation distribution. However, it is not easy to recommend the planting date to rain-dependent farmers, given the uncertainties of precipitation associated with climate change.

3.4.2. Methodology

For corn yield data analysis the AgroMetshell software was used. This program requires historical data, for a minimum period of 30 years, of precipitation, potential evapotranspiration, decades of seeding, soil type, retention capacity, and crop cycle to determine yields and to know the relationship between precipitation and the income. For the design of scenarios, that is, projection of temperature data (maximum and minimum) and daily precipitation for a period of 20 years, LARS-WG software and the HADCM3 model were used.

Analysis of the current situation

The average yields obtained in the maize crop, in the District of Chókwè, in the period between 1995 and 2010 are far below the potential. In most agricultural campaigns, yields ranged from 0.2 to 0.3 ton/ha, while the potential dryland yield in the District is 1 ton/ha. Generally, sowings carried out in December/January result in very low yields and production failure.

The Crop Water Satisfaction Index (CWSI), which establishes the relationship between the availability of water in the soil and the amount of water that the crop needs for its development throughout the cycle, was below 60%, that is, the recorded precipitation throughout the agricultural season, it was not sufficient for the crop's water satisfaction, which varies from 400-800 mm along the crop cycle. In the 1998-99 agricultural season, one of the best campaigns, the index was approximately 80%, with a yield of 0.4ton/ha.

To calculate the CWSI, we took into account precipitation data recorded over the campaigns, the normal precipitation of the District, potential evapotranspiration, sowing dates, varieties used, soil type and its retention capacity. The relative yield is obtained through a relationship with the CWSI.

During the vegetative and flowering stage, the Crop Water Requirements (CWR) are high and decrease in the last stage, that is, in the stage of maturation and ear formation. In the initial stage of the crop, water requirements increase until the vegetative stage (Figure 3.3).

The amount of water available for the crop depends on the depth explored by the roots, the soil water storage capacity and the plant root density. Thus, the rational management of soil and culture is of great importance for the growth and distribution of the root system, favoring the efficient use of water in the production process.

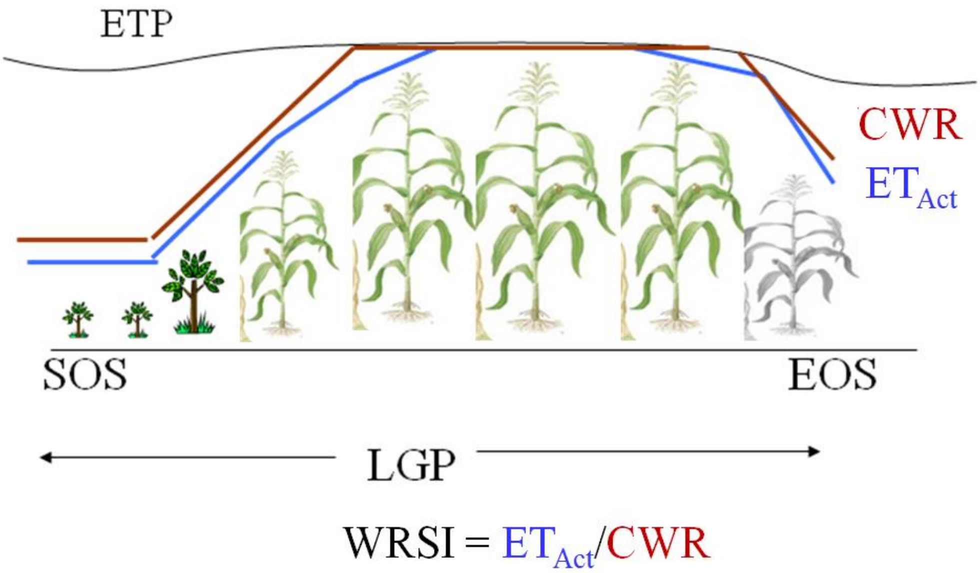


Figure 3.3: Relationship between Crop's Water Requirements and evapotranspiration (CWR: Crop Water Requirements; ETAct/: Actual Evapotranspiration; ETP: Potential Evapotranspiration; SOS: Start Of growing Season; EOS: End Of growing Season; LGP: Length of Growing Period (or Season); WRSI: Water Requirement Satisfaction Index.

Precipitation varies throughout the year, and the significant one occurs between the months of November and April. The best sowing period, based on precipitation data, is from the month of November, although its distribution over that period is irregular.

Projection of temperature and precipitation until 2030

The annual average temperatures of the district of Chókwé, in recent years, have varied between 22-26°C. However, projections of the minimum temperature for the period 2011 – 2030 indicate that it will be situated between 18.5-18.8°C; the maximum between 30.7-31.3°C and the average annual temperature will be 24.8°C, increasing 0.8°C from the current 24°C (Figure 3.4).

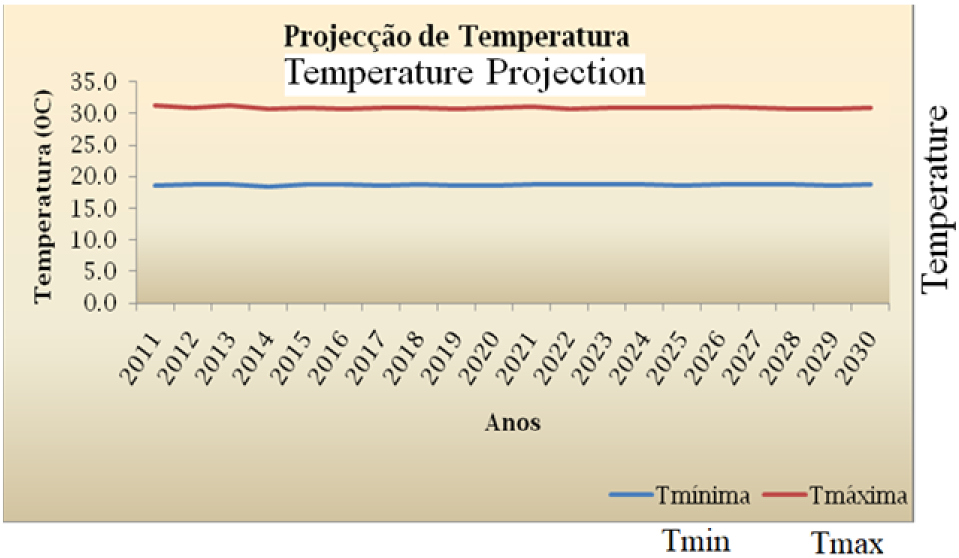


Figure 3.4: Projected minimum and maximum temperature for the period 2011-2030.

The accumulated annual precipitation in the district of Chókwè varies between 500-800 mm. In the period between 2011 and 2030, the accumulated precipitation will be between 420-1.218 mm, with the occurrence of extreme events (such as heavy rains in 2014) and precipitation shortages in 2024 (Figure 3.5).

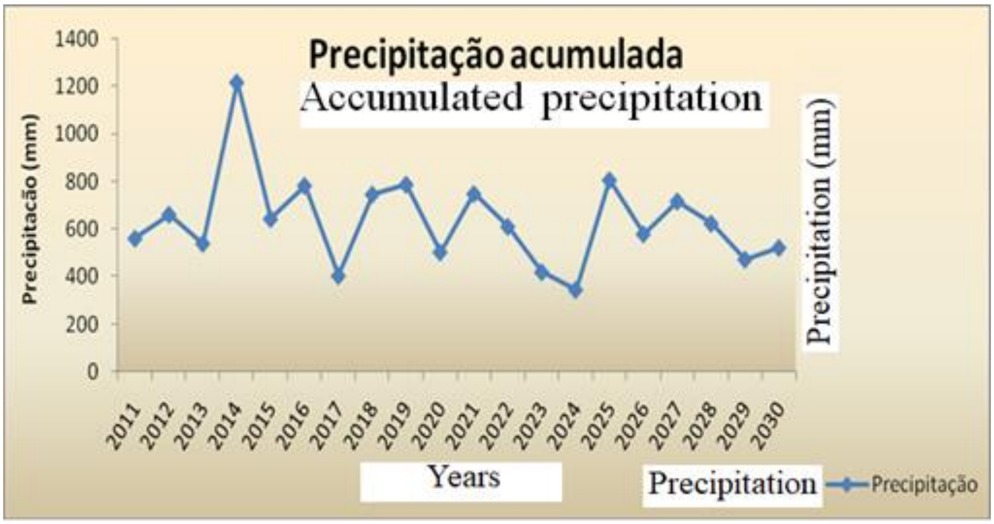


Figure 3.5: Projected accumulated rainfall for the period 2011-2030.

Results

1) At the level of the analyzed data

The low yields obtained in the maize crop, between 0.2-0.3 ton/ha, are directly related to the distribution and spatial variation of precipitation, sowing date, agricultural practices and low use of agricultural inputs;

Irregular fall or scarcity of precipitation in the critical stages of the crop (vegetative and flowering stages) results in losses, failure or very low yields.

2) At the level of Projections

Maize yields in the next 20 years may decline if adequate adaptation measures are not implemented, due to the expected reduction in accumulated annual precipitation and a predicted increase in the maximum temperature of around 5^oC, from the current 26^oC to 31^oC.

3.5. Livestock

Livestock plays a vital role for the rural population, it is one of the components of agriculture. The contribution of livestock to the national economy is incipient. In 2008, livestock represented 10% of total agricultural production and contributed only 1.7% to the Gross Domestic Product (OIE Report, 2008). However, livestock production is affected by climate change in food quantity and quality, disease distribution, management practices and production systems (Herrero et al. 2009).

The main limitations to the development of livestock production are as follows:

(i) Low productivity of existing herds due to the genetic quality of breeders and inadequate management practices;
(ii) Weak veterinary assistance network for the family sector;
(iii) Lack of infrastructure for watering and livestock management.

PEDSA identifies drought as one of the environmental factors causing a notable loss of productivity and the use of technologies to improve water availability and management as a key element to improve animal production. For example, in 2015, 6,767 cattle and 112 goats died nationwide due to drought.

In semi-arid regions, livestock production is a way for farmers to adapt to climate change, as animals are relatively less affected. However, several aspects of animal production are affected by climate change, including food quantity and quality, disease distribution, management practices and production systems (Herrero et al. 2009). Therefore, to achieve the aforementioned Government objectives, an investment is needed to deal with possible limitations to livestock productivity, including climate change.

The vulnerability and adaptation of pastures and livestock are matters of great concern in developing countries such as Mozambique, due to the great importance of livestock as a livelihood component and source of income for local communities. The objectives of this sub-chapter are:

(1) Assess the expected impacts and vulnerability of pastures and livestock to climate change;
(2) Identify adaptation programs and measures;
(3) Identify gaps, needs and priorities for education, training and public awareness on climate change.

It should be noted that the impacts of extreme weather events on livestock are already a reality in the country, as shown in Table 3.7. The impacts observed range from the loss of animals to death, to the destruction of livestock management infrastructure including the loss of pasture areas.

Table 3. 7: Impacts of extreme events on livestock.

Rainy season	Event	Location	Impacts
2000			• 20,000 head of cattle lost
	Heavy precipitation and floods		
2011-12	Irregularity of precipitation (drought) and Tropical Storm "Dando" and Tropical Cyclone "Funso"	Maputo, Gaza, Inhambane e Zambézia	• About 2,678 goats, 237 pigs, 156 cattle and 111 sheep were lost.
2012-13	flood	Maputo city and province, Gaza, Inhambane, Manica, Sofala, Tete and Zambézia	• Death by dragging 21 heads of cattle, 2 donkeys and 4 heads of swine, in Inhambane.
	Seca	Maputo and Inhambane Provinces	• 37.228 ha of crops affected and lost.
	Pests	Tete	• 324ha of crops affected and lost.
	Floods, drought and pests	cidade e província de Maputo, Gaza, Inhambane, Manica, Sofala, Tete e Zambézia.	• 182,281 of producers affected
2013-14	Precipitation	Maputo Province, Gaza, Inhambane, Sofala, Zambézia, Niassa and Cabo Delgado.	• 45,689ha affected, corresponding to 1.1% of the sown area, and 14,495ha lost and affected 24,989 families
2014-15	Irregular rains and drought	Sofala, Inhambane, Gaza e Maputo.	• 56,126 ha affected, corresponding to about 1% of the total area sown with different crops and about 38,000 producers.

Rainy season	Event	Location	Impacts
	Excessive rain and floods	Niassa, Cabo Delgado, Nampula, Zambézia, Sofala, Manica, Tete, Gaza e Maputo	• Death of 138 cattle, 29 goats, 13 pigs and 132 birds; • Several management infrastructures damaged, namely 01 pigsty, 07 carracicide tanks, 01 cattle and goat corral, 03 poultrIes and 1 warehouse. • Extensive grazing areas wetted and ideal grazing area per animal reduced.
2015-16			
2016-17	Floods	Sofala, Inhambane, Manica, Gaza e Maputo,	•
	Tropical Cyclone DINEO	Inhambane	• 18,861ha and 15,050 producers affected.
2017-18	Floods		• 274,742 ha of culture affected.
	Drought		• 223,502ha of crops affected and lost.
	Pests		• Afectados 41,975ha de culturas. 41,975ha of crops affected.

3.5.1. Vulnerability assessment of the pasture and livestock sector

For the vulnerability assessment the Limpopo River Basin in Mozambique was selected. This is located between latitudes 21°00'S and 25°00'S and longitudes 31°00'E and 35°00'E. It has an area of 79,800km² (Figure 3.6). This area was selected due to the variety of climates that occur in it (wetter on the coast and drier inland), the high fish potential and the long tradition of raising cattle, the animal species chosen for the analyses.

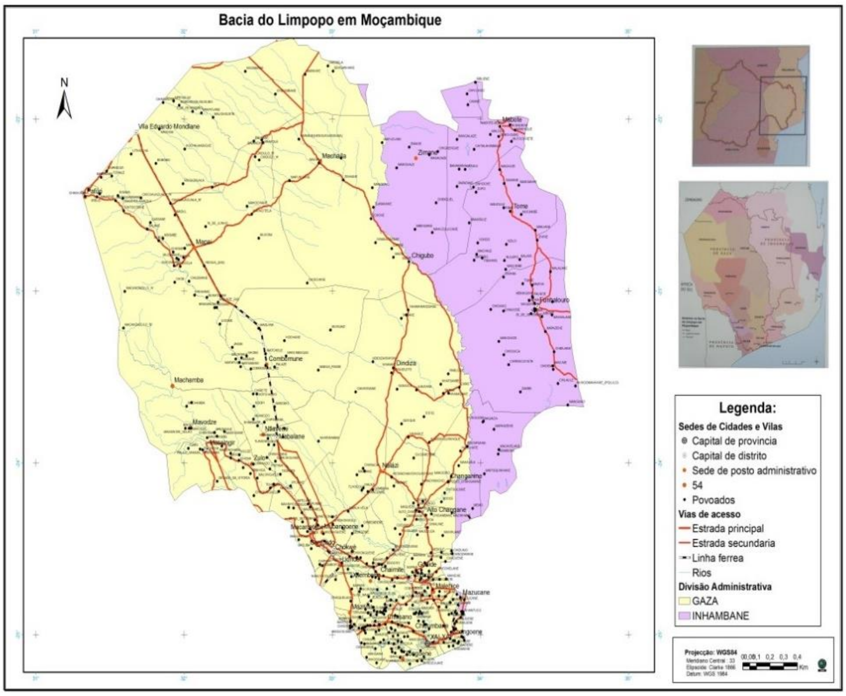


Figure 3.6: Study area location, Limpopo River Basin.

Climate and water availability

In the Limpopo River Basin the climate is characterized by two seasons: a warm and wet season, from October to March, and a cool and dry season, from April to September. Of the total annual precipitation, 76-84% is recorded during the hot and wet season (Reddy, 1986). The maximum temperatures range from 30-35°C and the minimum from 9-12°C. The observed evaporation and evapotranspiration, in mean annual values are higher on the coast than inland, between 2300-1,700mm, the average relative humidity varies from 75-65% (UGBL, 2011). The main rivers are the Limpopo, the Rio dos Elefantes, Changane and the Mwenezi. There are numerous lakes and swamps and vast wetlands.

Vegetal cover

In the Limpopo basin there are three large groups of vegetation formation (table 3.8). Most of the area of this basin is suitable for pasture (figure 3.7).

Table 3. 8: Main groups of plant formation in the study area.

VEGETATION FORMATIONS	SPECIES	CCURRENCE / LOCATION / FLORISTIC COMPOSITION
Dry deciduous savannah tree	**Dominant:** Colophospermum mopane **Tree species:** Ximenia americana, Boscia albitrunca e Euphorbia spp **Herbaceous layer:** Eragrostis rigidior, Cenchrus ciliaris, Schmidtia pappophoroides e Urochloa spp **Annual grasses:** Enneapogon cenchroides, Aristides adscensionis e Eragrostis viscosa **Limestone soils:** Typical mopane savanna **Basaltic soils:** Sclerocarya birrea (canhoeiro), Acacia nigrescens, Combretum apiculatum. Commiphora spp., Grewia spp. Kirkia accumunata, Terminalia sericea e Adansonia digitata (embondeiro) **Alluvial areas of the large river valleys:** Berchemia discolor, Diospyros mespiliformis	**Occurrence/Location:** Dry areas; forms a broadband that extends to Namibia; in the region of Chókwè, between the Rio dos Elefantes and Rio Limpopo up to 25km south of the confluence of these rivers; central part of Gaza and Inhambane provinces **Composition:** variable depending on differences in soil composition and moisture
Savana seca de caducifólias arbustivas	**Dominant:** Boscia spp., e Acacia spp; Combretum imberbe **Shrubs:** Grewia flava, Dichrostachys cinerea e Boscia rehmannii **Typical grasses:** Petalidium spp e o Catophractes alexandri	**Occurrence/Location:** Strip with a length of 10 to 50 km around the mopane savannah **Composition:** Complex association in which the proportion of shrubs is always greater than that of trees; vegetation with a xerophytic aspect;
Riparian vegetation or gallery forests	**Dominant:** Ficus syracuse, Trichilia emetica **Tree species:** Ficus syracuse, Trichiila emetica, Xanthocerecis zambesiaca, Combretum spp., Ekebergia capensis	**Occurrence/Location:** Near to the rivers, typical of wetlands; Along the Rio dos Elefantes, between Massingir and the confluence with the Limpopo

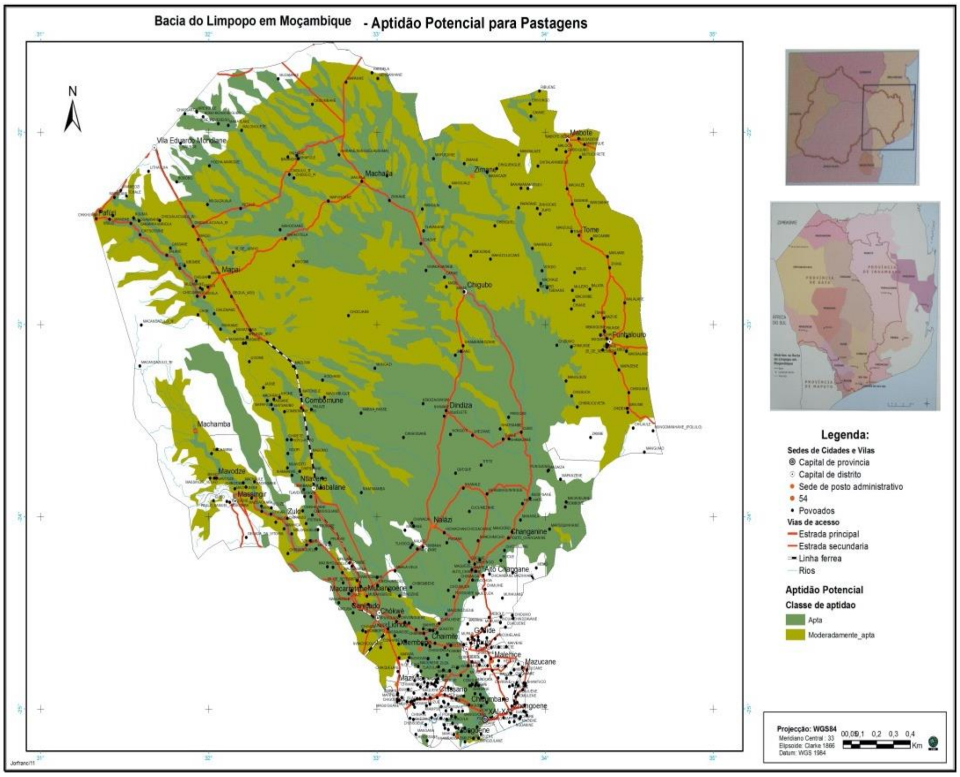


Figure 3.7: Potential aptitude for pastures.

3.5.2. Vulnerability assessment methods

The process of assessing the vulnerability of natural pastures and livestock is qualitative and was based on a literature review, and followed four steps:

1. The first step was to identify data and information regarding available projections on climate change in Mozambique, produced by INGC (2009), for 2040-2060 and 2080-2100. Projections indicate that there will be an increase in temperature and evapotranspiration and precipitation will be more variable. As a result, dry spells will be hotter and longer and precipitation more unpredictable (INGC 2009).
2. As a second step, the relationship between natural pastures, cattle raising and climate change was analyzed. Climate change can alter the productivity of pastures and, therefore, make livestock production vary. The impact on pasture productivity results from the increase in atmospheric CO_2-concentration, change in temperature and precipitation regime. Livestock production, especially small-scale production that depends on precipitation, will be substantially negatively affected. For example, in the prolonged drought in Mozambique in the year 2015, a high number of cattle died due to drought and consequent shortages of pasture and drinking water.
3. The third step consisted of collecting and evaluating data and information on the initial conditions considered in the analysis of vulnerability to climate in the near future. Baseline variables include forage and water availability and quality, natural pasture and cattle management, as well as the socioeconomic situation of the local human population. These aspects are closely interlinked and are affected differently in the event of a significant change in climatic conditions.

- Forage availability

Natural pastures are the main source of food for cattle. Its geographic distribution is fundamentally determined by climatic factors and physical and chemical properties of the soil. Forage availability is high during the rainy season and declines as the dry season progresses (Figure 3.8).

Figure 3.8: Cattle grazing in an area with scarcity of pasture during the dry season, in Inharrime district, Inhambane province.

- Forage quality

The pastures regrow in October/November, beginning of the rainy season and are palatable until March/April with the protein content between 70 to 75%, in relation to the other nutritive elements, that is, during the period of about six months (Owen-Smith, 1982). Nutritional value and palatability progressively decrease until the start of the next rainy season, so that during the last months of the dry season the nutritional needs of grazing animals are not met.

- Water availability

The availability of water for livestock is correlated with the thermo-pluviometric pattern and with the number of natural water points (lakes, rivers and natural depressions) and artificial (irrigation channels, small weirs, small reservoirs, excavations, boreholes, wells). In semi-arid areas, a large number of natural water sources remain without water in the cool and dry season (Timberlake and Reddy, 1996; Timberlake, 1988; PANESA, 1988). Therefore, during the dry season, animals depend on water obtained from artificial sources. The intensive use of water from the upstream Limpopo River, particularly in Zimbabwe and South Africa, has exacerbated flow reduction in the Mozambican part of the Basin during the cool and dry season (AFTWR 2007). In some sections, the Limpopo River dries up for periods longer than four months, even in a year of normal precipitation (Timberlake 1988), resulting in a shortage of water for livestock watering.

- Management of natural pastures

Cattle breeders interfere in the composition and structure of natural pastures, through management actions. In fact, during the dry season, fires are carried out with a view to renewing the pasture, reducing tick infestation or other objectives. However, many fires become uncontrolled (Vilela, 2010). The consequences of uncontrolled and frequent fires include the destruction of extensive areas of grazing necessary for the animals, increasing the distance that livestock must travel to satisfy their food needs. Therefore, there is a reduction in the time available for consumption and there is more energy loss in search of pasture, which reduces the productive and reproductive performance of individuals and herds (Vilela, 2010). However, controlled burnings carried out according to a management plan that considers climatic conditions, herbaceous biomass and density of grazing animals are an important management tool with several positive aspects in the productivity of pastures and livestock.

- Cattle management

The study area integrates the vast region of southern Mozambique, where livestock production is geographically concentrated, being at the base of this distribution, several factors including environmental and other cultural factors. The family sector in livestock is dominant, accounting for most of the production. The labor in livestock is family-run and cattle raising is under extensive grazing, with low inputs, without food supplement even at the most critical times, which means that the cattle are exposed to the effect of climatic extremes, especially to drought.

The animals feed on communal natural pastures during the day and are kept in corrals at night. Veterinary assistance is still deficient and adequate infrastructures for insecticide baths, vaccinations, etc., are in limited quantities. The yield from livestock production is low, serving only to meet the needs of the breeders themselves, especially the consumption and use of animals as traction force in agriculture or transporting goods.

3.5.3. Analysis of the main constraints of cattle systems and the profile of breeders

Livestock production in the district of Chókwé faces several challenges, highlighting the following: high risk of drought and floods, risk of infestation of livestock by diseases (eg foot-and-mouth disease), gradual reduction of pasture areas due to their conversion to other forms of land use, insufficient capital and availability of inputs, low level of coverage by veterinary extension services, and little investigation into the dynamics of natural pastures. In the study area, the family sector holds most of the cattle herd. Many families raise cattle in small herds, due to poverty and lack of resources to purchase more animals. For families who own livestock, livestock has many social, economic and cultural benefits, including consumption, bartering or sale during low agricultural income years, animal traction and traditional ceremonies.

Most smallholders have cattle from local breeds of animals that have low production rates but are generally better adapted to local conditions of high temperatures and limited availability of food and water than the more productive exotic breeds.

3.5.4. Vulnerability of pastures to climate change

Considering the available projections on changes in climate variables, compared to the annual average over the last 40 years (INGC, 2009), the potential impacts of climate change on pastures and livestock are presented in Table 3.9.

Table 3. 9: Assessment of possible impacts of climate change on pastures and livestock.

<table>
<tr><th colspan="2">VARIABLES
(Source: INGC, 2009)</th><th>PROJECTIONS (Source: INGC, 2009)</th><th>POSSIBLE IMPACTS (DIRECT)</th></tr>
<tr><td colspan="2">Minimum temperature</td><td>Similar rises in the Limpopo valley, with greater rises inland and in the September/November period</td><td rowspan="10">water availability
• Water stress
• Frequent droughts (meteorological and agricultural);
• Relatively more pronounced hydrological drought;
• Lack of water: one of the factors that could increase diseases among herds
Water availability
• Water stress
• Frequent droughts (weather and agricultural);
• Relatively more severe hydrological drought;
• Lack of water: one of the factors that could increase disease among livestock
Natural pastures
• Reduced pastures, changes in the duration of the growing season
• Pasture quality reduction trend
Cattle herds
• Reduction of animal performance
• Spread of diseases and parasites to new regions</td></tr>
<tr><td colspan="2">Maximum temperature</td><td>Increase between 2.5-3.0ºC</td></tr>
<tr><td rowspan="2">Seasonal variability</td><td>Maximum temperature</td><td>It will increase in most of the country in March/May and in June/August</td></tr>
<tr><td>Minimum temperature</td><td>Will increase in the South during September/November</td></tr>
<tr><td colspan="2" rowspan="3">Precipitation</td><td>Increase in most of Mozambique during December/February and March/May</td></tr>
<tr><td>Increases can often be less than approximate increases in evapotranspiration (0.1mm/day) during July/August and September/November</td></tr>
<tr><td>Larger increases in precipitation towards the coast</td></tr>
<tr><td colspan="2" rowspan="2">Precipitation variability</td><td>Suggests an increase in variability in June/August</td></tr>
<tr><td>In southern coastal regions increased seasonal variability during all four seasons</td></tr>
<tr><td colspan="2">Annual average precipitation</td><td>A slight increase in precipitation (10-25%) compared to the annual average for the past 40 years</td></tr>
</table>

VARIABLES (Source: INGC, 2009)	PROJECTIONS (Source: INGC, 2009)	POSSIBLE IMPACTS (DIRECT)
Sea level rise	By 2030, rising sea levels could cause the loss of more than 22% of wet shores.	(increase in disease incidence, which in turn reduces animal productivity and possibly increases animal mortality) • Thermal stress, with significant effects on milk production and reproduction in dairy cows. • Reduction in the quality of livestock products (meat, milk) • Animal population density

3.6. Water resources

Mozambique has abundant natural and water resources that provide great potential for: the production of a variety of crops; the development of livestock, fisheries, aquaculture and tourism; energy production; and industrial growth. However, the high variability of the climate that results in frequent and recurrent droughts and floods, the limited availability of water resources in the south of the country, the high dependence on international water resources and the very limited infrastructure of water management make the economy very vulnerable to water shocks, and water is a constraint to growth and poverty reduction.

The availability of the water resource depends on the geographic, climatic and even geological framework. However, for a proper assessment, it is important to categorize these resources, taking into account that they can occur superficially or underground.

3.6.1. Surface waters

Climatic, orographic, and pedological conditions are primary factors for the occurrence of surface waters. These factors directly influence the flow regime of the Mozambican River Basins, which are very extensive and with a total flow area in the national territory is about 2.5 million km^2, with 70% of this contribution coming from other countries. In Mozambique, 104 river basins have been identified, of which the majority of river systems originate in neighboring countries. Of these basins, 13 are considered main, namely the Maputo, Umbeluzi, Incomati, Limpopo, Save, Buzi, Pungwe, Zambezi, Licungo, Ligonha, Lúrio, Messalo and Rovuma river basins (Table 3.10).

According to Table 3.10, the central region of the country is where the largest hydrographic basin is located - the Zambezi basin - with an area of 1,200,000 km^2, of which 140,000 km^2 is in the national territory and 2,700 km of length, of which 820 km are within the national territory. The river system in this Basin drains water from Zambia and Angola, passing through Zimbabwe and Botswana to the mouth of the coast of Mozambique where it flows in the form of a delta with about 7,000 km^2 in surface. The flow of the Zambezi River is estimated to be around 16,000 m^3/s. Also in the central region we have the Save River, with a length of about 735 km, of which 330 km in Mozambique and 405 km in Zimbabwe. This basin has an area of about 106,420 km^2 (22,575 km^2 in Mozambique and 83,845 km^2 in Zimbabwe) and flows into Mozambique from west to east, flowing into the Indian Ocean in the coastal zone that forms the boundary between the provinces of Inhambane and Sofala.

To the north, the Rovuma river basin is located, with an area of 101,160 km^2, a narrow river for most of its course, widening only when it reaches the coastal plain. Its main tributaries on the Mozambican margin are: Messinge, Lucheringo and Lugenda. The Lúrio River, which rises on Mount Malema at more than 1,000 m in altitude, is about 1,000 km long, and has a hydrographic basin of 60,800 km^2, being considered the largest basin fully inserted in Mozambican territory.

In the Southern Region, the main water courses are Govuro, Inhanombe, Limpopo, Incomáti, Umbeluzi, Tembe and Maputo. The Limpopo, Incomáti, Umbeluzi, Tembe and Maputo rivers originate in neighboring countries and cross the Cordillera dos Libombos, reducing water capacity, forming floodplains

Table 3. 10: List of some main river basins in Mozambique.

Name	Other countries that share the use of rivers	Area in Mozambique (km^2)	Total Area (km^2)	Length in Mozambique (km)	Total length (km)
Zambezi	Zambia, Zimbabwe	140,000	1,200,000	820	2,700
Limpopo	South Africa	79,600	412,000	561	1,600
Rovuma	Tanzania	101,160	155,400	560	800
Save	Zimbabwe	25,575	106, 420	330	735
Incomati	South Africa	14,925	46,246	282	714
Maputo	Suaziland, South Africa	1,570	29,800	150	565
Púnguè	Zimbabwe	28,000	29,500	322	732
Buzi	Zimbabwe	25,600	28,800	320	360
Umbeluzi	South Africa, Eswatine	2,365	5,600	100	314
Tembe	Eswatine (Suaziland)	2,257	2,865	110	314
Futi	South Africa	777	1,924	60	70

Source: MICOA, 2007

Also in the context of surface water, lakes are one of the important reservoirs of surface water. Mozambique has about 1,300 lakes, of varying dimensions, spread across the territory. Of these, Lake Niassa is the largest of all and is located in the province of the same name. It is a lake of tectonic origin, associated with the East African Rift system. This lake has a total surface of 31,000 km^2, of which 20% belongs to the national territory. In addition to this lake, the country has others, natural and artificial, resulting from river dams. Among the artificial lakes, the Cahora Bassa reservoir, located in the District of Songo, in the province of Tete, stands out, with an area of about 2,739 km^2.

In the country, the impact of climate change registered in the balances made of the rainy seasons referring to the hydrographic basins has been the floods (Table 3.11).

Table 3. 11: Watersheds that have registered floods in the rainy seasons and human impact.

Rainy season	Cacthment	Affected areas	People	Families
2007/8	Save	Districts of Govuro (Inhambane) and Machanga (Sofala)		
	Búzi	District of Búzi (Sofala)		
	Púngue	Districts of Dondo and Nhamatanda in Sofala;		
	Zambeze	Districts of Marromeu, Chemba and Caia (Sofala), Tambara (Manica) Mutarara (Tete), Mopeia, Chinde and Morrumbala (Zambézia)		
	Licungo	Nante locality in Maganja da Costa district, Zambezia Province		
	Save	Govuro (Inhambane), Machanga (Sofala)		
	Búzi,	Búzi (Sofala) Buzi (Sofala)		
	Púngue	Dondo e Nhamatanda em Sofala		
	Zambeze	Marromeu, Chemba e Caia (Sofala), Tambara (Manica) Mutarara (Tete), Mopeia, Chinde e Morrumbala (Zambézia)		
	Licungo	Maganja da Costa, Província da Zambézia		
2009/10	Buzi	Buzi		
	Pungue	Dondo e Namatanda (Sofala)		
	Zambeze	Marromeu, Chemba e Caia (Sofala), Mutarara (tete) e Chinde (Zambézia)		
2010/11	Limpopo	Guija, Bilene, Chibuto, Chókwe, Xai-Xai distrito e Xai-Xai Cidade		
	Zambeze	Marromeu, Mutarara e Mopeia		
	Incomati	Manhica e Magude		
2013/14	Licungo	Maganja da Costa, Mocuba e Namacura	4,666	1,117
2014/15	Licungo	Severe flood causing flooding and destruction of socio-economic infrastructure especially in the **districts of Gurué, Lugela, Ille, Mocuba, Maganja da Costa and Namacurra.**		
	Zambeze	In terms of impacts, there was a record of isolated floods, especially in the **districts of Chemba, Caia, Morrumbala and Marromeu**		

Rainy season	Cacthment	Affected areas	People	Families
	Púngue	Isolated flooding of agricultural areas located in low-lying and riverside areas in **the districts of Nhamatanda and Dondo** and traffic restrictions in the locality of Metuchira/Pita a Lomaco (Nhamatanda district).		
	Búzi	Impaired transitability in the **district of Búzi** (interruption of the Batelão between Guara-Guara and Bandua).		
	Messalo	Impaired traffic between the **Administrative Posts of Mirate and Nairoto** (district of Montepuez). Flooding of agricultural areas located in low-lying and riverside areas and of neighborhoods and residential villages in the **districts of Macumia and Muindumbe**		
	Megaruma	Impaired traffic between the **districts of Mecufe and Ch**iure and flooding of neighborhoods and residential villages.		
	Muaguide	Collapse of the bridge over the Muaguide river, restricting transitability between the northern part of Cabo Delgado province and Pemba city. Flooding of agricultural areas located in low-lying and riverside areas; neighborhoods and villages in **Metuge district**		
	Ligonha	Interruption of the crossing by canoes between the **districts of Moma and Pebane**. Flooding of agricultural areas located in low-lying and riverside areas and flooded and besieged houses in the **district of Moma**		
	Lúrio	Impaired traffic between Cuamba and Mutuali districts; and Nampula and Cabo Delgado provinces.		
	Meluli	Impaired transitability between **Nampula City and Moma, Angoche and Larde districts.** Flooding of agricultural areas located in low-lying and riverside areas and residential neighborhoods in the **district of Larde.**		

3.6.2. Groundwater

Water resulting from precipitation, as well as surface water, are recharge sources for groundwater. For this purpose, the geological conditions of each location are decisive in the infiltration and storage of water in the form of groundwater. Land made up of sediments or rocks with high permeability and porosity are suitable for accommodating groundwater. Thus, sedimentary formations from the Cenozoic form the most productive aquifers in Mozambique, particularly the part occupied by alluvial sediments and dunes. For the part occupied by crystalline rocks, the waters are accommodated in fractures, which also dictates a very low yield of wells and holes.

Within the scope of transboundary water resources management, SADC promoted a mapping and definition of a set of transboundary aquifers for the region. Although the natural extent of these aquifers needs to be verified, these data are extremely useful in the context of managing transboundary water resources. Of these, those shared between Mozambique and other countries are the Karoo Sandstone Aquifer (Tanzania, Mozambique), Coastal Sedimentary Basin (Tanzania, Mozambique), Chire Valley (Malawi, Mozambique), Coastal Sedimentary Basin (Republic of South Africa, Mozambique).

For vulnerability assessment, the Maputo River Basin was selected (Figure 3.9) located in the extreme south of the country bordering the Republic of South Africa and Swaziland to the west, to the east it is bounded by the Indian Ocean, to the south by South Africa and North through the Umbeluzi basin. The Mozambican part is covered in its entirety by the district of Matutuine.

The Maputo Basin is rich in biodiversity and supports a number of protected and endangered areas due to the development activities taking place along the river. The main activities carried out along the river, in the Matutuine district, are agriculture and fishing, which play an important role in its economy. In 2011, when this vulnerability assessment was carried out, it was estimated that the basin provided 50% of water for agriculture, 35% for supply and 15% for industry.

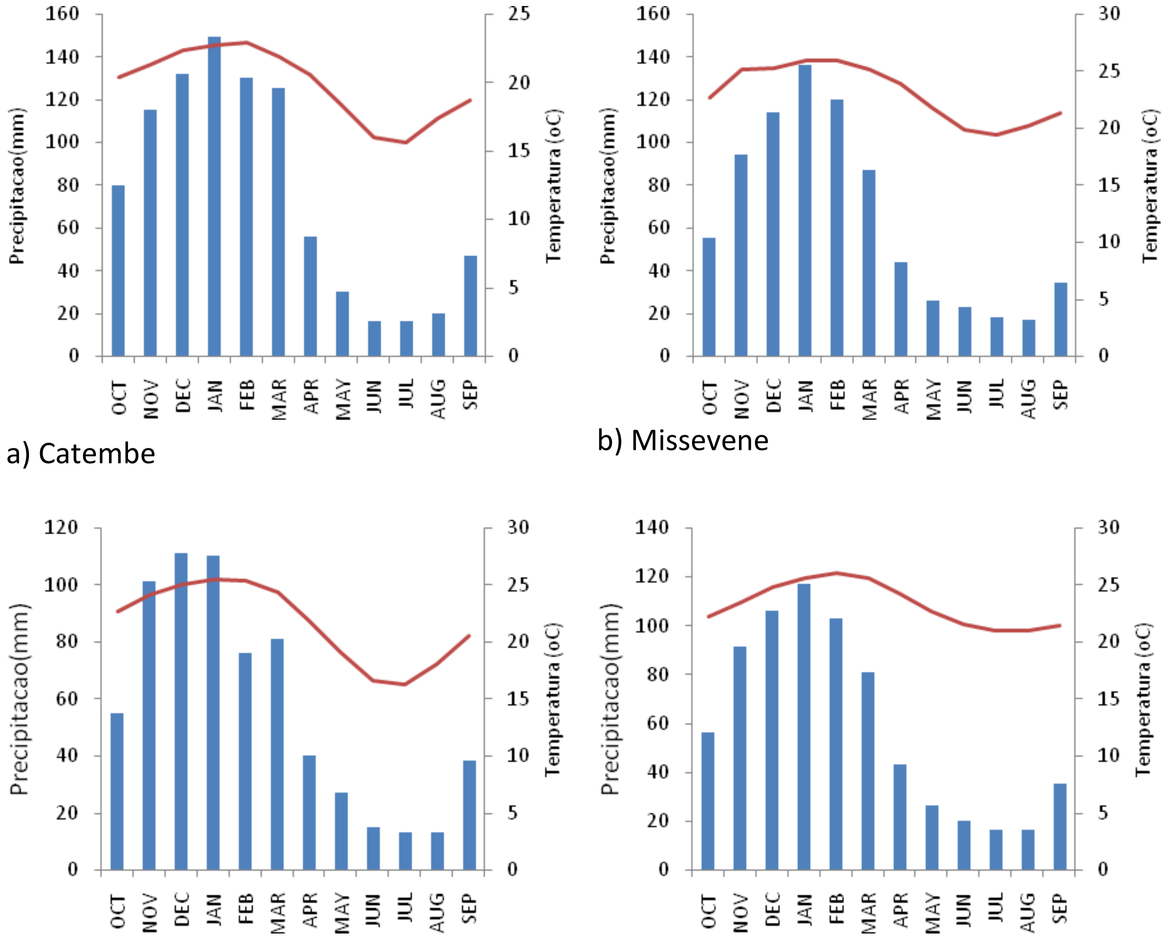
Figure 3.9: Geographical location of the Maputo basin.

3.6.3. Methodology

For Vulnerability Assessment, the Maputo Basin aims to simulate scenarios of the impacts of changes in climate variables on the hydrology of this basin. The study's main objectives are to analyze and quantify the possible impacts that may result from a possible change in the variables that influence the climate and to identify adaptation measures to reduce such impacts.

Temporal distribution of precipitation and temperature

As for the distribution of precipitation, it is clear that higher rates are registered in the administrative posts of Catembe and Missevene and occur between the months of October and April, with average precipitation values ranging from 80 mm/month to 140 mm/month. The dry months occur between May and September with precipitation values ranging from 20mm/month to 60mm/month. As with precipitation, the temperature in the study area varies proportionally, the higher the temperature, the higher the precipitation indices, where higher values coincide. The monthly high average temperature is registered in the months of October to April, varying between 19°C and 20°C and the lowest from May to mid-September (Figure 3.10).



a) Catembe

b) Missevene

c) Zitundo

d) Machangule

Figure 3.10: Temporal distribution of rainfall and temperature in the Maputo basin.

3.6.4. Vulnerability assessment methods

The vulnerability assessment methodology used in this study is schematically presented in figure 3. 11.

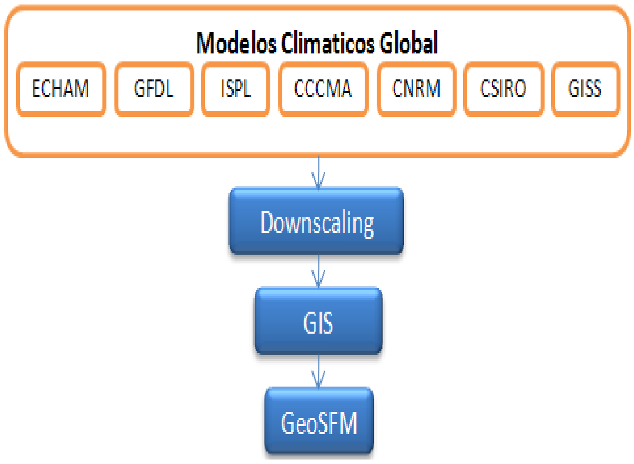


Figure 3.11: Assessment methodology for this study.

The analysis is based on methods recommended by Asante & Vilanculos (2009) on the impacts of climate change on hydrology in Mozambique, for a historical period of 40 years, between 1961 and 2000, to analyze the historical behavior of the past; and projections were made for the period 2046 – 2065, which proved to be consistent in the performance of global climate models. In a first phase, the analysis covered the entire area drained by the Maputo Basin and later analyzed, in detail, only the Mozambican part.

In the analysis of the conditions of water resources were introduced in the hydrological model, Geospatial Stream Flow Model (GeoSFM), daily evaporation and precipitation data generated by seven global climate models (ECHAM, GFDL, IPSL, CCCMA, CNRM, CSIRO and GISS) to simulate soil moisture conditions and subsequent generation of future daily flows. GeoSFM is the model produced by the USGS to determine the daily conditions of soils and water flows. The data used were acquired from INGC and ARA-Sul.

The determination of water availability along the Maputo hydrographic basin was made by comparing the average fluvial flow conditions of the past with those of the future produced by the GeoSFM model. The per capita value of 20-40/person/day was considered in the water availability scenario for consumption and compared with five classes defined for analysis, namely:

i) Much below normal (<-25%);
ii) Below normal (-25% - 10%);
iii) Normal (-10% -10%);
iv) Above normal (10%-25%);
v) Far above normal (>25%).

Considering the two extreme events (droughts and floods) that occur along the Maputo basin, scenarios were defined for these events, namely, (i) Changes in flood frequency; and (ii) Changing the frequency of droughts.

On the other hand, to analyze the frequency of flood peaks, four classes were defined, namely: (i) Below Normal (<-50%); (ii) Normal (-50% - 50%); (iii) Above normal (50%-100%); and, (iv) Much above normal (>100%). Due to the poor spatial feasibility of historical drought values, a point percentile analysis of the hydrological trend was performed using only the Madubula hydrometric station (E-6). Four classes are also defined: (i) Far below Normal (<10%); (ii) Below normal (10% - 25%); (iii) Normal (25% - 75%); (iv) Above normal (75% - 90%); and (v) Far above normal (> 90%). Observing Figure 3.12, it is possible to verify that the Maputo River in the dry period tends to present values below normal. This trend may prevail in the future.

3.6.5. Results

Future analysis of precipitation fluctuation

The results are shown in figure 3.12: variations in mean annual precipitation for two global climate models (ISPL and GFDL). The Legend of the figure indicates the "Average annual precipitation variation", from brown – much less precipitation (less than 25% negative) to dark blue – much more precipitation (positive change greater than 25%). It is evident that the models predict future probability of occurrence of normal precipitation with some tendency towards above normal. However, there is a scenario upstream of the basin whose probability will be normal with a trend below normal.

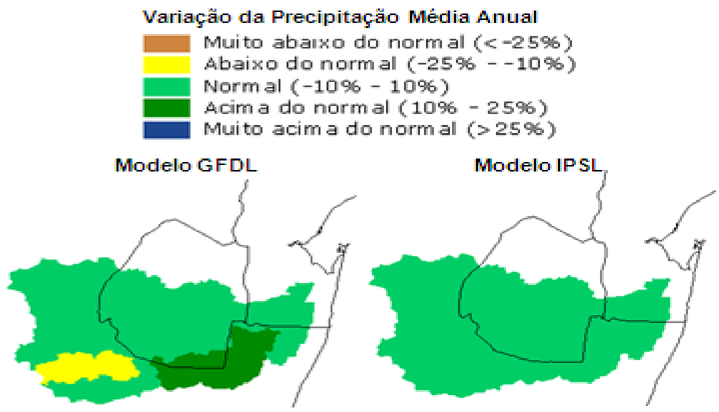


Figure 3.12: Average annual rainfall variation in the Maputo river basin.

Future analysis of flow fluctuation

a) Changes in flood peak magnitude

The results on the availability of water resources predicted by the seven global climate models used in this study (ECHAM, GFDL, IPSL, CCCMA, CNRM, CSIRO and GISS) are presented in Figure 3.13. From this figure it can be seen that the IPSL, CCCMA, ECHAM CSIRO and CNRM models show that the Maputo Basin will continue to receive much more water in the future, in the order of more than 25% compared to historical values. A second scenario shows that it can also occur where the behavior of flow levels in the past is not expected to change significantly.

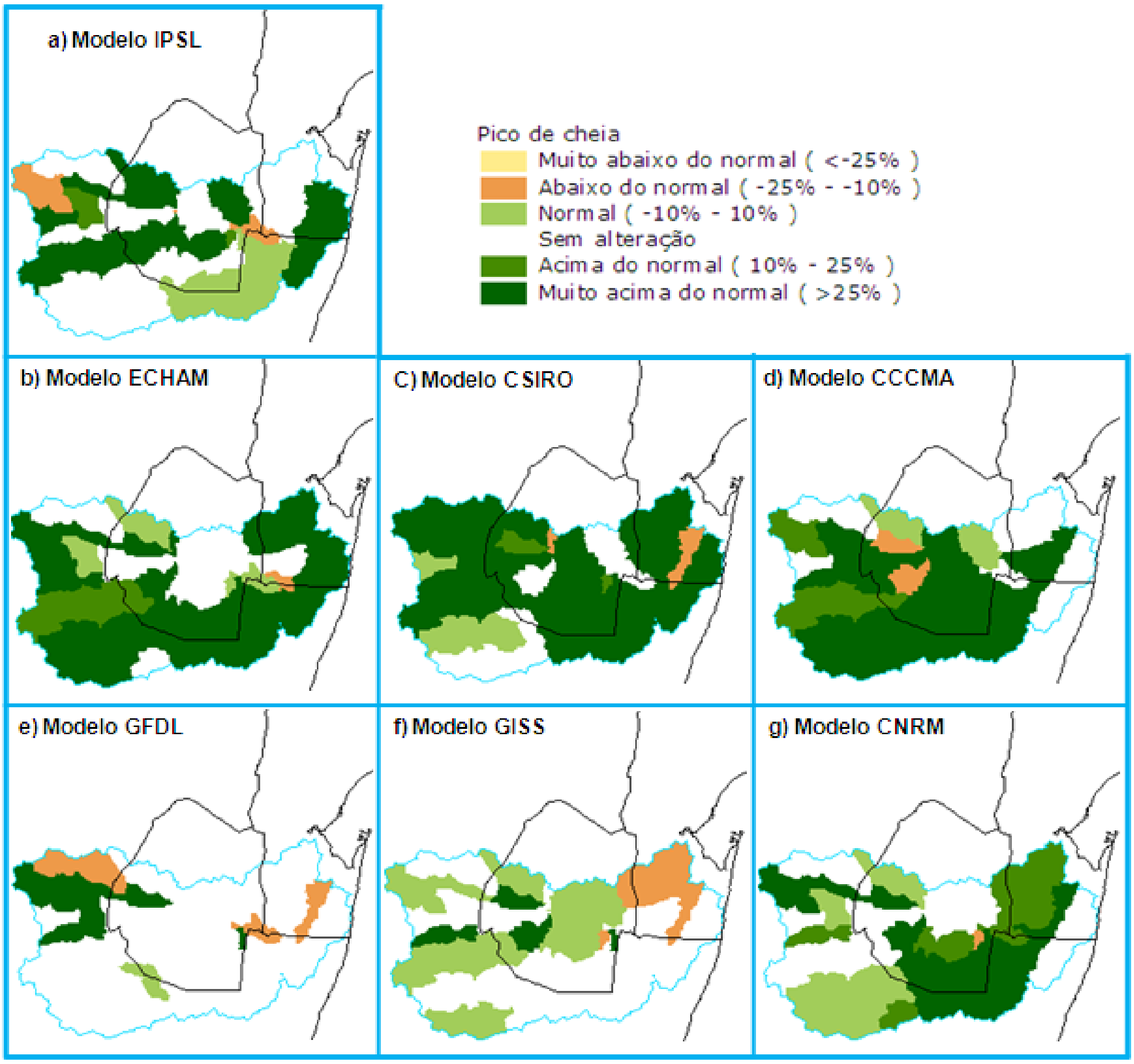


Figure 3.13: Different flood risk scenarios in the Maputo River Basin concerning changing flood peak magnitude.

a) Change in the frequency of peak floods

The results of the analysis of the frequency of occurrence of peak floods, predicted by the seven global climate models used in this study (ECHAM, GFDL, IPSL, CCCMA, CNRM, CSIRO and GISS) are presented in figure 3.14. The models show that the peak may register some fluctuations with increasingly frequent phenomena.

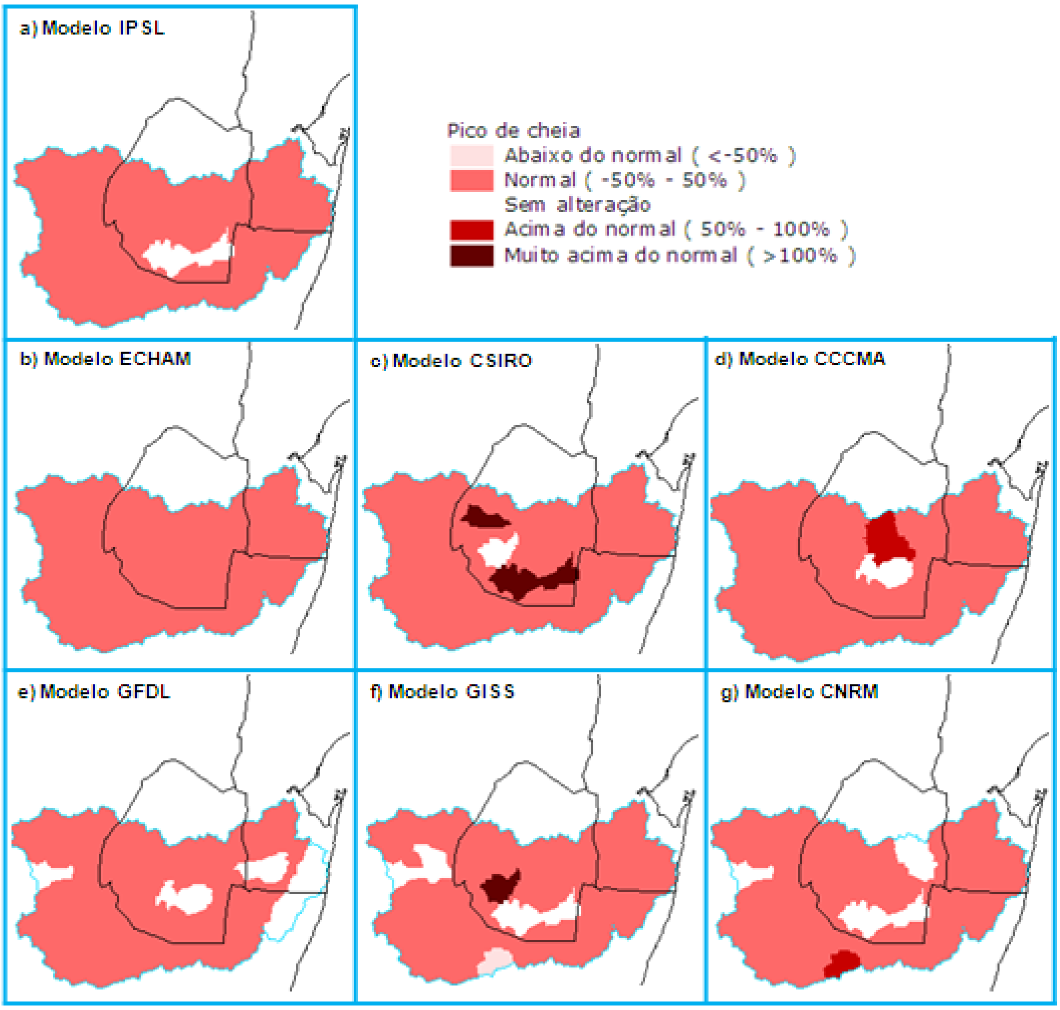


Figure 3.14: Different flood risk scenarios in the Maputo River Basin concerning changing the frequency of occurrence of the flood peak.

Drought flow analysis

The analysis of the climate vulnerability situation in the Maputo Basin, combining global models and projections through observed data, is controversial. If, on the one hand, the results of global models show increasingly frequent floods, the projections through observed historical data show a continuous reduction of drought flows (figure 3.15). This situation clarifies that this basin is vulnerable to the occurrence of more and more floods in the rainy season and increasingly severe hydrological droughts in the dry season.

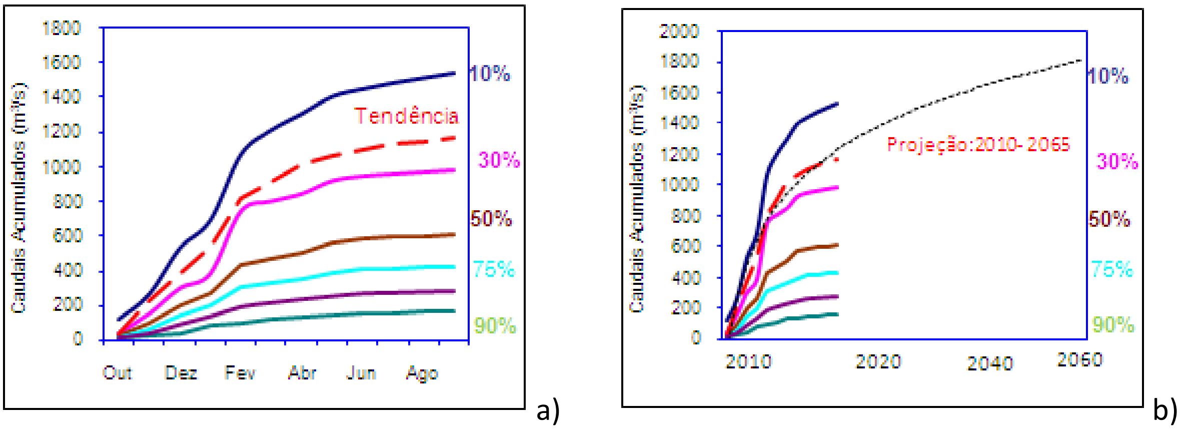


Figure 3.15: Current (a) and projected (b) situation of drought severity indices until the year 2065 in the Maputo catchment.

3.7. Fisheries Sector

The fisheries sector represents around 3% of the country's GDP, resulting from the export of shrimp, prawns and other fishery products. On the other hand, fishing resources are the source of subsistence and income for around 60% of the Mozambican population living in coastal areas. However, the IPCC (2007) indicates that coastal regions are those that will suffer most from the impacts of climate change. For these reasons, it is important to determine the vulnerability of fisheries resources to climate change and to identify adaptation mechanisms in order to achieve the sustainability objectives of the fishing activity. This sub-chapter assesses the vulnerability of the Sofala Bank shrimp fishery to climate change and proposes measures to adapt to the anticipated impacts.

3.7.1. Geographic location and justification for choosing the study area

The Sofala Bank is the continental shelf that extends over some 900 km of coastline from Angoche, in Nampula province, to the mouth of the Save River (Figure 3.16). The Sofala Bank has an area of 45,000 km^2 up to the 200 m bathymetric, representing 64% of the continental shelf of Mozambique.

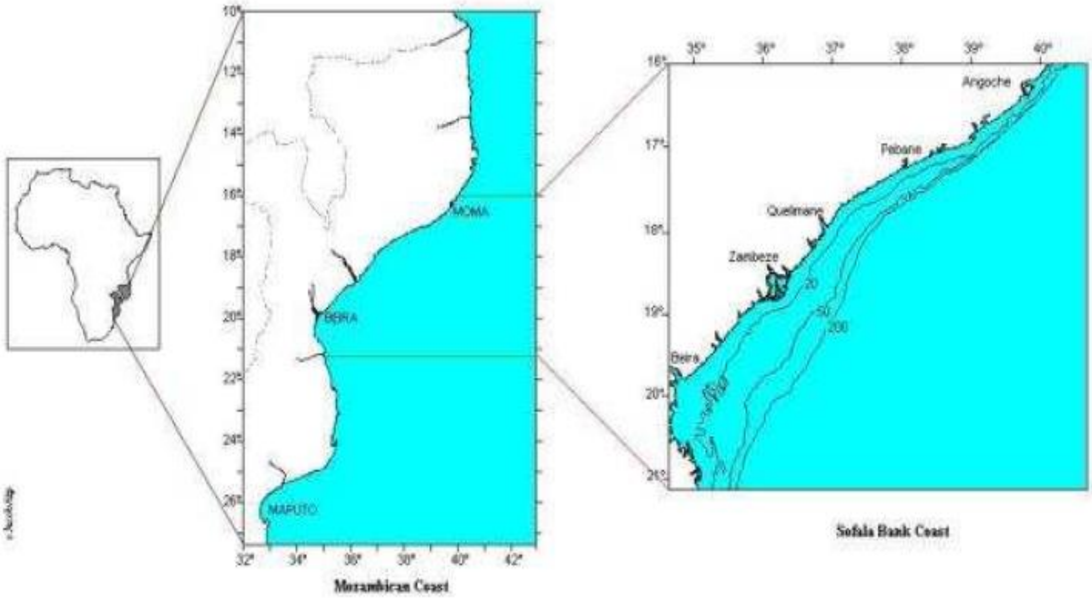


Figure 3.16: Geographical location of the Sofala Bank.

The Sofala Bank is home to the most productive fishing area in the country. About 70% of the fleet is based in the city of Beira and another small part is distributed in Quelimane and Maputo city as base ports (Ministério das Pescas, 2010). The Sofala Bank supports the largest shrimp fishery, of which the annual production is estimated at around 80 million dollars (Palha de Sousa et al., 2006). In the 2012 fishing season, environmental problems caused the dispersion of the resource resulting from the occurrence of three consecutive cyclones (Dando, Funso and Irina) at the beginning of the fishing season, which caused a reduction in the catch of the industrial and semi-industrial sectors (Table 3.12) (Diploma Ministerial No. 161/2014 of 1 October).

Table 3. 12: Number of vessels, catch in tonnes (in parentheses) per fishery in the Sofala Bank for the year 2009 (*2008 estimate).

Fishing	Industrial	Semi-industrial	Artisanal
Shrimp	58 (4.994 t)	35 (110 t)	24 (10 t)
Gamba	16 (1.163 t)	-	-
Fish (line fishing)	18 (83 t)	22 (734 t)	-
Tuna	155 (3.087 t)	-	-
Not specified (fish, molluscs and crustaceans)	-	-	16,118* (68,332 t)*

Source: IDPPE (2009) and Ministry of Fisheries (2010).

The main species that are caught by the industrial and semi-industrial fleet are the white shrimp Penaeus indicus and the brown shrimp Metapenaeus monoceros, which constitute 80-90% of the approximately 5,000 to 8,000 tons caught annually. These two species of peneids are coastal, occurring from the coastline to about 25 m in depth across the Sofala Bank, but mainly in mangrove fringed regions and river estuaries.

In short, the Sofala Bank has both ecological and socio-economic importance. The ecology of the area influences the availability, distribution and catches of shrimp and other fish target species.

- Shrimp ecology and fisheries management

The life cycle of peneid shrimp and many other crustaceans can be divided into two phases, a marine and an estuarine. Shrimp go through several stages throughout its life.

The shrimp fishery in the Sofala Bank is subject to a seasonal fence (provided for in the General Regulation of Maritime Fishing, Decree 43/2003 and in the Fisheries Law - Law no. 22/2013, of 1 November) which is intended for protection of juveniles of P. indicus that recruit from coastal, estuarine areas, mainly to deeper waters, where fishing activity takes place (Palha de Sousa et al., 2006, Brito, 2010). This fence was expanded in 2008, going from the previous three to three and a half month to six months a year, starting in September or October (resulting in a shorter fishing campaign) and also as a tool to control the high fishing effort and the high operating costs (Brito, 2010).

The reduction of fishing effort to the level that guarantees the bio-economic sustainability of the fishery set at 180,000 standard hours per year, or a fleet of approximately 43 freezer trawlers (Palha de Sousa et al. 2010), is being implemented by the authorities Mozambican Fisheries Management (National Fisheries Administration). Achieving these management objectives and maintaining them will ensure that the resource maintains spawning stock levels that produce sustainable recruitment and productivity even in the face of environmental variability.

3.7.2. Vulnerability assessment methods

There are several methods of identifying and assessing risk. This sub-chapter focuses on methods that require minimal data, which can be obtained either from the literature or from a working session (workshop type) with the participation of people with a broader spectrum of knowledge about the ecological and socio-economic aspects of the fishery in shrimp from the Bank of Sofala. Therefore, the identification and assessment of the risk to climate change cannot be seen only as a risk to the ecological sustainability of the fishery. Although ecological aspects of the fishery may be affected, it is important to bear in mind that other equally important risks arise from indirect events caused by the climate but with socio-economic effects on the fishery (eg epidemics, market aspects). Furthermore, there are other risks associated with our ability to face or adapt to climate change, namely aspects of governance and institutional capacity.

The identification of these risks should be done using the logical tree method, in a seminar, involving people with diversified interests and knowledge about the shrimp fishery. However, because a similar exercise had been done for the fishery in 2009, under ecosystem-based fishery management. The resulting results were taken into account (EAF-Nansen Project Team, 2009, IIP-Maputo, unpublished). Two risk prioritization methods were used: the qualitative method (informal) and the quantitative method (more formal).

Qualitative method

In situations where there was little quantitative knowledge, the three-level prioritization process was used. This methodology is particularly useful for assessing risks associated with socioeconomic and food security values.

Quantitative method (CxL)

Quantitative risk assessment methods are widely documented and published (eg Fletcher, 2005; Fletcher et al., 2002) and involve identifying the potential impact (consequence) that may result from a particular activity or event (eg, environmental factors). Combining the impact of the event and the probability of its occurrence makes it possible to quantify the level of risk or vulnerability. The equation for this method has the form:

Risk=probability x Impact...Equation 3.1

Probability and impact values range from 1 - 4. The resulting risk or vulnerability values range from 1 - 16 (as illustrated in the matrix in Table 3.13). The combination was based on an assumption of the problem occurring over a period and projections from INGC (2009) for temperature and precipitation were used. The other problems (e.g., circulation and cyclones) were based on global projections, due to the lack of national projections.

Table 3. 13: Sofala Bank shrimp fishery risk/vulnerability assessment matrix to climate change.

		Level of impact			
		Irrelevant	**Moderate**	**Relevant**	**Very relevant**
Probability		1	2	3	4
Very unlikely	1	1	2	3	4
Unlikely	2	2	4	6	8
Possible	3	3	6	9	12
Real	4	4	8	12	16

According to the combination of probability and impact (probability x impact) presented in Table 3.13, the risk/vulnerability of the Sofala Bank shrimp fishery to climate change can have the following levels:

- **1-2: INSIGNIFICANT** – Very small impact that does not require attention;
- **3-4: LOW** - Low impact or targets will be achieved without the need for adaptation or mitigation measures;
- **6-8: MEDIUM** - Impact must be mitigated for objectives to be achieved. It's an acceptable risk;
- **9-12: HIGH** – The risk is at a point where it is possible to predict that the objectives will not be achieved.

Since risk is the probability of something happening that has consequences on the intended objectives, in order to develop levels of consequence it is important to know clearly what the objectives are, in this case in the Sofala Bank shrimp fishery. Based on the objectives outlined in the documents that guide the ordering and management of this fishery, namely, the Fisheries Policy, the Master Plan, the Fishery Management Plan and other guiding documents, the following objectives (see Table 3.14) and levels of consequences were previously developed in the ecological risk assessment process used in this fishery vulnerability assessment process to climate change (EAF-Nansen project team 2009). For this purpose and for simplification, it is considered that climate change is the most significant source of natural mortality and that other sources of mortality, mainly resulting from fishing, will remain constant in the face of sustainable management actions of the ongoing fishing effort and emanating from the aforementioned guidance documents.

General objective of fishery management: stock sustainability - "keep spawning biomass levels at a level above which there will be no problem of overfishing recruitment in a situation of environmental variability.

Table 3. 14: Assessment of the levels of consequences of climate change on the shrimp fishery in the Sofala Bank.

Consequence Levels	INVENTORY SUSTAINABILITY OBJECTIVES: MINIMUM SPAWNING BIOMASS (SB) MUST REMAIN AT 15-20% OF VIRGIN BIOMASS (WHICH IS ACCEPTABLE FOR SHORT-LIFE CRUSTACEANS)
1- Irrelevant Quick recovery will happen if the event stops - measured in months	Possibly detectable, but little impact on population size and none on population dynamics; Spawning biomass (SB) 100-70% of non-fishing levels.
2 –Moderate Recovery would be possible if activity stopped – measured in months	Exploitation rate at maximum as recruitment/population dynamics is unaffected; SB < 70% > Brec (Biomass of recruits).
3 – Relevant Possible recovery years after event stop	SB <Brec - 5%. Recruitment levels of the stock or its capacity to increase are affected; SB <Brec - 5%.
4 – Very relevant	The extinction of the resource is certain, if the SB event persists < 5%

Recovery period measured in decades after event cessation	

3.7.3. Main identified risks and the vulnerability of the fishery

Studies that assess the vulnerability of the Sofala Bank fishery to climate change are scarce or even non-existent. The few known were directed to study the reference situation regarding circulation, tidal currents, freshwater discharges and to some extent the potential role of these elements in the ecosystem, with a focus on the large ecosystem of the Agulhas current (Ridderinkhof et al., 2001 Lutjeharms, 2006, GEF/UNDP/UNOPS 2008). Although some of these works mention the Sofala Bank (e.g., Leal et al., 2009; Da Silva, 1986) they generally do not make any reference to the complex interactions between physicochemical processes and biological resources.

Although it is difficult to determine with certainty the level of impact each can have on shrimp, the analysis of these studies identified the following climate-dependent ecological processes, with possible impacts on natural shrimp mortality, through direct or indirect effects: temperature; nutrients, precipitation, circulation, tropical cyclones.

- Precipitation/Salinity

The coastal region of the Sofala Bank is subject to marked variations in salinity that result from drastic changes in precipitation patterns and river discharges at seasonal, inter-annual and spatial scales (Brito and Pena, 2007; data in Bernardino Malawene, IIP, unpublished report).

The life cycle of commercially valuable peneid shrimp is characterized by a marine and a coastal phase (Ronnback et al., 2002). In the coastal zone of the Sofala Bank, where there are estuaries, juvenile shrimp require low salinity water, among other conditions (Brito and Pena, 2007). Da Silva (1986), followed by other authors (eg Gammelrsod 1992) have suggested that discharges from the Zambezi River, in particular, may influence the level of recruitment of the P. indicus species from coastal zones where brood occurs, to the open sea, by directly altering the number of recruits or by inducing changes in the age of recruitment. Similarly, Brito and Pena (2007) suggested that the change in salinity levels is possible to occur by the discharge of the smaller Púngue and Búzi rivers that play a role in the recruitment of juveniles of P. indicus and M. monoceros from the river estuary Pungwe to the open sea.

On the other hand, Gammelrsod (1992) correlated freshwater discharge volumes from the Cahora Bassa reservoir with commercial shrimp production in the Sofala Bank and found that the reduction in discharge levels corresponds to a reduction in catches. These authors recommend that discharges should follow the natural cycle and volume of discharges.

INGC projections (2009) for the central region of Mozambique (where the Sofala Bank is located) up to the year 2100 point to a progressive reduction in precipitation levels or a delay in the start of the rainy season. Given that the direct relationship between the reduction in precipitation and the increase in water salinity has already been established, we can qualitatively conclude that the habitat for the rearing of juvenile shrimp will be significantly degraded, with a consequent decrease in the recruitment of juvenile shrimp to the fishery.

The estimated risk is considered relevant since the decrease in the precipitation regime is POSSIBLE (level 3) and the consequences are related to the decrease in shrimp recruitment rates, at a RELEVANT level (level 3). Therefore, the level of vulnerability of the fishery to the decrease in precipitation is estimated at 9 (probability 3 x impact 3). This vulnerability level is considered HIGH and implies that stock recovery is only possible years after the event has stopped.

- Nutrients

It is imperative that water quality is at tolerable levels for aquatic organisms so that populations remain healthy and production is maximized. Adequate levels of nutrients (eg nitrogen, phosphorus) allow for a good ratio between primary producers (phytoplankton) and consumers. Both the composition and biomass of phytoplankton communities can be influenced by nutrient concentrations (Smith, 1982; Hecky and Kilham, 1988) which in turn influence population dynamics at higher trophic levels.

The current productivity of the Sofala Bank is generally characterized as being oligotrophic (Leal et al., 2009), that is, there is little natural availability of nutrients in the medium. Nevertheless, both along the Mozambican coast and on the Madagascar continental shelf there are outcrop cells with high nutrient content (Heileman et al., 2008), where theoretically there are also high primary productivity levels. On the other hand, ocean circulation, including strong tidal currents typical of the Sofala Bank, river and coastal sediment discharges can determine nutrient availability levels and levels of light penetration into the water column (turbidity) which in turn affects plankton population dynamics (Leal et al., 2009).

The coastal fishery for shrimp P. indicus, M. monoceros, P. monodon and deeper species such as M. japonicus, M. latisulcatus and P. semisulcatus and by-catch fauna is probably influenced by spatial and seasonal variation of productivity. A better understanding of these processes is urgently needed in order to identify priority areas for conservation, while improving the adaptive capacity of fisheries management in the face of predictable climate change (GEF/UNDP/UNOPS, 2008).

In short, changes in nutrient levels can cause changes in trophic relationships and shrimp mortality. The occurrence of algae outcrops increases primary consumers and undesirable changes in trophic relationships. It is important that in-depth quantitative studies are carried out to understand the variability of nutrients and their effect on energy flow and trophic relationships in the Sofala Bank in view of climate change. Given the level of uncertainty, it is not possible to quantitatively determine the level of vulnerability of the

Sofala Bank shrimp fishery to a possible variation in the concentration of nutrients in the open sea.

- Temperature

Surface water temperature (SST) has been monitored at the Sofala Bank, through research cruises carried out in the summer months. On the other hand, satellite data has been used for the systematic recording of data and to address the problem of lack of observations in periods where research cruises have not taken place. Increases in surface water temperature of the order of 1 - 2ºC have been reported in this ecosystem (Belarmino Malawene, IIP, unpublished report). Unfortunately, these monitorings have limitations due to the fact that they present data for only one month per year, which does not reflect the seasonal variability that occurs for this parameter, nor does it allow to correlate it with the biological attributes of the Sofala Bank. Satellite data available since 1957 for the large ecosystem of the Agulhas Current show an increase of about 0.68ºC up to the year 2006, which is an average increase in temperature below other major ecosystems in the world (Belkin, 2009).

In the context of shrimp population dynamics, it is important to know the natural mortality rate and this has been regularly determined in annual resource assessments (Palha de Sousa et al., 2010). The average water temperature and its variability play a considerable role in the natural mortality and growth rates of shrimp and other aquatic organisms (Pauly, 1980). Although there are limitations in monitoring this parameter and there are also uncertainties in the INAM and INGD forecasts for the year 2100, the vulnerability prediction exercise is relatively easier due to the large number of laboratory experiments on this variable and the tolerance of shrimp. On the other hand, despite the fact that the air temperature is normally more variable than that of the water, it is expected that proportional levels of lesser increase in water temperature may occur, which may contribute to the increase in the natural mortality levels of the shrimp (using the equation of Pauly, 1980).

Another factor related to the hydro-meteorological regime that may occur in the Sofala Bank is the light condition (lunar cycle and day/night). Penaeus latisulcatus and Penaeus japonicus, for example, burrow into the sand when the light is intense, such as that observed during the day or on full moon nights (Egusa and Yamamoto, 1961; Tanner and Deakin, 2001). Forecasting changes in light regimes due to the extension of summer, with longer periods of light, it is possible to predict that the catchability of these species may decrease.

From the point of view of vulnerability, an eventual rise in water temperature significantly increases shrimp mortality levels. Therefore, considering that global warming will also be reflected in the rise in the water temperature of the Sofala Bank, at a POSSIBLE probability (level 3), the consequence will manifest itself in a significant increase in natural mortality at a VERY RELEVANT level (level 4). Vulnerability of Sofala Bank shrimp to rising water temperature would be considered to be HIGH (probability 3 x impact 4=12).

- Circulation

The ocean circulation pattern in the Sofala Bank is possibly influenced by the large marine ecosystem of the western Indian Ocean. There are new data on the large marine ecosystem of Agulhas (ALME) that have improved our understanding of ocean-atmosphere dynamics and their relationship to ecosystem functions such as productivity, larval transport and fisheries. GEF/UNDP/UNOPS (2008) reported that new undersea channels are known (some more than 10 km wide and 100m deep), located in Mascarenhas (Eastern Madagascar) that influence the flow of the South Equatorial current and associated with the relationship with nutrients and productivity. There is a western boundary current that flows along the Southeast coast of Africa from 27°S to 40°S. The water in this stream comes from the eddies of the Mozambique channel of which the main source is the re-circulation of water from the gyrus (ocean cell) of the southwestern Indian Ocean Figure 3.17. The movement and direction of the Agulhas current vary both seasonally and geographically along its length. It is generally limited to the first 2300 m of ocean depth, but this depth limit increases with increasing latitude. Furthermore, seasonal variation creates oscillation in the height of the ocean surface.

Although these new data boost knowledge about the potential role of ocean circulation on Sofala Bank shrimp stocks, Brito (2010) says that it is not clear how his chemical oceanography affects the Sofala Bank's biological resources. A better understanding of the circulation on the Sofala Bank platform will help to better understand the movement of animals such as fish larvae and the dispersion of pollutants and nutrients. Therefore, the circulation in the ALME in the form of marine currents, associated with semi-diurnal tidal currents, river discharges and the physicochemical processes associated with it may be responsible for movements of peneid shrimp with influences on their availability and captures.

Shrimp vulnerability to possible changes in ocean circulation is of multiple order and is related to the role of ocean circulation in nutrient distribution, shrimp larvae, salinity and temperature patterns already evaluated above.

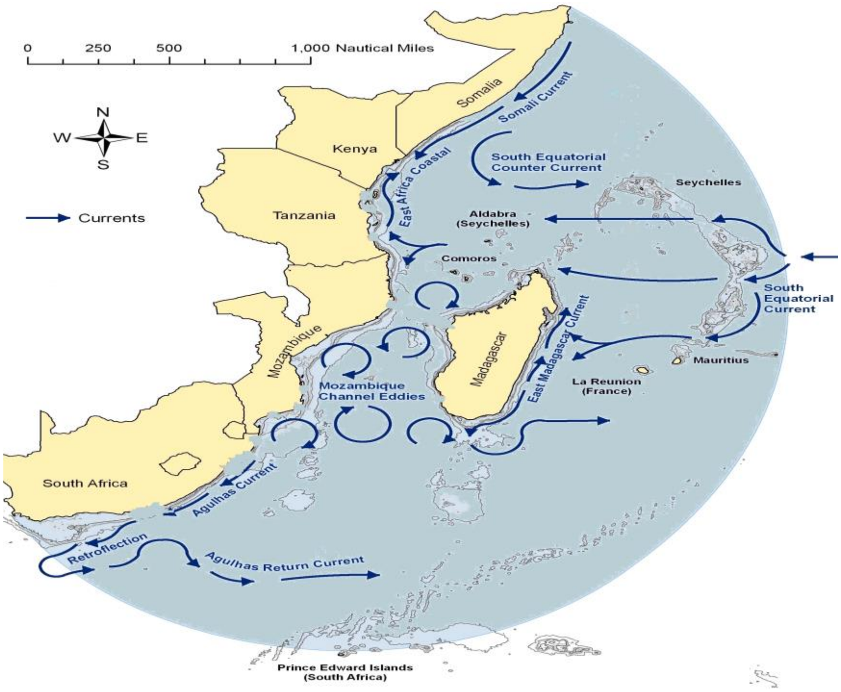


Figure 3.17: Circulation pattern in the Mozambique channel.

- Tropical cyclones

Climate change will influence the frequency and intensity of tropical cyclones, as described in the chapter on coastal vulnerability. These events are of interest to the Sofala Bank shrimp, as they build up sediment to the seafloor, burying benthic organisms, the shrimp's food source. This increases your natural mortality. With reduced abundance due to mortality, the fishery runs the risk of being bio-economically unviable. Surface water salinity is also affected by anomalous anti-cyclonic winds that blow in the Sofala Bank region and further south that block the transport of salt water out of the western Indian Ocean region. These winds are responsible for changes in salinity and precipitation, both related to El Niño (GEF/UNDP/UNOPS, 2008).

Part of the potential impact of cyclones will be the change in the level of fishing effort due to the destruction of boats and infrastructure to support fishing, among other socio-economic losses. The vulnerability of the fishery to cyclones and resulting from the increased frequency and intensity of these events is POSSIBLE (level 3) and the consequences are related to the increase in shrimp mortality rates and reduced fishing capacity with socioeconomic consequences, at a RELEVANT level (level 3). Therefore, the vulnerability level of the fishery to tropical cyclones is estimated to be HIGH (probability 3 x impact 3=9). This level of vulnerability implies that stock recovery is possible years after the event has stopped. The summary of identified risks is presented in Table 3.15.

Table 3. 15: Summary of the results of the Bank's shrimp fishery assessment process to climate change vulnerability and proposed mitigation actions.

Event	Objective	Risk/Vulnerability Level	Justification of the consequence	Mitigation actions
Reduction in precipitation levels/increase in coastal salinity.	Keep the biomass of recruits at levels that support the fishery.	Probability 3 x consequence 3 = 9 (HIGH) Recruitment levels of the stock or its capacity to increase are affected. SB <Brec - 5%	Relevant It is possible the occurrence of a significant reduction in precipitation and increase in salinity in estuaries with consequences of reduced recruitment rates. Possible recovery years after the event has stopped.	General: - Reduction of GHG emissions (IPCC 2007). - Integrated development of the fishing industry together with other socio-economic sectors in the country (eg dam construction and management). Sectors: - Maintenance of fishing effort levels recommended in the Fisheries Management Plan - Increased monitoring capacity - Ecosystem-based fishery management (EAF) - Develop new demersal fisheries in deeper waters that are theoretically less vulnerable to climate change - Training and awareness of stakeholders - Expansion of aquaculture activity

3.8. Coastal Zone

The country has a coastline of more than 2,700 km (Figure 3.18), made up of recent geological formations and of great natural variability. The coastline is characterized by an important variety of ecosystems (both marine and terrestrial), and can be divided into three regions: (i) Bays Region; (ii) Region of Rivers, and (iii) Region of Lagoons (Chemane et al., 1997). Each of these regions has physiographic characteristics that are decisive in the ecological and environmental characteristics as described below.

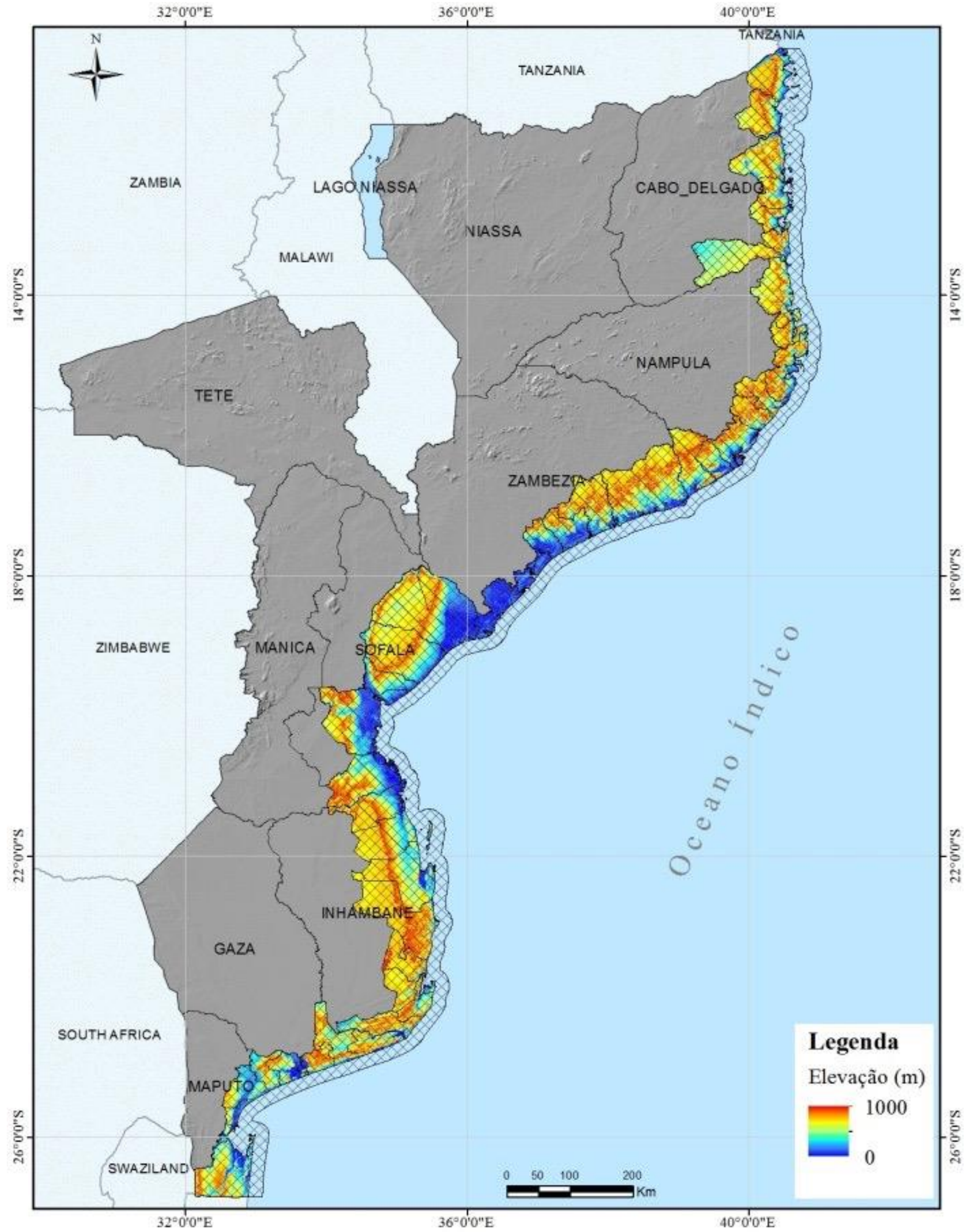


Figure 3.18: Map showing the coastal zone of Mozambique and its topographic layout.

3.8.1. Region of Bays

The Bay Region comprises the coastal zone located between the extreme north of Mozambique, in the District of Palma, to Ilha de Moçambique, in the province of Nampula. This coastal zone is dominated by a coastline of fossilized coral reefs, the same ones that characterize the Quirimbas Archipelago, a group of about 50 small islands arranged parallel to the coastline, in Cabo Delgado province. The coastline presents successive embankments, and it is in this sector of the coast that the third largest bay in the world is located, Pemba Bay. In general, in the bays, hydrodynamic conditions are of low energy, which favors the accumulation of fine sediments and the consequent development of the mangrove ecosystem.

Pemba Bay as well as other bays along this sector of the coast are characterized by the development of mangroves, preferably in more protected areas from the open sea. The proclamation and management of conservation areas is one of the ways of preserving the bay region. The Quirimbas National Park is made up of habitats such as forests, woods, savannas, mangroves, beaches, coral reefs and seagrasses. From the diversity of marine species, it is important to highlight sea turtles, dolphins and several species of fish. Coral reefs in the Quirimbas Archipelago are considered to be one of the few at a regional level, and are one of those that are little impacted either by human activity or by the effects of MC and even more, it is relevant for the sustainability of fishing activity and for ecotourism (Hill et al., 2009).

3.8.2. Region of Rivers

The Region of the Rivers comprises the central part of the coastal zone of Mozambique, in an extension that extends between the Island of Mozambique to the delta of the River Save. This Region is characterized by numerous rivers that drain into this coastal area, creating a typical landscape and ecosystem environment. The low topographic aspect of this coastal zone, associated with the frequent drainage of river waters, results in a marshy environment often protected by an embryonic dune system. Swamps are often colonized by mangroves that are distributed along the entire coast in central Mozambique (Barbosa et al., 2001). One of the places where this ecosystem is developed is the Zambezi River Delta, which in the observations of Shapiro et al. (2015), will have increased in coverage from 1994 to 2013. The central part of this region is dominated by large amplitude tides, reaching around 7m, particularly in the city of Beira. These tides are responsible for the estuary morphology that characterizes the mouths of the Púnguè and Búzi Rivers.

3.8.3. Region of Lagoons

The Region of Lagunas comprises the southern part of the coastal zone of Mozambique, in an extension that extends between the Delta of the River Save and the extreme south of the country, in Ponta de Ouro. In the classification Chemane et al (1997), this region is characterized by numerous lakes, part of which are classified as lagoons, taking into account their origin in processes of barrier island systems. The lagoons, particularly in the provinces of Maputo, Gaza and the southern part of the province of Inhambane are protected from the open sea by coastal dunes often parabolic in shape and oriented towards NW, the same direction as the prevailing wind system in this area. This wind regime induces a south-north coastal drift current, which is responsible for the sediment transport pattern from south to north in this area.

Also in the Lagunas region, the presence of conservation areas should be highlighted, especially the Bazaruto Archipelago National Park. This park is located along the coast of the districts of Vilankulo and Inhassoro, in the province of Inhambane, and has an extension of 1583 km^2. The park is rich in ecological diversity, with an emphasis on coral reefs and rare marine species such as dugongs and sea turtles.

3.8.4. Main Climate Risks in the Coastal Zone of Mozambique

The analysis of climate risks in the coastal zone takes into account that part of the climatic factors was responsible for the evolution of the coastal landscape, and for the establishment of unique ecosystems for each of the points in the coastal zone. For example, mean sea level fluctuations are understood to have been historically involved in the formation of recent coastal landscapes, and contributed to the evolution of ecosystems, as exemplified by Massuanganhe et al. (2018) in a study on the evolution of the mangrove ecosystem in the Save River delta. In this study, sedimentation processes and the type of sediment deposited throughout the history of landscape formation are considered responsible for creating optimal conditions for certain habitats, such as mangroves. To this end, the context of risk analysis for this approach is made by looking at the dynamics that coastal landscapes and ecosystems may take in response to changing climatic factors.

- Temperature

The trends and variation of maximum and minimum temperatures in the coastal zone, in the period 1990 – 2006 were 0.74 – 1.01°C and 0.52 – 0.65°C respectively (INGC 2009), and the projections made by INGC (1999) predict a trend of maximum and minimum temperature increase along the Mozambican coast, particularly in the central region. Given the proximity of the coast, its moderate influence on the region, it is expected that the trend of temperature increase will prevail towards the interior lands. Increased trends in both air and ocean temperatures are expected to continue, and will have a major impact on the relative rise in sea level among other ecological and socio-economic consequences in this region.

Another relevant parameter to be analyzed in the coastal zone of Mozambique is the surface temperature of the sea water (SST). A study by Zinke et al. (2019) on the SST fluctuation done in the Mozambique channel reveals an increasing trend situated between 0.58 ± 0.1°C for the period between 1970 and 2012. Another study by Rouault et al. (2010) also indicates that since 1980 sea surface temperatures in the Mozambique Channel have fluctuated between -0.05 and +0.1°C per decade.

The main risks that may arise from temperature fluctuations over the coastal zone are related to fragile ecosystems such as mangroves and coral reefs. Thus, despite the adaptability that these ecosystems may have, and the country's efforts to minimize human interference in the system, it is expected that with the rise in temperature, part of these ecosystems will be negatively affected.

- Sea level rise

Global sea level observations show a statistically significant rise in sea level resulting from human-induced climate change (IPCC 2007). It is currently thought that the underlying causes of sea level rise are due to:

(i) Thermal expansion of the oceans in response to global warming and;
(ii) Reduction of continental ice caps in temperate and high tropical regions.

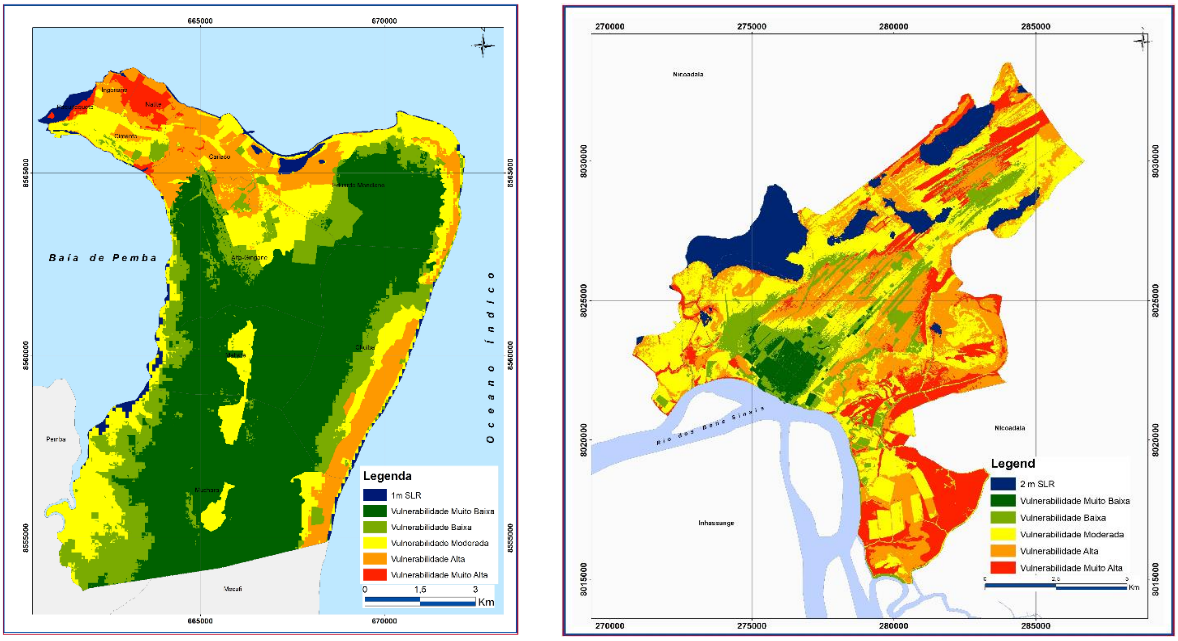
Given these two underlying causes, two sea level rise scenarios for an average payback period of 10 to 100 years (INGC 2009):

- Rise in sea level as a consequence of thermal expansion, with an increase in sea level expected to 15 cm, 30 cm and 45 cm in the years 2030, 2060 and 2100 respectively;
- Sea level rise as a consequence of the reduction in continental ice caps, with sea level rising to 15 cm, 110 cm and 415 cm in the years 2030, 2060 and 2100 respectively.

For coastal zones, particularly in Mozambique, vulnerability to rising sea levels may manifest itself in a combined and varied way, taking into account the environmental conditions that the coastal zone presents in its three regions. Variables such as topography, distance from the coastline, tidal range, wave height and the type of geological material that make up the coastline will be decisive in assessing the risk of rising mean sea level. For example, those sectors located in topographically low places are the most susceptible to flooding due to rising sea levels. On the other hand, the location of assets and interests will be important in determining the level of exposure given the rise in the average sea level.

The central region of the country (Region of Rivers) is one of the most susceptible to the impact of the rise in mean sea level, given the relatively low topography as described above (Figure 3.19). On the other hand, the fact that this region is drained by rivers, it is also susceptible to floods of river origin. A sea level higher than the current one, exacerbated by marine storms and river floods, can cause the elevation of estuarine waters to the breaking of the marginal banks of the channels, flooding vast areas, including places, where economic and housing infrastructure are implanted. Over the past few years, there have been several scenarios of invasion of sea water in some neighborhoods of the city of Beira, accompanied by the erosion of small systems of natural barriers of embryonic dunes.

The impact of rising sea levels has also been seen in other cities, such as Pemba and Quelimane (Figure 3.19). The direct impacts on the city of Pemba are verified in the neighborhood of Paquetequete (one of the population centers in the city of Pemba), located in a topographically low space. During periods of spring tides, flooding in homes is common in this neighborhood, causing damage to infrastructure and negative impacts on the lives of residents. Another negative impact that is expected from the rise in sea level is saltwater intrusion, particularly for the regions of the country where there is overexploitation of this resource.



A B

Figure 3.19: Vulnerability maps to extreme weather events for the cities of Pemba (A) and Quelimane (B). In the same maps are illustrated in blue color (SLR), areas of probable flooding for scenarios of sea level rise of 1m for Pemba and 2m for Quelimane.

Source: CCAP (2018)

- Tropical Cyclones

The coastal zone of Mozambique is one of the main gateways of cyclones formed in the Indian Ocean to the African continent (Fitchett and Grab, 2014; Mavume et al., 2009; Roy and Kovordányi, 2012) in a pattern illustrated in Figure 3.20. From 1950 to 2018, the country recorded an incidence of about 115 tropical cyclones, which occurred more frequently in the months of December, January, February and March (Figure 3.21). Most of these cyclones affected the central area of Mozambique, and in the list of the most severe cyclones, cyclones Eline (in 2000), Japhet (in 2003), Fávio (in 2007) and Dineo (in 2017) stand out. caused significant damage in the coastal zone of Mozambique and beyond. Part of the cyclones that directly hit the Mozambican coast produced significant damage over great distances depending on their magnitude, among other storm characteristics.

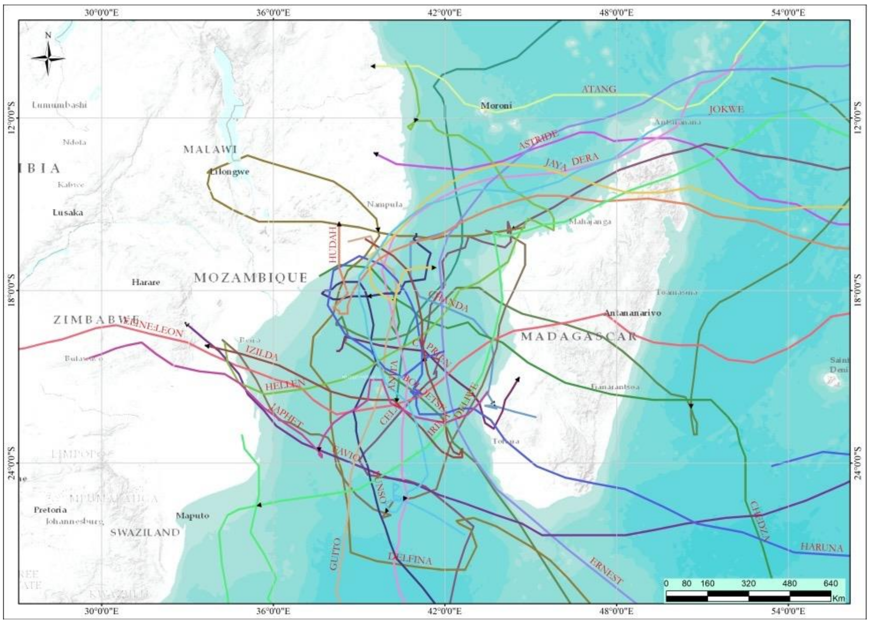


Figure 3.20: Map of the trajectory of the cyclones that hit Mozambique between 2000 and 2018.

The approach and incidence of cyclones on the coast bring a set of effects and impacts on the pattern of water circulation, which in turn influences the coastal environment, both in the component of the landscape environment, as well as in ecosystems. In the coastal landscape, one of the impacts of cyclones is the increase in wave energy, which is responsible for abruptly altering the pattern of sediment distribution. In cyclone events, some embryonic dunes are susceptible to rupture, and consequent dispersion of sediments, thus altering the landscape configuration and consequently the environment. On the other hand, chaotically dispersed sediments by cyclones can negatively affect nearby ecosystems. In a case study in the Save River Delta, Massuanganhe (2016) observed massive sedimentation episodes in the mangrove habitat, facts attributed to the Eline, Japhet and Favio cyclone events. Other types of direct impacts of cyclones on ecosystems are reported by Perry et al. (2014), which report the removal of coral blocks due to increased wave activity and massive accumulation of sediments.

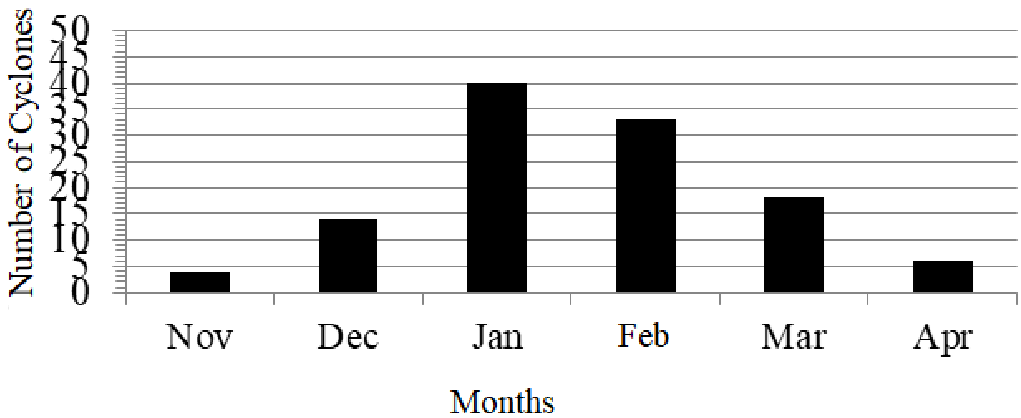


Figure 3.21: Monthly distribution of tropical cyclones that directly hit Mozambique between 1950-2018.

In 2017, the Tropical Cyclone Dineo stood out, which caused rains that resulted in floods, affecting the provinces of Gaza (districts of Chibuto, Guija and Chókwe) and Inhambane (City of Inhambane, Funhalouro, Homoine, Inharrime, Jangamo, Massinga, Maxixe, Morrumbene, Panda, Vilankulo and Zavala), with about 113,950 families affected, 96457 houses partially and totally destroyed. In response, the government represented by INGD, in coordination with partners, moved the affected families to safe areas.

- Coastal Erosion

In a medium and long term perspective, coastal erosion can be seen as a normal process, and part of the geomorphological evolution agenda of coastal environments, but the fact that it is occurring in an accelerated manner and is impacting daily activities, becomes worrying (Massuanganhe, 2016). Wave activity, tidal currents and mean sea level rise are among the factors that cause coastal erosion as shown by several case studies (Chemane et al., 1997; Massuanganhe and Arnberg, 2008). This erosion pattern is accelerated as the factors increase in intensity. For example, in scenarios of increasing cyclone intensity, strong winds are the main reason for the increase in wave intensity, which results in an accelerated dispersion of sediments.

It is important to note that erosion also depends on the availability of sediments and the degree of consolidation of the rocks. Places with very friable rocks are more susceptible to erosion when compared to places characterized by consolidated rocks, together with sediment supply sources. Analyzing, in general, the coastal zone located in the Bays Region, north of Mozambique, this is one of which the coastline is constituted by more consolidated sediments, which contributes to lesser erodibility.

Still taking into account the factors mentioned above, it appears that the coastal zone located in the Region of Rivers, in the center of Mozambique, is also one that has the lowest probability of erosion. However, it can be taken into account when taking into account the availability of sediments brought by rivers to the coast. In some places, such as in the Zambezi River Delta, as well as in the surroundings, stabilized beach sand crests are visible, indicating a history of sediment increment in this region for the last years. Still in comparative terms, in a general analysis, the Lagos Region can be expected to be one of the most susceptible to erosion, when taking into account the lack of availability of sediments coming from the continent and the presence of friable sediments from the dunes and beaches.

3.9. *Forests*

Mozambique has an estimated extension of forests of around 34 million hectares, representing around 41% of the national territory (MITADER, 2018a). Adding other woody vegetation, the area occupied by woody cover reaches 70% of the country. The forests in this country are heterogeneously distributed according to the agro-ecological characteristics of the different regions, where variations in factors such as altitude, precipitation and soils are observed. In this context, the central and northern regions have richer forest resources than the relatively poorer southern region.

The forest resource, properly exploited, can play an important role in the socio-economic development of the country and can also be an integral part of a response to mitigate the risks caused by land degradation and climate change. Consequently, the exploitation of forest resources tends to increase over time and the pressure on this resource increases over the years. This pressure not only leads to the reduction of forest cover itself but also the degradation of the forest ecosystem, soils, loss of habitat and biodiversity.

The main factors that put pressure on the forest include the opening of new areas for agriculture, the use of inappropriate agricultural practices involving logging, uncontrolled burning and the unsustainable use of forest resources in the exploitation of wood and charcoal production (CEAGRE and Winrock, 2016; MITADER, 2018a). According to CEAGRE and Winrock (2016), shifting agriculture contributes 65% to deforestation, human settlement 12% and forestry for wood fuels and wood 15% of the total in the country. According to Marzoli (2007) the deforestation rate was estimated at 0.58% for the period 1990 and 2002, and according to MITADER (2018), between 2003 and 2013, the deforestation rate was 0.79%. The national REDD+ strategy forecasts to 2030 indicate that, in a "business as usual" situation, deforestation could increase, with serious economic, environmental and social implications for Mozambique. Therefore, actions to reduce deforestation and forest degradation must be implemented. The national target is to reduce and maintain the deforestation rate at 0.58% by 2030, taking into account aspects related to development and poverty alleviation (MITADER, 2018).

Due to the socio-economic importance of the forest sector, the country has endeavored to assess its forests through forest inventories. However, the interaction between land use and land cover, anthropogenic activities and climate change in forest ecosystems in the country is not sufficiently known, and exhaustive statistical information on the dynamics of forest and forest activity and the effect of relevant factors in the existence of forests and their contribution to the social and economic development of the country.

This sub-chapter has as general objective the assessment of vulnerability and adaptation to the adverse impacts of climate change on the Mopane ecosystem, with the specific objective being to analyze the change in the extent of the Mopane ecosystem during the periods between 2003 - 2013 and 2014 – 2016.

3.9.1. Description, geographic location and justification for choosing the study area

The Mopane ecoregion is characterized by the dominance of the forest species Colophospermum mopane (Kirk ex Benth.) of the Fabaceae family, common at altitudes up to 1000m above mean sea level. Mopane generally forms pure stands to the exclusion of other species, but is often associated with a number of other trees and shrubs such as Kirkia acuminata, Dalbergia melanoxylon, Adansonia digitata, Combretum apiculatum, C. imberbe, Acacia nigrescens, Cissus cornifolia and Commiphora spp. (Marzolli, 2007).

Mopane occurs predominantly northwest of Maputo province (Moamba and Magude districts), most of the interior districts of Gaza and Inhambane provinces, south of Sofala and Manica provinces, north of Manica province and south of Tete province. In this ecoregion, there is generally a low density of human population, with a very high incidence of poverty, reaching 80% and a very low level of food security, mainly due to low precipitation and aridity of the soils. Regarding to the climate, the average annual temperature is above 24°C, which, combined with low levels of precipitation, results in water deficiencies above 600mm per year, sometimes reaching 1,500 mm/year. The altitude is generally less than 200 m above mean sea level, with sandy soils, except along river plains such as the Limpopo where the soils are alluvial, considered fertile for agriculture. Permanent water courses are scarce, which contributes to the scarcity of this resource.

Mopane was selected because according to World Bank (2008), its vegetation is degraded, with potential structural damage, which can be accompanied by local disappearance of species. On the other hand, Mopane is a resource of high ecological and economic importance. Mopane extraction for the production of wood and charcoal are the main income-generating activities, contributing to poverty alleviation when there is a drop in agricultural production due to severe drought that is expected to be more frequent with climate change. Mopane is an important food for ruminants (cattle, goats and sheep) which are a source of income for rural communities. This tree species is host to the caterpillar Gonimbrasia belina (Westwood) (Lepidoptera: Saturniidae), a source of protein for local populations and equally relevant to the local economy.

3.9.2. Vulnerability assessment methods

Following the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2006), MITADER (2018) applied wall-to-wall mapping techniques to obtain spatially explicit information on land conversion between different categories of land use and land cover over time. For this purpose, a systematic grid of sampling points 4 km apart from each other (the same used for the allocation of clusters in the national forest inventory using the stratified random sampling method) was established for visual analysis. of the historical series of deforestation activity data, considering the period between 2003 and 2016, using the Open Foris Collect Earth tool developed by FAO in partnership with Google. For each sampling point, a 100mx100m (1ha) square spatial sampling unit was defined, containing a grid of 5x5 subunits, 20 m apart from each other (Figure 3.22).

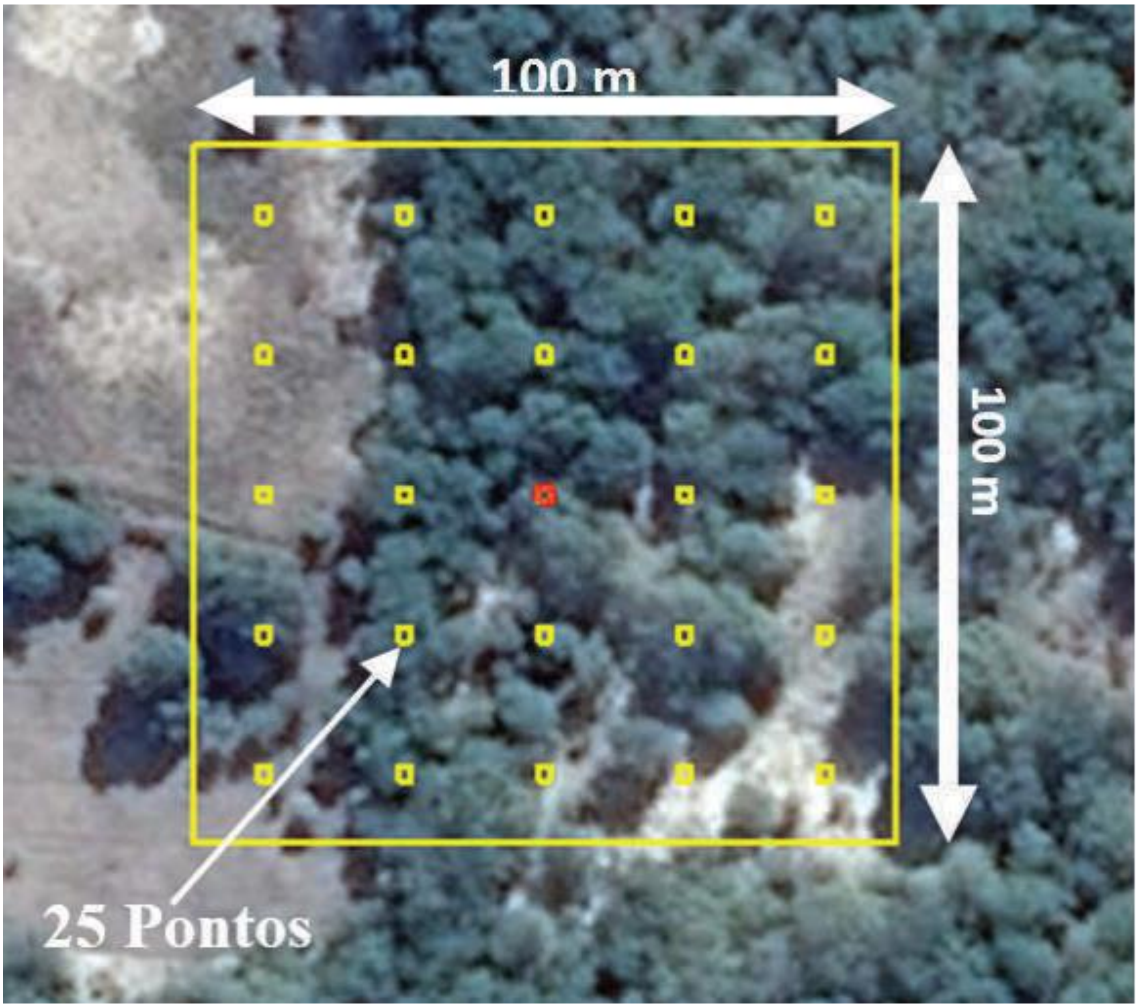


Figure 3.22: Spatial unit of deforestation assessment.

Source: MITADER (2018)

The sampling method adopted was based on the visualization of high and medium resolution images from the *Google Earth, Bing Maps, Earth Engine Explorer and Code Editor repositories*. These images, with the forms designed to record information about land use and land use change at each point of the grid, are automatically accessible through the *Collect Earth tool*, which is synchronized with the Earth Engine Code Editor that facilitates the interpretation of the type of vegetation and land use determination and land use change. Additionally, *Earth Engine (Explorer and Code Editor)* guarantees a complete multi-temporal series through 2001 medium resolution images (eg *Annual TOA Reflectance Composite, Annual NDVI Composite, Annual EVI Composite, Annual Greenest- Pixel TOA Reflectance Composite, etc. from Landsat 5 TM*), latest Sentinel–2 images from 2016, and from graphs of the spectral behavior of vegetation in MODIS MOD143Q1 images (16-day NDVI image composites). Hence, each sampling point in the grid had a complete multi-temporal assessment of land use and land use change, allowing for the creation of a national historical database of deforestation activity data.

3.9.3. Mopane Forest Vulnerability

The total forest area in the country in 2016 was about 34.2 million hectares. The forest area in 2003 was 37.0 million hectares, which means that 2.9 million hectares of forest were lost between 2003 and 2016. During the period between 2003 and 2013, the country lost 2,935,325 hectares of forest, with an average annual rate of 267.029 hectares, and a standard deviation of 50 176 hectares corresponding to a 0.79% deforestation rate (MITADER, 2018) (Figure 3.23). These data indicate that deforestation increased in the country by 18%, when compared to the period 1990-2002, of which the annual rate was 0.58% (219,000 hectares deforested per year).

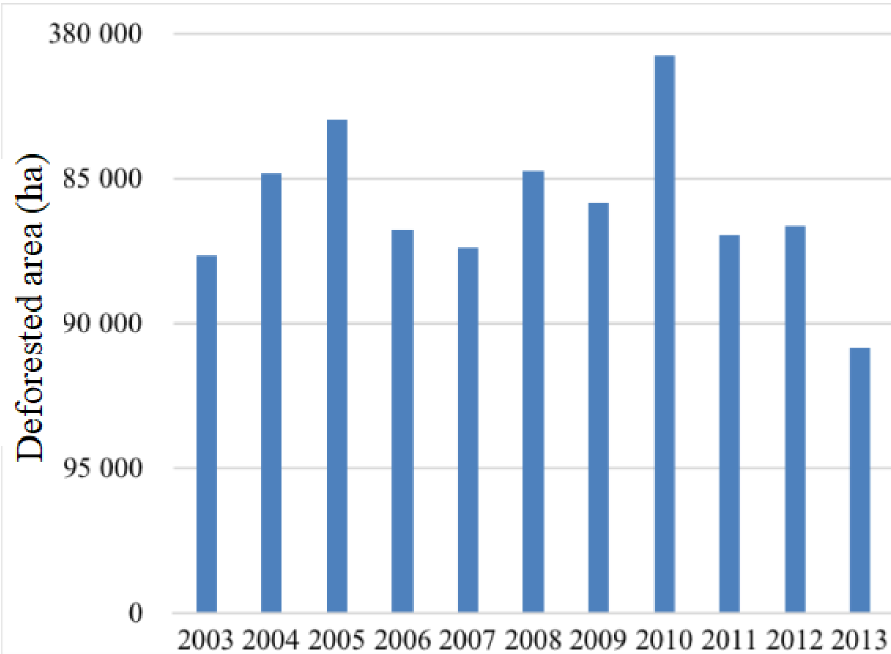


Figure 3.23: Annual deforestation in the period 2003-2013.

The Mopane Forest is the third largest in the country with about 2.9 million hectares, or 8.5% of the forest area of Mozambique. However, the total area covered by mopane reduced from around 3.0 million hectares in 2003 to around 2.9 million hectares. Mopane lost 80 435 hectares from 2003 to 2013. The percentage of forest area lost in mopane corresponds to 3% of the total lost.

In the period between 2014 and 2016 there was a significant reduction in the average annual deforestation compared to the period 2003 - 2013. The total area deforested in this period (259.227 hectares) corresponds to only 9% of the area deforested in the period 2003 - 2013 (2,935,325 hectares).

The tendency for temperature to rise, accompanied by lower levels of precipitation, can result in mesoclimatic changes in the region, with consequences for the development of vegetation, including the mopane ecosystem, with an emphasis on growth. Taking into account that mopane is mainly used for the production of charcoal, an important way of sustaining the population's life, this will have to demand larger areas, exacerbating the degradation of the ecosystem under analysis. Such modifications, likely accompanied by harmful events such as wildfires common in the study area, can affect habitat and biodiversity as well as resource availability, with negative impacts on the livelihoods of the most disadvantaged communities.

3.10. Energy

Mozambique has enormous energy resources that are still unexplored, including coal and natural gas, water potential, renewable resources such as solar, wind, water, geothermal, ocean and forest and agricultural biomass sources (ME, 2011). At the same time, the country is one of the countries with the lowest levels of energy consumption in Southern Africa, with around 80% of the country's energy consumption based on biomass (firewood and charcoal) and around 17% of the population with access to electricity (ME, 2011).

Access to energy is a condition *sine qua non* of the fight against poverty, as it is a means that intervenes in all key sectors of development, be it water, health, food refrigeration, lighting, domestic heating, transport, agriculture, or industrial production or modern means of communication (Sebastião, 2013). With a view to achieving one of the national development goals, the President of the Republic launched in November 2018 the "Energy for All until 2030" Program. This Program aims to intensify access to electricity for more families and companies at national level, as a contribution to the universal electrification of Mozambique by 2030, defined in the National Electrification Strategy (ENE), approved by the Council of Ministers on 16 October 2018 The Project will support the expansion of energy access to peri-urban and rural areas across the country, taking advantage of and expanding the existing national electricity grid and deploying mini-grids based on solar generation in areas not covered by the national grid.

Rainy season balance reports done by INGD demonstrate that the energy sector has been affected by the extreme events that occur in the country, particularly strong winds, tropical cyclones, floods and inundations (Table 3.16).

Table 3. 16: Impacts of extreme events on the energy sector.

Rainy Season	Event	Provinces	Number of Power Poles		Transmission line extension	Value needed to replace the equipment
			Low Voltage	High Voltage		
2011-12	Topical Cyclone Funso and Tropical Storm Dando	Niassa, Nampula, Sofala, Manica, Inhambane, Gaza e Maputo	416	318	41,905m	41,522,441.00MT

	Tropical Cyclone Dineo		1,016			

Extreme weather events have resulted in the destruction of privately owned as well as publicly owned solar panels. One of the examples is the destruction of 11 solar panels that supplied electricity to a health house in Mossuril district, in Nampula province, during the passage of Cyclone Jokwe, in Mossuril district.

3.11. Health

Climate change is a global phenomenon and it is urgent to establish the relationship between them and health, as the climate is one of the determinants of health and its change can exacerbate the health problems that already affect developing countries.

The resilience of the human population to climate change is related to water quality, environmental sanitation and food and nutrition security. According to the Intergovernmental Panel on Climate Change (IPCC 2014), most of the impacts of climate change in this sector, in developing countries, will be caused by malnutrition, malaria and diarrhea, and could lead to the worsening of cases of cholera, meningococcal meningitis, yellow fever, among others.

Mozambique is one of the countries that suffers the impact of climate change on health, resulting from extreme events (droughts, floods, tropical cyclones) that are increasingly frequent and intense. Climate change exacerbates diseases related to water, environmental sanitation, those spread by climate-dependent vectors, and malnutrition (USAID, 2018). However, the paucity of complete data on the relationship between climate and disease makes it difficult to quantify the potential impact of climate change on disease risk in the country (INGC, 2009).

In 2006, during the presentation of the first national communication to the UNFCCC, there was a lack of information and studies on health vulnerability to climate change. It is in this context that an analysis of vulnerability in the sector becomes important, with the following objectives: (1) to determine the potential impacts of climate change on health in Mozambique; and (2) identify climate change adaptation measures in the health sector.

3.11.1. Vulnerability assessment methods

The country's epidemiological profile is characterized by a large number of diseases of environmental origin, with malaria and diarrhea, with a special focus on cholera, the most worrying given their high prevalence (Gujral and Manjate, 2009; USAID, 2018). The prevalence of malaria and cholera could increase due to rising temperatures and frequent occurrence of droughts and floods (INGC, 2009; USAID, 2018). Therefore, health vulnerability analysis will focus on malaria and cholera.

Vulnerability assessment was carried out through bibliographic consultation, interviews with experts in the field and collection of data from the Weekly Epidemiological Bulletins. The study was carried out across the country, taking into account that these diseases are endemic and occur in almost all parts of the country. Currently, the occurrence of these diseases can be observed throughout the year, not restricted to the rainy season, which is normally considered to be the peak in Mozambique.

3.11.2. Vulnerability of the health sector to climate change

- Malaria analysis

Mozambique is one of the 10 countries in the world most affected by malaria, causing an estimated 44,000 to 67,000 deaths per year across all age groups. About 682,000 pregnant women and 2.8 million children under the age of 5 are at risk of contracting malaria (INGC, 2009). Most deaths occur in children under the age of 5 years.

Malaria is endemic throughout the country, transmission occurs throughout the year, with peaks during and after the rainy season (December – April). However, transmission intensity varies from year to year and region to region, depending on precipitation, altitude and temperature. In the last five years there has been a decrease in the fatality rate due to malaria. However, this disease is still one of the main causes of morbidity and mortality, it continues to be the most common cause of care in outpatient consultations, as well as the most frequent cause of hospitalization in Health Units (HU). It represents an enormous burden for the National Health Service, as around 45% of outpatient consultations are due to this disease, while in admissions, especially in pediatric wards, the contribution of malaria is 57% and in relation to intra-hospital mortality, malaria contributes 26% (MISAU-PNCM, 2012). Infection by the vector that transmits malaria is also a public health problem during pregnancy, as approximately 34% of pregnant women are parasitized (Mabunda et al, 2007).

The cost of malaria for humans, in social and human terms, is high. In Mozambique, malaria causes enormous damage to populations and causes a lot of suffering and loss of life. The illness reduces workers' productivity and school attendance (Mussá, 2004). Therefore, in parallel with other epidemics, this disease slows down the country's economic and social development.

According to INGC (2009), after the 2000 floods, the number of malaria cases was 4-5 times higher than in the non-flood period. The high number of cases was due, in large part, to intense rains that caused flooding and created favorable conditions for the multiplication of the anopheles' mosquito, the vector that transmits malaria. The change in the pattern of precipitation distribution, the increase in temperature and the occurrence of extreme events (floods, droughts and cyclones) more frequently, could make the pattern of malaria transmission unpredictable and make planning for its control difficult (USAID, 2018).

Additionally, the mosquito may expand its geographical distribution area and the disease will become part of the epidemiological profile of high altitude areas, generally with low temperatures and not affected by the disease. Poor sanitation and the existence of favorable conditions for the multiplication of the mosquito (eg, stagnant water and abundant vegetation) may favor the occurrence of the disease.

- Cholera analysis

Cholera, also known as “Dirty Hands Disease”, is an acute intestinal infection caused by Vibrião Cholerae. This disease arises due to the reduced supply network of drinking water in rural and peri-urban areas, and the low level of individual and collective hygiene of the population. Most families do not have clean water or toilets/latrines (Gujral and Manjate, 2009). In suburban areas, the latrine/family ratio is 1/150. In rural areas there are vast regions with hundreds of houses without latrines and open defecation is widespread. These factors predispose families to cholera.

This disease is one of the most difficult diseases for the health sector, as it requires an extra effort on its part to be able to respond effectively to outbreaks. In 2008 cholera reached 48 districts of the country, with a total of 12,306 cases and 157 deaths having been registered and the fatality rate was 1.3%. From 2008 to March 2009, cholera cases increased from 12,306 to 14,448, with 122 deaths in 54 districts and in all 11 provinces (MISAU, 2009). In the period from 2011 to 2015, there was a reduction in the total number of cases as well as in the number of affected provinces and districts, with an absence of cholera cases in the provinces of Gaza, Inhambane and Manica (Figures 3.24). In 2015, the country was hit by an epidemic of great magnitude, in which 9,861 cases and 70 deaths were reported, with a fatality rate of 0.7%, in 22 districts of 6 provinces (MISAU, 2016).

Cholera is one of the diseases that could be exacerbated by climate change in developing countries (IPCC, 2014; (USAID, 2018)). With the increase in temperature and irregularity of precipitation, there will be a shortage of drinking water and a decline in personal hygiene. The 1993 eruption was associated with the 1992/93 drought related to the El Niño phenomenon (INGC, 2009). In low-income countries, 26% of child mortality is due to diarrheal diseases and 88% of childhood diarrhea is attributed to contaminated water, inadequate sanitation and poor hygiene. High temperatures and the increase in the number of wet days per week increase the outbreaks of diarrheal diseases in Mozambique. Additionally, floods result in water pollution by fecal material, in areas of inadequate sanitation, which increases the risk of diarrheal diseases (USAID, 2018). According to INGC (2009), in Gaza province, after the 2000 floods, the incidence of diarrhea increased 2-4 times compared to periods without floods. Therefore, the more frequent floods will make cholera a constant disease in the country's epidemiological profile and affect more and more people. High temperatures and the increase in the number of wet days per week increase the outbreaks of diarrheal diseases in Mozambique.

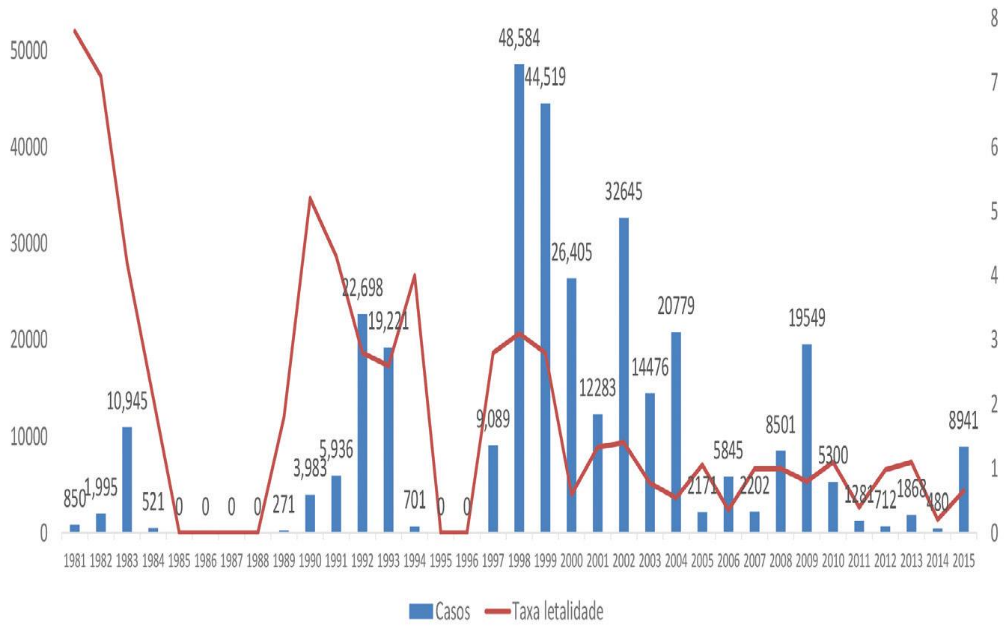


Figure 3.24: Evolution of cholera in the country (1981-2015).
Source: MISAU / Department of Epidemiology

When analyzing the distribution map of cholera cases (Figure 3.25), it can be seen that this disease mainly affects the central and northern parts of the country. Due to the extensive hydrological network, these areas regularly suffer from extreme events such as floods and floods, which makes the population of these regions more susceptible to contracting cholera.

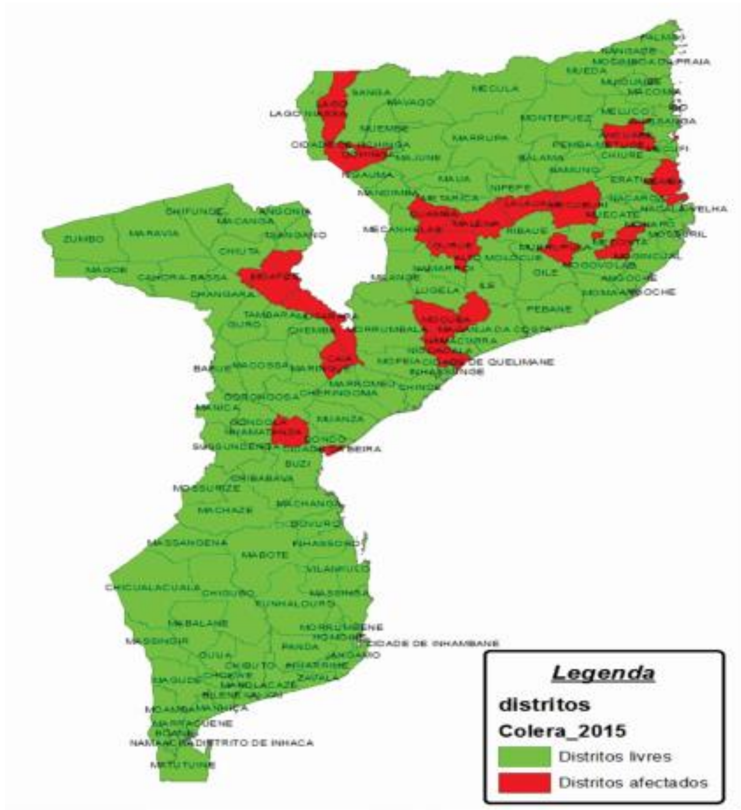


Figure 3.25: Distribution of cholera in Mozambique in 2015.
Source: MISAU/Department of Epidemiology.

3.12. Infrastructures

The infrastructure network at the country level is one of the main platforms for economic development. These include the road network, port, airport, hospital, school, communication platforms, electricity generation and transport, among others. Infrastructure in general is essential for a country to function and for everyday life. A particular relevance of the infrastructure sector is the fact that they significantly contribute to a country's adaptive capacity in the context of CC impacts. In situations of extreme weather events, such as cyclones, most attention in Mozambique has been turned to infrastructure, bearing in mind that these constitute the means by which most rescue operations will take place. Thus, any interruptions in the infrastructure systems programmed for these operations imply a re-dimensioning of the strategy to rescue, or provide food, medical and drug aid to the affected communities. In order to understand and minimize this effect, we highlight some initiatives taken by UN-Habitat and by the USAID Coastal Cities Adaptation Project (CCAP) in collaboration with district governments and municipalities, which carried out actions to develop house models. resilient to weather events, and in raising awareness and training for the need to map critical infrastructure. The purpose of identifying and mapping these infrastructures is to identify, recognize and, if possible, predict their degree of resilience in the face of expected extreme events. The criticality of the infrastructure lies in the fact that part of these are impacted by extreme events such as cyclones and floods, and negatively affect rescue activities.

3.12.1. Current Situation of Infrastructure in Mozambique

The implantation of infrastructure in Mozambique is a process that has evolved throughout the country's history. Soon after independence in 1975, the infrastructure that existed at that time underwent an evolution, which accompanied the country's socioeconomic development.

In line with the National Development Strategy (2015-2035), the construction sector will be boosted by the construction of logistics infrastructure for large projects in the area of natural resources, infrastructure in the area of electricity, water and transport and projects of construction of houses for housing. Recent projections indicate that due to the impact of climate change, there will be an increase in the frequency, intensity and magnitude of disasters, and if there is no investment in resilience, annual losses could reach 450 million dollars by 2040, due to damage to agriculture, infrastructure and energy production.

Next, the main existing infrastructures in Mozambique, their functionality, and the role they have played in the context of CM are described.

3.12.2. Road Network (Roads and Railways)

In Mozambique, the road network is managed by the National Road Administration (ANE) created by Decree 15/99 of 27 April 1999, as a public institution with legal personality and administrative and financial autonomy, under the supervision of MOPHRH. In the structuring of the ANE, the road network in Mozambique is classified into (i) primary (with 5,971 km; (ii) secondary (with 4,915 km); tertiary (12,603 km); and (iv) neighboring with (6,567 km). In this road network, National Road No. 1 stands out, which runs longitudinally along the national territory, in the North-South direction, with a length of approximately 2,500 km. all cities and district headquarters in the country, in addition to other points of great relevance.

From the perspective of transporting goods, the road network is supported and complemented by the rail and port system, which is managed by the Ports and Railways of Mozambique (CFM). The railway and port system has a network of approximately 2,983 km of railway line divided by a total of eight lines; three in the south zone, two in the central zone and three in the north zone. The rail network connects the three main ports in Mozambique (Port of Maputo, Port of Beira and Port of Nacala) to terminals located inland. Thus, the southern area of Mozambique has the Ressano Garcia Line, Goba Line, and Limpopo Line, which run from the Port of Maputo to South Africa, Swaziland and Zimbabwe respectively. In the central area, the railway network includes the Machipanda line that links the port of Beira to Zimbabwe, and the Sena line that departs from Dondo to the city of Chipata in Zambia. In the northern zone, the railway network has the Nacala-Cuamba Line, which departs from the Port of Nacala to the City of Cuamba, and two lines that connect two cities; the Cuamba-Lichinga and Cuamba Entre-Lagos Line.

The combination of road and rail network is preferred and practical for the transport of goods. In the disaster risk reduction agenda, INGD and partners have used these routes to transport material needed for prevention and mitigation. On the other hand, the GoM counts on these same infrastructures as a means of rescue in the event of a disaster.

Regarding to the impacts of CC, the infrastructure and road sectors have almost always suffered considerable damage. Cyclically, several kilometers of roads are flooded and removed by rainwater simultaneously with the ground. With the increase in river flows, several bridges and bridges have been damaged, resulting in the interruption of road traffic. The railway infrastructure, despite being more resistant to the impacts of bad weather in relation to the roads, they have also been affected, causing interruption in the railway transport.

The 2018 PES prioritizes the development of socioeconomic infrastructure, in this particular case, the rehabilitation of roads (the expectation is to rehabilitate 175km of national and regional roads, with 137km being possible, equivalent to 78%; a 95km asphalting plan of National and Regional roads, having been possible, having been possible 44km, equivalent to 46%; regarding to the construction, rehabilitation and maintenance of bridges, the plan was to cover 15 of them, having been possible 18 bridges, equivalent to 120% for Semester I of 2018).

3.12.3. Port and Airport Network

Mozambique, as a coastal country, has the privilege of having conditions for maritime navigation and therefore has a port network of great importance not only for the country but also for the southern region of Africa. The biggest ports in Mozambique (Port of Maputo, Port of Beira and Port of Nacala) in particular, are connected to the rail network, which guarantees the handling and transport of heavy loads to the hinterland countries. In addition to the rail connection, the ports are connected to the road network, which makes a good system for handling and loading cargo. At the same time, ports represent a port of entry for cargo to the country and the southern region, taking into account several large ships that dock there.

Airports are also a gateway for passengers and cargo from abroad as well as within the country. The country has an airport network consisting of eleven airports distributed throughout the country, and located in the cities of Maputo, Inhambane, Vilanculos, Beira, Chimoio, Quelimane, Nampula, Nacala, Tete, Pemba and Lichinga. Of these, Maputo International Airport, Vilanculos Aerodrome and Beira Airport receive international flights. Like ports, airports are connected to the road network which, in turn, guarantees the integrated transport of people and goods at a national level.

The port and airport network in Mozambique plays an important role in managing the risk to disasters caused by CC, and are listed as critical infrastructure in the same context.

Throughout the history of climate events in the country, particularly in situations of intense rains and floods, airport positions have been activated as arrival points for humanitarian aid to those affected, as well as in search and rescue actions, considering that some Roads have been limited for transitability, including to provide access to places affected by disasters.

3.12.4. Telecommunications and Electricity Infrastructures

The backbone of the telecommunications and electrical network in Mozambique is somewhat robust. The network was built since the 1980s, and followed the transformation story of the Mozambican telecommunications company, formerly known as Correios Telégrafos e Telefontes (CTT) until 1981, when it became known as Empresa Nacional de Telecomunicações. State-owned company, in 1992, became known as Telecomunicações de Moçambique, and in 2019 it merged with Mozambican mobile telephony, renamed Mozambique Telecom (Tmcel). During the evolution of the telecommunications company, several infrastructures were built, with an emphasis on fiber optics, part of which crossing the submarine part and another on the mainland that connects practically all the provinces of Mozambique, including the main cities. In addition to fiber optics, Tmcel currently has a network of towers across the country and stations with different communication equipment. There is also a network of other mobile phone companies and radio and television stations that use specific equipment that is often exposed, or in places at risk from CC.

The electricity grid in Mozambique is managed by Electricidade de Moçambique EDM, which operates the public service of generation, transmission, distribution and sale of electricity throughout the country. For the exercise of its activities, EDM has a series of infrastructures, ranging from power generation stations, transmission lines, energy transformation substations, among other infrastructures spread throughout the country.

Communication and electricity infrastructures are part of the list of critical infrastructures in the context of CC, bearing in mind that they are essential for rescue and rescue operations. The criticality of this type of infrastructure calls for the need to redouble efforts on the part of the GoM to ensure that they are increasingly resilient to bad weather. Over the last few years, communication and electricity infrastructures have been affected by extreme events, especially cyclones, in which strong winds have cyclically destroyed the equipment. As mentioned above, the destruction of equipment brings losses not only because of the damage, but also because their destruction negatively affects the operation of essential activities in the context of rescue and humanitarian assistance to victims.

3.12.5. Education and Health Infrastructures

The Education System in Mozambique has a network of infrastructures dedicated to the teaching process. Of these infrastructures, the network of primary, secondary and pre-university schools spread across the country stands out. Higher education infrastructures are also dispersed throughout the country, but these are preferably distributed at the level of the main cities in the country and at the level of the district capitals.

According to the Final Report of the Inventory of Infrastructure, Equipment, Human Resources, and Health Services (SARA-2018), in 2017 the country had a total of 1 625 public health units, of which 96% provided primary health care. in the 11 provinces of Mozambique and in 157 districts, being present in practically all districts of the country.

The GoM's effort to guarantee the right to Education and Health for the entire Mozambican population brings challenges for the construction of infrastructure and for the allocation of Human Resources, particularly in the most remote areas of the country. The challenge also extends to the component of the allocation of health equipment to health facilities and classroom equipment in desks and teaching materials. Some of the school infrastructure is still made of precarious material that is very susceptible to the impact of bad weather. On the other hand, although it is recommendable to build these infrastructures in “safe” locations, there are scenarios throughout the country where this option of choice is minimal given the need to provide these services close to the populations. However, the Government's effort has always been to build infrastructure with high standards, capable of resisting the impact of bad weather. This effort has led to the use of some school infrastructure as options for shelter centers to temporarily accommodate populations living in homes that are vulnerable to the impacts of extreme events.

As in other sectors, the school and hospital infrastructure sector is very susceptible to extreme events such as cyclones, heavy rains and floods.

3.12.6. Housing and other infrastructures

Housing infrastructure in Mozambique is under the responsibility of MOPHRH, which through the Fund for Housing Development (FFH) promotes access to decent housing, ensuring safety, durability, aesthetics, comfort and health. The FFH has directed its efforts particularly towards the youth and towards State Officials and Agents in coordination with the different segments of society. As part of its activities, from 2011 to 2018, the FFH built close to 4,000 houses and infrastructured close to 13,000 plots in the different provinces of the country. This number of infrastructures is still far from being satisfactory for what is the demand in housing at the country level.

Despite the GovM's effort to have regular and well-planned subdivisions, the growing pressure for housing demand, especially in urban areas, constitutes a major challenge for the issue of land use planning. With population growth, combined with the trend of migration from rural areas to the city, the demand for housing surpassed the capacity of municipalities to provide sufficient plots for this demand, and to control the quality of residential infrastructure to be built. Another problem associated with the quality of residential infrastructure is the costs for the construction of conventional houses, which in many cases are higher than the population's income. Thus, the main trend verified in the country was an increase in the use of land for the construction of residences and other infrastructure in peri-urban areas. For rural areas, populations prefer to settle in places close to district headquarters and administrative posts, water courses, roads and the coast, which also, in combination, contributes to a weak territorial ordering.

Informal settlements in the large cities of Mozambique bring environmental problems with them. Accelerated erosion and flooding are seen as the result of pressure on urban land use, a fact that contributes to the increase of factors to be considered in the impacts caused by CC. Thus, over the last few years, more and more areas at risk to flooding and erosion have emerged in large cities. These locations are properly mapped and signposted to avoid setting up residences in these locations.

3.12.7. Impacts of Climate Change on the Infrastructure Sector

The infrastructure sector is one of the most impacted by Climate Change, particularly in extreme events such as cyclones and floods. In each rainy season, there is always a negative balance in the different types of infrastructure in Mozambique. Thus, during the period under review, several infrastructures were destroyed by these events. In 2007, when Tropical Cyclone Favio passed through the Coastal Districts of the Province of Inhambane, around 80% of the infrastructure in the District of Vilankulo was damaged, including residences and tourist establishments. The destruction caused by this cyclone spread to other districts, damaging around 130,000 homes and around 130 schools. In 2008, Tropical Cyclone Jokwe affected Nampula Province, causing the destruction of 9,316 houses and damage to around 3,220 houses. Tropical Cyclone Funso hit the country with strong winds, affecting more the provinces of Zambézia, which had a record of 12 deaths, seven of which occurred in the district of Maganja da Costa, where 1,610 houses were destroyed and one death occurred in the capital city of Quelimane, with the occurrence of heavy rains that flooded most of the neighborhoods due to deficient drainage systems. In the city, floods destroyed 4 houses and several other towns along the coast suffered flooding. In Nicoadala district, the storm destroyed 66 homes.

3.13. Waste

Waste is a challenge for its management, taking into account the potential negative impacts it can cause to the environment, and its contribution to climate change. However, over time, these challenges have turned into opportunities, taking into account some initiatives that have arisen aimed at reusing, recycling and transforming waste into other useful products for society. Management initiatives take into account the volume of waste produced per capita, per day, combined with population density. Thus, despite the fact that the problem of waste belongs to everyone and also affects everyone, it is more accentuated in urban centers where the total cumulative amount of waste is greater. The sustainable management of waste remains a challenge in most cities and towns, and the main cause of the proliferation of solid waste in these places is attributed to the insufficiency of material and human resources and the weak public participation in its management and the lack of knowledge of its economic value.

Global data indicate that Mozambique has a per capita waste production rate of 0.5 kg/individual per day. It is also estimated that the country generates 7,247 tons of waste per day (Hoornweg and Bhada-Tata, 2012). In the classification of waste produced in Mozambique, 69% is of organic origin, 12% is paper, 10% plastic, and the remainder consists of other types of waste including metals and glass.

Mozambique has a total of 91 officially classified urban centers, of which 23 are cities and 68 towns. The country embarked on the process of autarchization, and currently has 53 Municipalities. The management of urban solid waste has been carried out by the Municipal Councils in the Municipalities, and in the towns the process continues under the responsibility of the local, district and/or town structures.

The GoM, through MITADER, conceived the Proposal for an Integrated Waste Management Strategy, which fits into the Strategic Plan for the Environment Sector (2005-2015), the Environmental Strategy for Sustainable Development in Mozambique and its pillars are summarized as per Next:

- Strengthen institutional capacity regarding to solid urban waste management;
- Implement different stages of urban solid waste management;
- Promote the establishment of partnerships between the public, private and civil society sectors;
- Raise the culture of urbanity;
- Create mechanisms for the mobilization of resources for the implementation of activities inherent to waste management and;
- Develop and implement an urban solid waste monitoring and management program.

This strategy aims to provide guidelines for an integrated management of solid waste in Mozambique, taking into account a systematic approach that considers the components of minimizing production, conditioning, collection, transport, treatment and final disposal, with a view to protecting public health and the environment.

The operational plan for implementing the strategy is subdivided into short (2013 to 2016), medium (2017 to 2020) and long term (2021 to 2025) actions. The total cost of implementing this plan is estimated at around 335 million meticais. Mozambican environmental legislation has the minimum requirements needed to allow the country to make progress in dealing with environmental, social and economic problems arising from solid waste management.

Among the various instruments in force on the GRS in Mozambique, the Decree no. , several legal and normative instruments, which, together, harmonize the solutions that make up a more comprehensive solid waste policy in the country. The most important legal instruments for solid waste management in force in the country are listed below:

- Law nº 2/97, of February 18, 1997, Law on Local Authorities;
- Law nº 11/97, of May 31, 1997, Law on Finance and Patrimony of local authorities;
- Decree nº 8/2003, of 18 February 2003, Regulation on the Management of Biomedical Waste;

- Decree nº 45/2004, Regulation on the Environmental Impact Assessment Process;
- Decree nº 11/2006, of 15 June 2006, Regulation on Environmental Inspection;
- Decree nº 13/2006, of 15 June 2006, Regulation on Solid Waste Management;
- Resolution nº 86/AM/2008, of 22 May 2006, Posture for Cleaning Urban Solid Waste in the Municipality of Maputo;
- Regulation on Urban Solid Waste Management, Decree nº. 94/2014 of 31 December, published in Boletim da República No. 105, 1st Series, of 11 November 2014;
- Master Plan for Solid Waste Management for the Municipality of Maputo.

In addition, there is the Solid Waste Master Plan; the Land Use and Occupation Law; Cleaning Posture Code, among other provisions. Regarding to the Government's 2015 – 2019 Five-Year Plan, Priority IV (Development of Economic and Social Infrastructure) sets out the Strategic Objective (iv): Build and expand sanitation infrastructure, including landfills.

As part of the initiatives of the GovM together with Partners, the National Strategy for Hospital Waste Management was created through the MISAU, which naturally contributes to the management and mitigation of solid waste in the country. In this Strategy, hospital waste is classified into 5 major groups, namely: Common waste, Infectious waste, Perforating-cutting waste, Anatomical waste and Chemical/radioactive hazardous waste. Therefore, a systematic and integrated management is recommended, following the fundamental stages of production, handling and final disposal. Strategy relies on monitoring, licensing and inspection by MITADER (MISAU, 2014).

3.13.1. Potential Environmental and Social Impacts of Waste in Mozambique

The total volume of waste produced has a great impact on the environment and society, especially in urban areas where the amount of waste produced is greater than in rural areas. In evaluating the potential environmental impacts of waste, their classification is of great importance. It is in the classification of waste where specific care in handling for each type is defined, as well as the potential impacts related to each type of waste. Eventually, it is in the classification of waste that the foundations for the entire chain of reuse, recycling and transformation reside, a fact that motivates comparative studies in the matter (Wen et al., 2014). In a perspective, waste can be classified according to its origin in municipal waste, and industrial waste. From another perspective, waste can also be classified according to its degree of danger into hazardous waste and non-hazardous waste (Wen et al., 2014).

Analyzing the situation in Mozambique, and taking into account that most of the waste is of organic origin (Hoornweg and Bhada-Tata, 2012), it can be inferior that part of these is easily re-introduced in the organic matter cycle in rural areas without significantly affect the environment in rural areas. In these places, waste material of plant and animal origin can easily be used as fertilizer in agricultural fields. However, for the urban environment, this type of waste is accumulated in the urban environment, and in enormous quantities, it constitutes a nuisance mainly when the waste starts to degrade. Municipal waste is mostly generated by human activity, and it can be categorized into recyclable waste, compostable waste, combustible waste, hazardous waste and others (Wen et al., 2014).

In some regions of the country, where industrial activity is installed, there have been many negative impacts associated with poor waste management. In the range of industries, mining has been one of the most impacted, on the one hand, due to the weaknesses of the reference instruments that guide waste management and, on the other hand, due to the fragility of management itself in some mining companies (Pondja, 2017). In Tete Province, for example, although the activity is carried out taking into account the environmental management instruments, complaints persist from the population of the town of Moatize, who report that the mining activity is emitting dust to the town, affecting most of the activities. daily rates of populations (Pondja, 2013). Another threat, still little visible to the local population, is the risk of water pollution (ground and surface) due to the handling of chemical residues, through heavy metals and solvent components, taking into account the fact that this mining activity is having place in the Zambezi Basin (Passe, 2018; Pondja, 2013; Pondja, 2017). All over the country there is a waste of denim and chemicals such as solvents, with the example of mercury used to separate gold in mining and garimpo operations (Kiefer et al., 2015; Shandro et al., 2009). Thus, this type of mining has significantly contributed to the degradation of the environment in terms of soil, groundwater and river water, depending on the handling and management system for this material. Other industries have also generated considerable amounts of waste, however, their treatment procedures are not very transparent or publicized.

The impacts of CC transcend the area of the environment and interfere in the MC area in different ways. The management of industrial as well as municipal waste sometimes involves burning or incineration, which contributes to the greenhouse effect. On the other hand, part of the impacts caused by poor waste management has been added to those impacts associated with climate change. It is common, for example, in some solid waste deposits to see a constant combustion of solid waste.

Hazardous waste, those considered to have a direct impact on health and the environment, have a special treatment in the Regulation on the Management of Hazardous Waste (Decree no. 83/2014 of 31 December). The Regulation establishes a detailed classification of hazardous waste, and includes bio-medical and radioactive waste in the list. Additionally, the Regulation defines the procedures to be followed in the handling of this waste and foresees heavy fines for infractions committed in the management process.

3.13.2. Solid Waste Management in Mozambique

Data referring to the amount of waste produced in Mozambique are scarce or not systematized. One of the reasons is the fact that waste management is autonomous for each municipality or town. On the other hand, each municipality or town strives for a management strategy that meets the local reality. Thus, in a macro way, waste management is based on the provisions of Decree no. 13/2006, of June 15, 2006, Regulation on Solid Waste Management, which establishes standards to be followed throughout the national territory in handling of solid waste. This decree attributes to MITADER the competence for a set of actions relating to the waste management process, which includes the issuance and disclosure of mandatory compliance rules, the environmental licensing of facilities or sites for the storage and/or disposal of waste, and overseeing the compliance with the provisions of the same regulation. In addition to MITADER, the Decree makes room for municipalities to approve specific rules on waste management, establish tariffs and fees for waste removal services. The Regulation on Solid Waste Management as well as other specific regulations of the autarchies provide for the application of fines to those entities that are involved in the non-compliance with the respective norms. With this instrument, MITADER has intervened in many situations where waste management is questioned.

Decree 13/2006 of 15 June 2006 is one of the important instruments in the waste management process in Mozambique. Thus, different waste management and handling practices are implemented by Municipalities, private companies and even natural persons. In the scope of waste management in Mozambique, MITADER, in partnership with the Japanese government, established in 2017 the Maputo Declaration, a commitment assumed by another 25 African countries. The African Clean Cities Platform aims to build synergies between African cities in order to promote better waste management, greater articulation with central governments, promote citizenship and mobilize society towards the importance of cleanliness, as well as contribute to achieving the goals of the Sustainable Development Goals (2015/30). The "Environment in Motion" Project was designed, of which the priorities are: (i) environmental education, (ii) effective inspection, (iii) construction of infrastructure for solid waste management and, (iv) construction of others infrastructure.

Municipalities located in the North and Center-North of the country benefit from the PRODEM Project (Municipal Development Program), a project resulting from a partnership between 26 municipalities, the GovM and four international partners, namely the governments of Denmark, Sweden, Switzerland and Ireland. This project has the general objective of reducing poverty and improving the well-being of citizens living in the municipalities covered by the program.

On the other hand, and in practical terms, solid waste management is implemented differently in several companies following their Waste Management Plan. Some multinational companies implement management standards with international ones, and clearly mention the management plan for the various types of solid waste, including hazardous waste. Some of these companies have incinerators with a low rate of emissions, contrary to what has been seen and practiced throughout the country where incineration has been carried out directly and without any protection or mechanisms to reduce emissions.

3.14. Social Protection

According to NCCAMS, the effects of climate change have unequal consequences, affecting more heavily the most vulnerable groups, namely women, children, the elderly, people with disabilities, displaced people and the chronically ill. Poor people often depend on sectors that are highly susceptible to extreme weather (eg agriculture) and live in vulnerable areas and homes (World Bank, 2017). Climate change will make poor people poorer and poorer. Therefore, sectoral climate change adaptation programs or multi-sectoral initiatives must prioritize the poorest, most vulnerable people in order to increase their resilience to climate shocks. Women and girls are among the groups most affected by poverty. In rural areas, these are the main practitioners of agriculture to ensure food security for the family and are responsible for fetching water and woodfuel for domestic use. Climate change will reduce agricultural productivity, the availability of water and firewood, which will exacerbate women's poverty and vulnerability. In this context, social protection measures, focusing on the most vulnerable social groups, will reduce the level of poverty and strengthen adaptation to climate change.

3.15. Biodiversity

Biodiversity represents a vital pillar for the development of Mozambique and for the livelihood of the majority of the population of this country (MITADER, 2015). The country has 4 groups of important natural ecosystems: (i) terrestrial ecosystems, (ii) marine and coastal ecosystems, (iii) inland water ecosystems and (iv) coastal ecosystems. These encompass considerable biological diversity estimated at over 6,000 plant species and 4,200 animal species (3,075 insects, 726 birds, 214 mammals, 171 reptiles and 85 amphibians). There is still considerable agricultural and livestock production potential and diversity, which is distributed across 10 agro-ecological zones. In terms of coastal and marine biodiversity, 194 species of coral, 9 plant species of mangrove, 13 of marine meadows, 5 of turtles, 18 of marine mammals (seven species of dolphins, 8 of whales, 2 of seals and 1 species of sea) are recorded. dugong), 2,626 species of sea fish (800 species associated with coral reefs, 92 cartilaginous fish) and 1,363 species of molluscs. The biodiversity of inland waters is equally recognized, notably Lake Niassa and the Zambezi Delta (MITADER, 2015).

With a view to contributing to contain the current trend of loss and degradation of biodiversity in Mozambique, and to ensure that in resilient and healthy ecosystems, the sustainability in the use of its components and the benefits generated contribute to sustainable national development, the Government formulated a Strategy and Action Plan for the Conservation of Biological Diversity in Mozambique 2015 – 2035. This recognizes that one of the main causes of the threat to biodiversity is climate change, due to its potential to cause species extinctions, alter their spatial and temporal distribution and alter fundamental biogeochemical and ecological processes. The Strategy recognizes that there is little knowledge about the consequences of climate change on biological diversity in the country. However, it identifies the following: the alteration and/or loss of ecosystems (mainly vulnerable ones, such as mangroves, corals, marine meadows, mountainous ecosystems, flooded savannas, etc.) and, consequently, the well-being of populations that depend on them. goods and services provided by ecosystems.

Regarding coastal and marine ecosystems, it is estimated that the effects of climate change result in the alteration of marine biodiversity by warming the water column and acidification, leading to bleaching and coral death (MITADER, 2018). Currently, coral reefs off the coast of Mozambique are recovering from the losses that occurred in 1988 due to the bleaching phenomenon induced by increases in sea temperature, caused by the El Niño Southern Oscillation (ENSO) phenomenon (MICOA, 2014).

It should be noted that the impacts of climate change on some components of biodiversity have already been considered. In the section on fisheries, the effect of changes in climatic variables on the quality of marine and coastal habitats was described. In the section on pastures and livestock, the effect of drought on natural pastures was analyzed, which are the source of food not only for cattle, but also for wild herbivores, which in turn support wild carnivores. The main adaptive response of mobile organisms to climate change and reduced availability of resources and degradation of habitat conditions is movement to areas where adequate resources and conditions exist.

In the section on agriculture, the effect of low agricultural productivity caused by drought on deforestation was discussed, which results in loss of specimens, fragmentation of ecosystems and loss of connectivity in the landscape. Fragmentation blocks the movements of organisms to access resources and conditions suited to their physiological needs, but it also blocks the flow of genes between sub-populations, reducing their genetic vigor and resilience to climate change. In the section on forests, in addition to deforestation, potential changes in species composition in forests due to climate change were discussed.

Extreme weather events affect the long-term viability of biodiversity conservation areas. On the one hand, low productivity in agriculture and livestock caused by extreme weather events, contributes to increased poverty and vulnerability of the rural population, which results in increased pressure on species and natural habitats to obtain livelihoods, causing loss of biodiversity. On the other hand, the sustainable use of biological resources is a climate change adaptation strategy, because it is a means of livelihood for families that lose their primary sources of livelihood due to extreme weather events. Therefore, the loss of biodiversity will exacerbate poverty.

3.16. Framework of Strategies and Measures for Adaptation and Climate Risk Reduction

Under the UNFCCC, Mozambique is part of the Group of Least Developed Countries, and, in the implementation of Article 4.9 of the Convention, the country formulated its National Adaptation Program of Action (NAPA), a document approved at the 32nd Session of the Council of Ministers held on December 4, 2007. NAPA presents, in a clear and simple way, the immediate and urgent needs of the country identified during the participatory assessment process, of which the implementation will increase the national capacity to deal with climate change (MICOA, 2007).

The four priority actions identified in the NAPA are:

(1) **Strengthening the early warning system** so that information reaches affected communities in good time. This action is budgeted at USD2,700,000.00 and contains the following activities:

- (i) Mapping and requalification of Administrative Posts and population agglomerates;
- (ii) Rehabilitation or installation of Synoptic/Udometric and hydrological stations;
- (iii) Training and capacity building; education and awareness;
- (iv) Improvement of the communication system;
- (v) Creation of a database on the studies;
- (vi) Creation of local natural disaster management committees.

(2) **Strengthening the capacities of agricultural producers to deal with climate change**, aiming to develop the capacities of agricultural producers, particularly those in the family sector, to deal with climate variability and change, with an estimated budget of USD2,500,000 This action contains the following activities:

- (i) Reduction of land degradation due to inappropriate agricultural practices;
- (ii) Reduction of crop and animal population losses in regions prone to drought, floods and tropical cyclones;
- (iii) Establishment of alternative livelihoods.

(3) **Reduction of the impact of climate change on coastal zones**, aiming to contribute to the sustainable development of the coastal zone, through the reduction of socio-economic impacts arising from climate change, introducing community-based integrated coastal management systems and raising awareness of State and community institutions on the vulnerability of the coastal zone. This action is estimated at USD2,000,830 and includes the following activities:

- (I) Systematization and mapping of knowledge about eroded areas and prone to coastal erosion, identification of causes and assessment of the socio-economic impact of the problem;
- (II) Preparation of the technical-scientific framework for combat and/or mitigation measures and the respective schedule of activities, as well as a preliminary assessment of the intervention costs;
- (III) Identification of suitable small, medium and large intervention techniques, including participatory mechanisms in the solution and/or mitigation of erosion problems;
- (IV) Transmission of practical knowledge and demonstration of techniques to combat/mitigate erosion to affected communities;
- (V) Identification of the main gaps in the legal framework and institutional framework on erosion and proposed scenarios of institutional arrangement adequate to the current reality, and recommended amendments and contributions to the current legislation;
- (VI) Identification and testing of an effective methodology for the transmission of knowledge about erosion and forms of prevention, mitigation and combat and processes adopted by the communities.

4) Management of Water Resources in the Scope of Climate Change aiming to promote the integrated management of hydrographic basins, considering the phenomenon of climate variability and change. The action estimated at USD2,500,000 includes the following activities:

- (i) Minimize human and material damage from flooding in river basins as a result of the variability of climatic factors;

(ii) Improve hydraulic infrastructure in the regional context;
(iii) Improve the information dissemination system;
(iv) Improve the sharing of water courses between Mozambique and neighboring countries;
(v) Protect biodiversity along major hydrographic basins.

After the formulation of the NAPA, the country began the process of preparing the SNA, the first version of which was available in 2011. Based on this version and other studies carried out in the area of climate change, with emphasis on the studies by INGD, the GovM, through MICOA, in February 2012 the participatory and comprehensive process of formulating the National Strategy for Adaptation and Mitigation of Climate Change began, which was coordinated by the Inter-Institutional Group for Climate Change (GIIMC).

One of the pillars of NCCAMS is Adaptation and Climate Risk Reduction, of which the objective is to make Mozambique resilient to the impacts of climate change, reducing as much as possible climate risks for people and goods, restoring and ensuring the rational use and protection of natural capital and built up. This pillar comprises eight strategic areas of intervention, namely:

1) Climate risk reduction
2) Water resources
3) Agricultura, pesca e Segurança Alimentar e Nutrição (SAN)
4) Social protection
5) Health
6) Biodiversity
7) Forests
8) Infrastructure – and the corresponding recommended strategic actions.

As part of the implementation of NCCAMS, with emphasis on the climate adaptation and risk reduction component, the Government drew up sectoral and local instruments aimed at integrating climate change into the planning and budgeting process, in particular:

- The 98 Local Adaptation Plans formulated by 2018, of which the aim is to integrate climate change into the planning and budgeting process at district level;
- The INAM Strategic Plan 2013-2016 approved by the Council of Ministers in November 2014 which outlines the following priority lines: (i) capacity building for weather forecasting services and SAP; (ii) improvement of applied research and knowledge management; (iii) improved observation, communication and data management; (iv) improved interaction with users.
- The data management and sharing protocol approved through a joint ministerial diploma between the Ministry of Transport and Communications and the Ministry of Public Works, Housing and Water Resources (INAM & DNGRH, 2019);

- National Action Plan for the expansion of climate-resilient agriculture and strengthening of the ministerial unit responsible for climate-resilient agriculture. This plan seeks to strengthen agricultural extension services to small farmers as well as knowledge management and sharing and strengthening in coordination with research and extension services;
- Integration of climate change into social protection, through the National Program for Productive Social Action, through which families living in vulnerable districts benefit from public works activities that increase their climate resilience;
- The Health Sector Strategic Plan 2014-2019.

In 2015, the Government submitted its Nationally Determined Intentional Contribution (INDC) of Mozambique 2020 – 2030 to the Convention, which became the Nationally Determined Contribution (NDC) of Mozambique 2020 – 2030 with the ratification of the Paris Agreement by the Assembly of the Republic, through the Resolution 23/2017 of December 29, 2017. The Mozambique NDC 2020 – 2030 includes the climate risk reduction and adaptation component.

In response to decision 1/COP 21, the country formulated its NDC covering a period of 5 (five) years (NDC Mozambique 2020 – 2025) and the respective Operational Plan of the NDC Mozambique 2025 and the NDC Partnership Plan 2018 – 2021, documents that were approved at the 39th session of the Council of Ministers held on December 11, 2018. This version of the NDC was later revised, in 2021, and the Mozambique 1UNDC was produced, which was launched on the sidelines of the COP 26, in Glasgow, chaired by the Prime Minister.

The adaptation component includes a portfolio of adaptation actions, measures, projects and policies in the following sectors/areas: Early Warning System, Agriculture and Fisheries, Water Resources and Sanitation, Health, Biodiversity, Forests, Social Security, Infrastructure, Areas Urban Areas, Settlements and Tourist and Coastal Areas and Communication, Education, Training and Awareness. This component is budgeted at around 75%, corresponding to USD 5,671,514,850.

It should be noted that the country has just validated, in a national seminar, its National Adaptation Plan, which aims to:

- Create an enabling environment to facilitate the integration of adaptation into planning and budgeting at national, provincial and district levels;
- Improve the capacity to manage and share data and information, access technology and finance adaptation; and
- Implement adaptation actions for greater resilience of the most vulnerable at district level.

Thus, Table 3.16 presents the adaptation and climate risk reduction measures contained in in the 1UNDC of Mozambique 2020 – 2025. Subsequently, Table 3.17 shows Actions and measures at NCCAMS and corresponding commitments assumed in the 1NDC of Mozambique 2020 – 2025.

Table 3. 17: Adaptation and climate risk reduction measures contained in the 1NDC of Mozambique 2020 – 2025.

Theme/Sector/Region	Focus
Objective 1: Create an enabling environment to facilitate the integration of adaptation into planning and budgeting	
Pillar 1: Institutional framework	
1. Strengthening of Coordination, institutional framework and updating of policy documents related to the Implementation of the NAP	Strengthening of climate action coordination: National Directorate of Climate Change, Ministry of Economy and Finance, provincial and district governments, integrated plan and budget. Integration of the NAP in the next PQG and sectoral planning instruments
Objective 2: Improve knowledge and capacity for management and sharing of data and information, access to technology and financing for adaptation	
Pillar 2: Knowledge, technology and finance	
2. Strengthening of the early warning system	Systematic information collection and real-time information for system power
3. Education, public awareness (communication) and research	Center for knowledge management and research, public awareness, technology development and innovation
4. Climate finance	Capacity building in project design, climate fund management
Objective 3: Implement adaptation actions to increase resilience of the most vulnerable	
Pillar 3: Resilience for the most vulnerable	
5. Vulnerable people's adaptive capacity increased - gender mainstreaming in policies and actions	Reinforcement of basic social protection measures with regard to climate change so that it contributes to the resilience of vulnerable populations Strengthening the capacity and guidance of the Productive Social Action Program to increase the resilience of vulnerable groups
6. Integrated Local Governance Plans	Implementation of Local Adaptation Plans TerritorIial management, local adaptation committees
7. resilient development mechanisms for urban areas and other settlements	Implementation of: Climate Change Resilient Urbanization Plan, (ii) city resilience action planning tool-CityRAP (iii) Stormwater drainage, wastewater treatment, waste management

8. Resilient agriculture	Productivity (alternatives to shifting agriculture, conservation agriculture, agroforestry systems), post-harvest loss reduction (storage and processing, value chains), pests and diseases
9.Food and nutrition security	Availability, access, food preference and nutritional value
10. Resilient Public Infrastructures	Roads and Bridges, Health Centers, Schools
11. Water resources management	Strengthen the capacity to capture, store and channel water for human consumption, animals, irrigation, etc. Water saving and reuse, irrigation systems
12. Improvement access to renewable energy	Reduction and efficiency of biomass energy, access to electricity and natural gas other alternatives including mini hydro, wind, solar (thermal and photovoltaic) plants
13. Reducing vulnerability of people to disease transmission vectors associated with climate change	Water, environmental sanitation, and hygiene, urban waste management (domestic, hospital and industrial).
14. Oceans and Coastal Areas	Promotion of tourism development, coastal erosion, sea level rise, saline intrusion, mangroves, fisheries (includes aquaculture - storage and processing, value chains) Increased fishing resilience Tourist areas and coastal areas with resilient infrastructure and green and sustainable coastal development
15. Strengthening the capacity to prepare and respond to climate risks and disasters Strengthening the capacity to prepare and respond to climate risks and disasters	Risk reduction, disaster response, rescue/rescue operations and post-disaster response
16. More resilient forests	MFS including processing of timber forest products and NTFP, Biodiversity conservation areas, ecotourism

Table 3. 18: Actions and measures by ENAMMC and corresponding commitments assumed in the PNDC of Mozambique 2020 – 2025.

.	Action	Mesure at ENAMMC	Action at 1UNDC	NAP
	Strengthen of the Early Warning System 4.6.1.1.1	Provide dedicated and appropriate meteorological information to each user (including the development of the fire warning) in a timely manner, identifying the most effective ways to reach various target audiences with the most appropriate instruments and tools including local languages.	Provide dedicated and appropriate meteorological information to each user (including the development of the fire warning) in a timely manner, identifying the most effective ways to reach various target audiences with the most appropriate instruments and tools including local languages.	
		Scale up the warning system, reaching the district (through sectoral institutions in improving the specific early warning system, particularly for agriculture, water and health).	Scale up the early warning system, reaching the district (through sectoral institutions in improving the specific early warning system, particularly for agriculture, water and health).	
		Articulate in a timely manner for all information transmission to key users and local communities.	Articulate in a timely manner for all information transmission to key users and local communities. Establishment of standards for the development and coordination of early warning systems for multiple events (development and approval of an effective coordination mechanism between key SAP actors).	

			Strengthening the role of INAM in coordinating the collection and monitoring of climate data (standardization of the method for collecting hydro-meteorological data under the supervision of various institutions/organizations, increase in the number of hydro-meteorological stations in the most vulnerable places).	
			Reinforcement of the climate and meteorological information system allowing for the prediction of the occurrence of drought (operationalization of tools to monitor the drought and issue of warnings about the imminence of drought).	
			The framework for the National Health Observatory of the INS for climate-sensitive diseases (Malaria, Dengue, Chikungunya, cholera and diarrhea) was prepared (WHO). The pilot for the integration of climate and epidemiological information and the development of an early warning system is underway in 4 provinces (Nampula, Sofala, Inhambane and Maputo).	
		Improve preparedness for imminent climatic disasters, including operations to remove and protect people and goods from risk areas and provision of means and equipment.	Improved preparedness for imminent climatic disasters (Strengthening the capacity of provincial and district bodies in disaster preparedness, including means of response) – 4.6.1.1.2.1.	

	Strengthening the Capacity to Prepare for and Respond to Climate Risks 4.6.1.1.2	Strengthen the role of INGD in coordinating operations, evacuation, relief, reconstruction and support for victims of climate disasters.	Strengthening the role of the INGD in the coordination of response and recovery operations to climatic disasters (Expansion of the coverage of Early Warning Systems of climatic phenomena for communities at greatest risk.	
		Strengthen the coordinating role of INGD and its partners in reducing vulnerability to drought in arid and semi-arid zones.	Strengthening the coordinating role of INGD and its partners in reducing vulnerability to drought in arid and semi-arid areas (ensuring a reliable flow of information on the imminence of drought and dissemination of timely response measures to communities) – 4.6.1.1. 2.3.	
		Reinforce the role of Multiple Use Resource Centers (CERUM) in supporting local communities in increasing the efficiency of management and use of natural resources, as well as in mapping vulnerable areas.	Strengthening the role of the CLGRD in reducing climate risk at the local level (Development of the terms of reference of the CLGRC, including actions for their sustainability; Strengthening their capacity and involvement in the flow of alert information and community awareness on climate change matters and disasters; Promoting the exchange of experience between local communities on local knowledge of managing extreme events.	
		Ensure the establishment and training of Local Disaster Risk Management Committees.	Ensure the establishment and training of Local Disaster Risk Management Committees.	

			Ensuring an effective top-to-bottom communication system and vice versa, adoption of a unified sustainable disaster recovery plan and operationalization of tools to assess the level of resilience at the local level).	
			Improvement of the system for disseminating early warnings at the local level (Strengthening the capacity and involvement of the media and media, including community radios, in the dissemination of warning information and community awareness on climate change matters and risk management of disasters).	
			Strengthening the role of Local Climate Risk Management Committees (CLGRD) in reducing climate risk at the local level (Development of the terms of reference of the CLGRD, including sustainability actions; Strengthening their capacity and involvement in the flow of alert information and sensitization of communities on issues of climate change and disasters; Promotion of the exchange of experience between local communities on local knowledge of managing extreme events, including actions taken to minimize their effects).	
		Strengthen shared water resources management capacity.	Establishment of an Optimal Water Resources Monitoring Network.	

	Increase water resources management capacity	Create capacity to regulate and accommodate flood peaks (dams/dykes) and/or diversion (assessing the sustainability of water transfer between river basins).		
		Improve knowledge about the quality and quantity of groundwater resources.	mproved knowledge about the quality and quantity of water resources 4.6.1.2.1.3.	
			Exploration/Development of deep aquifers as alternatives for water supply in drought-affected areas.	
		Apply practices that allow for aquifer recharge.		
		Improve rural and urban rainwater drainage and sanitation systems.		
	Increase access and capacity to capture, store, treat and distribute water	Increase storage capacity per capita at all levels (domestic, community, urban, national) to ensure water supply to the population and economic sectors.	Increase in storage capacity at all levels 4.6.1.2.1.3.	
			Promotion of Security Plans and Institutional Capacity Building of the main actors.	
		Conserve rainwater in excavated and underground reservoirs, mainly in the South zone.	Conservation of rainwater in excavated and underground reservoirs mainly in the south (improvement of rainwater collection, conservation and management through capacity building and promotion of appropriate	

			technologies) 4.6.1.2.4.	
		Explore technologies to improve water availability (eg, desalination).	Construction of multi-purpose water supply systems including desalination for arid and semi-arid zones using clean energy sources.	
		Build agro-hydraulic infrastructure on the main surface courses and small, easy-to-maintain dams for irrigation and animal drinking purposes.	Development of small water impoundment/storage infrastructure.	
		Ensure the non-contamination of water in case of scarcity or flood to prevent the spread of waterborne epidemics.		
		Promote low water consumption systems and reduce existing waste in the urban water distribution network.	PACA II – Community Adaptation Action Plans	
			PACA III - Community Adaptation Action Plans	
	Promoting more resilient rural sanitation solutions for floods		Development of more appropriate infrastructure construction technologies for rural sanitation from the point of view of environmental protection and preservation.	
		Diversify and introduce crops that are more resistant to variation in climatic parameters.		
	Increasing the resilience of agriculture and	Improve agricultural production and productivity through the availability of technologies and inputs suitable for MC.	Availability of technologies and inputs suitable for climate change.	

	livestock 4.6.1.3.1			
			Dissemination of improved technologies for agricultural production, agroforestry systems, natural resource management, conservation agriculture, irrigation, vaccination, artificial insemination, reduction of post-harvest losses and processing of products of plant and animal origin, and food and nutrition education.	
			Expansion of the electricity grid and improvement of energy quality to make agrarian enterprises viable and encourage investment in the six Argarian development corridors.	
			Encouraging the production and conservation of seeds: Implementation of the Action Plan for the Production and Conservation of Seeds and Promotion of Low Cost Grain and Seed Storage Systems, contained in the Technological Action Plan for Adaptation for Agriculture.	
		Combat and control of pests and diseases in crops and storage.		
		Strengthen agro-ecological zoning and land use planning.		
		Develop programs and national action plan for soil conservation and nutrition (conservation		

		agriculture).		
		Improve animal nutrition through pasture management and forage production techniques.		
		Improved epidemiological surveillance and control of animal diseases.		
		improve and expand technical assistance to producers in terms of intervention quality.		
	Aumento da resiliência da pesca 4.6.1.3.2	Promote aquaculture as an alternative means of reducing the amount of fish and increasing demand.		
		Regenerate mangroves and implement measures to protect algae and seagrass, corals and other fish breeding and feeding areas.	Regeneration of mangroves and implementation of protection for algae and seagrasses, corals and other fish breeding and feeding areas.	
		improve the quality of information and capacity of small-scale fisheries.		
		Reinforce the control and management measures of fishing activity, guaranteeing access to clean technologies in order to guarantee the renewal and maintenance of stocks.		
			Development of tools for the integration of adaptation in the planning and budgeting process in fisheries – new	

	Ensuring adequate levels of food security and nutrition	Improve the mechanisms that facilitate the flow, transport and marketing of food products.		
		Improve the availability, access and utilization of food.		
		Create community-based food processing and preservation industries.		
		Promote agro-processing for the good use of food products.		
		Establish nutrition education programs and surplus management mechanisms.		
		investigate and promote the use of nutritious species in the various foods consumed by communities.		
	Development of low carbon agricultural practices 4.6.2.3.1	Encouraging conservation agriculture.	Promoting conservation agriculture/climate-smart agriculture for fodder and food production 4.6.2.3.1.1: Implementation of the Conservation Agriculture Action Plan and the Rainwater Harvesting and Conservation Action Plan (Adaptation Technological Action Plan for Agriculture).	
		Promote agricultural practices that reduce GHG emissions (particularly in the sugarcane harvest).	Promotion of the use of integrated agroforestry systems for the recovery of areas degraded by shifting agriculture 4.6.2.3.1.2.	

			Prevention of uncontrolled fires associated with shifting agriculture.	
		Use highly energy efficient water pumping systems for crop irrigation.	Promotion of the use of renewable energies for irrigation/water pumping systems 4.6.2.3.1.3.	
		Recover methane from agricultural activities in intensive farming systems (in particular in rice fields).	Promoting the use of methane from rice cultivation systems for energy production / improved low emission rice production systems 4.6.2.3.1.2.	
		Promote the collection of and biodigestion of animal and plant waste for the use of methane for energy generation.		
	Increase the adaptive capacity of vulnerable people	Develop and apply innovative approaches to community-based adaptation.	Development and application of approaches to community-based adaptation through Local Adaptation Plans 4.6.1.4.1.	
		Strengthen existing social protection systems with regard to CC so that they contribute to the resilience of vulnerable populations.	Reinforcement of basic social protection measures with regard to climate change so that it contributes to the resilience of vulnerable populations 4.6.1.4.1.2.	
		Strengthen the capacity, guidance and focus of productive basic social protection programs to increase the resilience of vulnerable groups.	Strengthening the capacity to guide and focus the productive social action program to increase the resilience of vulnerable groups 4.6.1.4.1.3.	
		strengthen links between social protection systems and natural disaster response systems, including	Strengthening the links between the social protection system and the natural disaster response system,	

		linkages with early warning systems.	including articulation with early warning systems 4.6.1.4.1.4.	
	Reducing people's vulnerability to disease transmission vectors associated with CC	Strengthen the capacity to prevent and control the spread of vector diseases through the correct mapping of their distribution and spatial mobility.	Strengthening the capacity to prevent and control the spread of vector diseases through the correct mapping of their distribution and spatial mobility 4.6.1.5.1.1.	
		Promote and use clean technologies and create recreational spaces and forest areas and buffer zones in cities.	Promote and use clean technologies and create recreational spaces and forest areas and buffer zones in cities.	
		Conduct a baseline study on diseases that are favored by climate change.	Conducting a baseline study on diseases that are favored by climate change 4.6.1.5.1.3.	
		Establish a surveillance system and specific control measures on diseases favored by climate change.	Establishment of a surveillance system and specific control measures on diseases favored by climate change 4.6.1.5.1.4.	
			Development of the Health Sector Adaptation Plan to Climate Change and completion is scheduled for the end of November 2021. The preparation of the Health NAP is based on the results and recommendation of the vulnerability assessment and adaptation to climate change of the health sector in Mozambique carried out in 2019. The Plan is being prepared in collaboration with MISAU,	

			INS, and Eduardo Mondlane University with technical and financial support from WHO through funds from the Government of Flanders.	
	Planning and management of biodiversity and coastal ecosystems 4.6.2.3.3		Rehabilitation of deforested areas for pasture creation, agricultural practice, exploitation of forest resources 4.6.2.3.3.1	
	Planning and management of biodiversity and coastal ecosystems 4.6.2.3.3	Develop actions and programs for adaptive conservation to climate change.	Application of management practices that increase the adaptive capacity of ecosystems - 4.6.1.6.1.5; (linked to national biodiversity strategy, target 10: By 2035, place at least 20% of ecosystems critically affected by climate change under adaptive ecosystem management).	
	Ensuring the protection of biodiversity	Identify and implement adaptation actions that guarantee the protection of endangered flora and fauna species.		
		Establish transboundary conservation areas to maintain ecosystem functions and allow wildlife migrations.	Establishment of transboundary conservation areas to maintain ecosystem functions and allow wildlife migrations - 4.6.1.6.1.3.	
		Apply management practices that increase the adaptive capacity of ecosystems, maximizing the use of habitats and conservation of biodiversity.		

		Reclassify and resize conservation areas, identifying areas at risk of biodiversity loss.	Reclassification and resizing of conservation areas, identifying areas at risk of loss of biodiversity.	
			Identification and replication of lessons and best practices for mitigation and adaptation (Target 10.3 of the National Biodiversity Strategy).	
			Promoting the survey of knowledge on the contribution of biodiversity to the increase in carbon stock, with a view to mitigating and adapting to climate change (based on Goal 15 of the National Biodiversity Strategy).	
	Promote mechanisms for planting trees and establishing forests for local use	Develop programs for planting trees with multiple uses and economic value in order to respond to the needs of products for local communities, seeking to value local initiatives, combating deforestation and preventing fires and their spread.		
		Explore agro-silvo-pastoral systems, allowing diversification of livelihoods and incomes.	Establishment and increase in the adoption of integrated agroforestry systems (agro-silvo-pastoral); use of multiple-use forest species: shade/nitrogen fixation/forage (REDD+, MozBIO, FIP, Sustenta, Payment for carbon credits in Zambézia) – new.	
		Promote community management programs for forest resources.		

			Rehabilitation of degraded ecosystems and pastures through landscape rehabilitation (REDD+, MozFIP) – new.	
	Develop resilience mechanisms of urban areas and other settlements	Develop and update climate-responsive territorial planning and ordering instruments and strengthen their implementation	Development and updating of climate-responsive territorial planning and ordering instruments and reinforcement of their implementation 4.6.1.8.1.1	
		Map vulnerable or at risk infrastructure, depending on the type of weather phenomenon (floods, cyclones, sea level rise).	Mapping of vulnerable or at risk infrastructure, depending on the type of weather phenomenon (floods, cyclones, sea level rise) 4.6.1.8.1.2.	
			Mapping of regions prone to soil erosion and landslides 4.6.1.8.1.7.	
		Recast building codes for transport, telecommunications, energy distribution, buildings, hydraulic and wastewater treatment infrastructure to make them climate-resilient.	Recasting of building codes for transport, telecommunications, energy distribution, buildings, hydraulic and wastewater treatment infrastructures in order to make them climate-resilient 4.6.1.8.1.3.	
		Ensuring that investments, particularly public ones, in risk areas are climate-proof.	Ensuring that investments, particularly public ones, in risk areas, are climate-proof 4.6.1.8.1.4.	
			Development of projects for the construction of water supply infrastructures taking into account the occurrence of the main natural phenomena 4.6.1.8.1.8.	
			Adoption of measures that are resilient to natural hazards during the implementation of water supply infrastructure	

			(capture, storage, transport and distribution) 4.6.1.8.1.9.	
		Promote the design and implementation of potential insurance mechanisms against climate risks in the built heritage.	Promotion of the design and implementation of potential insurance mechanisms against climate risks in the built heritage 4.6.1.8.1.5.	
			Preparation of projects for the construction of water supply infrastructures taking into account the occurrence of the main natural phenomena 4.6.1.8.1.8.	
	Adapt the development of tourist areas and coastal areas to reduce the impacts of CC	Assess the main climate risks on resources and areas of tourist interest.	Assessment of the main climatic risks on resources and areas of tourist interest 4.6.1.8.2.1	
		Advise operators on appropriate building codes.	Advice to operators on appropriate building codes 4.6.1.8.2.2.	
		Promote good practices among operators and tourists, through public-private partnerships, aimed at the resilience of the sector and the conservation of ecosystems.	Promotion of good practices among operators and tourists, through public-private partnerships, aimed at the sector's resilience and ecosystem conservation 4.6.1.8.2.3.	
		Develop coastal conservation and coastal protection practices.	Development of coastal conservation and protection practices 4.6.1.8.2.4.	
		Promote the adoption of climate insurance for tourism activities and infrastructure.	Promoting the adoption of climate insurance for tourism activities and infrastructure 4.6.1.8.2.	
			Implementation of the Technological Action Plan and Project Ideas for Coastal Zone and Infrastructure.	

	Adjust the current legal framework in line with ENAMMC	Identify gaps and need to adjust legal instruments to incorporate CC issues.		
		Provide the sectors with instruments (strategies, policies, regulations and standards) that ensure the integration of the ability to monitor, detect and respond in a timely and effective manner to the challenges of CC.		
		Strengthen the institutional framework at the grassroots (district) level with a view to greater interaction with communities.		
		Promote the integration of MCs in local committees, encouraging the convergence of the various existing themes		
	Adjust the current institutional framework in line with ENAMMC	Finalize the process of updating the CONDES statutes to integrate other actors		
		Enable the CT-CONDES to respond to the intersectoral coordination requirements of the MCs through the establishment and operation of the MC Coordination Unit (UMC) in the CONDES Secretariat		
		Create the statutes of the GIIMC making it a formal entity	Institutionalization of the GIIMC, the CGCMC and the Climate Change Network and their strengthening with a view to their sustainability	

		Strengthen, train and empower institutions for monitoring and supervising laws and regulations		
		Proactively interact with institutions of the State, Government, Civil Society, Community-Based Organizations, Academia, the Media	Holding of the National Climate Change Conference, every 2 years	
		Develop capacity for designing, analyzing and monitoring policies by defining the National MRV System for MCs		
	Develop research on MC	Accelerate the process of creating a Knowledge Management Center - production, management and dissemination of information on CC		
		Create multisectoral research teams – Climate Change Network	Institutionalization of the GIIMC, the CGCMC and the Climate Change Network and their strengthening with a view to their sustainability	
		Design the National MRV System in order to collect monitoring data on the effects of CC, including parameters related to monitoring the impacts of CC and the effects of adaptation measures, activity data and GHG emission factors	Updating climate scenarios and downscaling (regionalization of results) to cover the Mozambican territory	
			Development of at least 2 national emission factors so that it is possible to realize the use of TIER 2 in priority sectors (eg energy and waste)	
		Use study results to design policies for the lives of populations	Promotion of studies and research on climate change aimed at reducing climate risk and low carbon	

			development potential	
		Establish a peer review system for CM research		
		Create exchanges between the Government, academia, the private sector, and civil society to generate and share knowledge		
		Adapt and enhance research institutions (academic and others) in matters related to the environment in the current context related to MC		
		Promote regional and international exchange		
	Fortalecer as instituições que recolhem dados que alimentam os inventários de GEE e as Comunicações Nacionais	Distribute responsibilities to the ad-hoc group and dissemination of reports (according to the National System)		
		Expand the network, ensure its maintenance and define standards for meteorological, hydrological, hydrometric and agrometeorological stations		

		Create an integrated climate information management system between INAM, DNA, IIAM and INAHINA		
		Reinforce the standardization mechanism of equipment and database		
		Strengthen institutions for the systematic collection and processing of relevant data for inventories and National Communications		
			Updating climate scenarios and downscaling (regionalization of results) to cover the Mozambican territory	
	Develop and improve the level of knowledge and intervention capacity on CM	Update the training needs assessment and adjust and implement the respective plan	Formulation and implementation of a technical-institutional capacity building plan for the implementation of the NDC within the scope of the Capacity Building Initiative of the Paris Agreement (CBIT – Capacity Building Initiative for Transparence)	
		Strengthen the Designated National Authority (AND) for CDM Projects and Program and enable it to identify opportunities in all sectors to improve the country's negotiating capacity on climate change		
		Develop and integrate CC content into formal and informal education programs	Integration of subjects and development of climate change syllabus in school curricula from 1st to 11th grade	

			Integration of subjects and development of climate change syllabus at the institute for training technical staff	
		Raise awareness of the general public and disseminate information on CC, including the dissemination of ENAMMC, policies and international agreements on the subject	Implementation of the communication and awareness plan for climate change adaptation and mitigation	
		Create integrated planning and budgeting capacity (PESOE, PESOD, PES), including aspects of adaptation and mitigation to CC		
		Create capacity in FUNAB to guide the design and elaboration of projects and/or programs for access to international funds (eg: GEF, Adaptation Fund, FCPF, Least Developed Countries Funds – LDCF, Special Fund of MC – SCCF , Green Climate Fund – GCF, Fast Start, Climate Investment Fund, among others)		
		Strengthen FUNAB's financial management and auditing capacity, in its capacity as Coordination Agency for the Financing of CC projects		
		Build capacity at UMC for the integrated management and monitoring of ENAMMC, its projects and/or CC adaptation and mitigation programs, including reporting on implemented projects and programs.		

			Development and maintenance of the NDC transparency portal	
	Promote the transfer and adoption of clean and resilient technologies to CC	Develop and implement the technology needs assessment and the respective plan		
		Use the CDM and similar instruments as catalysts for the promotion of technology transfer for the mitigation of CM, supplying technological needs and limitations.		

4. Chapter 4: Mitigation Options

4.1. Introduction

As part of the Convention, Mozambique assumed the commitment to formulate, implement, publish and regularly update national and, where possible, regional programs containing measures to mitigate climate change, taking into account emissions by sources and removals by sinks of all GHGs not controlled by the Montreal Protocol.

The country is also committed to promote and cooperate in the development, application and dissemination, including the transfer of technologies, practices and processes that control, prevent and reduce GHG emissions in all relevant sectors, comprising energy, transport, industry, agriculture, forests and waste, as well as promoting sustainable management and cooperating in the conservation and enhancement of GHG sinks and reservoirs not controlled by the Montreal Protocol.

In response to the commitments, Mozambique has integrated in its policies, strategies, plans and development programs, measures that, when implemented, contribute to the mitigation of national emissions and/or promote low carbon development in the context of sustainable development.

After the formulation of the first version of the SCN, which included the mitigation component, the NCCAMS was formulated, considering the pillar of mitigation and development of low emissions, of which the objective is to identify and implement GHG emission reduction opportunities contributing to sustainable use of natural resources and access to financial and technological resources at affordable prices and the reduction of pollution and environmental degradation, promoting low carbon development.

As part of the Kyoto Protocol and considering the Clean Development Mechanism (CDM) an opportunity to attract projects that promote technology transfer, the country prepared for this purpose, and designated the sector of environment as the national authority responsible for approving projects of the CDM and designed the corresponding criteria to be used. According to the UNFCCC Secretariat database, there are 14 prior CDM communications in Mozambique (Annex 8.1).

In addition, the CDM Secretariat database holds 9 Activity Programs (PoAs) registered in Mozambique (Annex 8.2), with 135 program activities (CPA) registered in these 9 PoA, with an expected annual emission reduction of around 740 thousand tCO_2eq, corresponding to the reduction period from 2014 to 2030 an expectation of reduction of more than 3 million tCO_2eq). The database has 10 projects and registered PoAs, which have issued around 850,000 CERs to date and with the potential to issue more than 5 million CERs annually (Annex 8.3).

Considering the set of CDM plus projects registered in the voluntary market (VCS and Gold Standard) the number of projects registered in Mozambique will be around 50.

By strengthening developing countries' mitigation actions through Nationally Appropriate Mitigation Actions (NAMAs) and the non-market based mitigation approach – Reducing Emissions Resulting from Deforestation and Forest Degradation – REDD+, the country explored opportunities for CDM, having identified the agriculture, transport, forestry and waste sectors with potential for NAMAs. However, the NAMA in the Waste sector is at the advanced stage of formulation; while the NAMA of the transport sector is in the process of being transformed into a project and competing for available climate finance. The remaining two NAMAs (agriculture and forests – production and sustainable use of charcoal are part of the actions of the Mozambique NDC that seek support for their formulation and implementation).

The Government approved, on 2 November 2016, the National Strategy for Reducing Emissions from Deforestation and Forest Degradation, Conservation of Forests and Increase of Carbon Reserves Through Forests (REDD+) 2016-2030, in which the country set the goal of reducing emissions from deforestation and forest degradation, improving the conservation of forest ecosystems and increasing forest carbon reserves, thus avoiding the emission of 170 $MtCO_2$/year by 2030.

With the negotiations of the Paris Agreement, the country formulated and submitted to the Convention its Intentional Nationally Determined Contribution, covering the period from 2020 – 2030. This document was updated in 2018 and the Nationally Determined Contribution of Mozambique 2020 – 2025 was formulated, which in 2021 Mozambique's First Updated Nationally Determined Contribution 2020 – 2025 was reviewed and produced.

The mitigation component of the Mozambique 1UNDC 2020 – 2025 represents the effort that the country will make in order to participate in the realization of the purposes of the Paris Agreement. Thus, with the implementation of this contribution, Mozambique expects to reduce around 40 million tCO_2eq in the period between 2020 and 2025. The emission reductions proposed in Mozambique's mitigation contribution would represent a mitigation effort of around 1.2 tCO_2eq per capita until 2025, a very relevant number when comparing the total GHG emissions per capita in Mozambique, which were respectively 0.6 tCO_2eq in 1990 and currently, around 2 tCO_2eq (total emissions with LULUCF) (MTA 2021).

Also within the scope of the Paris Agreement, the country assumed the commitment to formulate and submit to the Convention the Strategy for the Long-Term Development of Low Greenhouse Gas Emissions, a document in the process of being finalized and which is in line with the mitigation components of the NCCAMS and the 1UNDC of Mozambique 2020 – 2025.

It should be noted that Mozambique indicates in its NDC that the achievement of the proposed target is conditional on the availability of financial, technological and capacity-building support from the international community. The mitigation component is budgeted at around 25% of the total cost of the NDC.

This chapter presents mitigation measures contained in the NCCAMS and in the Mozambique 1UNDC 2020 – 2025. It is important to mention that the Mozambique NDC includes several sectors such as Agriculture and Sustainable Land Use, Waste Management, Energy Security and Sustainability of industries; and, the mitigation component of NCCAMS covers the following sectors:

(i) Energy

- Energy including transport;

(ii) Industrial processes and Use of products;

(iii) Agriculture, Forestry and Other Land Uses; and

(iv) Waste.

4.2. Methodology

The methodology for updating the mitigation component was based on the bibliographic review of the different instruments that contain mitigation actions or measures and that were developed in the period 2011-2021. These are the NCCAMS, sectoral strategies, the Government's Five-Year Plan (PQG 2020 – 2024), the First Updated Nationally Determined Contribution of Mozambique 2020 – 2025, Technological Action Plans for the Energy and Waste Sectors (formulated under the TNA), the First Biennial Update Report (in process of being finalized) and the Nationally Appropriate Mitigation Actions (NAMA) documents in the pipeline). The emission scenarios (Benchmark and Mitigation) were developed in the context of the elaboration of the NDC approved by the Government in 2018 and updated in the formulation of the First Biennial Update Report of Mozambique and the Strategy for the Long-Term Development of Low GHG Emissions from Mozambique 2020 – 2050. These scenarios reflect the country's commitments under the Paris Agreement. The emission scenarios (Reference and Mitigation) were developed in the context of the preparation of the NDC approved by the Government in 2018. Therefore, the NDC is the instrument that presents the most up-to-date mitigation scenarios in the country. These scenarios are part of section 4.3 where the country's commitments under the Paris Agreements are presented. The emission scenarios (Benchmark and Mitigation) were developed in the context of the elaboration of the NDC approved by the Government in 2018 and updated in the formulation of the First Biennial Update Report of Mozambique and the Strategy for the Long-Term Development of Low GHG Emissions from Mozambique 2020 – 2050. These scenarios are part of section 4.3, where the country's commitments under the Paris Agreements are presented. However, as pointed out in the ICTU table contained in the Mozambique 1UNDC 2020 – 2025 document, emission reductions are based on a process of quantification of specific emission reductions related to each mitigation action. Therefore, the scenarios may not be compatible with GHG emissions linked to the methods provided for in national inventory methodologies, nor follow the same pattern of sectoral aggregation of the IPCC.

It should be noted that the first version of the mitigation chapter of the SCN prepared in 2010 served as the basis for the formulation of NCCAMS's low carbon mitigation and development pillar.

4.3. Mozambique's Mitigation Commitments under the Paris Agreement (NDC Mozambique 2020 – 2025)

The GoM approved in December 2018 the NDC of Mozambique 2020 – 2025 and the respective Operational Plan. This Contribution was revised between 2020 and 2021, giving rise to the Mozambique 1UNDC 2020 – 2025, which was launched at COP 26 and submitted to the Convention on December 27, 2021.The country's NDC document constitutes the national action plan for the implementation of the Paris Agreement, and contains national commitments in response to the purposes of the Paris Agreement to the United Nations Framework Convention on Climate Change (UNFCCC). The Paris Agreement was adopted at the Conference of the Parties (COP21) with the aim of limiting the increase in global average temperature to below 2°C, compared to pre-industrial levels and continuing efforts to limit warming to 1.5 °C.

It should be recalled that the 1UNDC of Mozambique 2020 – 2025 updates the INDC of Mozambique 2020 – 2030 previously submitted to the UNFCCC on 1 October 2015 and which served as the basis for the negotiation of the Paris Agreement.

The Mozambique NDC 2020 – 2025 comprises actions and policies, covering the following strategic areas:

i. Improved access to renewable energy;
ii. Expansion of the urban network;
iii. Increased energy efficiency;
iv. Promotion of low-carbon urbanization;
v. Control of industrial emissions, including associated waste and sewage
vi. Development of low carbon agricultural practices and
vii. Promotion of efficient use of biomass.

According to the Mozambique 1UNDC 2020 – 2025, the implementation of policy and program actions contained in this document will jointly and greatly limit emissions by sources and increase GHG removals by sinks while contributing to the improvement of the quality of life of Mozambicans, by increasing access to renewable energy and basic sanitation services and promoting the efficient use of natural capital, thereby reducing environmental degradation.

Mozambique's 1UNDC indicates that the country is open to participate in market mechanisms to be established, which allow access to clean technologies so that national emissions arising from the exploration, management and use of the natural capital at its disposal are mitigated.

For the development of the Reference and Mitigation scenarios, the LEAP System (Heaps, 2016) was considered. It was previously used in the analysis of measures proposed in INDC, and in the study of the feasibility of low-carbon development options - EBAC (Sousa et al., 2016). It is a widely used tool for analyzing energy policy and assessing climate change mitigation. The LEAP System belongs to the Stockholm Environment Institute (SEI) and allows the future use and production of energy to be projected based on economic and social growth assumptions.

The reference and mitigation scenarios developed cover the period from 2020 to 2050, as these were developed within the scope of the formulation of Mozambique's Low Emissions Long-Term Development Strategy and, for the NDC, the period 2020 – 2025 was considered and, for the First Biennial Update Report, the period from 2020 – 2030.

The NDC formulation process was participatory and comprehensive, with provincial, national and sectoral consultations. Mitigation options were selected locally, from the various sectors relevant to this exercise, with attention to the aforementioned documents, INDC, NCCAMS and PQG2015-2019 for the necessary alignment (Table 4.2). In the working sessions, which took place in July 2018, a brief Multi-Criteria Analysis (MCA) was developed to score the alternative options. In the end, a qualitative ordering of the measures was achieved, which provided the starting point for the quantified study. Likewise, a partial, measure-by-measure analysis was developed, which follows the cost-effectiveness analysis (CEA) methodology.

The results of the emissions compilation exercise and the projection to 2030 are illustrated in Figure 4.1, for the baseline and mitigation scenarios associated with energy (production and consumption), waste and forestry measures. Details on the assumptions and measures considered in these scenarios are described in the Mozambique NDC plan document.

In 2021, the process of reviewing the Mozambique NDC 2020 – 2025 began and resulted in the Mozambique 1UNDC. The contributions of measures in reducing emissions by industry are shown in Figure 4.2, which represents the mitigation scenario for the baseline and mitigation scenarios associated with energy (production and consumption), waste and forestry measures. Details on the assumptions and measures considered in these scenarios are described in the Mozambique NDC plan document. As mentioned above, with the implementation of the NDC, Mozambique expects to reduce around 40.48 MTonCO_2eq in the period between 2020 – 2025. The main sectors that are expected to contribute to most of this reduction are: Agriculture and Livestock and Sustainable Land Uses and Energy Security, contemplating more than 90% of the total reductions.

The contributions of measures to reduce emissions by industry are shown in Figure 4.2, which represents the mitigation scenario. From Figure 4.2, it can be noted that the branch that stands out in terms of contribution for emission redution is Forests and land use, associated with the actions for combating deforestation and forest restoration, which also comprises the actions foreseen in the NAMA of Coal and others conservation and biomass strategies. These accumulate savings of around 30 MtCO_2eq between 2020-2025. The other measures - electricity production, energy use and waste - in this period, correspond to savings of 1.9 $MtCO_2eq$ (MITADER, 2018).

Figure 4.2, on the one hand, highlights the relative importance of the forestry and land use sector in the country's balance of emissions, on the other hand, it reflects the fact that Mozambique's energy mix is low in emissions, given the country's large water capacity (MITADER, 2018).

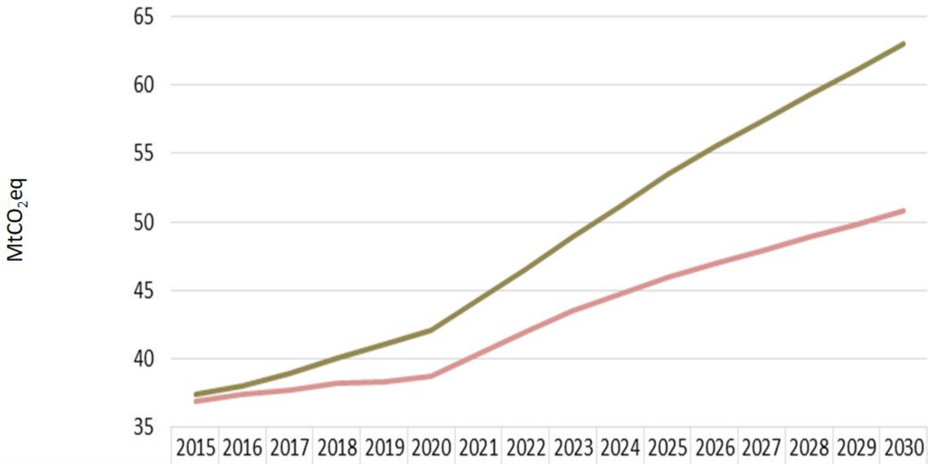
However, it should be noted that emissions from the energy sector, considering the consumption of petroleum products, make its contribution quite significant. In the last decade, which coincides with the period under evaluation in this paper, the transport subsector showed a significant increase trend, determined by the increase in road transport, both for passengers and goods. According to the Ministry of Energy's statistical report (ME, 2012), the consumption of diesel and gasoline grew at an average rate of 6% per year between 2000-2011. Although more recent statistics are not available, preliminary results from the BUR Biennial Report Update indicate that, over the period 2000-2018, fuel consumption by road transport doubled as a consequence of the increase in the national car fleet. The results of the BUR report will, of course, reflect a more complete picture in terms of emissions from the energy sector.

One action can be identified in the Strategy for Integrated Development of the Transport System (MTC, 2014) and in the Master Plan for Mobility and Transport for the Metropolitan Area of Maputo, 2013-2035 (CMM, 2014), related to the *Promotion of urbanization low carbon, namely promoting the mass use of gas for domestic, industrial and public and private transport as an alternative to less clean energy sources. This action is translated into two measures: (i) acquisition of buses powered by natural gas and (ii) conversion of vehicles powered by gasoline to natural gas.*

The introduction of Metrobus in January 2018 is also an action with important mitigation potential, as it can promote the use of public transport, through energy efficiency in transport, in the medium-long term. Metrobus is a private sector initiative consisting of an integrated transport system, including buses and railcars, aimed at transporting passengers in the metropolitan region of Maputo. On the other hand, in recent years there has been an effort to improve road traffic through the adoption of lanes dedicated to public transport, in the metropolitan region of Maputo, which has the greatest pressure on the number of public transport users. The implementation of these actions in other municipalities in the country would bring positive impacts both from the point of view of mitigation and the improvement of the public transport system.

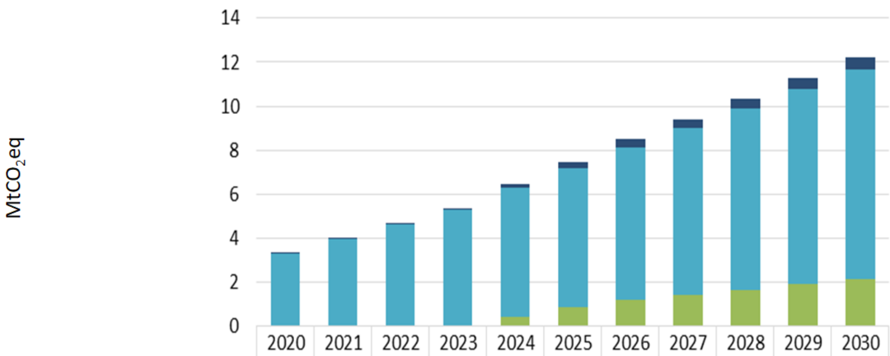
The remarkable growth trend in the transport subsector, due to the increase in the number of cars, is reflected in its significant contribution to the balance of GHG emissions in the country. This finding stems from the analysis of the preliminary results of the biennial report, similarly to other countries with similar characteristics to Mozambique. Therefore, given the importance of this subsector, not only in terms of GHG emissions, but also from a socio-economic and environmental point of view (due to the pollution of which the consequences are already being felt in the country's urban centers), it is necessary to carry out a comprehensive study (in addition to the NAMA for vehicular gas described in section 4.6) to establish a baseline for this subsector. This reference would allow, on the one hand, to improve the emission estimates - in combination with the GHG inventories - and, on the other hand, to assess the potential interventions that can be made in this subsector, taking into account socio-economic and environmental aspects, as mentioned above.

Regarding to waste, emissions from this sector will grow substantially after 2025, associated with the NAMA on waste, estimated to accumulate 591 $KtCO_2eq$ between 2020-2025, and about 2.27 $MtCO_2eq$ between 2026-2030.



	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Reference	37,42	37,98	38,94	39,99	41,03	42,05	44,32	46,59	48,87	51,15	53,44	55,44	57,32	59,20	61,08	62,98
Mitigation - total	36,87	37,43	37,75	38,16	38,36	38,73	40,35	41,94	43,53	44,72	45,97	46,95	47,91	48,86	49,81	50,77

Figure 4.1: Estimated total GHG emissions, by scenario, 2015-2030.
Source: MITADER (NDC, 2018).



	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Waste	0,009	0,019	0,037	0,074	0,149	0,303	0,353	0,404	0,454	0,505	0,556
Forest and land use	3,314	3,955	4,595	5,236	5,876	6,311	6,951	7,592	8,232	8,873	9,513
Electricity generation	0,000	0,000	0,000	0,011	0,391	0,838	1,166	1,399	1,637	1,879	2,127
Energy use	0,000	0,000	0,018	0,018	0,018	0,018	0,018	0,018	0,018	0,018	0,018

Figure 4.2: Contribution of measures with mitigation potential, 2020-2030.
Source: MITADER (NDC, 2018).

Table 4.1: Alignments of NCCAMS with the 1UNDC of Mozambique 2020 – 2025

(Source: Adapted from Mozambique's First Updated NDC 2020 – 2025)

NCCAMS		Measure at NDC	REDD+	LTS	Others
Action	Measure at NCCAMS				
Improve access to renewable energy4.6.2.2.1	Promote the electrification of rural communities using renewable energy				
	Promote the use of renewable energy sources (biogas, biomass, solar, wind, thermal, wave and geothermal)	Promotion of the use of renewable energy sources - hydro 4.6.2.2.1.1			
		Technological Action Plan for Regular Hydroelectric Turbine Technology			
		Promotion of the use of renewable energy sources - wind 4.6.2.2.1.2			
		Promotion of the use of renewable energy sources – Photovoltaics 4.6.2.2.1.3			
		Implementation of the Technological Action Plan for Regular Scale Photovoltaic Plants - TNA			
	Promote the expansion of the national grid or the creation of micro-grids for energy distribution	Expansion of the urban network, creation of new connections; promotion of 100% coverage in the connection of domestic consumers in suburban areas, in districts and interconnected to the national electricity grid (SILE)			
	Promote and disseminate techniques and technologies for the production and sustainable use of biomass		✓	✓	

NCCAMS		Measure at NDC	REDD+	LTS	Others
Action	Measure at NCCAMS				
	energy				
	Evaluate mitigation mechanisms in electricity generation and transmission infrastructures				
Increase energy efficiency 4.6.2.1.2	Ensure availability and access to low-carbon fossil fuels;				
	Promote initiatives to replace high-carbon and non-renewable fuels with low-carbon or renewable fuels in the transport and production process sectors;				
	Ensure the implementation of low carbon regulatory instruments, programs and projects for the transport sector, such as the production of biodiesel for use in transport fleets that generate new sources of income and diversify the economy in rural areas;				

NCCAMS		Measure at NDC	$REDD^+$	LTS	Others
Action	Measure at NCCAMS				
	Develop energy microgeneration projects and programs in commercial and residential buildings 4.6.2.1.2	Installation of 50,000 photovoltaic lighting systems or from wind turbines			
		Installation of 5000 solar PV systems for pumping water for domestic, community or public use in isolated (SIE) or mixed (SILE/SIE) areas, including agricultural irrigation and livestock watering			
	Promoting the use of efficient household appliances	Powering 5,000 glaciers for domestic use, through photovoltaic technology or with wind turbines, in homes in areas isolated from the national electricity grid (SIE)			
		Replacement of 2,500,000 incandescent light bulbs in efficient light bulbs in all domestic consumers in the country.			
		Productive use of energy – construction of 8 centers for fish conservation			
	use "clean coal" technologies in coal-fired power plants (including the use of cogeneration, where applicable)				
	Reduce emissions associated with thermal power plants.				
Ensuring compliance with regulatory	Recover methane during the mineral and hydrocarbon				

NCCAMS		Measure at NDC	REDD+	LTS	Others
Action	**Measure at NCCAMS**				
standards for emissions from extractive industry activities	extraction process				
	Assess possibilities for carbon capture and storage				
Promote low-carbon urbanization	Develop and implement policies and measures to integrate the energy efficiency component and the use/use of renewable energy sources into the guidelines for building infrastructure such as buildings, communication routes and related structures				
		Construction of the 450 MW thermal power plant based on natural gas: Technological Action Plan for Natural Gas Combined Cycle Technology			
	Increase in Energy Efficiency in Travel	Expansion of Metrobus to the main capitals of the country			
	Encourage the use of solar thermal systems in large commercial and industrial buildings, public and residential buildings				

NCCAMS		Measure at NDC	REDD+	LTS	Others
Action	Measure at NCCAMS				
	Encouraging the replacement of incandescent light bulbs with energy-saving light bulbs				
	Promote the widespread use of gas for domestic, industrial and public and private transport as an alternative to less clean energy sources	Massification of LPG - Increasing the number of people with access to cooking gas to around 309.02% compared to the current			
		Massification of Natural Gas Use: o Construction of ten (10) Compressed Natural Gas Supply Stations, - Import of one hundred and fifty (150) buses to CNG - Import of one thousand (1000) kits and respective conversion cylinders for Natural Gas. - Conversion of 1000 cars to NG			
		Repair of 150 NG-powered buses for public transport			
	Promote, through building codes and production standards, energy efficiency practices and the use of equipment for the use of renewable energy sources and decentralized energy production				

NCCAMS		Measure at NDC	REDD[+]	LTS	Others
Action	Measure at NCCAMS				
Control emissions from industrial processes including waste and associated effluents	Develop policies and measures for inspection and regulation of industrial activity in order to control compliance with national legislation and international conventions				
	Encourage investors to assess potential GHG emissions from investment projects when considering clean energy sources and technologies				
	Promote energy microgeneration projects and programs in the industrial sector				
Develop low-carbon agricultural practices	Encourage conservation agriculture				
	Promote agricultural practices that reduce GHG emissions (in particular in sugarcane harvesting)				
	Use high energy-efficient water pumping systems for crop				

NCCAMS		Measure at NDC	REDD+	LTS	Others
Action	**Measure at NCCAMS**				
	irrigation				
	Recover methane from agricultural activities in intensive farming systems (particularly in rice paddies)				
	Promote the collection and biodigestion of animal and plant waste to use methane for energy generation				
Reduce the rate of deforestation and uncontrolled fires	Sustainable exploitation of forests in order to maximize their potential for carbon capture and sequestration	- Establishment and increase in the adoption of integrated agroforestry systems (agro-silvo-pastoral); use of multiple-use forest species: shade/nitrogen fixation/forage (REDD+, MozBIO, FIP, Sustenta, Payment for carbon credits in Zambézia). - Rehabilitation of degraded ecosystems and pastures through the rehabilitation of landscapes (All Country)			
	Promote mechanisms that lead to the natural regeneration of forests				
	Create mechanisms to prevent the spread of fires				
Reduce the rate of	Develop programs for the				

NCCAMS		Measure at NDC	REDD+	LTS	Others
Action	**Measure at NCCAMS**				
deforestation and uncontrolled fires	sustainable exploitation, regeneration and protection of mangroves, algae and seagrasses associated with the potential for carbon capture and sequestration (Blue Carbon[4])				
Manage and recover waste	Promote the reduction, reuse and recycling of waste				
	Encourage the establishment of landfills with recovery and subsequent use of methane	Promotion of sustainable waste management in Mozambique (NAMA OF WASTE) Implementation of the Technological Action Plan and Project Ideas for the Management and Treatment of Urban Solid Waste			
	Promote the generation of energy from waste using anaerobic digestion processes, thermal or mechanical treatment				

[4] Blue Carbon

4.4. Nationally Appropriate Mitigation Actions

Nationally Appropriate Mitigation Actions (NAMAs), according to the Bali Action Plan (2007), are one of the instruments through which developing countries can expand their actions within the scope of the implementation of the UNFCCC Convention, reducing its GHG emissions from the normal trend it has been following. The actions contained in the NAMAS of developing countries must be monitored, reported and verified (MRV) and are implemented with the support of the Annex I countries in terms of finance, technology transfer and capacity building. The criteria that make an action a NAMA are:

(i) Result in the mitigation of GHG emissions;
(ii) Be in line with national development plans;
(iii) Have potential co-benefits for sustainable development;
(iv) Have an impact that can be measured, reported and verified (MRV).

Mozambique adhered to this instrument, having already started with the development of NAMAS in the areas that we will describe below, highlighting the potential for reducing emissions and the contribution to the country's sustainable development.

4.4.1. NAMA Promoting a Sustainable Charcoal Value Chain in Mozambique

This NAMA, in abbreviated form, is called NAMA for Vegetal Coal. It is part of the actions and policies proposed in the NDC of Mozambique 2020 – 2025 that seek funding for its formulation and implementation, of which the objective is to reduce by 25% the volume of wood used to produce charcoal consumed in Maputo, and consequently, emissions from GHG resulting from coal produced and consumed in Maputo. For this purpose, NAMA provides:

- More efficient technology transfer for the production and consumption of charcoal. The coal production technologies considered are: coal waste briquettes and improved ovens, and for consumption are improved stoves. Thus, NAMA has a goal of replacing 200 traditional ovens with more efficient ovens, and marketing 100,000 improved stoves;
- The formalization of the charcoal production chain/value chain, improving sustainable forest management (promoting good forest management practices) and controlling the use of resources; and, increasing opportunities to access green income alternatives (green economy) with the creation of green business models;
- The establishment of a coal certification system; and,
- Reduction of forest degradation associated with charcoal production and other environmental, social and economic problems.

During the implementation of ICAT Phase I, the 2018 version of the ICAT Guidelines on Sustainable Development (ICAT-Sustainable Development Guidelines: Guidance for assessing the environmental, social and economic impacts of policies and action) was tested using the NAMA for Charcoal. Results indicate that with the implementation of the Charcoal

NAMA there is a potential to achieve zero net emissions compared to BAU in the first two years of NAMA implementation; in 2025, emission reductions could reach 314 521 ± 45,138 TCO_2eq, equivalent to 119% of reference emissions, and corresponding to a contribution of between 1 - 1.5% to the achievement of the target defined in the NDC of Mozambique 2020 – 2025 (Figure 4.3, Rosta et al., 2019)

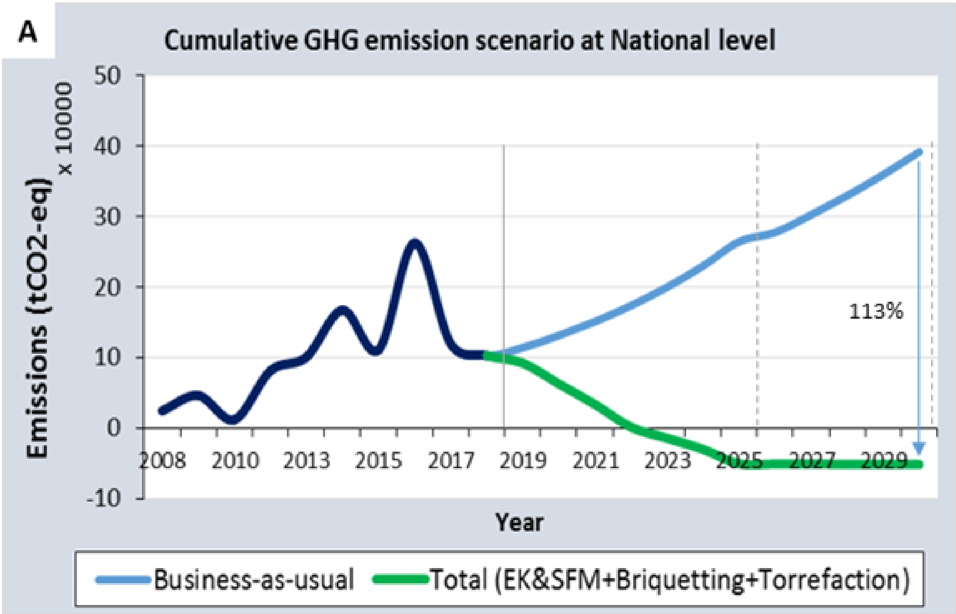


Figure 4.3 Cumulative scenario of emission reduction potential from technologies: improved furnaces; sustainable forest management and charcoal wastes briquetting; reference scenario (BAU).
Source: (Rosta et al., 2019).

The Districts covered by this action are: Chicualacuala, Guijá, Mabalane, Mapai and Massingir in Gaza province and Magude in Maputo province including the improved stoves in Maputo city and Matola area. The NAMA Coal Implementation Period is 2014-2020 and extending into the NDC implementation period (2020-2025).

The country's interest in implementing this NAMA consists of the contribution that NAMA is expected to bring to the country's sustainable development. The Table 4.2 shows the impacts of the environmental, social and economic dimensions expected from NAMA.

Table 4.2: Impacts on the environmental, social and economic dimensions of Charcoal NAMA.

Impact category	Specific impact identified	Indicators	Baseline (Business as usual - BAU) – National	Source	NAMA 2020-2030 Scenario
ENVIRONMENTAL DIMENSION					
Climate Change Mitigation	Reduced GHG emissions from improved distributed ovens and implemented sustainable forest management Increased emissions due to increased need for transport	CO_2eq emission from the coal production process and transport from the production area for Maputo	Colliers will continue to use traditional ovens (100% use of traditional ovens); • Coal transport emissions of about 25.71 t CO_2; • The area where charcoal production takes place has some regeneration and Mopane cutting; • There is no forest management; • Both large and small producers use the same area for the production of charcoal; • Coal is produced in traditional kilns with low efficiency (10-20%), and powdered coal waste and small fragments remain unused; • left in the field. There is no	Deliverable Report # 2: Cumulative Cenário, Field estimates	• Introduce 200 improved ovens, with gradual increase over time (Oven Casamança with 20 - 30% average conversion and 30% efficiency); • Emissions from transporting coal have increased, but energy content versus emissions from transport will reduce significance; • Trees are selectively cut for charcoal production; • More than 40% of charcoal producers use improved ovens; • The small-scale producer does not overlap with the large-scale producer; • More than 50% of producers will use improved ovens (All oven technologies will be introduced across the country. The average efficiency considered for all technologies is 40%, with an average conversion of 3:1); • 25% reduction in the amount of CO_2

Impact category	Specific impact identified	Indicators	Baseline (Business as usual - BAU) – National	Source	NAMA 2020-2030 Scenario
			roasting activity • O% producers applying acquired knowledge about the use of improved ovens or modern energy (briquettes and pellets) • 100% of charcoal and logging waste not used and		emitted with the prevention of deforestation; • At least 25% of producers applying acquired knowledge on the use of improved ovens or modern energy (briquettes and pellets), certified in the use of improved ovens, sustainable forest management practices, by 2025. • Increase of at least 2% of waste used for coal and briquette production per year, from 2020
Energy produced in a sustainable way	Increased complementary biomass and charcoal waste used for charcoal production, which will increase access to charcoal and other forms of energy (briquettes, roasted material) produced in a sustainable way	Number of licensed coal producers involved in efficiently and environmentally friendly produced coal	4% of licensed operators -100% of the charcoal not produced sustainably	EDM, 2012; ME, 2012; Renewable energy Strategy, DINAF, 2009	• It is expected that this NAMA will contribute to increasing sustainable charcoal production by 2% per year • At least 20% of charcoal is produced sustainably By 2025
		Number of charcoal consumers using produced charcoal in a	• 28% of the population with access to clean energy (electricity and gas) • 80% of urban and peri-urban areas depend on charcoal and	EDM; 2012 Brower et. al, 2004; Falcão, 2008	It is expected an increase of 25% of people per year consuming sustainable charcoal in urban and peri-urban areas of the main cities of Maputo, Matola. Taking in account the national level, it is expected

Impact category	Specific impact identified	Indicators	Baseline (Business as usual - BAU) – National	Source	NAMA 2020-2030 Scenario
		sustainable way	firewood for energy production. At least 60% can be considered as a population dependent on coal.		that the urban and peri-urban areas of the main cities of Nampula and Zambézia are also included.
SOCIAL DIMENSION					
Education	Improved access to education for local children	Number of children enrolled in school	Assumptions of the scenario provided by the PEE (2012-2016) in which enrollment (10%) and transition rates between different levels of education are expected to be maintained. School dropout rate (31.4%) and repetition rate (28.2%). Transition from 7th to 8th grade (80%), 10 to 11 (60-70%). School entrance and transition rates will be maintained between different levels of education.	MINED (2012-2016) Fieldwork estimates; Baumert et al. 2016	The increase in income will allow the coverage of education expenses by the families involved in the charcoal value chain.
	Improved ability for charcoal to be produced sustainably as a result of capacity building and knowledge development for	Number of workers in the charcoal value chain using more efficient charcoal production technologies and sustainable forest	Previous projects report that awareness campaigns for the production of sustainable charcoal have been carried out. However, no registration is available.	ACES project, 2017; Chaposa Project, 2001, OSRO project, 2006, FAO GCP, 2004, Baumert et al. 2016	The NAMA project includes awareness-raising activities and training.
Gender equality	Increased promotion of gender equality and	% of women involved in charcoal value	Historically, the percentage of women in charcoal production, at national level, does not exceed	Fieldwork estimates,	The organization of charcoal workers into associations will allow the integration of women and other groups in the value

Impact category	Specific impact identified	Indicators	Baseline (Business as usual - BAU) – National	Source	NAMA 2020-2030 Scenario
	women's empowerment by coal associations created	chain activities	10%.(Rosta et all, 2019)	Greenlight (2016)	chain. NAMA has forest management activities and stoves that can create opportunities.
ECONOMIC DIMENSION					
Work	Increase in the number of people employed in the charcoal value chain (green jobs)	Number of people working in the sector	87 000 People employed	Alberto et al, 2003; Nhacale et al, 2009	Increase of workers to 100,000 in 2025 and 150,000 in 2030 (average of 15 years)
Income	Local communities will receive 20% of shared revenue from coal licensing	Value of revenue from the licensing of charcoal delivered to the community	Government keeps only about 4% of revenues from licensing in the charcoal sector.	Nhancale et al. (2009)	SDAE will be able to increase its revenue by around 50.1 million MT in 2025 and 100.7 million MT in 2030, of this amount 10.0 million MZN per year will be delivered to communities in 2025 and 20.1 million of MZN per year in 2030 as their shares of 20% of license revenue.
Revenue	Increase in total revenue in the sector (% GDP)	% change in the forest sector revenue as result of NAMA	Forest sector GDP varies between 4 to 11%, increased illegal logging and lack of recording limits the contribution	Alberto et al, 2003; Nhacale et al, 2009	Improvement of registration and control of licensed charcoal and produced efficiently, is expected an increase in forest sector revenue by 5% a year, from the NAMA implementation.

4.4.2. NAMA Massification of the Use of Gas Vehicles in Maputo and Matola

Also designated, in abbreviated form, as NAMA for Gas Vehicles, is part of the actions and policies with which the country intends to contribute to the purposes of the Paris Agreement. This is also one of the actions of the NDC of which the formulation and implementation depends on international support.

Although natural gas proves to be economically viable, there are barriers that prevent the widespread use of vehicle gas in the country. A preliminary analysis identified the following barriers/challenges:

(i) Lack of a national NG supply network;
(ii) Lack of qualified human resources for the conversion and supply of CNG vehicles;
(iii) Lack of financial support to develop the needed infrastructure to implement the measure.

However, this exercise identified the following opportunities

(i) Availability of the resource in the country, and independence from other actors;
(ii) Basic legal documents to promote the use of existing CNG;
(iii) International support for the measure, through the reduction of GHG emissions;
(iv) Promoting entity involved with knowledge in the use of CNG (AutoGas);
(v) Win-win effect for the environment, safety and health of inhabitants, and support for competitiveness:
  - Savings on fuel imports
  - Promotion of direct and indirect jobs
  - Reduction of fuel costs
  - Support the fulfillment of GHG emission reduction targets
  - Reduction in car maintenance costs
  - Reduction in the number of road accidents
  - Reduction in diseases associated with car pollution.

NAMA for Gas Vehicles is expected to promote:

1. Acquisition of 400 natural gas minibuses in the first year;
2. Construction of 6 conversion centers and a technical inspection center for natural gas equipment in Maputo and Matola;
3. Conversion of 500 state cars and 25,000 private cars from gasoline and diesel to natural gas;
4. Construction of 20 filling stations in Maputo and Matola;
5. Training of technicians (144 people);
6. Preparation of a feasibility study for the construction of filling stations and conversion and inspection centers;
7. Introduction of new standards and in the legislative framework for CNG vehicles.

Reduction of Greenhouse Gas (GHG) emissions

To estimate the emission reductions that will result from the massification of vehicular gas, the LEAP model previously built and used in the analysis of the measures proposed in the

Mozambique NDC 2020 – 2025 and in the respective Operational Plan of the Mozambique NDC, as well as in the Feasibility Study of Low Carbon Development Options – EBAC (Sousa et al., 2016). The baseline emission scenario until 2030 previously established in the aforementioned studies (the baseline) was used and the estimated energy savings were applied. This results in a mitigation scenario that we call NAMA VNG MM scenario.

NAMA is expected to promote the conversion of 5,000 State cars over a three-year period, with 1,000 cars being converted in the first year; 2000 in the second; and the remaining 2000 in the third. In addition to State cars, a further 25,000 private cars are expected to be converted, starting in year 2, with the conversion of 1000 by year 9, when 6,000 will be converted, corresponding to 3.19% of the total indicated park; and 400 minibuses to be purchased in total in year 1 (Table 4.3) (Sousa et al., 2016 It is assumed that for the conversion of state and private cars, 50% of the converted ones were gasoline powered and consumed 12L/100km, and 50% diesel, which consumed 8L/100km. It was also assumed that converted cars consume 10% less fuel. Due to the calorific power ratio the value could be lower, but given the road conditions, a higher value is justified.

Table 4.3: NAMA VNG MM phasing.

		Minibuses		**State Vehicles**		**Private Vehicles**
Year 1	F1	400		1,000		-
Year 2		-	F2	2,000		1,000
Year 3		-		2,000		1,500
Year 4		-		-		2,000
Year 5		-		-		2,500
Year 6		-		-	F3	3,000
Year 7		-		-		4,000
Year 8		-		-		5,000
Year 9		-		-		6,000
Year 10		-		-		-
Total		400		5,000		25,000

Finally, it is considered that state and private cars make up to 30000 km/year, with minibuses circulating 150000 km/year, as a result of:

Circulation speed	50	km/h
operating time	12.00	h/day
distance travelled	600.00	km/day
Anual distance travelled	150,000	km/year

The values obtained from this analysis appear to be reasonable: total emissions decrease, despite the increase in emissions from the use of natural gas, as these are more than offset by the reduction in gasoline and diesel emissions, as seen in Figure 4.4.

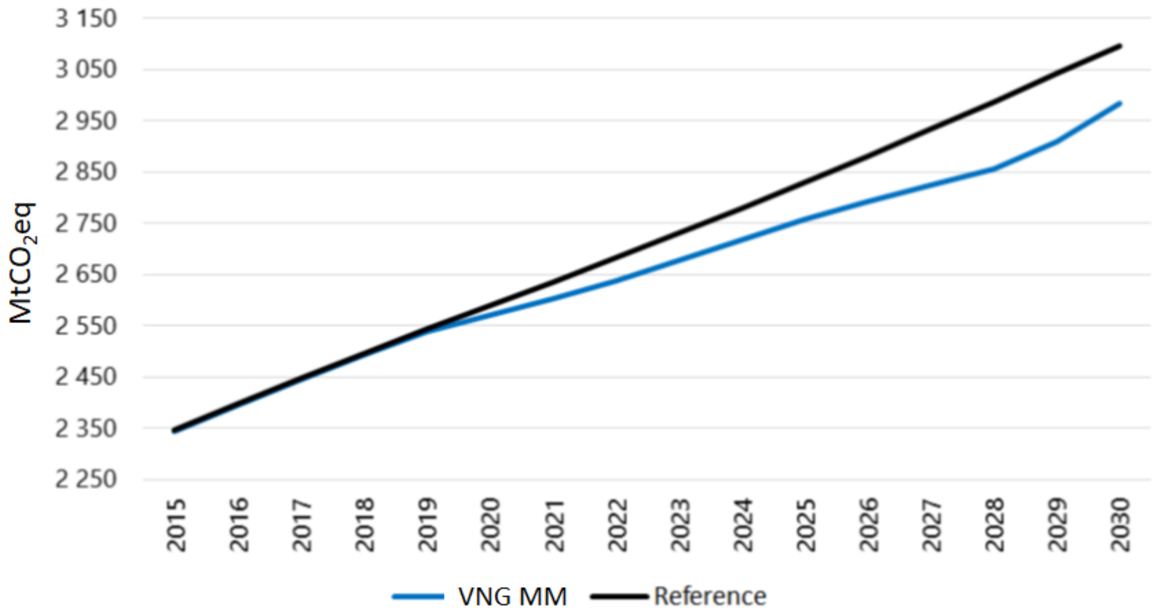


Figure 4.4: Emission savings trends arising from reduced use of gasoline and diesel, and additional emissions resulting from increased use of VNG.

The annual balance is summarized and in Figure 4.5.

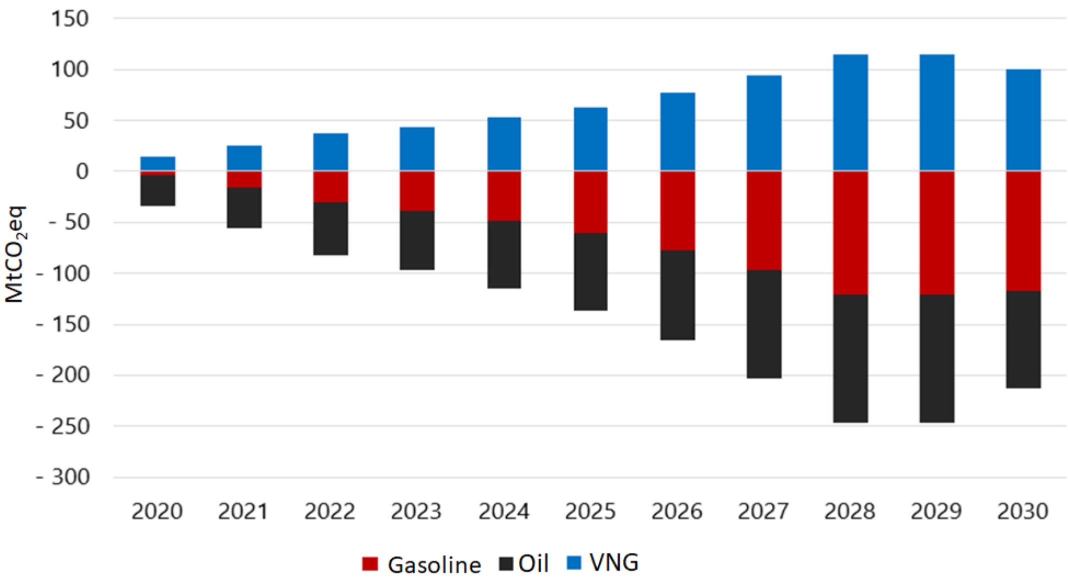


Figure 4.5: Effects of VNG MM Massification – differences in emissions, by fuel.
Source: Sousa et al (2016).

Table 4.4: Emission savings per year resulting from the Massification of VNG.

Year	$KtCO_2eq.$ saved
2020	19
2021	31
2022	44
2023	52
2024	62
2025	73
2026	89
2027	108
2028	132
2029	132
2030	112
Total	855

Source: Sousa *et al. (*2016)

In summary, emission savings are 855$KtCO_2eq.$, accumulated between 2020 and 2030. Mozambique has privileged access to natural gas, which, used in transport, is a proven global alternative to diesel and gasoline, which is more economical and more ecological. In a context which the national use of other renewable energy solutions in transport is unrealistic, the use of natural gas, in its compressed form, can contribute to sustainable mobility. However, in Mozambique the current infrastructure conditions and the social availability for a change of fuel are existing barriers that need to be overcome.

This NAMA has great advantages in the conversion of cars to the use of compressed natural gas, as well as in the acquisition of small VNG buses to replace others, in poor conditions, which also brings numerous indirect social, economic and environmental benefits.

The State officially supports a strategy for the mass use of natural gas, including compressed natural gas in transport, and has already launched legislation in this regard. Other support from the public sector is also expected, such as new legislation, direct and indirect financial support and support for research.

4.4.3. NAMA Sustainable Waste Management in Mozambique

Within the scope of the implementation of Strategic Action: Managing and recovering waste - from NCCAMS - the Ministry of Land and Environment – MTA, in collaboration with the National Fund for Sustainable Development - FNDS, the National Association of Mozambican Municipalities - ANAMM and the The French Development Agency is formulating the NAMA for Sustainable Waste Management in Mozambique (hereinafter referred to as the NAMA for Waste). This will be implemented in the Municipalities of Maputo, Nampula and three others of category “C”, yet to be defined.

NAMA for Waste operationalizes the Sustainable Waste Management Program, of which the abbreviated form is ValoRE (contraction of the word Valor e Waste – giving value to waste, which is an initiative of the President of Republic of Mozambique. This Presidential initiative aims to increase the amount of waste which is being reused, recycled and/or treated sustainably in the country.

This appreciation will create a favorable regulatory and financial environment for the promotion of:

1) Investments in sustainable waste treatment and recycling infrastructure;
2) Establishment of sustainable waste value chains to strengthen recovery, recycling and other forms of waste recovery in municipalities to be covered by the initiative.

In the first phase (2021-2026) implementation of NAMA for Waste, it is estimated that around 803,248 Ton of CO_2eq will be reduced, and 2,785,610 Ton CO_2eq by 2030. The co-benefits of sustainable development that NAMA is expected to bring to the country, include:

1. Policy reforms;
2. Strengthening municipal regulations for the sustainable treatment of waste;
3. Operationalization of the Extended Producer Responsibility Regulation with a focus on the introduction of the Environmental Tax on Packaging;
4. Environmental benefits;
5. 775,9 thousand tons of urban solid waste treated in a sustainable manner, through recycling, composting and safe disposal in landfills in the first phase (2021-2026) and 2,255.1 thousand tons by 2030.

- ***Social benefits***

a) 695 direct jobs created;
b) 4,450 Indirect jobs created.

4.4.4. Sustainable and low-carbon agriculture and livestock development

The Sustainable Agriculture & Livestock low carbon development is a NAMA idea proposal that was developed with FAO support to compete in the NAMA Facility's 6th NAMA proposal submission cycle which seeking funding for formulation. With this proposal, the country will benefit from the resources in the NAMA Facility to implement one of the actions foreseen in the NDC of Mozambique 2020 – 2025, as well as in the NCCAMS and other strategies, policies and plans in the agriculture sector.

This NAMA is intended to solve the problems facing the livestock sector, with the increase in the animal population, with emphasis on cattle. The country has about 1,914,498 cattle raised in extensive systems with a carrying capacity of 7ha/unit/year, which does not respect the male/female ratio. These cattle contribute with CH_4 emissions from enteric fermentation and manure as well as emissions from degraded pastures resulting from overgrazing.

This NAMA includes the following components:

(i) Sustainable cattle management, reducing the consumption of natural pasture by 50%;
(ii) Transfer of improved agricultural technologies based on low carbon development (use of sustainable practices through the integration of conservation agriculture, livestock and forests);
(iii) Development of the meat value chain, using low-emission systems, including the use of renewable energy sources throughout the chain;
(iv) Development of supplementation and food and nutrition security for livestock.

In the preliminary analysis, co-benefits of NAMA were identified for direct users - family sector livestock farmers - and other actors involved. Regarding livestock farmers in the NAMA implementation area (Maputo, Gaza, Inhambane, Manica and Tete provinces) who have livestock as a source of wealth, without, however, being a source of family income, the following benefits were identified:

- Increase in family income with the extraction of steers for the marketing and sale of soy and corn, through program contracts with small feed and meat processing plants and its derivatives to be installed within the scope of NAMA;
- Increased employment through the development of the meat, soy and corn value chain;
- Promotion of jobs as a result of the use of renewable energy sources in the meat, soy and corn value chain.

Other benefits expected from this NAMA are:

- Institutional technical strengthening for better monitoring of the initiative in order to respond to MRV's challenges;
- Organization of livestock farmers into associations;
- Training of livestock farmers;
- Development of infrastructural, technological and technical capacity for the processing and conservation of meat and its derivatives;
- Development of feed production, storage and processing capacity;
- Market guarantee;
- Reduction of pre-mix import costs for feed production;
- Contribute to the collection of data to carry out research with an emphasis on the development of local emission factors to be used in national GHG inventories.

4.5. Reduction of GHG Emissions

Preliminary estimates show that:

- Within the scope of Mozambique's NDC, the country expects to reduce between 2020 and 2025, 30.19 Mega Ton of CO_2eq;

- It is estimated that NAMA will contribute about 12 percent of the reductions set out in the NDC;
- Emissions estimates for a head of cattle are around 140g of CH_4 per day (FAPE and Gree Me – Fabio Reynol). In Mozambique, where there are about 1,914,498 heads (PNISA, 2015) and assuming that NAMA will extract 30% of these heads, we will have 268,029g of CH_4;
- The use of renewable energy sources will also promote low emission development in the livestock sector;
- It is recommended to promote agro-forestry systems in the production of soy and corn, where possible.

4.6. Experience in reducing emissions in the context of carbon market projects

In the period 2010 – 2016, eight carbon projects were registered in the country: four project were registered under the UNFCCC's Clean Development Mechanism, three projects under the Gold Standard and one project was registered under both schemes. Upon registration, the projects estimated that they would generate over 8 million carbon credits over their lifetime, equivalent to an emission reduction of over 8 million ton CO_2. The projects were estimated to lead to an emission reduction of 1.1 million ton CO_2 in the period 2010 – 2016.

Table 4.5: Carbon projects registered during the period 2010-2016

Carbon Standard	Project title	Registration date	Sector	Estimated carbon credits (2010-2016)	Issued carbon credits
CDM	Cimentos de Mozambique - Matola Gas Company Fuel Switch Project	rejected	Fuel switch	259,155	-
CDM	New gas fired power plant at Ressano Garcia	16/11/2016	On-grid energy	-[5]	-
CDM	Niassa Reforestation Project	14/01/2014	Forestry	78,391	-
CDM - POA	Off-grid renewable energy for rural electrification in Mozambique managed by FUNAE	5/5/2016	Off-grid energy	4,857	-
GS	Improved Kitchen Regimes : Improved Cook Stoves In Chamanculo C, Maputo	23/02/2015	Cook stoves	28,368	19,404

[5] The project was only projected to start issuing carbon credits in 2017

	(Mozambique)				
GS	Improved Cook Stoves In Chamanculo C, Maputo (Mozambique), Phase II	29/03/2016	Cook stoves	24,367	16,464
GS	Improved Cook Stoves In Chamanculo C, Maputo (Mozambique), Phase III	29/03/2016	Cook stoves	22,584	13,798
GS+CDM	Cleanstar Mozambique - Maputo Ethanol Cookstove And Cooking Fuel Project 1	5/4/2013	Cook stoves	721,808	-
Total				1,139,530	49,666

The first carbon credits in Mozambique were issued by the Gold Standard in 2015 for a project on improved cook stoves. In total, 49 666 credits were issued in the period 2010 – 2016, equivalent to an emission reduction of 49 666 tCO_2. While projects were registered in the off-grid and on-grid electricity sector, including a project on gas-fired power generation, and for reforestation, all issued carbon credits in the period 2010 – 2016 were for projects related to clean cooking.

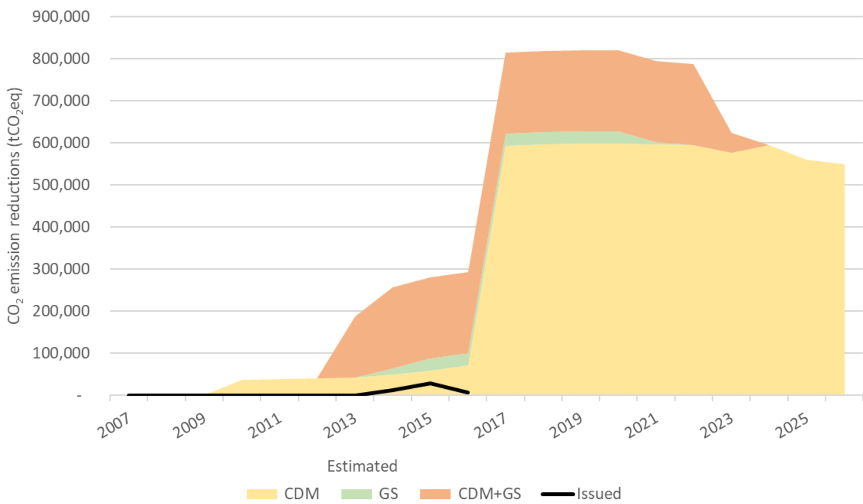


Figure 4.6: Estimated and issued carbon credits for projects registered in the period 2010-2016[6]

As can be seen in the chart above, the mitigation potential associated with projects registered in the context of carbon markets in Mozambique is quite high. However, the level

[6] The sharp increase in the estimated emission reductions from 2017 onwards is based on the registration of the CDM project "New gas fired power plant at Ressano Garcia" which was projected to start generating 541,610 carbon credits from 2017 onwards

of verified emissions reductions that led to the issuance of carbon credits is almost negligible compared to the full potential of the projects. Mozambique will investigate with further depth, in the context of preparation of the subsequent BUR and BTRs the status of implementation of such projects and whether or not emission reductions have been taking place beyond those formally verified and issued in accordance with the relevant carbon market mechanisms rules.

4.7. Reduced Emissions from Deforestation and Forest Degradation – REDD+

The National REDD+ Strategy

The national REDD+ strategy was finalized and approved by the government in 2016 with the objective to conserve wooded areas, promote sustainable development, and to reduce deforestation by enhancing forest resilience to climate change, all with integrated approach to rural development. This strategy also aims to increase carbon stocks by reducing emissions of 170MtCO_2e per year and restore 1 million hectares of forests until 2030.

The national REDD+ strategy address strategic actions to tackle deforestation and forest degradation, considering the commercial agriculture, shifting agriculture, extraction of timber products, production of firewood and charcoal, urban expansion, mining and livestock as the drivers of deforestation and forest degradation.

The national REDD+ strategy has six strategic pillars: (i) governance; (ii) sustainable agriculture; (iii) alternative sources of energy; (iv) protection of conservation areas; (v) sustainable forest management; and (vi) restoration of degraded forests and forest plantations.

The national REDD+ strategy document is available at https://www.fnds.gov.mz/index.php/pt/documentos/publicacoes/estrategia-nacional-do-redd

The Safeguard Instruments

To support the implementation of the National REDD+ Strategy, a Social and Environmental Strategic Assessment (SESA), was produced. The objective of the Strategic Environmental and Social Assessment (SESA) for the REDD+ National Strategy is to integrate key environmental and social considerations in the design and actual establishment of forest development initiatives, considering a long-term perspective in which integrated rural development and improved wealth and well-being of rural communities and the country in general are based on the sustainable use of natural resources, particularly land and forests.

The SESA identifies priority environmental and social considerations to guide design, implementation and operation of forest development and investment programs. It establishes the legal, institutional and governance framework within which such programs should take place. The SESA is also anchored in long-term economic and social development objectives, and sets a strategic framework for individual forest development programs. It identifies priority environmental and social considerations that are important at national level.

With a focus on forest development and improved and sustainable forest management, more specifically the objective of the SESA is to (i) promote the harmonization of the forest, agriculture, energy and rural development specific strategies and policies in order to support the integration of sustainable resource management and use in forest and rural development planning processes; (ii) contribute to streamlining forests, agriculture, energy and rural development in the long-term integrated development planning for sustainable economic growth and poverty reduction; (iii) identify environmental, social and local economy investment opportunities, and promote environmentally sustainable and socially responsible development; and (iv) support the understanding and inclusion of priority environmental and social considerations in the preparation of forest investment programs that will stem from the country's REDD+ Strategy.

The SESA document is available at https://www.fnds.gov.mz/index.php/pt/component/edocman/sesa-for-redd-strategy-mozambique-october-30/download

The Results

Mozambique's deforestation rate has reached an all-time low since it was monitored (2003): in 2016 just over 50,000ha were deforested in the country, compared to around 230,000ha in 2003 and 360,000ha in 2010.

Between 2014 and 2016 alone, the reduction in the rate of deforestation avoided the emission of 78.8kt CO_2e into the atmosphere, which in itself constitutes an extremely ambitious contribution by Mozambique to the global reduction of GHG emissions.

The 2016 values represent a reduction in this rate of about 85% when compared to 2010. Since that year, the deforestation rate has been falling sharply (with a brief exception in 2012 for unidentified reasons), which demonstrates a success that the country is very proud of in the definition and implementation of policies and instruments to combat deforestation.

Mozambique believes that this result is due to the combination of a wide range of intersectoral measures, including poverty reduction, which the REDD+ Framework adopted at the Warsaw COP gave substance and consistency. However, the country recognizes that the drivers that underlie deforestation and the challenges facing the implementation of measures that oppose them are strong and, as such, we will not sit back in the face of the excellent results we have achieved so far. The country now needs to strengthen its capacity to continue to promote the implementation of measures to combat deforestation and to continue its monitoring in order to identify and timely correct any changes in this course and for this it will continue to count on the support of our international partners.

Figure 4.7 shows the trend of emissions associated with deforestation, which, as can be seen, shows the significant downward trend described in the paragraphs above.

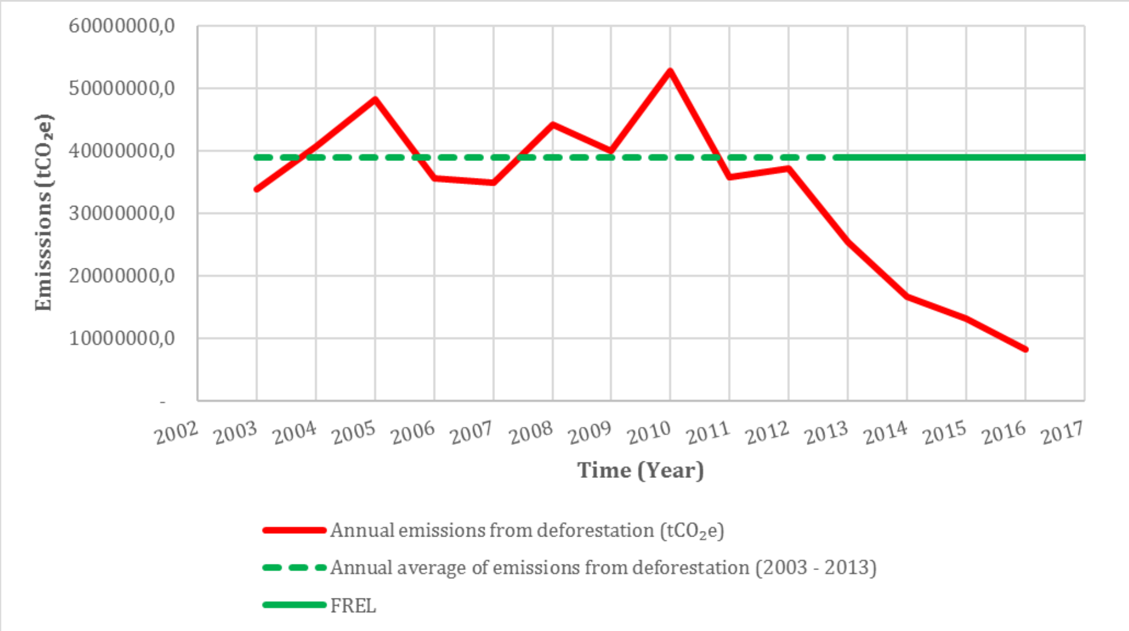


Figure 4.7 – Emissions associated with deforestation

More detailled information on the results of REDD+ can be found in the REDD+ Technical Anex being submitted together with the first BUR of Mozambique.

5. Chapter 5: Other information relevant to the convention

5.1. *Technology transfer*

Technology transfer is an overarching theme in policy discussions on climate change and it is identified as a way to mitigate GHG emissions and adapt to the impacts of climate change (UNFCCC[7], articles 4, 9 and 11). It is also considered as a broad set of processes that encompass the flows of knowledge (know-how), experience and resources to mitigate and adapt to climate change amongst different stakeholders such as governments, private sector entities, financial institutions, NGOs and research / education institutions (IPCC, 2000a).

Technology transfer plays a key role in the effective global response to the challenge of climate change. As technology is a source of emissions, achieving global GHG reduction requires innovation to make current technologies cleaner and climate-resilient. GHG emissions in developing countries are increasing with population and economic growth. Therefore, the rapid transfer of technologies to developing countries that help, preferably, to monitor, limit or adapt to climate change, without harming local economic development is of extreme urgency (IPCC, 2007).

The GovM, through the Ministry of Science, Technology and Higher Education (MCTES), acting as manager of the science and technology portfolio, guarantees support in the assimilation and appropriation of specific requirements and performance of technologies, as well as ensuring the mechanisms and the technology and knowledge transfer platform (know-how). For instance, the GovM have designated the MCTES as the Designated National Entity for the UNFCCC Technological Mechanism.

5.1.1. National Technology Needs Assessment (TNA)

Mozambique conducted its first Technology Needs Assessment (TNA) in 2015-2016. The diagram below (Figure 5.1) shows the organizational structure and institutional arrangement established and the stakeholders engaged in the implementation of TNA process in Mozambique. This assessment identified priority technologies to respond to climate change in the sectors of: (i) Infrastructure and coastal zone and (ii) Agriculture, for adaptation; (iii) Energy and (iv) Waste, for mitigation.

[7] United Nations Framework Convention on Climate Change

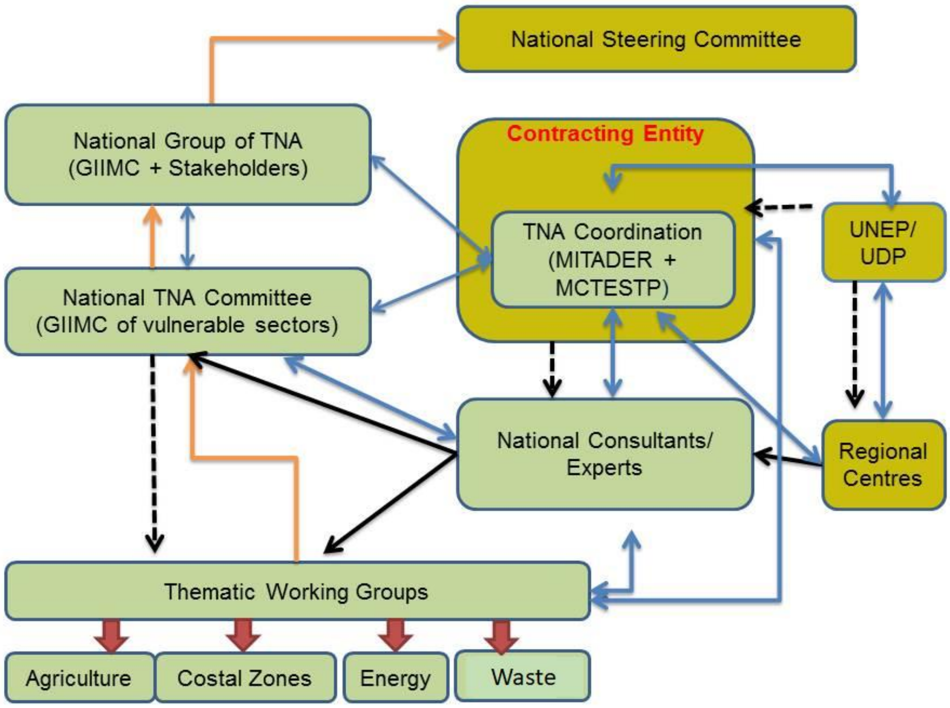


Figure 5.1: Organizational structure created in 2015-2016 for the implementation of the TNA project in Mozambique.

The implementation of this project aimed to trigger the process of assessment of technological needs leading to filling gaps in the field of climate change technologies identified in the National Adaptation Strategy for Adaptation and Mitigation of Climate Change. The TNA project was implemented in three stages, namely (i) prioritization of technologies; (i) analysis of barriers and identification of enabling structure; and (iii) design of the Action Plan for Priority Technologies and identification of Project Ideas. Therefore, nine reports were produced in connection with the implementation process, namely:

(1) Technological Needs Assessment Report - Prioritization of Technologies: Coastal Zones (TNA [8], 2016);
(2) Technological Needs Assessment Report for Adaptation to Climate Change for the Agriculture Sector in Mozambique (TNA [9], 2018);
(3) Technological needs assessment report: electricity generation and urban solid waste management (TNA [10], 2017);

[8] https://unfccc.int/ttclear/misc_/StaticFiles/gnwoerk_static/TNA_key_doc/8109688a2897482aabf97fe85604ee1c/96e9404096d744148a0d1927b12f7448.pdf 1

[9] https://unfccc.int/ttclear/misc_/StaticFiles/gnwoerk_static/TNA_key_doc/77a930f6e1644d7c828c03a3abdc129a/761b429db3124dcbb5ec6c01df401b9d.pdf

[10] https://unfccc.int/ttclear/misc_/StaticFiles/gnwoerk_static/TNA_key_doc/e2178df3bd664737890e39d352ae8bef/517b03f80b324698b6b8f4a488fca058.pdf

(4) Report on the analysis of barriers and identification of the favorable structure – for the transfer of technologies to adapt to climate change – coastal zones (BAEF [11], 2017);
(5) Report on the Analysis of Barriers and Favorable Environment for the transfer and diffusion of technologies in the Agriculture Sector in Mozambique (BAEF [12], 2018);
(6) Report analysis of barriers to the transfer and diffusion of climate change mitigation technologies and respective enabling framework: Technologies for Electricity Generation and MSW Management and Treatment (BAEF [13], 2017);
(7) Report on the technological action plan – for the transfer of technologies to adapt to climate change in Mozambique – coastal zones: *Technological Action Plan for Mozambique's Adaptation to Climate Change – Coastal Zones* (TAP [14], 2018);
(8) Report on the Action Plan and Ideas for Adaptation to Climate Change Projects for the Agriculture Sector (TAP [15], 2018);
(9) Technological action plan report and project ideas: technologies for electricity generation and urban solid waste management and treatment (TAP [16], 2018).

The summarized actions in these reports are in line with the efforts taken by the GovM to the Convention, aiming to determine the country's technological priorities able to respond to climate change and, consequently, support national sustainable development as well as to improve national capacity and facilitate the implementation of TNA priorities.

5.1.2. Technological needs of climate change in Mozambique

The selection of priority sectors for the technological needs assessment exercise was based on the commitments made by the country, through the Nationally Determined Contribution (NDC). Indeed, the sectors of energy, agriculture, forestry and land use as well as municipal solid waste were indicated in the NDC as those in which the national commitment will be made through GHG mitigation, while infrastructure and coastal sectors including agriculture, will be focused on adaptation. These actions are conducive to increasing resilience and climate risk reduction underway and planned for the post-2020 period (NDC).

[11] https://unfccc.int/ttclear/misc_/StaticFiles/gnwoerk_static/TNA_key_doc/dd2063cbf73f4cdf8cdfaf6df041fc58/5a21e05e5bb74d1eaebcecb94820ddd2.pdf
[12] https://unfccc.int/ttclear/misc_/StaticFiles/gnwoerk_static/TNA_key_doc/905aff460d2f432086810952caf5fc1e/b913747545b341a99f6acc4994377b7f.pdf
[13] https://unfccc.int/ttclear/misc_/StaticFiles/gnwoerk_static/TNA_key_doc/bb3d33600f064afaa992914c59e3540d/ac2a764c0d4f479c8ed0b6994f7d1f28.pdf
[14] https://unfccc.int/ttclear/misc_/StaticFiles/gnwoerk_static/TNA_key_doc/5e2e2d9f76c04e05805b27b82bfb3e6e/24c5cca1433645cda98a8c31c4c60471.pdf
[15] https://unfccc.int/ttclear/misc_/StaticFiles/gnwoerk_static/TNA_key_doc/c0538c63479143f387e3596d544e5e06/e6941b092b014c96b5c3fe2a18b8b632.pdf
[16] https://unfccc.int/ttclear/misc_/StaticFiles/gnwoerk_static/TNA_key_doc/5a064530d9bf457f9326a52a5f8c433c/0cddaf49f900432ea0babbe051ebe7d0.pdf

The exercise of identifying technological options was based on various sources and criteria and the sociocultural context (for more details refer to TNA reports) taking into account the existence of GHG emissions, climate vulnerability, increased resilience, consistency with strategies, programs, policies and national development priorities, contribution to sustainable development, need for infrastructure, competitive advantages, operation and maintenance costs, direct socio-economic impact (positive), technological maturity, availability of technology in the market, human capacity, protection of resources natural and environmental and biodiversity, promoting ecosystem services and private investment, reducing poverty and inequalities, generating income, creating employment and improving income. The weights associated with each criterion were determined by the stakeholders involved in the process.

The TNA process in Mozambique produced a total of 52 technologies (Table 5.1) related to climate change mitigation and/or adaptation. Of these, fourteen (14) are from coastal zones, oriented towards adaptation to climate change; fourteen (14) are from agriculture to adapt to climate change; fifteen (15) are from electricity generation to mitigate climate change and eight (8) are from management and treatment of municipal solid waste to mitigate climate change. Table 5.2 shows the prioritized technologies options. The scores made were intended to give a general idea of the classification used for this prioritization of technologies.

Thus, the prioritised technologies for the Coastal Zone and Infrastructure sector were: 1) flood early warning system, (2) beach nourishment, and (3) mangrove restoration, aimed to reduce the vulnerability of communities and infrastructure in Mozambique. Prioritized technologies address the main pressure factors that contribute to the vulnerability of coastal areas and infrastructure, by promoting the protection of environmental resources and natural assets (beach nourishment), by promoting ecosystem services (mangrove restoration), and by reducing vulnerability of communities (early warning system).

Prioritised technologies for the Agriculture Sector were: (1) production and conservation of seeds and grains and promotion of low-cost storage systems (2) conservation agriculture and (3) drilling holes for multiple uses. After presenting the results by the Multiple Analysis Criteria (MCA)[17] to the Technical Council of the former Ministry of Agriculture and Food Security, it was recommended to give priority to “rainwater harvesting and conservation” as the prioritised technology for the resilience of the agricultural sector. Given that only three technologies were to be used in the Barrier Analysis (BA) and in the preparation of the Technological Action Plan (TAP), it was decided to replace “multipurpose drilling holes” option with “rainwater harvesting and conservation” (Report TNA-Agricultura, 2018). Therefore, “rainwater harvesting and conservation” became the third prioritised technology for the BA and TAP purposes (Table 5.1-5.2). It is important to mention that “conservation

[17]https://unfccc.int/files/adaptation/methodologies_for/vulnerability_and_adaptation/application/pdf/multicriteria_analysis__mca_pdf.pdf

agriculture” is the current adaptation technology option that is being promoted in the country.

The technologies selected for the Electricity Generation Subsector were: (1) Solar Photovoltaic Systems (Regular Scale, 150 MW), (2) Natural Gas Combined-Cycle (NGCC, 650 MW) and (3) Regular scale Hydropower Turbines (600 MW), amongst the diverse sources available for electricity generation in Mozambique (Table 5.1-5.2). These technologies are part of the National Energy Policy given their contribution to the diversification of the energy matrix and the fact that they make use of the country's abundant resources, including their high potential to mitigate GHG emissions. Within the scope of national development efforts, the country is already on the route of Natural Gas Thermal Power Plant technology to make use of the abundant natural gas in the national subsoil, which also contribute to the mitigation of national GHG emissions. Other national sources of electricity generation no less important include those from wind, coal and biomass, considered important for use in the rural and peri-urban domestic context.

Regarding to the MSW management sector, the three prioritized technologies were: (1) the Sanitary Landfill with Biogas production, (2) the Sanitary Landfill Biogas Production Bioreactor and (3) Pyrolysis (Table 5.1-5.2). These technologies have the particularity of allowing the treatment not only of MSW but also other types of waste as long as they are organic, with a view to producing electricity and reducing the volume of waste deposited. Modern MSW management is particularly important for Mozambique, as its technologies will serve as a highly profitable MSW management model and contribute to support GHG mitigation in the country. Nevertheless, it is recommended that for places where the technologies prioritised above cannot be implemented, composting or incineration should be considered as acceptable alternatives.

Table 5.1: The technological options identified and prioritised in the first Technology Needs Assessment (TNA-2018), by type of response (adaptation and/or mitigation) and activity sector

# Options	Coastal zone and Infrastructure technologies for climate change adaptation	Score	Agricultural Technologies for Climate Change Adaption	Score	Electricity generation technologies for climate change mitigation	Score	Municipal solid waste management and treatment technologies for climate change mitigation	Score
1	Flood Early Warning System	90.8	Production and promotion of low-cost improved storage systems for grain and seed	81	Regular scale Photovoltaic Solar Systems (150 MW)	76	Sanitary Landfill with Biogas Production	81
2	Beach Nourishment	87.5	Conservation agriculture	80	Natural Gas Conventional Combined Cycle (NGCC, 600 MW)	66	Biogas Production Bioreactor Sanitary Landfill	80
3	Mangrove Restoration	85.8	Rainwater harvesting and conservation	73	Regular Hydraulic Turbines	63	Pyrolysis	66
4	Dikes	81.1	Drilling boreholes for multiple uses	74	Medium Solar Photovoltaic Systems (20 MW)	61	Potting Compost	59
5	Dams and Weirs	72.5	Crop diversification	72	Natural gas combined-cycle (NGCC) turbines with carbon capture and storage (CCS)	60	Gasification	56
6	Flood Mapping	66	Production and conservation of forage and livestock	68	Advanced Natural Gas-fired Combined-	60	Anaerobic Biodigestion	54

# Options	Coastal zone and Infrastructure technologies for climate change adaptation	Score	Agricultural Technologies for Climate Change Adaption	Score	Electricity generation technologies for climate change mitigation	Score	Municipal solid waste management and treatment technologies for climate change mitigation	Score
			supplementation		Cycle (ANGCC)			
7	Vegetated and reinforced Dunes	64.5	Agro-forestry, pasture and mix cropping systems	68	Hydropower (Small-scale Hydro power Plants)	56	Incineration	46
8	Breakwaters	64.2	Greenhouse vegetable production	65	Biomass Bubbling and Fluidized Bed Systems	48	Plasma Gasification	33
9	Coastal Retreat	60.1	Drip and sprinker irrigation	56	Onshore Wind Turbines	43		
10	Steep roads	51.5	Education and awareness campaigns for adaptation to climate change	35	Integrated Coal Gasification Combined Cycle (IGCC) double unit Power Plant	40		
11	Displacement of the population	37.6	Strengthening crop and animal breeding programmes for climate change adaptation	32	Offshore Wind Turbines (400 MW)	38		
12	Floating Agriculture	32.7	Upscaling the implementation of Integrated Pest Management (IPM) technologies to control pests and diseases of major economic importance	27	Advanced Coal Spray Systems with Carbon dioxide Capture and Storage (CCS)	34		

# Options	Coastal zone and Infrastructure technologies for climate change adaptation	Score	Agricultural Technologies for Climate Change Adaption	Score	Electricity generation technologies for climate change mitigation	Score	Municipal solid waste management and treatment technologies for climate change mitigation	Score
13	Aterros	14.8	Improvement of agrometeorological and agro-hydrological network and early warning system and dissemination of information	23	Advanced Coal Spray Systems with no Carbon dioxide Capture and Storage (n/CCS)	32		
14	Flood isolation	12.6	Farmer field schools	20	Integrated Coal Gasification Combined Cycle (IGCC) with Carbon dioxide Capture and Storage (CCS)	31		
15					Integrated Biomass Gasification Combined Cycle (B-IGCC)	1		
	Total technology options: **14**		Total technology options: **14**		Total technology options: **15**		Total technology options: **8**	

Table 5.2: The technological options identified and prioritised in the first Technology Needs Assessment (TNA-2016), by type of response (adaptation and/or mitigation) and activity sector. This prioritisation was based on the analysis of various criteria out of 52 options considered.

Response type	Sector	Subsector	Technological Options	Total score (% of max possible score)
Adaptation	Coastal Zone and Infrastructure		Flood early warning system	90.8
			Beach nourishment	87.5
			Mangrove Restoration	85.8
	Agriculture		Production and promotion of low-cost improved storage systems for grain and seed	81.0
			Conservation agriculture	80.0
			Rainwater harvesting and conservation	74.0
Mitigation	Energy	Electricity generation	Regular scale Photovoltaic Solar Systems (150 MW)	~78.0
			Natural Gas Conventional Combined Cycle (NGCC, 650MW)	~67.0
			Regular scale Hydraulic/Hydropower Turbines (500MW)	~63.0
	Waste	Municipal solid waste	Sanitary Landfill with Biogas Production	~81.5
			Biogas Production Bioreactor Sanitary Landfill	~80.0
			Pyrolysis	~66.0

5.1.3. Alignment of prioritised technologies with relevant national plans, policies and strategies

The prioritisation process of the technology options took in account the alignment with the following national plans, policy and strategic documents: (i) Nationally Determined Contribution (NDC); (ii) Mozambique Government five-year Plan (PQG); (iii) National Climate Change Adaptation and Mitigation Strategy (NCCAMS); (iv) Disaster Risk Reduction Master Plan (PDRRD); (v) Disaster Management Law (LGC); (vi) National Development Strategy (ENDE); (vii) New and Renewable Energy Development Strategy (EDENR); (viii) National Biofuels Policy and Strategy (PEB), among others (Tables 5.3 – 5.6). Tables 5.7 – 5.10 present the purpose, benefits and target of technology diffusion, technology scale of implementation and cost estimation, and the main barriers encountered in the diffusion-transfer process of each prioritised technology option.

Table 5.3: Technologies identified and prioritised in the TNA-2016 for adaptation response in the Coastal Zones and Infrastructure Sector including their alignment with relevant national plans, policies and strategic documents.

Sector	Technology options	NDC	PGQ 2020 - 2024	Other sources (Policies, strategies, etc)
Coastal Zone and Infrastructure	Flood early warning system	Sectoral Plan for Flood early warning system (SAP) (Sec. 4.6.1.1.1, 4.6.1.1.1.2 e pp 244)	✓	NCCAMS, ENDE, PDRRD, LGC.
	Beach nourishment	Sectoral Plan for Infrastructure, Urban Areas, Other Settlements and Tourism and Coastal Areas (Sec. 4.6.1.8.2, 4.6.1.8.1.2, 4.6.1.8.2.2, 4.6.1.8.2.3, 4.6.1.8.2.4 & 4.6.1.8.2.5)	✓	NCCAMS, ENDE, PDRRD, LGC.
	Mangrove Restoration	Sectoral Plan for Infrastructure, Urban Areas, Other Settlements, Tourism and Coastal Areas (Sec. 4.6.1.8.2, 4.6.1.8.1.2, 4.6.1.8.2.2, 4.6.1.8.2.3, 4.6.1.8.2.4 & 4.6.1.8.2.5)	✓	NCCAMS, ENDE, PDRRD, LGC.

Table 5.4: Technologies identified and prioritised in the TNA-2016 for adaptation response in the Agriculture Sector, including their alignment with relevant national plans, policies and strategic documents.

Sector	Technology options	NDC	PGQ 2020 - 2024	Other sources (Policies, strategies,etc)
Agriculture	Production and promotion of low-cost improved storage systems for grain and Seed	Sectorial Plan for Agriculture, Forestry and Fisheries (Sec. nova, pp 179)	✓	NCCAMS, ENDE
	Conservation Agriculture	Sectorial Plan for Water Resources (Sec. 4.6.2.3.1.1)	✓	NCCAMS, ENDE

	Rainwater harvesting and conservation	Sectorial Plan for Water Resources (Sec. 4.6.1.2.2 & Sec. 4.6.1.2.4)	✓	Priority recommended by the Technical Council of the Ministry of Agriculture and Food Security NCCAMS, ENDE

Table 5.5: Technologies identified and prioritised in the TNA-2016 for adaptation response in the Agriculture Sector, including their alignment with relevant national plans, policies and strategic documents.

Sector	Technology options	NDC	PGQ 2020 - 2024	Other sources (Policies, strategies,etc)
Agriculture	Production and promotion of low-cost improved storage systems for grain and Seed	Sectorial Plan for Agriculture, Forestry and Fisheries (Sec. nova, pp 179)	✓	NCCAMS, ENDE
	Conservation Agriculture	Sectorial Plan for Water Resources (Sec. 4.6.2.3.1.1)	✓	NCCAMS, ENDE
	Rainwater harvesting and conservation	Sectorial Plan for Water Resources (Sec. 4.6.1.2.2 & Sec. 4.6.1.2.4)	✓	Priority recommended by the Technical Council of the Ministry of Agriculture and Food Security NCCAMS, ENDE

Table 5.6: Technologies identified and prioritized in the TNA-2016 for the mitigation response to in the Energy Sector including their alignment with relevant national plans, policies and strategic documents.

Sector/ Subsector	Technology options	NDC	PGQ 2020 - 2024	Other sources (Policies, strategies,etc)
Energy / Electricity generation	Regular scale Photovoltaic Solar Systems (150 MW)	Sectoral Plan for Energy (Sec. 4.6.2.1.1, pp 201- Improving access to renewable energies)	✓	SDG #7.2, EDENR, ENE (Energy for all by 2030, pp23 Sec. 5)

Sector/ Subsector	Technology options	NDC	PGQ 2020 - 2024	Other sources (Policies, strategies,etc)
	Natural Gas Conventional Combined Cycle (NGCC, 650MW)	Sectoral Plan for Energy (Sec., pp 225-Massification of Natural Gas Use)	✓	ODS SDG #7.2, EDENR, ENE (Energy for all by 2030, pp23 Sec. 5)
	Regular scale Hydraulic/Hyropower Turbines (500MW)		✓	SDG #7.2, EDENR, ENE (Energy for all by 2030, pp23 Sec. 5)

Table 5.7: Technologies identified and prioritized in the TNA-2016 for the mitigation response in the Waste Sector including their alignment with relevant national plans, policies and strategic documents.

Sector/ Subsector	Technology options	NDC	PGQ 2020 - 2024	Other sources (Policies, strategies,etc)
Waste / Municipal Solid Waste	Sanitary Landfill with Biogas Production	Sectoral Plan for waste (Sec. 4.6.2.4.1 pp 257 - Manage and recover waste)	✓	SDG # 7.a; PEB; NAMA for waste, NCCAMS, PEB
	Biogas Production Bioreactor Sanitary Landfill	Sectoral Plan for waste (Sec. 4.6.2.4.1 pp 257 - Manage and recover waste)	✓	PEB, NAMA for waste, NCCAMS,
	Pyrolysis	Sectoral Plan for waste (Sec. 4.6.2.4.1 pp 257 - Manage and recover waste)	✓	PEB, ENE; NAMA for waste, NCCAMS.

Table 5.8: Prioritised adaptation technology options along with their purpose, benefits, target diffusion, scale and cost estimation, and the main barriers in the Coastal Zone and Infrastructure Sector.

Sector	Technology options	Technology description	Target and benefits of technology diffusion	Scale of implementation/estimated technology costs (USD)	Technical and economic barriers	Comments
Coastal Zone and Infrastructure	Flood early warning system	Prior detection of the occurrence of flood/flood risk events, allowing the public to be warned in advance about its occurrence, so that actions can be taken to reduce the adverse effects of this event. As such, the primary objective of an early warning system for the occurrence of flood/inundation hazard events is to reduce exposure to these hazards in coastal areas.	Contribute through timely given information on the occurrence of floods, as well as the mapping of flood/inundation risk areas to reduce the loss of property in communities, and improve local planning and, for instance, the quality of life, and poverty reduction. The forecast information, when shared in time, also contributes to	Increase (by 2030) 50% coverage of the Flood Mapping and Early Warning System, and the percentage of populations with information and knowledge about the appropriate actions to be taken to reduce flood risks. $6,786,000	Insufficient network of meteorological, oceanographic and hydrological stations; absence of an efficient data transmission system; limitation of modeling results; limitation of technical capacity. High capital investment costs; absence of a post-project funding mechanism.	Technology contained in the Technological Action Plan (TAP). Technology prioritized using Multiple Analysis Criteria (MCA). The action plan for this technology will take 9 years.

Sector	Technology options	Technology description	Target and benefits of technology diffusion	Scale of implementation/estimated technology costs (USD)	Technical and economic barriers	Comments
			decision making aimed at improving the economic performance of the local community and the country at large.			
Coastal Zone and Infrastructure	Beach nourishment	It is a soft engineering technology for coastal protection that involves the artificial addition of adjustable quality of sediments to the area of the beach that has a sediment deficit. Periodic replacements or additions of sedimentary material on the	Contribute, through the expansion of beaches, to boost tourism activities and develop new poles of resort attraction in new areas, and, therefore, encourage the development of the agricultural, fisheries and infrastructure	Implement the beach nourishment program on a national scale in 4 coastal districts or municipalities, which have the most degraded (eroded) beaches, and/or the most vulnerable coastal zone (by 2030), in accordance with the target established in the analysis report of barriers, contributing to increased coastal protection, and thereby reducing exposure to	Limited technical capacity to deal with problems linked to coastal zones. High costs for feasibility studies and beach nourishment implementation; lack of clarity on an integrated view of coastal	Technology contained in TAP. Prioritized technology using MCA. The action plan for this technology will take 18 years

Sector	Technology options	Technology description	Target and benefits of technology diffusion	Scale of implementation/estimated technology costs (USD)	Technical and economic barriers	Comments
		beaches are necessary to maintain the system's efficiency. Initially it was used in response to shoreline erosion, however it can also be used to reduce the effect of floods/inundações. It is generally used on sandy beaches, however, it can be applied in the replacement of other beach material that is not sand. The replenished material keeps the beach at a width that helps provide coastal protection.	sectors, among others. Disseminate the importance of the different options for coastal management for future generations, ensuring respect for the preservation of nature and the importance of multi-sector integration in the coastal zone. Improve the efficiency of the sediment deposition mechanism from dredging, thus contributing to	vulnerability in the coastal zone of Mozambique. US$ 102,798,000	zone problems.	

Sector	Technology options	Technology description	Target and benefits of technology diffusion	Scale of implementation/estimated technology costs (USD)	Technical and economic barriers	Comments
			the creation of synergies between the coastal protection and transport sector.			
Coastal Zone and Infrastructure	Mangrove Restoration	It is the restoration of a damaged state (both by human activities and natural processes) of the global wetland function, where a mangrove forest previously existed in its normal or less damaged state. Restored mangroves or wetlands are of importance because they provide essential functions in terms of managing coastal flooding and	Make use of the potential of current legislation and existing infrastructure to implement and disseminate the technology. Through it, poverty is reduced, as the restored mangroves provide a favorable environment for the development of species in	Increase of restored mangrove areas up to 50,000 hectares by 2030, at a rate of 2500 hectares per year, which will represent a reduction of deforested area of 700 hectares per year. Also improve the functionality of coastal ecosystems, contributing to increased coastal protection, and thereby reducing exposure and vulnerability in the coastal zone of Mozambique. US$2,631,290.00	Limited technical capacity and knowledge. Lack of budget allocated to natural resource management committees; lack of awareness of the private sector.	Technology contained in TAP. Prioritized technology using MCA. The implementation of the action plan for this technology will take 22 years

Sector	Technology options	Technology description	Target and benefits of technology diffusion	Scale of implementation/estimated technology costs (USD)	Technical and economic barriers	Comments
		erosion. These habitats induce dissipation of wave and tidal energy, and act as natural defenses to retain sedimentary material, thus guaranteeing the movement of land towards the sea.	ecosystems, thus improving the quality of life. The cost/benefit assessment of this restoration revealed that the economic value of the mangroves, which have already been restored, massively contributes to the country's economic performance, through the potential which these resources represent for the local and national economy.			

Table 5.9: Prioritised adaptation technology options along with their purpose, benefits, target diffusion, scale and cost estimation, and the main barriers in the Agriculture Sector.

Sector	Technology options	Technology description	Target and benefits of technology diffusion	Scale of ambition/estimated technology costs (USD)	Technical and economic barriers	Comments
Agriculture	Seed production and conservation and promotion of low-cost improved storage systems for grain and seed	It is an action or activity that can contribute to the resilience of communities to climate change, as it guarantees the availability of good quality seeds. Good quality seeds have vigor that allows them to withstand the pressure caused by the limited availability of water and high temperatures and resist the attack of pests and diseases. The existence of safe, long-term storage facilities ensures that grain supplies are available during periods of drought. It is important to be able to store food after harvest to avoid compulsive selling at	Ensure rapid recovery and resumption of production after crop destruction or loss due to drought, floods and cyclones. Improved low-cost storage systems can contribute to resilience by allowing for storage of grain, keeping it in quantity and quality for populations during and after drought, flood or cyclone. Seed storage, on the other hand, will guarantee the availability of seeds	Farmer associations and communities, research institutions, seed distribution and certification authorities (Seed Department), CTA and some NGOs. $5,216,400	Low quality of certified seeds and low production and productivity of commercialized seeds, low availability of improved seed varieties. High production and transaction costs and therefore lack of financial capacity of seed companies and farmers to purchase improved seeds and storage systems; lack of	Technology contained in TAP. Prioritized technology using MCA. The action plan for this technology will take twelve years.

Sector	Technology options	Technology description	Target and benefits of technology diffusion	Scale of ambition/estimated technology costs (USD)	Technical and economic barriers	Comments
		low prices. Suitable low-cost systems for storing grain and seeds in Mozambique are bag silos, metal silo and polyethylene.	for resumption of production after a poor harvest or crop losses due to droughts, floods and cyclones.		market and access to credit for products.	
Agriculture	Conservation Agriculture	Agricultural system that seeks to conserve soil and water, i.e., conservation of soil organic matter, increase soil water retention and reduction of soil erosion and pollution. This system combines three principles namely: minimal disturbance and permanent ground cover (crop cover or waste cover) and crop rotation or intercropping. It is a suitable technology for arid and semi-arid areas, where soils are poor in organic matter and prone to	Improve substantial investments in research to identify techniques and practices appropriate for different agricultural contexts, demonstrate functional techniques and practices, invest in hiring and training technical personnel who will conduct research, demonstrate and	75% of small-scale farmers living in the arid and semi-arid areas of Gaza, Inhambane, Manica, Zambézia, Tete and Nampula provinces. US$1,322,500	High cost of technology implementation; lack of financial capacity and access to credit for farmers; poor investment in research.	Technology contained in TAP. Prioritized technology using MCA. The action plan for this technology will take 6 years

Sector	Technology options	Technology description	Target and benefits of technology diffusion	Scale of ambition/estimated technology costs (USD)	Technical and economic barriers	Comments
		desertification.	assist farmers. Investment will also be directed towards supporting extension services, capacity building for farmers and raising awareness of farmers and society about CA through the introduction of CA into curricula.			
Agriculture	Rainwater harvesting and conservation	Method used to capture, store and conserve rainwater from roofs and runoff for domestic consumption and agriculture in arid and semi-arid regions. Rainwater harvesting represents a climate change adaptation strategy for people who live subject to great precipitation	Increase drought resilience by providing water for crop irrigation, livestock irrigation and human consumption during periods of lack of precipitation or in areas with low precipitation and/or areas that have	75% of people living in arid and semi-arid regions in Maputo, Gaza, Inhambane, Manica and Tete do Sul provinces US$134,696,050	High preparation, installation and maintenance costs; limited government financial capacity for promotion and farmers to implement the systems; weak local capacity for mapping, building	Technology contained in TAP. Prioritized technology using MCA. The implementation of the action plan for this technology will take 10 years

Sector	Technology options	Technology description	Target and benefits of technology diffusion	Scale of ambition/estimated technology costs (USD)	Technical and economic barriers	Comments
		variability, both for domestic supply and to improve harvesting, livestock and other forms of agriculture.	experienced irregular precipitation. To a small extent, it can also contribute to flood resilience because it will help to reduce excess stormwater runoff.		and maintaining systems and weak private sector involvement	

Table 5.10: Prioritised mitigation technology options along with their purpose, benefits, target diffusion, scale and cost estimation, and the main barriers in the Energy Sector.

Sector/Subsector	Technology options	Technology description	Target and benefits of technology diffusion	(USD) Scale of ambition/estimated technology costs (USD)	Technical and economic barriers	Comments
Energy /Electricity generation	Regular scale Photovoltaic Solar Systems (150 MW)	Solar panels are designed to capture both direct radiation from the sun and diffuse radiation emitted through clouds. Photovoltaic system technologies can be divided into three generations, based on the materials they comprise and their performance. These generally consist of c-Si or thin-film solar modules. The selected system belongs to the first generation and consists of multicrystalline silicone (mc-Si), a well-	1) Increased electricity supply capacity; 2) promote and mitigate greenhouse gas emissions; 3) promote the transfer of photovoltaic technology on a regular scale 4) develop a stable number national experts 5) optimize access to energy.	3 Plants of 150 MW each and knowledge transfer (know-how) to (4-6) national specialist technicians by 2030. US$ 4,006,870,000	Mismatching between sales tariff and production costs; Inability to mobilize funding; Economic recession, national currency inflation and exchange rate instability; Lack of interest from the national bank, high tax and customs fees; Deficit of intensive consumers and apparent inability to adapt the	Technology contained in TAP. Prioritized technology using MCA. The action plan for this technology could be executed in three possible timeframe scenarios: Short Term: 2020-2023 Medium Term: 2024-2028 Long Term: from 2029

Sector/Subsector	Technology options	Technology description	Target and benefits of technology diffusion	(USD) Scale of ambition/estimated technology costs (USD)	Technical and economic barriers	Comments
		established technology in the market, with relatively high efficiency and effective costs. In fact, the majority of the current global photovoltaic generation is about 90% reliant on this crystalline honeycomb technology.			supply to mega-consumers of electricity; State monopoly in electricity trading.	
Electricity generation	Natural Gas Conventional Combined Cycle (NGCC, 650MW)	Combined Cycle electricity generation is a hybrid system that uses the gas power cycle and the steam power cycle simultaneously. The gas power cycle uses the hot gases from burning fuel to drive the gas turbine (Brayton Cycle) and generate electricity. On the other	1) Increased electricity supply capacity; 2) Mitigation of Greenhouse Gas Emissions 3) Transfer of Conventional Combined Cycle Natural Gas Technology 4) Optimization of access to electricity	1) Transfer and implement the technology to produce an additional 3.25 GMW of electricity for the national electricity grid using the country's abundant natural gas, by 2030; 2) develop national internal capacity	Regulated market and state monopoly; Inability to attract investments into the electricity generation sector; Economic recession and national currency inflation; Weak interest of national banks in	Technology contained in TAP. Prioritized technology using MCA. The action plan for this technology could be executed in three possible timeframe

Sector/Subsector	Technology options	Technology description	Target and benefits of technology diffusion	(USD) Scale of ambition/estimated technology costs (USD)	Technical and economic barriers	Comments
		hand, in the steam power cycle (Rankine Cycle), flue gases are used to generate high pressure steam in the boiler. The steam is then channeled to the turbine (steam) where it is driven by steam, generating electricity in the generator connected to it.		$4,000,000,000	the electricity sector; Disincentive tax / customs fees for the import of technological components; Deficit of intensive consumers; Weak capacity of the national electricity transmission and distribution network; Lack of immediate availability of natural gas; Retracting regional market; Natural gas discoveries in	scenarios: Short Term: 2020-2023 Medium Term: 2024-2028 Long Term: from 2029

Sector/Subsector	Technology options	Technology description	Target and benefits of technology diffusion	(USD) Scale of ambition/estimated technology costs (USD)	Technical and economic barriers	Comments
					other East African countries; Natural gas price instability.	
Electricity generation	Regular scale Hydraulic/Hyropower Turbines (500MW)	A hydroelectric plant uses the power of water to produce electricity. This process uses the power of the current of water to move the blades of a turbine that drives an electricity generator. Turbines can be Pelton, for water columns greater than 200m; Francis, for intermediate water columns (between 20 and 200 m) or Kaplan, for low water columns, less than 20 m.	1) Increased electricity supply capacity; 2) Mitigation of Greenhouse Gas Emissions 3) Transfer of Regular Scale Hydroelectric Technology 4) Optimization of access to electricity	1)Implement 2 Hydroelectric Power Plants to produce 1.2 additional GMW of electricity for the national electricity grid, by 2030; 2) develop national internal capacity US$ 4,207,800,000	Inability to mobilize financing for the electricity generation sector; Particularly high investment capital; Weak interest from national banks in the electricity sector; limitation of the national transport, transmission, and distribution network; Disincentive tax and customs fees for the import of	Technology contained in TAP. Prioritized technology using MCA. The action plan for this technology could be executed in three possible timeframe scenarios: Short Term: 2020-2023 Medium Term: 2024-2028

Sector/Subsector	Technology options	Technology description	Target and benefits of technology diffusion	(USD) Scale of ambition/estimated technology costs (USD)	Technical and economic barriers	Comments
					technological components; regional market saturation; (undeclared) monopoly of the state.	Long Term: from 2029

Table 5.11: Prioritised mitigation technology options along with their purpose, benefits, target diffusion, scale and cost estimation, and the main barriers in the Waste Sector.

Subsector	Priority technology options	Technology description	Target and benefits of technology diffusion	Scale of ambition/estimated technology costs (USD)	Technical and economic barriers	Comments
Municipal Solid Waste	Sanitary Landfill with Biogas Production	The sanitary landfill (without a bioreactor) is nothing more than a container built on the ground, where urban solid waste, especially the non-recyclable fraction, is stored	1) Reduction in the accumulated volume of MSW; 2) Reduction of more than 85% of current GHG emissions/ton of MSW	Modernize the MSW Management and Treatment System in Nampula and Build 1 Sanitary Landfill with Biogas Generation. US$23,000,000	Weak capacity of municipalities to invest in technology; weak interest from the private sector to invest in the sector; local/national	Technology contained in TAP. Prioritized technology using MCA. The action plan for this

Subsector	Priority technology options	Technology description	Target and benefits of technology diffusion	Scale of ambition/estimated technology costs (USD)	Technical and economic barriers	Comments
		progressively and cumulatively. The site is commonly an excavation made in the ground, of compacted surfaces, far above the upper limit of the water table and far from any natural surface watercourse.	3) Modernization of the MSW management value chain 4) Reduction of direct environmental pollution 5) Adding Economic Value to MSW 6) Generation of Employment and consequent socio-economic development in the municipality covered.		financial unavailability in the current economic context; weak national capacity to mobilize resources for the sector	technology could be executed in three possible timeframe scenarios: Short Term: 2020-2023 Medium Term: 2024-2028 Long Term: from 2029
Municipal Solid Waste	Biogas Production Bioreactor Sanitary Landfill	The bioreactor landfill technology referred to in this study has a minimum capacity per unit of 500 tonnes of organic MSW daily. The main difference	1) Modernize MSW management and treatment services; 2) reduce by about 85% the greenhouse gas emissions that would potentially be	Implement two MSW treatment units based on this technology, by 2030, in the largest national urban agglomeration, the	Weak interest from the private sector to invest in the sector; local/national financial unavailability in the current economic	Technology contained in TAP. Prioritized technology using MCA. The action

Subsector	Priority technology options	Technology description	Target and benefits of technology diffusion	Scale of ambition/estimated technology costs (USD)	Technical and economic barriers	Comments
		between this technology and the previous one is fundamentally based on the bioreactor, an additional element that allows the biochemical processing of biodegradable waste components. In effect, a bioreactor landfill is a landfill that uses improved microbiological processes to transform and stabilize moderately degradable organic waste constituents within a period of 5 to 10 years of implementation of the bioreactor process.	released by MSW if the current scenario prevailed	Metropolitan Area of Maputo (1500 ton/day of organic MSW). US$73,200,000	context; weak national capacity to mobilize resources for the sector; shortage of landfill specialists for biogas generation; institutional weakness.	plan for this technology could be executed in three possible timeframe scenarios: Short Term: 2020-2023 Medium Term: 2024-2028 Long Term: from 2029
Municipal Solid Waste	Pyrolysis	Pyrolysis of MSW can be described as a thermochemical process	1) Reduction of greenhouse gas emissions;	8 RSU Pyrolysis Centers distributed in an equal number	Weak interest from the private sector to invest in the sector;	Technology contained in TAP.

Subsector	Priority technology options	Technology description	Target and benefits of technology diffusion	Scale of ambition/estimated technology costs (USD)	Technical and economic barriers	Comments
		of decomposition of solid organic waste at high temperatures (500-800°C), in the absence of air or oxygen, which promotes the conversion of MSW into gas (synthesis gas), liquid (ammonia salts, pyrolytic tar and fuel oil) and solids (coal). In fact, the main objective of this technology is to convert large volumes of MSW into gas (fuel) and condensates, reducing, in the first place, the volume of MSW quite sharply. The gas phase is mainly composed of CO, H_2 CH_4 and other hydrocarbons heavier (up to 6 carbons) than methane. The	2) Reduction of accumulated volumes of MSW 3) Greater efficiency in collecting and treating MSW 4) Greater degree of urban health 5) Adding value to MSW.	of municipal cities US$91,300,000	Financial limitation to invest in technology; High cost of MSW pyrolysis technology; local/national financial unavailability in the current economic context; Deficit of specialists in MSW pyrolysis; institutional weakness; difficulty in recruiting qualified/competent labor; weak MSW collection capacity.	Prioritized technology using MCA. The action plan for this technology could be executed in three possible timeframe scenarios: Short Term: 2020-2023 Medium Term: 2024-2028 Long Term: from 2029

Subsector	Priority technology options	Technology description	Target and benefits of technology diffusion	Scale of ambition/estimated technology costs (USD)	Technical and economic barriers	Comments
		proportions of the composition of the products depend on variables such as temperature, the heating rate imposed on the pyrolytic reactor, residence time, which determine the type of pyrolysis.				

The suggested technologies in the selected sectors aforementioned in Tables 5.1, 5.2, 5.3-5.6 and 5.7-5.10 constitute a technological, financial, strategic and regulatory challenge for the country, aiming at their successful transfer and implementation in the various sectors and socio-economic domains of society. In fact, the transfer, diffusion and implementation of any new or modern technologies in Mozambique requires the existence of material, financial, human, technical-technological and legal conditions that enable the recipient to receive the technologies and create from them, a positive change in the economy without disturbing its socio-environmental conditions.

5.1.4. Project ideas for selected technologies

The identification of project ideas was carried out by the technology working groups analyzing their effectiveness to ensure adaptation and mitigation in the Coastal Zone and Infrastructure, Agriculture, Energy, and, Waste sectors, based on climate change scenarios for Mozambique.

1. For the Coastal Zone and Infrastructure Sector and the following project ideas were identified:
   - 1.1 Flood EWS and mapping through the establishment of a technical training program;
   - 1.2 Preparation of a Technical Financial, Economic and Environmental Feasibility Study for Mangrove Restoration in Mozambique, and implementation of a Mangrove Restoration Pilot Project;
   - 1.3 Identification of a financial model that enables nourishment of beaches in Mozambique, and implementation of a pilot project.

2. For the Agriculture Sector, the following project ideas were identified
   - 2.1 Conservation agriculture (CA) by raising awareness and promoting CA through demonstration plots and audiovisual information in Mozambique;
   - 2.2 Mapping of areas with potential for implementation of rainwater capture and use systems (RWHC);
   - 2.3 Massification of seed production through the training of farmers and extension workers.

3. For the Energy Sector, the following project ideas were identified:
   - 3.1 Electricity generation from regular scale solar photovoltaic systems (150 MW);
   - 3.2 Electricity generation from conventional combined cycle thermal power plants powered by natural gas (NGCC, 650 MW);
   - 3.3 Electricity generation from regular scale hydroelectric turbines (600 MW).

4. For the Waste Sector, the following project ideas were identified:
   - 4.1 Management and treatment of MSW from a landfill for the production of biogas;
   - 4.2 Management and treatment of MSW from a bioreactor landfill for biogas production;
   - 4.3 Management and treatment of MSW from Pyrolysis for solid waste production.

The identified project ideas are presented in Tables 5.12 – 5.15 and contain information about their geographic scope of implementation and estimated costs necessary for their implementation.

Table 5.12: Project Ideas for the Coastal Zone and Infrastructure Sector.

Project idea	Specific ideas	Scale of Implementation	Estimated costs for the technology
Flood EWS and mapping through the establishment of a technical training program	• Visit to institutions Flood Forecasting and Mapping of risk areas • Identification of priority areas for training • Implementation of training programs	National	USD 5,280,000.00
Preparation of a Technical Financial, Economic and Environmental Feasibility Study for Mangrove Restoration in Mozambique, and implementation of a Mangrove Restoration Pilot Project	• Create a multi-stakeholder commission to prepare the terms of reference for hiring a consultant • Preparation of the technical, financial, and economic feasibility study for mangrove restoration in Mozambique	National	USD 144,720.00
Identification of a financial model that enables the nourishment of Beaches in Mozambique, and implementation of a pilot project	• Development of a financial model that makes beach nourishment viable; • Adapt the institution to implement the financial model that makes Beach nourishment feasible	National	USD 180,600.00

Table 5.13: Project Ideas for the Agriculture Sector.

Project idea	Specific ideas	Scale of Implementation	Estimated costs for the technology
Conservation agriculture (CA) by raising awareness and promoting CA through	• CA projects through demonstration plots • Training extension workers; • Production and	5 Provinces: Manica, Gaza, Inhambane, Nampula and Zambezia	USD 1,322,500.00

Project idea	Specific ideas	Scale of Implementation	Estimated costs for the technology
demonstration plots and audiovisual information in Mozambique	dissemination of audiovisual materials		
Mapping of areas with potential for implementation of Rainwater Capture and Use (RWHC) systems	• Selection and hiring of companies to carry out the mapping • Survey of areas where rainwater catchment systems can be built • Map areas with potential for RWHC and map production	All districts located in arid and semi-arid areas that were affected by drought covering at least 75% of the population in these areas.	USD 6,903,450.00
Massification of seed production through the training of farmers and extension workers.	• Creation of technical capacity and infrastructure for seed certification and quality control; • Massification of seed production through the training of farmers and extension workers; and, • Promotion of improved storage systems for grains and seeds	In total, 3 districts will be covered per province and are expected to cover about 75% of the population in the target districts and have a high potential for agricultural production.	USD 1,345,500.00

Table 5.14: Project Ideas for the Electricity Generation Subsector.

Project idea	Specific ideas	Scale of Implementation	Estimated costs for the technology
Electricity generation from regular scale solar photovoltaic systems (150 MW)	• Institutional Capacity Building; • Tariff adjustment; • 3 photovoltaic plants of 150MW nationwide	Locations to be identified	USD 320,000,000.00 ±80,000,000.00. For three plants, which constitute the idea in the short, medium and long term, the total costs rise to USD 1000, 000, 000.00
Electricity generation from natural gas conventional combined cycle thermal power plants (NGCC, 650	• Institutional Capacity Building; • Update of the Master Plan for Natural Gas in Mozambique; • Progressive	Locations to be identified	USD 4,000,000,000.00 ±25% (ranging between USD 4,000,000,000.00 and 5,000,000,000.00).

MW)	implementation of 5 Combined Cycle Thermal Power Plants		
Electricity generation from regular scale hydroelectric turbines (600 MW)	• Tariff adjustment; • Mapping and prediction capability of the climatic influence on the flows of the rivers covered by the project • 2 projects for 600MW hydroelectric power plants each	Locations to be identified	USD 2,100,000,000.00, with a margin of ± 35%. With the indicated margin of 35%, these costs may vary from USD 1,365,000,000.00 a USD 2,835,000,000.00 per unit

Table 5.15: Project Ideas for the Waste Sector.

Project idea	Specific ideas	Scale of Implementation	Estimated costs for the technology
Management and Treatment of Urban Solid Waste from a landfill for the production of biogas	• Improvement of MSW collection capacity; • Implementation of the Technological Project itself.	Municipality of Nampula, pilot project for technology transfer to Mozambique	USD 15,500,000.00. part of these, USD 11,400,000.00 are for the implementation of the Technological Project.
Management and treatment of Municipal Solid Waste from landfill bioreactor for biogas production;	• Implementation of the MSW value chain; • Institutional capacity building; • Implementation of the Technological Project	Maputo Metropolitan Area (Maputo, Matola and Boane)	USD 83,300,000.00, from which the technological project absorbs USD 76,250,000.00 and the institutional capacity, USD 3,650,000.00. excluding projects for the use of pyrolysis products.
Management and treatment of Municipal Solid Waste from Pyrolysis of solid waste	• Concession of Municipal Solid Waste Management Systems to Private Operators; • Creation and	8 Capital Cities: Xai-Xai, Inhambane, Chimoio, Quelimane, Nacala, Pemba and Lichinga	USD 95,000,000.00, with the costs for concession models equal to USD 1,500,000.00, those inherent in the creation of the fee collection model, USD 1,050,000.00 e os restantes and the remaining USD 91,300,000.00, to pay for

	establishment of a more effective and reliable municipal tax collection scheme; • Implementation of the Technological Project.		the technology, for each city municipal

5.2. Research and systematic observations

Research and systematic observations are an integral part of a framework defined in the context of capacity and capacity development in light of the Marrakesh agreements signed by the signatory governments of the UNFCCC. Mozambique is also a signatory to the Convention and has been making efforts to promote and collaborate in research and systematic observations on climate change, as one of the requirements of Articles 4 and 5 of the Convention.

5.2.1. Search

The GovM has recognized that the increased exposure of people and economic assets to the risks of climate change and climate-related disasters will lead to an exponential increase in the loss of human life and property and economic damage. In response, the GoM recommended that several studies be carried out, including the "Impact of climate change on disaster risk in Mozambique" conducted by the National Institute for Disaster Risk Management and Reduction (INGD) in 2008 and 2009 (also referred to as INGC Phase I). This research, widely cited and the first to apply climate change models at a regional scale in Mozambique, provided the country with an important insight into the possible impacts of climate change on national investment and poverty reduction plans, and the major coastal zone segments characterized by human settlements and socio-economic infrastructure.

The study found that climate change and disaster risk go hand in hand because most of the impacts of climate change will be felt in the form of heightened risk, spread, intensity and frequency of natural disasters. On the other hand, the project "Responding to Climate Change in Mozambique", also conducted by INGD, between 2009-2012 (also referred to as INGC Phase II), in collaboration with national and international institutions, focused on identifying scientific solutions for the potential impacts of climate change and supported the country in formulating and implementing its response to climate change, building resilience, by reducing disaster risk and vulnerability (adaptation) in a structured way.

Mozambique, as a signatory of the UNFCCC since 1995, the Hyogo Plan of Action (2005-2015, also reaffirmed in the Paris Agreement in 2015) and the Sendai Framework for Disaster Risk Reduction (2015-2030) took some actions to develop towards the mitigation of GHG emissions and reduction of climate risks, as well as, in the formulation of development policies in order to respond to the impacts of climate change, promotion and cooperation in the areas of scientific and technological research, technical and socio-economic, systematic observations, education, training and public awareness. In order to develop more effective long-term responses that allow the country to strengthen its resilience to climate change the Council of Ministers approved the NCCAMS in 2012 (MICOA, 2012).

The NCCAMS addresses issues of education and research in its several objectives and actions. One of the objectives highlights the need to “create institutional and human capacity, as well as explore opportunities for accessing technological and financial resources for its implementation”. On the other hand, within the scope of the strategic actions of the main pillars, it indicates that “Developing research on climate change” is part of the cross-cutting issues highlighted in the Strategy. For its implementation, it is defined amongst strategic actions that knowledge management will be carried out through a Climate Change Knowledge Management Center (CGCMC) to be created and hosted by the Mozambique Academy of Sciences, at MCTES (formerly MCTESTP), based on existing entities and with thematic groups to be managed by the responsible public entities.

This Center is the repository of studies carried out and has the function of coordinating research, dissemination and training based on the needs that will be identified by all stakeholders, in particular by the Inter-Institutional Group on Climate Change (GIIMC) in conjunction with the former Climate Change Unit (UMC). In addition, the center will work through the climate change network (Figure 5.2) which comprises twelve thematic areas (available for new thematic areas) which will be responsible for identifying knowledge or coordinating its production.

Figure 5.2: Structure of the Climate Change Network
Source: UNDP-MITADER [18] (2016).

MCTES prioritizes and promotes research development in Mozambique (MCTESTP, 2012). It is responsible for developing and implementing the National Science, Technology and Innovation Strategy (ECTIM, 2006) and other policies, standards for the development of science, technology and innovation for Mozambique (BR, 2021). The strategy contains nine priorities, including education, agriculture, energy and water. Amongst cross-cutting strategic areas the environmental sustainability, points climate change as being a crucial component amongst research lines and must be addressed in all key priority actions.

Main research institutions

According to statistical data, the country has 53 Higher Education Institutions (MCTESTP[19], 2019) of which 22 are public (9 universities, 8 higher institutes, 2 higher schools and 3 academies) and 31 are private (10 universities, 19 higher institutes and 2 higher schools). Some of these institutions have representations in several provinces. There are currently more than 16 (sixteen) public institutes of scientific and technological research (IPPCTs) in

[18]Operationalization Report of the National Climate Change Network
[19] MCTESTP, https://www.mctestp.gov.mz/por/Ensino-Superior/Instituicoes-de-ES/Instituicoes-de-ES

the country with research, development, engineering and extension mandates, as illustrated (Table 5.15). The focus of IPPCTs is mainly on applied research and extension. Some IPPCTs, in particular those involved in the exploitation of natural resources (forestry, fishing), are engaged in research monitoring. It should be noted that in the period from 1995 to 2008, the number of public and private higher education institutions grew at almost the same rate. However, there is a marked growth of private institutions and a stagnation in public institutions in the period from 2008 to 2015 (MCTESTP, 2017).

Table 5. 1: Public Institutions for Scientific and Technological Research (MCTESTP, 2015)

Institutions	Types of activity
1. National Institute of Hydrography and Navigation (INAHINA)	Monitoring, Applied Research and Extension
2. National Institute of Meteorology (INAM)	Monitoring, Applied Research
3. National Institute of Health (INS)	Basic and Applied Research
4. Health Research Center (CISM)	Basic and Applied Research, Monitoring and Extension
5. Regional Center for Health Development (CRDS)	Monitoring and Extension
6. Mozambique's Institute of Agricultural Research (IIAM)	Applied Research and Extension
7. National Center for Cartography and Remote Sensing (CENACARTA)	Monitoring and Development
8. Small Scale Fisheries Development Institute (IDPPE)	Development and Extension
9. Fisheries Research Institute (IIP)	Monitoria e Pesquisa Aplicada
10. Mozambique's Engineering Laboratory (LEM)	Engineering and Applied Research
11. National Institute of Statistics (INE)	Applied research
12. National Institute for Education Development (INDE)	Applied research
13. Socio-cultural Research Institute (ARPAC)	Applied research
14. Eduardo Mondlane University (UEM)	Basic and applied research
15. Pedagogical University (UP)	Applied research
16. Internacionais Higher Institute for International Relations (ISRI)	Basic and applied research

The majority of research is carried out in public universities, which employ over 60% of lectures with master's degrees and approximately 80% of the doctorates existing in the country. The three main and oldest public universities, the Eduardo Mondlane University (UEM), the former Pedagogical University (UP) and the Higher Institute of International Relations (ISRI) have well-established research activities. UEM has more than 300 different research projects underway, UP and ISRI have also increased their research efforts (ECTIM, 2006). Several public universities seek to institutionalize field research by introducing degree thesis programs and establishing research funds for this purpose (e.g., UEM). Public universities emphasize, applied research, followed by basic research and extension (service provision). Almost all research is funded by external sources, which significantly influence the research agenda. In recent years, some private universities (eg ISCTEM, ISUTC, ISPU, UCM, UDM) have also made efforts to establish various research programs (MCTESTP, 2017).

Climate change research

Research on climate change is still fragmented, mainly, in the various departments/bodies of academic institutions, notwithstanding there is an effort to bring together knowledge and research through cross-fertilization of various scientific knowledge. UEM is the institution where research is more consolidated, given its more systematic and traditional participation in several studies and projects with national and international institutions in the field of climate change. Nevertheless, UEM is still setting its agenda on climate change research. So far, the institution has approved a two-year Master's course in Disaster Risk Management and Climate Change Adaptation that is already being implemented. Current climate change research at EMU is more focused on climate change adaptation and climate change mitigation.

In general, UEM has been involved in providing scientific evidence for climate change, through collaborative projects with national and international institutions / organizations; Table 5.16 presents some climate change publications available involving Mozambican institutions and cooperating/collaborating partners. This partnership has been conducted in the components of vulnerability and adaptation/mitigation to climate change, early warning, coastal protection, preparing cities and capacity development, community resilience, water demand, food security, extreme events, GHG emissions inventories, etc. The results of these partnerships has contributed to respond to support national decision-making bodies in the formulation of strategies, plans and other important instruments such as NCCAMS (2013-2025), the National System for Monitoring and Evaluation of Climate Change (SNMAMC, 2014) among others.

Increasing collaboration and fertilization of climate change knowledge amongst the national institutions will bring research under the same roof. The Mozambican Academy of Sciences (ACM) has already hosted the Climate Change Knowledge Management Center (CGCMC) which still requires its creation and legal establishment by government authorities. The governance and functioning structure that has been designed for this Center has the entire integrated systemic approach to climate change research, including its role in bridging the gap between science and policy as well as supporting government in decision-making. Amongst the various actions advocated by NCCAMS, the establishment of the CCGMC was identified as one of the priorities to respond to ongoing and future climate change including recurring disasters in the country (MITADER, 2012). However, the CGCMC has received ad-hoc support to develop some activities, while it awaits the government's decision. It is worth to mention the support provided by the Climate Resilience Pilot Program (PPCR) in the 2014-2016 period and the USAID Coastal Cities Adaptation Project in the 2017-2018 period.

Table 5. 2: Publications of scientific literature available on climate change involving Mozambican institutions and cooperation/collaboration partners, during the period 2011-2019.

Author (s)	Title	Institution (s)
Artur, L.; F. Afonso; L. Mangoele; A. Beleza; N. Adrião (2015)	Climate Compatible Development: Lessons from Mozambique. CIDT, UK	Eduardo Mondlane University, National Disaster Management Institute, Ministry of Land, Environment and Rural Development, Ministry of Economy and Finance
Brockhaus, M. and Korhonen-Kurki, K. and Sehring, J. and Di Gregorio, M. and Assembe-Mvondo, S. and Babon, A. and Bekele, M. and Gebara, M.F. and Khatri, D.B. and Kambire, H. and Kengoum, F. and Kweka, D. and Menton, M. and Moeliono, M. and Paudel, N.S. and Pham, T.T. and Resosudarmo, I.A.P. and Sitoe, A. and Wunder, S. and Zida, M. (2017)	REDD+, transformational change and the promise of performance-based payments: a qualitative comparative analysis. J. Climate Policy, Vol. 17 (6), pp. 708-730 DOI: 10.1080/14693062.2016.1169392 https://doi.org/10.1080/14693062.2016.1169392 EID: 2-s2.0-84973144035	CIFOR Bogor, Helsinki University Centre for Environment, University of Helsink,…, Eduardo Mondlane University, Centro Internacional de la Papa, CIFOR Burkina
Chenene, M., Boaventura, C., Mavume, A., Queface, A. and Alberto, T. (2011)	"Technological barriers for climate change adaptation: the case of Mozambique" in Overcoming Barriers to Climate Change Adaptation Implementation in Southern Africa: Edited by Lesley Masters and Lyndsey Duff, ISBN 978 7983 02951, Africa Institute of South Africa and Institute of Global Dialogue, Pages 201-225.	Eduardo Mondlane University
D Yamba, H Walimwipi, S Jain, P Zhou, B Cuamba and C Mzezewa (2011)	Climate change/variability implications on hydroelectricity generation in the Zambezi River Basin. J. Mitigation and Adaptation Strategies for Global Change Vol. 16 (6) pp. 617-628. Springer Netherlands	Centre for Energy, Environment and Engineering Zambia, University of Zambia, Energy, Environment, Computing and Geophysical Applications, EnerConsult Pvt Ltd,

Author (s)	Title	Institution (s)
		Eduardo Mondlane University
Elin Norström, Jan Risberg, Helene Gröndahl, Karin Holmgren, Ian Snowball, João Alberto Mugabe, and Sandra Raúl Sitoe. (2012)	Coastal paleo-environment and sea-level change at Macassa Bay, southern Mozambique, since c 6600 cal BP. Quaternary International, 260, 153-163 https://doi.org/10.1016/j.quaint.2011.11.032	Stockholm University, Eduardo Mondlane University
Elin Norström, Helena Öberg, Sandra R Sitoe, Anneli Ekblom, Lars-Ove Westerberg, and Jan Risberg (2017)	Vegetation dynamics within the savanna biome in southern Mozambique during the late Holocene. The Holocene, 28(2), 277-292. https://doi.org/10.1177/0959683617721327	Stockholm University, Eduardo Mondlane University
G Maúre, I Pinto, M Ndebele Murisa, M Muthige, C Lennard, G Nikulin, A Dosio, A Meque (2018)	The southern African climate under 1.5°C and 2°C of global warming as simulated by CORDEX Regional Climate Models Environmental Research Letters, DOI: 10.1088/1748-9326/aab190	Eduardo Mondlane University, University of Cape Town, Chinhoyi University of Technology, Council for Scientific and Industrial Research, Swedish Meteorological and Hydrological Institute, European Commission Joint Research Centre, Red Cross Red Crescent Climate Centre, the Hague, the Netherlands & National Institute of Meteorology
IIP Relatório Annual (2012)	Estação de monitoria ambiental de Pemba – Três anos de monitoria ambiental no Canal de Moçambique ao largo da Costa de Cabo Delgado para o estudo de Variabilidade e Mudanças climáticas no canal de Moçambique. IIP 70 p	Instituto de Investigação Pesqueira
Korhonen-Kurki, K. and Brockhaus, M. and Sehring, J. and Di Gregorio, M. and Assembe-Mvondo, S.	What drives policy change for REDD+? A qualitative comparative analysis of the interplay between	CIFOR Bogor, Helsinki University Centre for Environment, University of Helsink,

Author (s)	Title	Institution (s)
and Babon, A. and Bekele, M. and Benn, V. and Gebara, M.F. and Kambire, H.W. and Kengoum, F. and Maharani, C. and Menton, M. and Moeliono, M. and Ochieng, R. and Paudel, N.S. and Pham, T.T. and Sitoe, A. (2019)	institutional and policy arena factors. J. Climate Policy, Vol. 19 (3), pp. 315-328, DOI: 10.1080/14693062.2018.1507897 EID: 2-s2.0-85051989455	IHE Delft Institute for Water Education, University of Leeds,…,Eduardo Mondlane University
Karin Holmgren, Jan Risberg, Johan Freudendahl, Mussa Achimo, Anneli Ekblom, Joao Mugabe, Elin Norström & Sandra Sitoe (2012)	Water-level variations in Lake Nhauhache, Mozambique, during the last 2,300 years. Quaternary International, 260, 153-163 https://doi.org/10.1016/j.quaint.2011.11.032	Stockholm University, Eduardo Mondlane University
Kathryn L. Colborn, Emanuele Giorgi, Andrew J. Monaghan, Eduardo Gudo, Baltazar Candrinho, Tatiana J. Marrufo & James M. Colborn	Spatio-temporal modelling of weekly malaria incidence in children under 5 for early epidemic detection in Mozambique, scientific reports 8:9238, DOI:10.1038/s41598-018-27537-4	Department of Biostatistics and Informatics, University of Colorado Anschutz Medical Campus,…, Instituto Nacional de Saúde
Lindsay M. Horn, Anjum Hajat, Lianne Sheppard, Colin Quinn, James Colborn, Maria Fernanda Zermoglio, Eduardo S. Gudo, Tatiana Marrufo and Kristie L. Ebi	Association between Precipitation and Diarrheal Disease in Mozambique, Int. J. Environ. Res. Public Health 2018, 15, 709; doi:10.3390/ijerph15040709	University of Washington,…, Instituto Nacional de Saúde
Lucas Lavo António Jimo Miguel, Fialho Paloge Juma Nehama, João Wagner Alencar Castro (2019)	Lagoon-barrier system response to recent climate conditions and sea level rise, Mozambique, Africa. Estuarine Coastal and Shelf Science, 216, 71-86. https://doi.org/10.1016/j.ecss.2017.12.013	Federal University of Rio de Janeiro, Eduardo Mondlane University
Luis Artur, Irene Karani, Melq Gomes, Sérgio Maló, Saíde Anlaué (2014).	Tracking Adaptation and Measuring Development in Mozambique. Research Report. IIED, London. ISBN: 978-1-78431-095-0	Eduardo Mondlane University, Africa Climate Change Resilience Alliance (ACCRA)
Lindsey Jones, Eva Ludi, Elizabeth Carabine, Natasha Grist, Aklilu Amsalu, Luís Artur, Carina Bachofen, Patrick Beautement, Christine Broenner,	Planning for an uncertain future: promoting adaptation to climate change through Flexible and Forward-looking Decision Making. ODI Pub	Overseas Development Institute, Eduardo Mondlane University

Author (s)	Title	Institution (s)
Matthew Bunce, Janot Mendler de Suarez, William Muhumuza, Pablo Suarez and Daniel Zacarias (2014)	Research Report. London se1 8nj, UK ISBN 978 1 909464 63 6	
Luís Artur, D. J. M. Hilhorst (2012)	Everyday realities of climate change adaptation in Mozambique. Global Environmental Change (22) 529-536	Eduardo Mondlane University, Wageningen University, Netherlands
Luís Artur (2011)	Continuities in crisis: everyday practices of disaster response and climate change adaptation in Mozambique, PhD thesis	Eduardo Mondlane University, Wageningen University
Mavume, A., Pinto, I. and Massuanganhe, E. (2014).	Potential Climate Change Impacts on Maputo Bay. In: Bandeira, S. and Paula, J. (Eds.). The Maputo Bay Ecosystem. WIOMSA, Zanzibar Town, pp 407-421.	Eduardo Mondlane University, University of Cape Town
Mavume, A., Alo, B.I., Blivi, B.A., Müller, C., Odubanjo, O., Aflakpui, G.K.S. Fofack, H.L., Sedogo, L.G., Mwan-jalolo, M., Nowbuth, M.D., Boko, M.C., Murisa, M., Serdeczny, O., Schulze, R.E., Diop, S., Ayonghe, S.N., Schmiedel, U., Tesema, Z.W. (2015).	Climate Change Adaptation and Resilience in Africa: Recommendations to Policymakers. Lisa Frost Ramsay and Daniel Olago (Eds). Publishers: Network of African Science Academies (NASAC).	Eduardo Mondlane University, Network of African Science Academies (NASAC).
Meque, A., Abiodun, B.J. (2015).	Simulating the link between ENSO and summer drought in Southern Africa using regional climate models. Clim Dyn 44, 1881–1900 (2015). https://doi.org/10.1007/s00382-014-2143-3	University of Cape Town, Instituto Nacional de Meteorologia
Uamusse, M.M., Tussupova, K., Persson and K.M. (2020)	Climate Change Effects on Hydropower in Mozambique. Appl. Sci. 2020, 10(14), 4842; https://doi.org/10.3390/app10144842	Eduardo Mondlane University Lund University
República de Moçambique/Conselho de Ministros (2012).	National Climate Change Adaptation and Mitigation Strategy http://www.cgcmc.gov.mz	Ministério da Terra, Ambiente e Desenvolvimento Rural, Eduardo

Author (s)	Title	Institution (s)
		Mondlane University
República de Moçambique/ Ministério de Saúde (2019).	Avaliação da Vulnerabilidade e Adaptação às Mudanças Climáticas do Sector de Saúde em Moçambique. Relatório de Pesquisa do Ministério de Saúde	Universitat Autònoma de Barcelona, Eduardo Mondlane University
Van Logchem, B. & Queface, A.J. (eds.) (2012).	Responding to Climate Change in Mozambique: Synthesis Report. INGC, Research Report. http://ingc.dirisa.org/repository/phase-2-theme-reports/phase-ii-reports-english/.	National Disaster Management Institute, Eduardo Mondlane University
Quan, J. and Naess, L.O. and Newsham, A. and Sitoe, A. and Fernandez, M.C (2017)	The political economy of REDD+ in Mozambique: Implications for climate compatible development. J. Making Climate Compatible Development Happen, pp. 151-181 DOI: 10.4324/9781315621579 EID: 2-s2.0-85027527424	Department of Development Studies School of Finance and Management Centre for Development, Environment and Policy (CeDEP), Eduardo Mondlane University
Raimundo, Ines (2017)	Food insecurity in the context of climate change in Maputo City, Mozambique: challenges and coping strategies. In Elizabeth Thomas-Hope (Editor). Climate change and food security- Africa and the Caribbean. Earsthcan-Routledge, London and New York, pp 172-180.	Eduardo Mondlane University
R Spalding-Fecher, F Yamba, H Walimwipi, H Kling, B Tembo, I Nyambe, A Chapman, B Cuamba (2014)	Water Supply and Demand Scenarios for the Zambezi River Basin: Climate Change and Upstream Development Impacts on New Hydropower Projects in the Zambezi Project. Research Report for Climate & Development Knowledge Network	University of Cape Town, Eduardo Mondlane University

Author (s)	Title	Institution (s)
Randall Spalding-Feche, Arthur Chapman, Francis Yamba, Hartley Walimwipi, Harald Kling, Bernard Tembo, Imasiku Nyambe & Boaventura Cuamba (2016)	The vulnerability of hydropower production in the Zambezi River Basin to the impacts of climate change and irrigation development. Mitig Adapt Strateg Glob Change, 21:721–742 DOI 10.1007/s11027-014-9619-7	Carbon Limits AS, OneWorld Sustainable Investments, Centre for Energy Environment and Engineering, Snow Systems Zambia, Poyry Energy, University College London, University of Zambia, Eduardo Mondlane University
Roland Hunter, Felisberto Afonso, Alberto Mavume and Mark New (2017).	Problems and Solutions for Climate Change Resilience and Adaptation in Mozambique: State of Adaptation Knowledge, Policies and Practices to support Conservation Agriculture. ACDI Research Report, pp 1-88.	African Climate Development Initiative - Eduardo Mondlane University
Roland Hunter, Felisberto Afonso, Alberto Mavume and Mark New (2017).	POLICY BRIEF: Opportunities for climate change adaptation and resilience through promotion of Conservation Agriculture in Mozambique. ACDI Policy Brief, pp 1-10.	African Climate Development Initiative - Eduardo Mondlane University
República de Moçambique/ Ministério de Saúde (2019).	Avaliação da Vulnerabilidade e Adaptação às Mudanças Climáticas do Sector de Saúde em Moçambique. Relatório de Pesquisa do Ministério de Saúde	Universitat Autònoma de Barcelona, Eduardo Mondlane University
Salau, O.R., Adeleye, O.A., Adeleye, F.A., Américo, J. (2018).	The Links between Climate and Malaria Disease in Ekiti State, Nigeria. International Journal of Preventive Medicine Research Vol. 4, No. 3, 2018, pp. 60-67 http://www.aiscience.org/journal/ijpmr ISSN: 2381-7038 (Print); ISSN: 2381-7046	Department of Physics, Ekiti State University, Ado-Ekiti, Department of Guidance and Counseling, Ekiti State University, Ado-Ekiti, Department of Surveillance, Instituto Nacional de Saúde
Stringer, L.C. and Dougill, A.J. and Thomas, A.D. and Spracklen, D.V. and Chesterman, S. and Speranza,	Challenges and opportunities in linking carbon sequestration, livelihoods, and ecosystem service	University of Leeds, Manchester Metropolitan University, University of

Author (s)	Title	Institution (s)
C.I. and Rueff, H. and Riddell, M. and Williams, M. and Beedy, T. and Abson, D.J. and Klintenberg, P. and Syampungani, S. and Powell, P. and Palmer, A.R. and Seely, M.K. and Mkwambisi, D.D. and Falcao, M. and Sitoe, A. and Ross, S. and Kopolo, G. (2012)	provision in drylands. J. Environmental Science and Policy. Vol. 19-20, pp. 121-135. DOI: 10.1016/j.envsci.2012.02.004 https://doi.org/10.1016/j.envsci.2012.02.004 EID: 2-s2.0-84859135468	Bern, Bioclimate, Research and Development, University of Edinburgh,…, Eduardo Mondlane University Desert Research Foundation of Namibia, University of Malawi
Sandra Raúl Sitoe, Jan Risberg, Elin Norström, Ian Snowball, Karin Holmgren, Mussa Achimo and João Mugabe (2014)	Paleo-environment and flooding of the Limpopo River-plain, Mozambique, between c. AD 1200–2000. https://doi.org/10.1016/j.catena.2014.10.038	Eduardo Mondlane University - Stockholm University
Sandra Raúl Sitoe, Jan Risberg, Elin Norström and Lars-Ove Westerberg (2017)	Late Holocene sea-level changes and paleoclimate recorded in Lake Lungué, southern Mozambique. Palaeogeography Palaeoclimatology Palaeoecology, 485, 305-315 https://doi.org/10.1016/j.palaeo.2017.06.022	Eduardo Mondlane University - Stockholm University

Main sources of funding

The main funding sources established and operating in the area of climate change in Mozambique include the State Budget (OE), the National Research Fund (FNI), the National Fund for Sustainable Development (FNDS), the Global Environment Facility (GEF), the Green Climate Fund (GCF) and the Adaptation Fund (AF).

The National Research Fund (FNI) is a national public institution, endowed with legal personality and administrative autonomy, under the Minister who oversees the area of Science and Technology. The FNI is one of the funding mechanisms created by the GovM, through Decree n. 12/2005, of 10 June, revised by Decree n. 50/2015, of 31 December, to promote the dissemination of scientific knowledge, scientific research, technological innovation and training of researchers, contributing to the reduction of poverty in the country. FNI's main funding domains include research, innovation and technology transfer projects that address issues in line with the strategic, cross-cutting areas defined in the ECTIM. The fund is intended for public and/or private entities dedicated to, or interested in the development of research, science and technology.

The National Sustainable Development Fund (FNDS) is a public institution with a national scope, endowed with administrative, financial and patrimonial autonomy and supervised by the MTA. The FNDS arises from the global need to adopt sustainable development models that foresee the emergence of multilateral financing funds, in accordance with the new SDGs approved by the UN. Among several attributions, the FNDS is focused on financing programs for environmental management, climate change adaptation and mitigation, sustainable forest management, biodiversity conservation, land administration and land use planning. On the other hand, the FNDS has the mission to contribute for the operationalization of the strategic objectives of governance from an economic, social and environmental perspective, operating in a flexible and transparent manner and respecting national and international standards of compliance.

Green Climate Fund (GCF) is an international entity responsible for the operationalization of the UNFCCC financial mechanism established in the year 2010, during COP 16, by a consensus decision of 194 countries. The purpose of this fund is to support the needs of developing countries in the implementation of projects aimed at promoting climate change mitigation and adaptation to its impacts, as well as guiding investment to promote a paradigm shift towards low emissions and development of climate resilience. The GCF operates through International, Regional, National Accredited Entities. International Accredited Entities are the World Bank, UNDP, PMA, IUCN, ADB among others. Therefore, the Accredited Regional Entity is UNEP. The FNDS will be the National Accredited Entity, and is currently in the process of accreditation, to access GCF funds. The MEF through the National Directorate of Monitoring and Evaluation, took responsibility on December 30, 2016, as DNA and Focal Point, to exercise its power to coordinate the activities of the GCF according to the country's priorities, namely the PQG, NCCAMS, END, Policies, Strategies and Plans aligned with the NDC.

The first project approved by the GCF was on November 14, 2019, within the framework of climate resilient food security for small farmers and women in Mozambique through systems-based integrated risk management. This project was developed by the WFP. Currently, Mozambique has a total of 7 projects approved by this fund.

- Adaptation Fund (AF)

The Adaptation Fund (AF) was established by the Kyoto Protocol of the United Nations Framework Convention on Climate Change. The Adaptation Fund was created by the 7th session of the Conference of the Parties (COP 7) in 2001 through decisions taken in Marrakesh, Morocco, although it was not launched until operationalized and its Council established in follow-up decisions during COP 13 in December 2007 in Bali, Indonesia. (https://www.adaptation-fund.org/af-10-years/).

The Ministry of Land and Environment (MTA) coordinates most of the funds associated with climate change projects established at the national level, originating from bilateral and multilateral international cooperation. At the national level, one of the funds associated with climate change issues is the FNDS. Funds hosted by the MTA are coordinated by the GEF focal point, represented by the FNDS. Therefore, projects are submitted to the FNDS, which assesses them with the UNFCCC Focal Point. The assessment is carried out taking into account the relevant national instruments, namely, the NCCAMS, the END and the PDRRD, the NDC and the PQG. The final decision on the approval of these projects rests with the GEF headquarters depending on the approval that has been made by the FNDS in coordination with the Focal Point of the UNFCCC. MICOA/MITADER – Convention Coordinator and UNFCCC Focal Point, GEF, AF, Paris Agreement and GCF - Designated National Authority.

In addition to national funds (FNI, FNDS) and multilateral institutions (GEF, AF), Mozambique has received support from various organizations through various projects/programmes. On the other hand, there are other sources of funding available, not exclusively for the purposes of projects or programs on climate change, but involving other related dimensions in some ministries or supervised institutions and in academic institutions. Section 5.3.3 (Tables 5.27-5.28) presents several projects/programs that have been supporting Mozambique in the area of climate change and related issues.

5.2.2. Systematic observations

Weather and climate observations

Systematic climate observations form the fundamental basis for a better understanding of the spatial and temporal behavior of climate. Although there are still no institutions dedicated to collecting data and specific information for monitoring climate change and impact assessments, the observations made by operational government institutions contribute to a database on the monitoring of climate and its changes.

The National Institute of Meteorology of Mozambique (INAM) is the main institution responsible for the collection, processing and archiving of meteorological and climatic data in Mozambique. INAM collects meteorological data from its network of meteorological stations that are operated throughout the country. INAM is mandated to provide meteorological information to support planning, as well as to provide early warning, where necessary, to minimize risks to life and property. INAM provides a number of different weather forecasts and products throughout the year, including, but not limited to, daily and seasonal weather forecasts, weather and climate observations, and specialized products for the aviation and marine sectors. The public forecasts issued by INAM include three daily forecasts - two 24-hour forecasts issued in the morning and afternoon respectively, plus a 'four-day' forecast issued each morning. In addition to the daily forecasts broadcast by the Social Communication, such as national news and the INAM website, the Institute prepares seasonal agricultural forecasts for each province that are presented at the beginning of the agricultural season, usually in September (that is, in the weeks before the start of the rainy season, when farmers start preparing their land).

hydrological observations

The Regional Water Administrations (ARAs - South, Centre, North Centre, North and Zambezi) and the National Directorate of Water Resources Management (DNGRH) are institutions under the supervision of the Ministry of Public Works, Housing and Water Resources (MOPHRH) that do the provision of hydrological and precipitation data while ensuring hydrological information services to support water resources planning and management in climate change monitoring and analysis, environmental management and planning, hydroelectric operations and dams, irrigation system planning and early warning of water-related disasters. The main themes of hydrological services are:

1. Water resources planning and allocation;
2. Operational management of hydraulic infrastructures;
3. Environmental management;
4. Flood Risk Assessment, Risk Reduction Planning and Flood Control;
5. Drought management in the early warning system;
6. Pollution management;
7. Climate change;
8. Irrigation management.

Agro-climatic observations

The Agricultural Research Institute of Mozambique (IIAM), subordinated to MADER, is the main agricultural research institution in Mozambique. IIAM is primarily focused on research and development to support the productivity and efficiency of Mozambique's agricultural sector, particularly through the generation of local and timely research outputs to inform stakeholders across the agricultural value chain. IIAM is also responsible for communicating pertinent technical information to stakeholders relevant to the agricultural sector, government policy makers, extension workers and farmers at the field level. IIAM's research focus includes agronomic, forestry and animal sciences, rural sociology and economics and agribusiness, which is undertaken with the aim of providing scientific, technical and administrative guidance to MADER and other public institutions involved in the agricultural sector.

Ocean observations and sea level monitoring

The National Institute of Hydrography and Navigation (INAHINA) is an institution supervised by the Minister that oversees the Maritime Transport sector and is an integral part of the Ministry of Transport and Communications. INAHINA's main function is to facilitate safe navigation in the country's coastal and inland waters, through hydrographic and oceanographic services as well as installation, rehabilitation and maintenance of navigation aids including the calibration of magnetic compass needles. The observation and monitoring of sea level is part of its attributions in the field of coordination, cooperation, development and monitoring of research activities, studies and work in the field of hydrography, nautical cartography, oceanography and navigation. Studies on sea level rise (SLR) are being carried out at INAHINA, INAM and at the academic level (eg UEM).

Until now, the evaluation carried out was based on historical data measured from tide gauges and satellite altimetry. Nevertheless, a study conducted by INGD (INGC, 2009) in partnership with national, regional and international institutions made an assessment, combining the historical approach and climate projections of sea level rise using scenarios described in the IPCC (2007) known as SRES[20]. More up-to-date observational data and sea level rise (SLR) projections taking into account more recent scenarios need to be considered for a more consistent assessment.

Observations of ocean-physical-biological data and monitoring of the occurrence of fisheries resources

The National Institute of Fisheries Research (IIP) is a public institution under the Ministry of the Sea, Inland Waters and Fisheries (MIMAIP) and which carries out research work

[20] SRES (IPCC's Special Report on Emissions Scenarios - Relatório Especial sobre Cenários de Emissões)

necessary for the scientific knowledge of fisheries resources in Mozambican jurisdictional waters with a view to their management, conservation and optimization of its operation. IIP conducts fisheries research cruises that allow scientific monitoring of the occurrence of fishery resources in Mozambican jurisdictional waters and the measurement of physical and chemical parameters of the aquatic environment. The information produced through these cruises complements the data collected from the commercial and subsistence fishing activity and is used to assess the degree of exploitation of resources with a view to sustainable fisheries management. Through research cruises, oceanographic data (CTD), data on nutrients, sediments, winds, currents, primary productivity, marine mammals and others are collected.

Public health monitoring and surveillance

The National Health Observatory (ONS) is a nationwide institution, under the Ministry of Health (MISAU). ONS is a national virtual center designed for the systematic observation and strengthening of the national health information system. With foundations in its attributions, the ONS has focused its activities, since its creation in 2015, on the analysis of secondary data based on data source triangulation in order to "inform for action" and ensure the well-being of the population. The ONS integrates: (i) data from different sources, namely, from ministries, research institutions, NGOs, civil society and academic institutions; (ii) the functions of established health information, monitoring and surveillance systems (eg, CISM, INS). ONS recommends, whenever necessary, the production of primary information to entities with this mandate.

The ONS works through multi-institutional and multidisciplinary platforms (HIV; Women's and Children's Health and Nutrition; Climate, Environment and Health; Mortality; Antimicrobial Resistance; Health Systems and PACE) that form the knowledge management network. Through the Climate, Environment and Health platform, the institution participates in the National Forum on Climate Foresight (FNAC), where annual risk maps for climate-sensitive diseases are produced for the subsequent rainy season. The main indicators used in FNAC are divided into categories namely: socio-demographic, health – programmatic, meteorological/climatic and environmental.

Data and information users

Table 5.17 shows some institutions that use meteorological and hydrological information/data, among others, from the providers, including their purpose and priority of use.

Table 5. 3: Role of institutions that use meteorological (os) and hydrological (os) information/data from the provider institutions (MOPHRH, 2016).

Institution	Purpose of use	Priority of use (Key/Primary/ Secondary)
Basin Management Units (UGBs)	Use of hydrological information for planning and operations in river/(hydro) water use and management. UGBs also interact with local governments to provide accurate information on the state of river water levels and risks to local communities.	Primary
Electricidade de Moçambique (EDM) and other energy producers (eg Cahora Bassa Hydroelectric Dam (HCB), etc.) including ARAs and UGBs	Use of hydrological information for electricity planning and production	Primary
Institute for Agricultural Research of Mozambique (IIAM)	Use of hydrological and meteorological information (short and long term) for agricultural development (agricultural and animal production)	Primary
Farmers (large and small scale-public/private), eg Xinavane and Maragra cane fields, and others	Use of hydrological and meteorological information (short and long term) for agricultural activities	Secondary
National Institute of Civil Aviation of Mozambique (IACM) / National Land Transport Institute (INATTER)	Use of hydrological and meteorological information (short and long term) for the development of air and road transport	Primary
Transport operators (air and road)	Use of hydrological and meteorological information (short and long term) for air navigation and road transport activities	Secondary
National Institute of Hydrography and Navigation (INAHINA)	Use of hydrological and meteorological information (short and long term) for fishing and navigation activities (sea/river)	Primary
Fishing Operators (public/private-	Use of hydrological and	Secondary

large or small scale)	meteorological information (short and long term) for fishing and navigation activities (sea/river)	
Media (radio, TV, newspaper, etc.) (public and private, including community)	Use of hydrological and meteorological information (short and long term) for public dissemination	Secondary

5.2.3. Current stage of observations in Mozambique

The systematic observation network in Mozambique suffered a progressive degradation after independence until the 2000s. After the 2000 floods there were national investments and those of international partners that allowed the observation network to be better today than in the period prior to the year 2000, despite the fact that its spatial representation remains deficient. New automatic observation systems were introduced during this period, however this process was not adequately accompanied by the training of qualified personnel to guarantee its maintenance, aggravated by the fact that budgets did not guarantee sufficient funds this equipment.

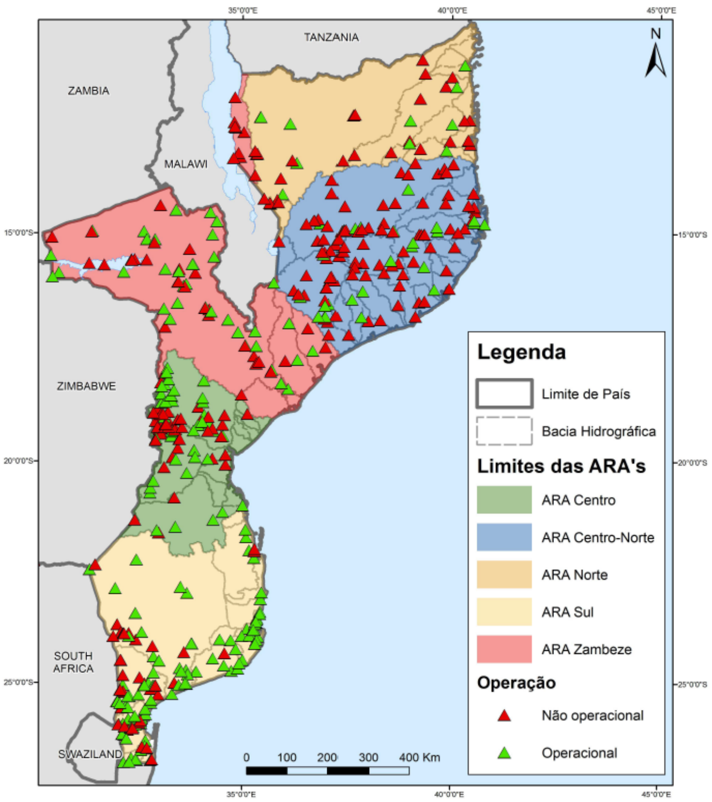
Improving Mozambique's hydro-meteorological services has the potential to increase productivity in sectors such as agriculture, fisheries/marine, hydropower, aviation, road transport, infrastructure planning and health. Hydro-meteorological information can increase the productivity of these key sectors of the economy, providing knowledge that can be translated into an increase in economic production, through better planning and adequate management of infrastructure.

The role of hydro-meteorological services provided by ARAs, DNGRH and INAM is recognized in various legislative packages, strategies and policies of the GovM. However, the effectiveness of services in fulfilling their role has been hampered by a series of challenges characterized by the low density of precipitation stations (many in need of rehabilitation and calibration) and different levels of technological solutions. For any of the institutions there was no systematic project for the development of the network and the location of the stations is limited to provincial and district headquarters, as well as strategic locations such as airports, agronomic experimental posts and parts of the coast. Nevertheless, DNGRH and INAM are leading the implementation of a study to optimize the network and hydro-meteorological services (MOPHRH, 2016), with the objective of designing the necessary interventions that will lead to its improvement in its functioning in the country.

Hydrological Observations Network

According to the hydrological data used and provided by the 5 Water Administrations (ARAs) and confirmed by the DNGRH central database and analysed in the study report carried out by the consultancy company SOLOMON (MOPHRH, 2016), there are a total of

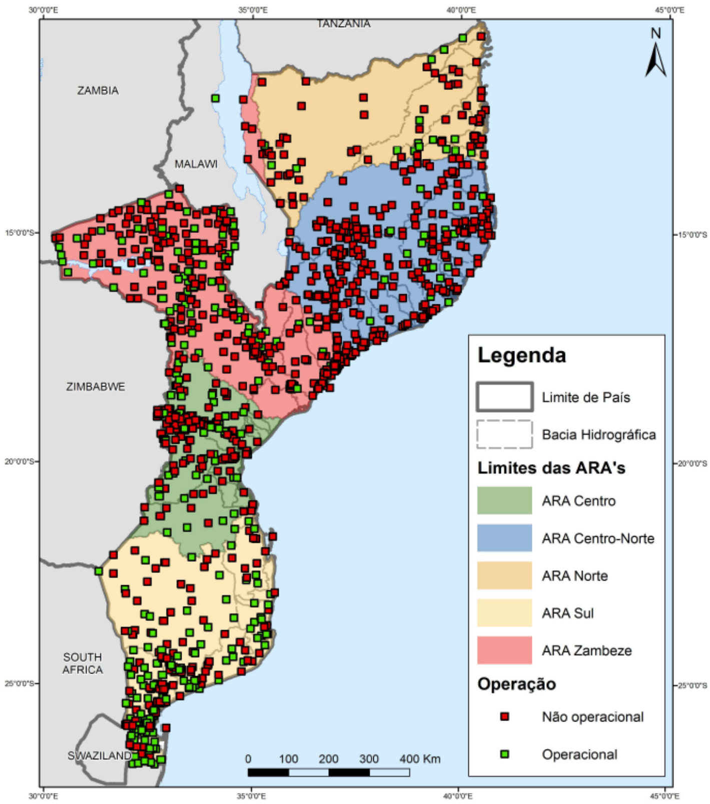
116 operational stations which belongs to those entities (Figure 5.3). According to this report, the hydrological observations collected from the hydrometric stations of the ARAs and DNGRH cover the period from 1930 to 2014, with particular emphasis on the period from 1942 to 1981, where the number of operational stations increased significantly.



Admnistração Regional de Águas	Estações hidrométricas operacionais
ARA-Sul	42
ARA- Zambeze	26
ARA - Centro	26
ARA - Centro – Norte	12
ARA - Norte	10
Total	116

Figure 5.3: Spatial distribution of operational and non-operational hydrometric stations (see map) and the number of operational stations (see table) in the flow monitoring network by DNGRH and ARAs (MOPHRH, 2016).

In the rainfall data monitoring network, a total of 322 operational stations belonging to DNGRH and ARAs were found (figure 5.4).



Admnistração Regional de Águas	Estações pluviométricas operacionais
ARA-Sul	160
ARA- Zambeze	87
ARA - Centro	32
ARA - Centro – Norte	22
ARA - Norte	21
Total	322

Figure 5.4: Spatial distribution of operational and non-operational rainfall stations (see map) and the number of operational rainfall stations (viz. the table) in the rainfall monitoring network by DNGRH and ARAs (MOPHRH, 2016).

Weather and climate observations network

INAM operates the country's main meteorological and climate observation network. The maps below (Figure 5.5) and Table 5.18 illustrate the evolution of the network over time, using as reference the years 1975, 2000, 2011 and 2018 and its spatial distribution. As it can be seen between 1975 and 2000 there was a sharp general fall in the national network of observations managed by INAM. Between 2000 and 2011 progress was made with a significant increase in synoptic stations and the installation of two modern weather radars as a result of significant investments mobilized in response to the devastating floods of the year 2000. Between 2011 and 2018 there was a more significant increase in the various types of stations of the INAM observation network.

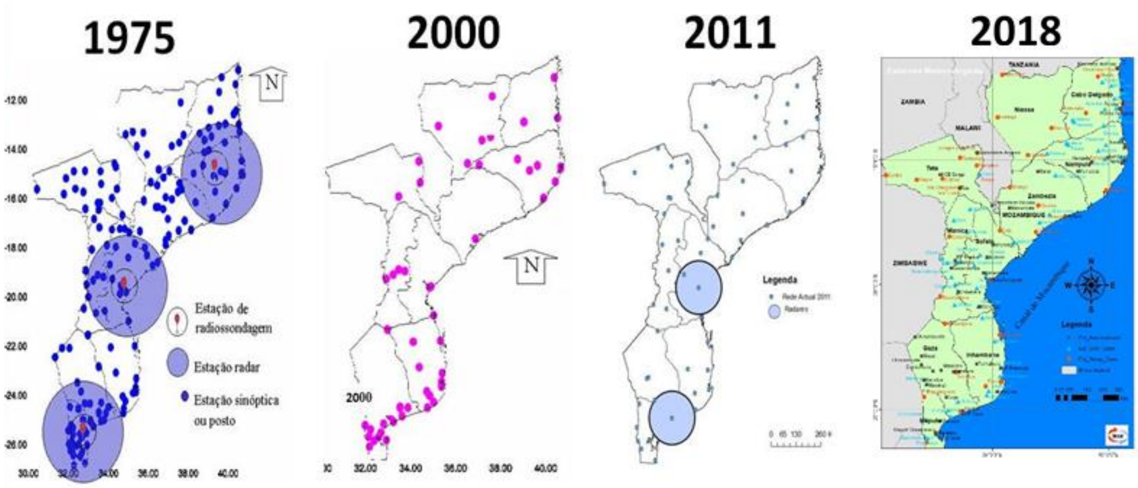


Figure 5.5: Spatial distribution of INAM station networks (see map) and the number of synoptic, climatological, agro-meteorological, aerological and radar stations (INAM, 2016).

Table 5. 4: Number of operational and non-operational synoptic, climatological and agro-climatic stations of INAM.

	Year			
Type of station	**1975**	**2000**	**2011**	**2018**
Synoptic stations	28	21	41 (29 Conventional 12 Automatic – inoperable)	62 (40 Conventional 22 Automatic)
Climatological posts	125	27	38	55
Agro-climatological posts	21	9	12	12
Air stations	3	0	0	1 non operational
Meteorological radars	3	0	2 non operational	2 non operational

Agro-climatic observations network

IIAM is the main national agrarian institution dedicated to research in the agricultural and livestock areas, having a network currently composed of 2 climatological, 17 agro-climatic and 3 odometric stations, as shown in Table 5.19. Of these stations, only 12 are operational, however, some equipment is obsolete and has not been calibrated for a long time.

Table 5. 5: Network of IIAM stations.

Type of station	Number
Climatological posts	2
Agroclimatological posts	17
Odometer posts	3
Total	22

Sea level observations network

The National Institute of Hydrography and Navigation (INAHINA) is the Mozambican institution (subordinate to the Ministry of Transport and Communications), responsible for installing and maintaining the tide stations, as well as for the acquisition, processing, archiving and dissemination of sea level data. This institution has a network made up of thirteen sea level observation stations, of which only four (Maputo, Inhaca, Inhambane, Beira, Quelimane, Chinde and Pemba) are currently in operation, which means that maintenance, acquisition, processing, archiving and dissemination are being done only for these stations.

The oldest records date back to the 1970s. Figure 5.6 shows the map of Mozambique with INAHINA tide stations operational. Data processing is being carried out in accordance with international standards, based on basic procedures for measuring and interpreting sea level (UNESCO, 1985). To standardize the tidal network, in 2005, Mozambique upgraded two GLOSS stations in Pemba and Inhambane, during the ODINAFRICA III project, in collaboration with INAHINA, SANHO and POL. The project was funded by the IOC, and the main purpose of this update was to record sea level to monitor coastal zones and the impacts of global change in Africa, providing near real-time observations of sea level.

The main reason for the non-functioning of the tide gauge network is related to the damage of some tide stations and equipment by port operators, particularly in Maputo, Beira and Pemba; the obsolescence of some equipment; lack of qualified operators and poor maintenance of oceanographic instrumentation. Lack of updating programs/software and equipment for observation, processing and validation of oceanographic data. In short, the number of permanent oceanographic observation points for a coastline of about more than 2,700 km is quite reduced.

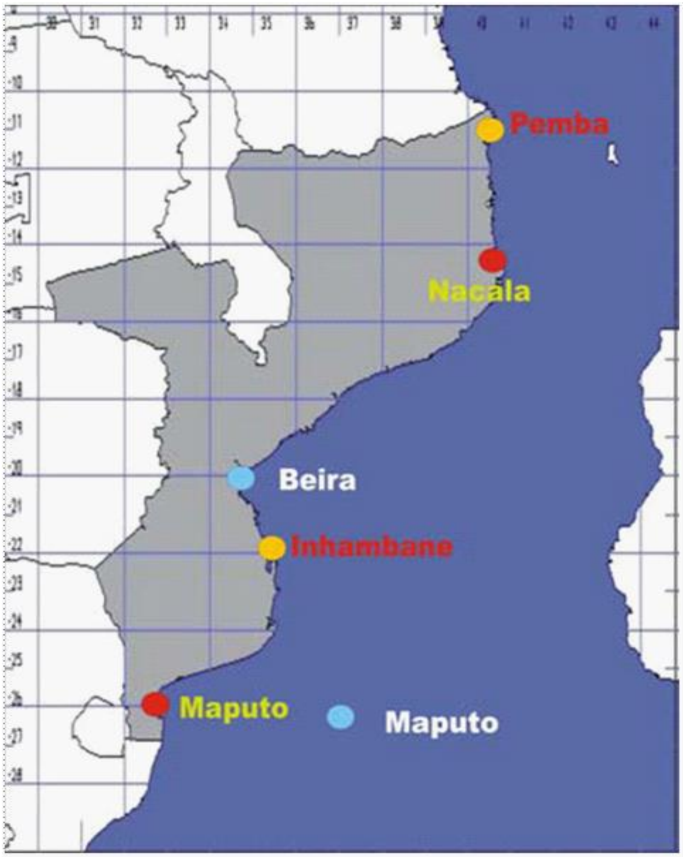


Figure 5.6: Operational INAHINA tide stations represented with colors to denote the different types of instruments installed.

Database

The policy of free access to essential meteorological data é facilitado for the provision of a public service of excellence defended by institutions providing data of public interest. These institutions archive historical data from conventional stations in the network and other sources of observation with several information, referring to daily measurements, in accordance with the international standards and techniques of the affiliated international organizations. The majority of institutions are committed with database management and have been progressively digitizing historical data with the support and financing from donor institutions. Tables 5.20 – 5.25 below show the variables stored in the different databases of institutions that carry out systematic observations in Mozambique.

Table 5. 6: INAM data observations.

Type of station		Observed data	Observation frequency
Synoptic		Wind (direction and force), Atmospheric pressure, Pitch evaporation, Tank evaporation, Insolation, Solar radiation (direct and diffuse), Air humidity, Dry air temperature, Maximum temperature, Minimum temperature, Minimum turf temperature, Depth temperature (de 10, 20, 50, 100, 200 and 300 cm), Precipitation, Soil status, Cloud cover (quantity and type of clouds), Visibility, Significant Phenomena (Fog, Mist, Mist, Thunderstorm, Lightning, Hail, etc.)	03, 06, 09, 12, 15, 18 e 00 Hours, Universal Time
Agro-meteorological		Wind (direction and force), Pitch Evaporation, Tank Evaporation, Insolation, Air humidity, Dry air temperature, Maximum temperature, Minimum temperature, Minimum turf temperature, Depth temperature (from 10, 20, 50, 100, 200 and 300cm), Precipitation, Soil State, Cloudiness (quantity), Visibility, Significant Phenomena (Fog, Mist, Mist, Thunderstorm, Lightning, Hail, etc.)	09, 15 e 21 Hours local time
Climatological	Station	Wind (direction), Atmospheric pressure, Pitch evaporation, Tank evaporation, Insolation, Solar radiation (direct and diffuse), Dry air humidity, Air temperature, Maximum temperature, Minimum temperature, Minimum turf temperature, Depth temperature (from 10, 20, 50, 100, 200 and 300cm), Precipitation, Soil State, Cloud cover (quantity and type of clouds), Visibility, Significant Phenomena (Fog, Mist, Mist, Thunderstorm, Lightning, Hail, etc.)	09, 15 e 21 Hours local time
	Post	Wind (direction), Tar Evaporation, Precipitation, Air Moisture, Dry Air Temperature, Maximum Temperature, Minimum Temperature, Cloudiness (quantity, Significant Phenomena (Fog, Mist, Mist, Thunderstorm, Lightning, Hail, etc.)	09h Local time
Automatic (ECA)		Temperature (dry air, maximum and minimum), Humidity, Precipitation, Atmospheric pressure, Wind (direction and force)	Hourly
Automatic (AWS)		Temperature (dry air, maximum and minimum), Air humidity, Solar radiation, Precipitation, Atmospheric pressure, Wind (direction and force), depth (10; 20; 50 and 100 cm)	Hourly

Type of station	Observed data	Observation frequency
Automatic (AWOS)	Wind direction and strength, Temperature (dry air, Maximum and minimum), Humidity, Atmospheric pressure, Precipitation, Solar radiation, Cloud cover (quantity, height of clouds), Visibility along the Runway and Visibility and present time	Hourly
Lightning Detectors	Dry air temperature, Air humidity, Solar radiation, Precipitation, Atmospheric pressure, Wind (direction and force) and detects lightning.	Hourly

Table 5. 7: IIAM data observations.

Type of station	Observed data	Observation frequency
Synoptic/Agro-meteorological	– Temperature – Precipitation – Wind – Pressure – Relative Humidity - Radiation – Evaporation – Satellite Data Access – soils	

Table 5. 8: DNGRH data observations.

Type of station	Observed data	Observation frequency
Meteorological and hydrological	– Precipitation – Evaporation – flow – hydrometric height – Water quality	

Type of station	Observed data	Observation frequency
	– Underground water (about 8000 holes until 2000)	

Table 5. 9: INAHINA data observations.

Type of station	Observed data	Observation frequency
Oceanographic	– Tides – Currents – Hydrographic surveys – Topographic surveys – Physical parameters of water – waves	

Table 5. 10: IIP data observations.

Type of station	Observed data	Observation frequency
	– Oceanographic (CTD: Conductivity, Temperature, Depth), – Nutrients – Sediments – Winds – Currents – Primary productivity – Marine mammals among others. – Data on commercial and subsistence fishing activity	

Table 5. 11: ONS data observations.

Type of station	Observed data	Observation frequency
Health data and indicators	– Socio-demographic – Health - programmatic – Meteorological/Weather – Environmental	

National early warning system

The national early warning system is coordinated by INGD, through the CENOE. This body, as coordinates emergency related actions and disaster response, works with 3 levels of surveillance, namely: surveillance without alert, partial alert and full alert. At the first level of alert, CENOE has a permanent system of service officers, exercising the functions of collecting and processing information in close coordination with the sectors listed in Table 5.26 and other relevant sectors.

Table 5. 12: Institutions involved in the Early Warning System and their functions.

Institutions	Activities	Functions in the Early Warning System
INAM-National Institute of Meteorology	Monitoring of meteorological conditions and climate events	Responsible for the provision of weather forecast, climate forecast (so far, forecast of precipitation behavior during the rainy season), provision of information in case of risk of occurrence of weather and climate events that may pose a risk to the country .
DNGRH-National Directorate of Water Resources Management	Hydrological monitoring and forecasting	Monitoring the situation of national river basins and providing information on floods in river basins
SETSAN-Technical Secretariat for Food and Nutrition Security	Monitoring of food situation	Responsible for the food security component
DNGM-National Directorate of Geology and Mines	Management and Research in the area of mineral resources	Responsible for the seismology component
MISAU-Ministry of Health	Monitoring of health aspects related to climate	Responsible for providing information on the occurrence of diseases particularly linked to the climate and for coordinating response actions.

This early warning system works particularly during the season of greatest frequency of weather and climate events that may contribute to the occurrence of disasters (rainy season in Mozambique: October-April). During this period, CENOE organizes weekly coordination meetings. However, the system is generalized, that is, it does not respond effectively to situations at the local level. To address this aspect, INGC, in collaboration with national and international institutions, is in the process of establishing EWS aimed at certain areas of greatest risk. This collaboration has established EWS for the hydrographic basins, where the Búzi EWS stands as one example of transferable best practice (INGC, 2009).

National Climate Outlook Forum

The National Climate Outlook Forum in Mozambique is coordinated by the National Institute of Meteorology (INAM) and involves the following national institutions:

- The National Institute of Meteorology (INAM);
- The National Institute for Disaster Risk Management and Reduction (INGD);
- The National Directorate of Water Resources Management (DNGHR);
- The National Institute of Health (INS);
- The National Directorate of Agriculture and Forests (DNAS).

This forum discusses and analyzes seasonal climate forecast and its implications for different sectors of national life.

5.3. Regional and international cooperation

Mozambique participates in various regional and international initiatives, whether in scientific committees/conferences and multidisciplinary projects/programs making contributions on the current stage of climate change science in the country and the region. Some of the projects/studies listed above are part of this contribution. On the one hand, in the chapter of systematic research, a number of cooperation agreements/memorandum of understanding, have bee signed by higher education institutions aiming for joint mobility programs for professors and researchers, publications including the development of projects, contributing for the promotion of research, particularly in the area of climate change. Some examples of country joint initiatives are listed below.

5.3.1. Cooperation agreements

Within the systematic observations, there are joint initiatives to highlight:

- **The Revised SADC 2000 Protocol, on Shared Watercourses,** intends that Member States exchange hydro-meteorological data for the purpose of cooperation, prevention and mitigation of the effects of floods.
- **Mozambique is also a signatory to the Zambezi Course Commission Agreement - ZAMCOM** (signed 2004, ratified 2011). The sharing of data from the Zambezi River is also the specific objective of the Memorandum of Understanding signed between Mozambique, Zambia and Zimbabwe in July 2011 ("MoU for collaboration in the exchange of information and data on river basin management in the three countries that share the Zambezi watercourse").
- **The Inco-Maputo Interim Agreement** signed in 2002 also known as the “Tripartite Inco-Maputo Agreement” and the Rovuma Agreement 2002, among others. ARA-Sul has agreements with the Department of Water Affairs (DWA) of South Africa, DWA of Swaziland, KOBWA and ICMA, through REMCO for data sharing and information exchange for the management of the Incomati River basin.

- Mozambique is an active member and signatory of international and regional climate monitoring platform initiatives for mutual collaboration in the field of meteorology, through INAM.
- **Mozambique is a member of the WMO** since 1976, is committed to promoting meteorology, forecasting and hydrological monitoring, providing observations to the global observations network.
- **Mozambique is a member of MASA** (Meteorological Association of Southern Africa) through INAM, of which the constitution dates back to 11 May 2009, and is associated with the African Center for Meteorological Application for Development (ACMAD). In addition, INAM is also a member of the SADC Drought Observatory (DMC), organized by the Botswana Meteorological Service.
- Mozambique signed, through INAM, a memorandum of understanding with the Meteorological Services of South Africa (SAWS). The memo covers technical assistance, research and training, particularly in Numerical Weather Forecasting.
- **Mozambique has participated in the cycle of Regional Climate Forecast Forums for Southern Africa (SARCOF)** for the elaboration of the seasonal climate forecast of the member countries and of consensus for different rainy seasons in the region.
- Mozambique has participated in regional meetings of ODINAFRICA and the Ocean Teacher Global Academy IOC-UNESCO, through the National Institute of Hydrography and Navigation (INAHINA).

5.3.2. International Observation Network Programs

In the framework of international observation networks programs, some of the initiatives Mozambique is taking part are presented as follows:

- **WIGOS Program** – WMO's Integrated Global Observation System, aims to integrate existing observation systems, in order to provide more efficiently and effectively the data/information necessary for the provision of services.
- **Program GCOS** – Global Observation System of Cima, ensuring the availability of observations and information related to the climate to potential users, Mozambique is the focal point of region 1.
- **OSCAR Surface Program** – It is an official repository of the world meteorological organization of WIGOS Metadata for all stations and observation platforms based on the surface.
- **Mozambique is a member of the Integrated African Health Observatory (OIAS)** and has the obligation, through the National Health Observatory (ONS), to collect information on systematic, programmatic and priority measurement indicators for the sector in order to feed the OIAS.
- Mozambique is part of an international partnership with WHO in the development of an Alert System for Climate-Sensitive Diseases (EWARS) based on a tool developed by WHO, as part of a project on Health Sector Resilience to Climate Change funded by FLANDERS and DFID.

5.3.3. Climate change programmes/projects

Mozambique has made efforts under the UNFCCC to reduce greenhouse gas emissions and adapt to the impacts of climate change. For this purpose, several actions and measures of adaptation and climate risk reduction, mitigation and promotion of low carbon development in line with NCCAMS, have been carried out by the GovM, through the implementation of several projects, in partnership with cooperation partners to achieve the objectives of the NDCs. International and national climate change funds will support the implementation of actions by the country's NDCs during their term.

Annex 6.8 lists all programs/projects that were implemented in the period between 2010 and 2016 in the adaptation and mitigation components in various geographic contexts of the country, as well as the support received for their respective implementatation and that have contributed to the implementation of the actions provided for in the NDCs as well as to the achievement of objectives of the Convention.

Communication and information sharing

According to the National Framework for Monitoring and Evaluation of Climate Change (CONDES, 2014), effective communication and sharing of information produced through monitoring, evaluation and learning activities are essential for evidence-based decision-making for the development of better climate change policies and more effective allocation of resources for investments aimed at responding to climate change threats and associated risks. The delay in establishing the climate change knowledge management center (CGCMC) in Mozambique, the institution proposed to deal with CC matters, does not guarantee access to its portal (created in 2016), from the public and other stakeholders.

The establishment of the CGCMC and the continued operation of this portal would ensure the visibility of Mozambique's efforts in the face of the challenges posed by climate change, at regional and international levels, through the publication of relevant information (e.g., adaptation programs/projects and mitigation measures implemented and approved for the country, summaries of climate science research results for policy makers, presentations at national and international events related to climate change, technical reports and articles, briefings to the media, data and information network).

5.4. Education, training and public awareness

Article 6 of the United Nations Framework Convention on Climate Change (UNFCCC) highlights that the 197 signatory parties commit to "the development and implementation of educational and public awareness programs on climate change and its effects" at the national level and international. Likewise, the parties to the Paris Agreement commit to improving education on climate change (Article 12). On the other hand, the Marrakesh agreements, contained in decision 2/CP.7, reafirm that capacity building for developing countries is essential to enable their full participation and effective implementation of their commitments under the Convention.

Despite the widely promoted commitments, recognitions and programs for the education sector, their implementation remains a challenge and requires coordination, support and resources. Yet it is the responsibility of governments to integrate climate change education at all levels and aspects of education systems. Despite the issue of climate change already being part of the national political and economic reality and with increasing press coverage and other "media", the majority of the population is still not sufficiently informed about the matter. The perception that exists is that climate change is a technical and complex issue, easy to be understood only by experts. Despite these difficulties, education, capacity development and public awareness activities related to climate change have been developed, albeit in a non-integrated and coordinated manner.

5.4.1. Climate Change in education and training subsystems

Education and training are recognized as strategic priorities in the development of human resources in key national instruments (For example, ECTIM, 2006; NCCAMS, 2013). However, both education and training on climate change in the country are not yet established as integral programes in the different education and training subsystems. Generally speaking, education and training on climate change at the level of these subsystems has been approached in isolation as part of a curricular subject in some educational institutions. NCCAMS recognizes the need to develop and integrate education curricula (formal and informal) and training on climate change. Its massification will require the development of coordinated curricula, involving the education sector and relevant institutions in the area of climate change, including the training of teachers/trainers. At higher education level, some initiatives exist that have ended up in the development of curricula that are being implemented in the area of climate change, although situations of isolated approach to this subject in the various educational establishments also persist.

5.4.2. Climate change in the sectors

At the sectoral level, the development of human resources is important both in terms of training and in terms of entry into advanced training programs offered in higher education. Sometimes, specific short-term training allows professionals to gain skills that help them solve specific and urgent concerns in their institutions. Generally speaking, training in this area is not institutionalized and its realization is often associated with the implementation of a projects/programs or initiatives developed on an ad-hoc basis.

5.4.3. Public awareness of climate change in Mozambique

The impacts of climate change observed in Mozambique often associated with the intesification of droughts, floods and tropical cyclones indicators and the increase in the dangerousness and destructiveness of extreme events combined with consequences on ecological and economic systems have drawn public attention to climate change.

In addition, government efforts in partnership with cooperating partners have significantly contributed to increase public awareness of climate change. For example, the implementation of the Pilot Program for Climate Resilience (PPCR) in Mozambique allowed, through its technical assistance project (2014 - 2016), the development of the first management platform content on climate change. This platform came to function as the

Climate Change Knowledge Management Center - CGCMC (www.cgcmc.gov.mz) after its official launch in 2016. Through this page, it was possible to disseminate significant and high quality of information of public interest related to climate change. That was disseminated trhough reports, publications, events, seminars, climate change projects/programmes, newsletters, policy briefs, including media and virtual social media (e.g., facebook, etc.).

In 2017, the USAID Coastal Cities Adaptation Program (CCAP) established a bridge with the PPCR program after the end of it on climate change activities. This was done particularly on public awareness with the aim of using and maximizing the existing knowledge and activities in the various national sectors. The Academy of Sciences of Mozambique (ACM), through a CGCMC appointed Committee, developed an online platform to conduct short courses and, subsequently implemented a one on climate change adaptation (CMA) and disaster risk reduction (DRR), with support from the CCAP Program. This course, the first of its kind, was launched, disseminated and implemented nationwide in 2018 for a significant number of beneficiaries.

Several associations and activists have been involved in public awareness campaigns on the need to preserve the environment and ecosystems in the face of ongoing climate change, as well as those projected by climate models and which give us an overal idea of what our future will be and what the consequences and implications will be facing.

National media such as radio, television, newspapers and other media and social networks have played a very important role in disseminating and informing about climate change since this matter became part of the national political and economic reality, in the various debates and public speeches and beyond. Table 5.29 shows some initiatives identified and framed in Mozambique's efforts at the level of “education, training (capacity) and public awareness” as a contribution to achieving the Convention's objectives.

Table 5. 13: Some initiatives identified and framed in the efforts of "Education, training (training) and public awareness", which contribute to the achievement of the Convention's Objective.

Name of the initiative	Objective(s) of the initiative	Institution that propmote	Date/Year
Communication, Education and Training Plan on Climate Change	Implement the Communication Plan at the national level in order to involve the maximum and diverse number of target audiences possible in understanding the issue of climate change - Decision makers, technicians, population in general, agricultural producers, children, teachers and educators, families, youth, seniors	MTA (ex. MITADER)	Included in the NDC Operational Plan and the NDC 2018 – 2021 Partnership Plan.
Launch of the online course on Adaptation to Climate Change and Disaster Risk Reduction	Support the development of a methodological guide to allow the populations to familiarise themselves with key procedures in the event of floods in their comunities.	USAID-CCAP, ACM, UEM	2018
Local seed production for drought resilience	Empower communities to produce seeds locally to improve productivity and food production under water-scarce conditions.	UNDP, IIAM	2018
Preparation of the course manual on Adaptation to Climate Change and Disaster Risk Reduction	Improve the responsiveness of educators, students, technicians and municipal managers, public and political decision-makers and other stakeholders in the face of climate change and disasters.	USAID-CCAP, UEM	2017-2018
Resilient homes for the residents of Ilha de Moçambique municipality	Empower the municipality's artisans to adapt to resilient construction techniques so that future homes can withstand in weather events situations;	USAID-CCAP, Municipality IM	2017-2018
Strengthening agricultural production capacities to deal with climate change to increase food security through the	Increase the capacities of Mozambique's agricultural and livestock sector to deal with climate change, through the scaling up and	IIAM, FAO	2015-2018

Name of the initiative	Objective(s) of the initiative	Institution that propmote	Date/Year
farmers' field school approach	adoption of climate change adaptation technologies and practices by farmers through a network of schools on the peasants' farm		
Integrating climate change adaptation into development planning – IAC Course 6	Integrate the response to climate change vulnerability in the process of designing policies and projects, with an emphasis on analyzing the feasibility of concrete adaptation measures - Mozambique (Macaneta).	IAC/Ex-MITADER	2016
Community Action Plans (CAP)	Increase resilience to the impacts of climate change in nine (9) communities - Mozambique (Matsequenha, Mahelane, Pinda, Ponte de Lúrio, Malingapansi, Messica, M'Bolera, Nhamassonge, Senga-Senga).	PACA/Ex-MITADER	2016
Training course (training) in climate change adaptation (AMC) and disaster risk reduction (RRD) for the municipalities of Quelimane, Pemba and Nacala-Porto	To train municipal managers and technicians, university professors and members of civil society organizations in cities in matters of AMC and DRR so that they can better face the challenges of MC in their municipalities.	USAID Coastal Cities Adaptation Program (USAID-CCAP), UEM, Municipalities P, Q & N-P	2015-2016
Preparation of the training course manual on Low Carbon Strategies - EBAC	Implement capacity development actions and capacities that contribute to the adoption of a Low Carbon development, through the strengthening of institutional capacity in matters of MRV and GHG, education and awareness; identification and sectoral integration of INDC	EBAC CAOS Project - Butterflies and Sustainability, Ltd. I and MITADER	2015
Development of the first climate change content management platform at the Mozambique	Strengthen the technical capacity of the GovM to integrate climate change resilience into the knowledge management and evidence-	World Bank-PPCR and MITADER	2014-2016

Name of the initiative	Objective(s) of the initiative	Institution that propmote	Date/Year
Academy of Sciences	demonstration component.		
Optimization of national hydro-meteorological monitoring and forecasting	Design and implement an optimized monitoring network and forecasting services for hydro-meteorological phenomena.	World Bank - PPCR, INAM, DNGRH	2014-2016
Integrating climate change adaptation into development planning - IAC MOZ COURSE 4	Implement Fast Start measures in Portugal, with funding from the Portuguese Carbon Fund – Mozambique (Zona Centro and Tete).	IAC/ex-MITADER	Setembro de 2015
Integrating climate change adaptation into development planning - IAC MOZ Course 4	Build capacity to integrate the response to vulnerability to climate change in the policy and project design process, with an emphasis on analyzing the feasibility of concrete adaptation measures.	IAC/ex-MITADER	Setembro de 2015
Training for the Development of Low Carbon and Resilient Strategies Course 1	Increasing Mozambique's capacity to define low carbon development strategies – Mozambique (Maputo).	EBAC/ex-MITADER	Março de 2015
Integrating climate change adaptation into development planning - IAC MOZ Course 1	Integrating climate change adaptation into development planning - IAC MOZ Course 1 Integrating climate change adaptation into development planning - IAC MOZ Course 1 Building capacities to integrate climate change vulnerability response into the policy and project design process, with an emphasis on analysis of the feasibility of concrete adaptation measures – Mozambique (Ilha de Moçambique).	IAC/ex-MITADER	Março de 2015
Assessing the feasibility of IAC adaptation options	Contribute to reducing vulnerability to the impacts of climate change – Mozambique	IAC/ex-MITADER	2015
Operationalization of the decisions of	Strengthen DNGRH's technical capacity on water	Water Resources and	2011-2015

Name of the initiative	Objective(s) of the initiative	Institution that propmote	Date/Year
the AMCOW[21] in the field of climate change by integrating water security and climate resilience issues into water resources planning and development processes.	security and climate resilience in water resources planning and development processes with certification by UNITAR.	Climate Development Program (WACDEP[22]), DNGRH	
Promote climate resilience livelihoods through agricultural production and sustainable management of land and water resources	Improve adaptation and resilience mechanisms to climate change, diversifying communities' livelihood options	IIAM	2011-2014
Problems and solutions for resilience and adaptation to climate change in Mozambique	Identify available knowledge and deepen understanding of the risks, impacts, vulnerabilities and adaptation responses to climate change in the agriculture sector in Mozambique.	UNDP, UCT, UEM	2015-2016
Climate Change Action Plan for the Fisheries Sector	Strengthen the control and management of fishing activity and underlying ecosystems, with a view to ensuring the renewal and sustainability of fisheries resources; establish coordination and communication mechanisms for the implementation of the Action Plan in marine protected areas; strengthen the management and protection of marine and coastal ecosystems;	IIP	

[21] Conselho Ministerial Africano sobre Água (AMCOW)

[22] WACDEP é um programa do Conselho de Ministros Africanos sobre Água (AMCOW) implementado pela GWP (Parceria Global da Água) e Parceiros a fim de realizar os compromissos relacionados às mudanças climáticas expressos pelos Chefes de Estado e de Governo africanos na Declaração de Sharm el - Sheikh de 2008 sobre água e saneamento.

Name of the initiative	Objective(s) of the initiative	Institution that propmote	Date/Year
	improve the development of aquaculture, sustainable and adapted to CC.		
Artisanal Fisheries Adaptation to Climate Change Project	Ensure the sustainable exploitation of fisheries resources and ensure the integrity of ecosystems	IIP, RARE	2014
Coastal Resilience to Climate Change	Strengthen Mozambique's capacity to manage access to fisheries resources and reduce poverty for coastal artisanal fishers, with the support of policies and institutions at national, provincial, district and local levels, and the immediate objective of demonstrating a scalable (gradual) approach to reduce vulnerability to climate change through improved fishing activities and management of natural resources.	Governo da Suécia - NDF/BM, MIMAIP, IUCN, RARE	2015-2019

6. Chapter 6: Constraints, Gaps, Financial Needs and Capacity Building Techniques

6.1. Constraints and Gaps

Mozambique has implemented initiatives that identified existing constraints and gaps both for the preparation of national communications, biennial transparency reports and NDCs and for mobilization of resources, formulating and implementing adaptation and mitigation actions, including cross-cutting actions. These initiatives also present the training needs required to overcome the identified gaps and constraints.

Annex 8.7 presents constraints and gaps identified in the context of the following initiatives: National Capacity Self - Assessment (NCSA) - NCSA - Thematic Report, National Adaptation Programmes of Action, Nationally determined contributions (NDCs) and its respective Implementation Plan that includes the needs submitted by the country to the NDC Partnership (NDC Partnership Plan 2018 – 2021) and in the process of preparing the SCN. In the process of updating the Second National Communication, the information produced in the following ongoing initiatives was considered:

- **Mozambique's First Biennial Update Report** (PBURM, funded by the GEF and implemented with assistance from UNEP) and Mozambique's
- **Mozambique's Long-Term Low Emissions Development Strategy 2020 – 2025** (formulated with support from the NDCP (NDC Partnership) – these two documents contributed to the updating of the chapter on national GHG inventories and the chapter on mitigation; and,
- **Technological Needs Assessment (TNA),** an initiative implemented with the support of UNEP-DTU that resulted in project ideas reported in this document including capacity building needs.

With the approval of ENAMMC in 2012, bases were created for the implementation of adaptation measures and climate risk reduction, in some sectors, especially agriculture, social protection, fisheries and health, having formulated their plans that integrate adaptation measures to climate change. At the same time, the Government, with the support of cooperation partners, started the process of formulating and implementing Local Adaptation Plans (PLAs), a process that promotes the participation of communities in the assessment of their vulnerabilities, identification and prioritization of measures that implemented will help to create the ability to deal with climate change. The Balance of Implementation of ENAMMC made in 2019 by the Government with the support of UNDP identifies the following weaknesses in the implementation of the Strategy:

1. The institutional framework designed at ENAMMC is outdated and did not function as a guide.
2. SNMAMC is not being implemented and this weakens ENAMMC because the scopes are not documented
3. Lack of Provincial Adaptation Plans that should culminate in a National Adaptation Plan
4. Poor implementation of PLAs due to limited funds;
5. Frequent technicians mobility among different sectors
6. Weak involvement/participation of the private sector
7. Poor implementation of legal instruments
8. Weak human resources capacity in the sectors to monitor compliance with legislation related to CC
9. Deficit of technicians for the area of CC
10. Dependence on partners to fund the implementation of PLAs
11. Centralization of inventories at the MTA level
12. Weak implementation capacity of ENAMMC actions
13. Change of Ministries and sectors that deal with MCs in the country
14. Lack of legal instrument for the GIIMMC (Weak inter-institutional coordination)
15. Non-implementation of the CC Network
16. Lack of a legal instrument that creates the CGCMC

Despite the institutional framework designed at ENAMMC being outdated and not function as a guide, its implementation resulted in the following strengths:

i. ENAMMC is a widely recognized and accepte document as a reference document for climate change in Mozambique
ii. Building of local resilience was identified as a priority for the first period and provided the basis for the preparation of PLAs
iii. The NDC action plan was drawn up using the ENAMMC framework and thus provided continuity and a strong link between the two instruments.
iv. The preparation of PLAs and their appropriation in some districts.
v. The existence of an enabling working environment among tecnhical teams at district, provincial and national levels (GIIMC)
vi. The availability of legal instruments in the environmental sector
vii. The integration of CM themes in courses implemented in national universities
viii. The Approval of the National REDD+ Strategy
ix. The ENAMMC's strategic vision

6.2. Capacity development needs

Through the capacity needs self-assessment initiative in 2008, Mozambique developed the National Capacity Building Plan (PNFC) for Effective Implementation of the three Rio Conventions (UNFCCC, CBD and UNCCD). Among several attributes, this plan was conceived to respond to the country's need to develop capacities at all levels, in order to translate the provisions of these international agreements for the promotion of sustainable development into its own instruments, integrating them into national development policies and strategies. In Mozambique, climate change is viewed as one of the areas that requires capacity development at all levels.

Despite the efforts developed through the PNFC and other initiatives, there is still limited information about which institutions and individuals are involved in activities linked to climate change, much less their potential in the country. A survey at the national level could help Mozambique to capture this dimension and assess the actual existing capacity and make use of it, in the effective implementation of the various climate change programs that increasingly demand more qualified human resources. The roadmap on capacity development needs described below is based on the findings obtained through the components of this communication, namely, national GHG inventories, mitigation measures, adaptation measures and other relevant information (technology transfer, research and systematic observations).

This survey is oriented towards having a concrete idea of the technical institutional capacity and introduce the necessary improvements, in order to implement the activities foreseen in the various components of the national communications, in a more effective way, to achieve the Convention's objectives. On the other hand, the NDC 2018-2021 partnership plan contains the needs (financial, technological and technical) identified by the sectors with actions and/or responsibilities in the NDC for its execution in the context of climate action.

6.2.1. Capacity building needs for carrying out greenhouse gas inventories

In general, in the component of national GHG inventories, three main constraints related to the process of preparing and updating GHG inventories were identified: Deficient sectoral statistics, lack of specific emission factor sectors and deficient knowledge of GHG inventory techniques. On the other hand, the lack of knowledge and skills on inventory techniques suggests that it is the most limiting factor of all. **Table 6.1** presents in more detail the main constraints and capacity development needs including target institutions in the energy sectors; industrial processes and product use; agriculture, forests and other land uses; and waste.

6.2.2. Capacity building needs for climate change adaptation

In the climate change adaptation component, several constraints and capacity development needs were also identified. The most common constraints related to the eight adaptation sectors covered include lack of data from different sectors; and the lack of knowledge about climate change, its impacts and other associated matters. In this context, it is suggested to carry out a comprehensive training program /qualification of national technicians in the formulation and management of projects that contribute to the mobilization of climate funds and others, including the strengthening of institutional capacity, particularly in the development of data infrastructure to support adaptation activities. It is also suggested that there should be training and capacity development programs in more specific aspects and needs of each sector. **Table 6.2** presents in more detail the main constraints and needs for training and capacity development including target institutions in the energy sectors; infrastructure; coastal areas; agriculture; livestock and pastures; forests; fisheries; biodiversity and waste.

6.2.3. Capacity development needs for climate change mitigation

In general, the climate change mitigation component, identified several constraints and capacity development needs. The most common constraint related to the four mitigation sectors covered is the "weak capacity to design projects to access climate funds". Not less important is also the "lack of databases/statistics". In this context, it is suggested to carry out a comprehensive training/capacity development program for national technicians in the formulation and management of projects that contribute to the mobilization of climate funds and others, including the strengthening of institutional capacity, particularly in the development of data infrastructure to support mitigation activities. It is also suggested that there be training and capacity development programs in more specific aspects of the needs of each sector. **Table 6.3** presents in more detail the main capacity building constraints including target institutions in the energy sectors; industrial processes; agriculture, forests and other land uses; and waste.

6.2.4. Capacity development needs for technology transfer

In the context of technology transfer, several constraints and capacity development needs were also identified as follows:

(i) In the infrastructure and coastal zones sector (flood early warning system; beach nourishment and mangrove restoration), as described in the TAP Infrastructure and Coastal Zones (ICZ)report (2018). The technological options in this sector highlights the lack of trained technicians, at national level, to implement the technology; limited institutional and organizational capacity for technology implementation, as the most common constraints found in technology implementation. **Table 6.4** presents in more detail the main constraints and capacity development needs including the target institutions identified in ICZ sector;

(ii) In the electricity generation subsectors (solar photovoltaic systems; conventional gas combined cycle; and regular scale hydraulic/hydroelectric turbines); and solid waste management and treatment (landfill with biogas production; bioreactor landfill for biogas production; and pyrolysis), as described in the TAP Energy & Waste report (2018). The technological options of the electricity generation and solid waste management and treatment subsectors highlight the shortage of specialists and the difficulty in recruiting qualified labor as the most common constraints found in the implementation of technologies in the electricity and generation subsectors. Treatment and management of solid waste. **Table 6.5** (electricity generation) and **Table 6.6** (waste) presents in more detail the main constraints and capacity development needs including the target institutions identified in these sectors;

(iii) In the agriculture sector (seed production and conservation and promotion of low-cost storage systems for seeds and grains; conservation agriculture and rainwater harvesting and conservation), as described in the TAP Agriculture report (2018). The agricultural sector's technological options highlight the lack of specialists, lack of practices and weak technical skills; lack of integration of agricultural content and specialized techniques in the courses offered by most agricultural training institutions, as the most common constraints found in the implementation of technologies. **Table 6.7** presents in more detail the main constraints and capacity development needs including the target institutions identified in this sector.

6.2.5. Capacity development needs for research and systematic observations

Both observations and the research present as main constraints the low level of funding for these areas and the lack of qualified human resources. It is necessary to rethink the vast dimension and complexity of environmental problems in the country and on the doubled gains that may arise from investing in the massive training of qualified human resources in the areas of research and observation, particularly from institutions which are the data providers or users of meteorological, hydro-meteorological, hydrographic, agro-meteorological and public health surveillance, including equipment for processing and analysing the observed data.

Just as an example, an early warning system to be effective and able to properly inform requires an observation network with good coverage along with adequate infrastruture and platforms capable of transmitting data in real time. Despite its geographical location prone to extreme destructive events, Mozambique continues to rely on much external support to make its predictions. There is also a lack of climate, hydrological and weather forecasting models including qualified human resources to work with these platforms. In most cases such working environment and facilities require huge financial resources and adequate international assistance which will require support for mobilization.

Table 6.8 shows the main constraints and capacity development needs in the targeted institutions, namely, INAM, DNGRH, IIAM, IIP, INAHINA and ONS; Tables **6.9 – 6.10** show actions taken at the level of ministerial and sectoral levels; and **Table 6.11**, the list of projects to be developed and financed and to include in the implementation of Mozambique's Nationally Determined Contribution (NDC).

Table 6.1: Main constraints and capacity development needs identified for conducting greenhouse gas inventories (GHG).

Source: SCN Review Report - 2020 Greenhouse Gas Inventories Component.

GHG inventories	Constraints	Capacity development needs	Target group
Energy	• Lack of databases on production, import, export and national consumption of energy and fuels; • Lack of stratification of the National Automobile Park, Transport Sector (Road, Maritime and Air);	• Strengthening the capacities of relevant sub-sectors to produce specific, reliable and consistent statistics; • Design and application of an appropriate database and its effective management, at different levels; • Creation of an updated Modern Sectoral Registration System	MIREME, MTA, INE, Energy Sector Companies
Industrial Processes and Product Use	• Lack of database with credible and consistent industrial statistics: ○ Production, import, export, etc.; ○ Quality and diversity of the national industrial park; ○ Classification and quantification of the national industry and its products	• Training in the preparation of industrial statistics • Creation of a database on sectoral imports and imports, their production and their inputs (raw materials used) as well as production statistics (eg, energy and financial intensity of production); • Modernization and update of the Industrial Park Register	MIC, MTA, INE, Companies of the National Industrial Sector
Agriculture, Forests and Other Land Uses	• Database with deficient stratification and still under development; • Poor quality of currently available data; • Dependence on reports produced by international organizations on sector statistics	• Training: ○ In methodologies for estimating deforestation and forest degradation; ○ To interpret and quantify data obtained via satellite with due precision; ○ In the management of forestry and agriculture databases (agrarian statistics)	MASA, MTA, INE, INIA, INIVE, IIAM
Waste	• Lack of characteristic data: generation and composition of Waste and Effluents generated in the country (urban, rural and peri-urban environments)	• Training for: ○ Characterization, quantification and registration of waste, effluents produced in the country and treatment technologies; ○ Creation of an effective database on the production,	MTA, ANMM, Municipalities; district authorities;

		management and treatment of waste and effluents	SDAE
General	• Deficient Sectoral Statistics (deficient data stratification); • Lack of specific Emission Factors for national circumstances; • Deficient knowledge of GHG inventory techniques	• Training for the development and management of Databases for the Mass and Energy Balances of the Sector; • Training of IES and research institutions for the development of specific FE for Mozambique; • Training HEIs in GHG inventory techniques including the use of IPCC software for national GHG inventories (creation of a specialized inventory unit to advise sectors and lead national inventories)	IES, MTA, MCTESTP, Nacional Research institutions; INE; National Economy Sectors

Table 6.2: Main constraints and capacity development needs for climate change adaptation.

Source: SNC Review Report - Adaptation Component 2020.

Adaptation	Constraints	Capacity development needs	Target group
Energy	• Installation of infrastructure (transmission towers, poles) without due regard for the risks to atmospheric phenomena; • Dependence of a considerable part of the population on the use of charcoal and firewood as an energy source.	• Development of climate resilience capacity building programs and projects in the energy sector; • Intensify inspection both in the production as well as in the sale of charcoal and firewood	MIREME, MTA
Infrastructure	• The relevance in prioritizing infrastructure for construction and rehabilitation is defined at the central level, driven by criteria related to economic development, leaving some gap in the prioritization component of the MC component; • Housing infrastructures evolve without observing their quality, and part of them without complying with the framework of territorial planning; • Weak level of security in housing infrastructure.	• Training in critical infrastructure assessment matters at country level, including its level of criticality; • Training in assessing the degree of resilience of infrastructures to extreme events; • Training of those involved in the process of monitoring the multiple activities of urbanization and occupation of urban land; • Promote comprehensive training of populations on building infrastructure that is more resilient to extreme weather events.	MOPHRH
Coastal Zone	• The integration of different sectors and actors in coastal areas is still incipient, despite the availability of several legal instruments to regulate the set of activities carried out in these areas. • The impacts of CC on the coastal areas as well as extreme events are still managed in a fragmented way, and there is a weakness in the inclusion of these within the perspective of the	• Need for practical training in the integrated approach, to be applied in coastal areas. • Training in the component of tools for the holistic and integrated analysis of multiple factors, as well as in the long-term perception of the perspective of landscape changes; • Training in the area of quantifying groundwater for each region, monitoring the sustainable use of water resources and determining the	MOPHRH, MIMAIP

	management of coastal areas. • Little approach has been made about groundwater in coastal areas, its availability and sustainability in the face of possible over-extraction given the increase in population in these areas.	sustainable flows of water resources to be extracted.	
Agriculture	• Lack of database on the practice of climate-smart agriculture techniques • Weak knowledge about the tolerance of different cultures to climate change • Weak capacity to design projects to access climate fund	• Capacity building for institutions to carry out research on the relationship between crop productivity and climatic variables • Capacity building in agricultural database management • Training extension workers on climate-smart agriculture	MADER
Livestock and pastures	• Lack of data on the impact of climate change on the productivity of grazing animals • Weak knowledge of pasture management and forage conservation	• Capacity development for institutions to carry out research on the relationship between animal productivity and climate variables • Training of producers and extensionists on pasture management and forage conservation	MADER
Forests	• Lack of data on deforestation rates at the local level • Weak capacity to design projects to access climate funds	• Training in methodologies for estimating deforestation and forest degradation	MTA
Fisheries	• Scarce studies on the impact of climate change on fisheries resources • Scarcity of resources for the practice of sustainable fishing	• Capacity development for research institutions and fisheries administration for research and promotion of good fishing practices	MIMAIP
Biodiversity	• Weak knowledge of the impact of climate change on different components of biodiversity	• Capacity building of institutions to carry out research on the impact and response of biodiversity components to climate change	MTA MIMAIP

Waste	• There is a weak sharing of methodologies and experiences in the matter of solid waste management at country level by the municipalities and district administrations; • The inventory of data on solid waste does not exist or is not systematized at national level; • Populations deposit waste with no interest to select according to waste classification; • Weaknesses in compliance with hazardous waste management procedures in industries and mining activities.	• Sistematic training to ensure standardized type of waste throughout the country. • Ensure that each district or municipality begins to characterize and inventory the waste produced, so that they form part of national statistics; • Capacity building of the population in matters of waste management; • Training to increase the monitoring of the waste management system in industries.	MTA, Munipalities
General	• Lack of database of different sectors • Lack of knowledge about climate change, its impacts and other associated matters	• Development of an effective database for the various sectors needs • Capacity developmentg on climate change and impacts for the various sectors needs	

Table 6.3: Main constraints and capacity development needs for climate change mitigation.

Source: SNC Review Report - Mitigation Component 2020.

Mitigation	Constraints	Capacity development needs	Target group
Energy	• Lack of production, import, export and consumption databases for the sector • Weak capacity to design projects to access climate funds • Weak capacity to develop sector strategies and policies	• Training for the development and management of data bases for Energy Balances • Training in the use of mitigation analysis tools such as Low Emissions Analysis Platform (LEAP) and Greenhouse Gas Abatement Cost Model (GACMO). • Training with a view to active participation in the formulation of sector policies • Development of a data infrastructure	MIREME, MTA
Industrial Processes	• Lack of legal instruments for inspection and regulation of industrial activity, in order to control compliance with national and international environmental legislation • Lack of industrial statistics	• Training in environmental matters in the process of drafting legal instruments for the sector • Training in the preparation of industrial statistics • Development of a data infrastructure	MIC, MTA
Agriculture, Forests and other Land Uses	• Weak capacity to design projects for access to climate funds (eg cement, minerals, etc.)	• Training in deforestation and forest degradation estimation methodologies • Training in forestry and agriculture database management	MTA, MADER
Waste	Weak ability to design projects to access climate funds	• Training to conduct research and research in the waste sector; • Training institutions for collecting, processing and systematizing information and creating a database on studies carried out in this area; • Train national technicians in the formulation and management of projects that contribute to the	MTA, Municipalities

		mobilization of climate funds and others. • Training for monitoring, reporting and verification (MRV), including the effects of policies, strategies, plans and projects • Training to attract the participation of the private sector and civil society in the development of waste management projects	
General	• Weak capacity to design projects to access climate funds • Lack of sectoral data and statistics	• Training for national technicians in the formulation and management of projects that contribute to the mobilization of climate funds and others. • Development of a data infrastructure	

Table 6.4: Main constraints and capacity development needs for technology transfer in the technological adaptation options selected in the Infrastructure and Coastal Zones (ICZ) Sector.

Source: Adapted from the TAP-I&ZC 2018 report.

Coastal Zone and Infrastructure	Constraints	Capacity development needs	Target group
Flood early warning system	• Insufficient network of meteorological, oceanographic and hydrological stations to allow the acquisition of observed data for the initialization and calibration of numerical weather forecast models • Lack of maintenance and need to expand the radar network • Lack of knowledge regarding the acquisition, processing and validation of meteorological data obtained by satellites	• Improve and expand the network of observation stations, including radars and ensure procurement and maintenance services • Technical training in meteorological, hydrological and oceanographic observation • Training in satellite observation data processing and analysis • Training in the transmission of river and oceanographic meteorological information • Training in numerical modeling, which includes	Coastal Municipalities INAM, INGD, DNGRH, END, Academia

	• Lack of an efficient system for transmitting meteorological, oceanographic and hydrological data and information in real time for national and international consumption • Absence of a model (precipitation, wind, etc.) adjusted to local conditions. Existence of hydrological models developed only for the Umbelúzi, Maputo, Incomati, Licungo, Zambezi and Limpopo basins • Limited technical capacity at local and central level for the implementation of Flood EWS activities or mapping at district or local level	the use of numerical models adjusted to local conditions • Establishment of regional weather forecasting centers, which allow forecasts and mappings to be carried out at a smaller scale, (up to district scales) • Technical training in flood EWS that includes the mapping of flood risk zones.	
Beach nourishment	• Deficit of trained technicians, at national level, to implement the technology and the need to hire foreign specialists. • Absence of an institutional mechanism to regulate Beach feedback • Limited institutional and organizational capacity • Lack of experience and practice in beach management • Low levels of technical capability, and/or limited access to required equipment.	• Improve the technical capacity and management of beach feedback projects at the level of coastal municipalities and at the central level in matters of feasibility studies and the implementation of beach feedback projects. • Establishment of an institutional mechanism with technical and financial resources at the same time, which regulates and promotes, at national level, the practice and implementation of coastal protection technologies such as the Refeeding of Beaches. At provincial and district level, with coastal and beach management responsibilities at a local level.	Coastal Municipalities, MTC, MOPHRH, MIMAIP, OEM, MITADER, MCTESTP, Academy
Mangrove restoration	• Lack of knowledge about the specifics (amount of water, substrate that provides growth, the appropriate climate for certain species, etc.) suitable for planting and growing mangroves • Lack of knowledge in institutions that carry out	• Establishment of capacity building programs for stakeholders (Local community, and technicians from government institutions) in the mangrove restoration process in matters about specific specificities for mangrove planting and growth.	Coastal Municipalities, MTC, MIMAIP, MITADER, MCTESTP,

	mangrove reforestation/restoration • Lack of inter-institutional coordination to facilitate the optimization of resources for capacity building, financing and implementation of mangrove restoration initiatives	• Establishment of an institutional mechanism, which optimizes the resources existing in the different institutions in Mozambique, improves the dissemination of existing knowledge on mangrove reforestation • Elaboration of an instrument that regulates the entire process of Restoration of Mangroves in the country, as well as improves the mechanisms of inter-institutional coordination, and through this make the reforestation of mangroves effective.	Academia
General	• Deficit of trained technicians, at national level, to implement the technology • Limited institutional and organizational capacity for technology implementation	• Improve the capacity of national technicians in the different technological options foreseen for the implementation of technologies in the infrastructure sector and coastal areas • Strengthening institutional capacity for the implementation of technologies in the infrastructure sector and coastal areas	Coastal Municipalities, MTC, MIMAIP, MITADER, MCTESTP, Academia

Table 6.5: Main constraints and capacity development needs for the transfer of technology in the technological mitigation options selected in the Electricity Generation Subsector. Source: Adapted from the TAP-Energy & Waste 2018 report.

Electricity generation & Solid waste	Constraints	Capacity development needs	Target group
Electricity generation subsector: photovoltaic solar systems	• Inability to mobilize financing for the photovoltaic electricity generation sector • Deficit of "know-how/knowledge" at national level • Lack of specialized training institutions • Lack of competent local human capital development plan • Deficient legal framework and difficulty in enforcing the law • Lack of capacity to offer technological services nationwide	• National training in the design of electricity generation projects with appropriate technologies to mitigate GHG emissions • Consistent program of specialized training and targeted recruitment • Partnership agreements with training and research institutions • Creation of operational instruments that guarantee institutional consolidation • Strengthening institutional capacity • Creation of incentives and training for small and medium-sized companies to provide technical assistance services	MIREME, EDM, INP, MCTESTP, Academia
Electricity generation subsector: Conventional gas combined cycle	• Lack of "know-how/knowledge" at national level • Lack of systematic human resource development plan • Lack of specialized training institutions	• Establishment of partnerships with specialized training and research and research institutions • Human resources development plan • Mobilization of financial resources for the creation of competent research centers in energy technologies	MIREME, EDM, INP, MCTESTP, Academia
Electricity generation subsector: Regular scale hydraulic/hydroelectric turbines	• Lack of "know-how/knowledge" at national level • Lack of systematic human resource development plan • Lack of specialized training institutions	• Establishment of partnerships with specialized training and research and research institutions • Human resources development plan • Mobilization of financial resources for the creation of competent research centers in energy technologies	MIREME, EDM, INP, MCTESTP, Academia

General	• Lack of specialists in the different technological options selected for the implementation of technologies in the subsectors of electricity generation • Difficulty in recruiting qualified/competent labor	• Criação de uma capacidade local de prestação de serviços técnicos; parcerias com instituições de pesquisa e formação profissional • Elaboração e implementação de um plano director de capacitação institucional • Creation of a local capacity to provide technical services; partnerships with research and professional training institutions • Development and implementation of a master plan for institutional capacity building	ANMM, EDM, MTA, MCTESTP, Academia

Table 6.6: Main constraints and capacity development needs for the transfer of technology in the technological mitigation options selected in the Solid Waste Subsector. Source: Adapted from the TAP-Energy & Waste 2018 report.

Solid waste	Constraints	Capacity development needs	Target group
Solid waste subsector: Landfill with biogas production	• Deficit of experts on landfill with landfill gas generation in Mozambique • Difficulty in recruiting qualified/competent labor	• Creation of a local capacity to provide technical services; establishment of partnerships with research and professional training institutions • Elaboration and implementation of a master plan for institutional capacity building	ANMM, EDM, MTA, MCTESTP, Academia
Solid waste subsector: Landfill bioreactor for biogas production	• Deficit of experts on landfill (bioreactor) with landfill gas generation in Mozambique • Difficulty in recruiting qualified/competent labor	• Creation of a local capacity to provide technical services; partnerships with research and professional training institutions • Development and implementation of a master plan for institutional capacity building	ANMM, EDM, MTA, MCTESTP, Academia
Solid waste subsector: pyrolysis	• Specialist deficit on treatment of MSW by pyrolysis in Mozambique • Difficulty in recruiting qualified/competent labor	• Creation of a local capacity to provide technical services; partnerships with research and professional training institutions • Elaboration and implementation of a master plan for institutional capacity building	ANMM, EDM, MTA, MCTESTP, Academia
Geral	• Lack of specialists in the different technological options selected for the implementation of technologies in the subsectors of solid waste treatment and management • Difficulty in recruiting qualified/competent labor	• Criação de uma capacidade local de prestação de serviços técnicos; parcerias com instituições de pesquisa e formação profissional • Elaboração e implementação de um plano director de capacitação institucional • Creation of a local capacity to provide technical services; partnerships with research and professional training institutions • Development and implementation of a master plan for institutional capacity building	ANMM, EDM, MTA, MCTESTP, Academia

Table 6.7: Main constraints and capacity development needs for technology transfer in the selected adaptation technology options in the Agriculture Sector. *Source: Adapted from the TAP-Agriculture 2018 report*

Technology options	Constraints	Capacity development needs	Target group
Seed production and conservation and promotion of low-cost storage systems for seeds and grains	• Low quality of basic seed used to produce certified seed.	• Training extension workers and farmers in the production, handling and conservation of seeds. • Training local artisans to manufacture some of the storage systems, such as metal silos.	MEF; IIAM; UEM/FAEF; Development partners;
Conservation agriculture	• Low quality of the basic seed used to produce certified seed. • Low quality of basic seed used to produce certified seed. • Limited human and technical capacities to conduct research, adequate, technology demonstration and appropriate assistance to farmers in the transfer and diffusion process of Conservation Agriculture (CA). • Weak government and international donor investment in agricultural sector research and training. • Lack of technical and communication skills on the part of the existing technical staff (agronomers and extensionists) to ensure	• Development of a human resources training program to strengthen and improve scientific and technical skills in CA and assess perceptions of appropriate technologies and practices and their adaptability in the agricultural context. • Promotion of investment and capacity building in research and development (R&D) to identify techniques and practices appropriate to the local context, which help in the identification and production of cover crop seeds with private sector involvement, producing evidence of the advantages of CA over conventional agriculture and development of CA technology packages. • Conduct participatory research and training approaches to bridge the gap between research	Coastal Municipalities, MTC, MOPHRH, MIMAIP, OEM, MITADER, MCTESTP, Academia

	research and promotion of CA in the country. • Lack of integration of conservation agriculture content in courses offered by most agricultural training institutions. • Absence of practical classes in non-degree training that would serve to develop practical skills and experience on how to conduct demonstration batches to promote CA. Non-degree training is generally carried out for extension staff by different institutions that promote CA.	and farmers' CA implementation. • Training in technical and ecological principles of CA to carry out research and transfer techniques and practices considering each context. • The provision of technology transfer approaches and appropriate CA techniques involving participatory learning methods with the involvement of extension agents, research institutions, NGOs and farmers organized or not in associations. • Raising awareness among producers and the public about climate change can help to overcome personal attitudes and misconceptions related to barriers to adopting CA. • Promotion of collaboration between public research institutions, universities, the private sector, extension services, farmers and experts should be promoted and strengthened to improve the transfer and diffusion of technology and knowledge. • Development of curricula in secondary, technical and higher education institutions that teach agriculture.	
Rainwater harvesting and conservation	• Lack of highly qualified human resources to carry out mapping, construction and maintenance of large rainwater collection and conservation systems (RWHC). • Lack of national training institutions dedicated to mapping, building and maintaining large RWHC systems.	• Integration of “rainwater harvesting and conservation issues” into curricula at different levels of education as adaptation for drought resilience. • Training in construction, management and maintenance of large RWHC systems. • Creation of infrastructural conditions to carry out	MEDH; MESTP; MASA; MOPHRH; Academia

	• Lack of trained personnel to manage and maintain large RWHC systems. • Lack of trained personnel to manage and maintain small RWHC systems.	training aimed at mapping, construction and maintenance of large rainwater capture and conservation systems • Training in construction, management and maintenance of small RWHC systems.	
General	• Lack of specialists, lack of practices and weak technical skills in the different technological options selected in the agriculture sub-sectors in Mozambique • Lack of integration of agricultural content and specialized techniques in courses offered by most agricultural training institutions.	• Development of curricula in secondary, technical and higher education institutions that teach and train agriculture with a strong practical and technical component. • Integration of agricultural content and respective specialized techniques in curricula at different levels of education in agricultural training institutions.	MEDH; MESTP; MASA; MOPHRH; Academia

Table 6.8: Main constraints and capacity development needs for research and systematic observations.

Source: Adapted from institutional documents consulted in November 2020.

Research and s. observations	Constraints	Capacity development needs	Target group
Meteorological observations and station network	• Network of conventional and automatic weather stations still in insufficient number • Lack of maintenance and consumables for weather stations • Lack of spare sensors for weather stations • Lack of availability of real-time forecast models • Lack of availability of coastal flooding models taking into account the threats of storm-induced sea level rise and mean sea level rise caused by global warming	• Increase in the volume of projects for the installation of more meteorological stations, including staff training to ensure their maintenance and operability • Develop projects that guarantee the acquisition and sustainability of spare parts. • Advanced and continuous training in modeling and involvement of research institutions in testing weather forecasting and coastal flooding models.	INAM
Hidro-climátic observations and station network	• Network of hydro-climatic stations still in an insufficient number, and little availability of equipment for automatic transmission of data on precipitation, runoff, flow and hydrometric level of rivers. • Poor availability of real-time hydrological flood forecasting models for river basins and vulnerable regions. • Vandalization of some installed stations; • Lack of financial resources for the operation and intervention in the secondary and primary network; and lack of appropriate computer equipment for information management.	• Increase in the volume of projects for the installation of more meteorological stations, including staff training to ensure their maintenance and operability • Promote ongoing awareness campaigns in communities about the importance of installed stations and the offense represented by their vandalization under the law • Increase in the volume of projects for the acquisition of network accessories and IT equipment, including staff training to ensure their maintenance and operability	DNGRH
Agro-climatic observations and	• Network of agro-climatic stations still in insufficient number, and little availability of	• Increase in the volume of projects for the installation of more Agro-meteorological	IIAM

Research and s. observations	Constraints	Capacity development needs	Target group
station network	automatic data transmission equipment.	stations, including staff training to ensure their maintenance and operability	
Oceanographic observations and network of stations	• Network of oceanographic stations still in insufficient numbers, and little availability of automatic data transmission equipment	• Increase in the volume of projects for the installation of more tide and oceanographic stations, including training of personnel to ensure their maintenance and operability	IIP
Tidal and oceanographic observations and station network	• Network of tidal and oceanographic stations still in insufficient number (eg, digital tide gauges, ondographers and ADCP) and remote, automatic and real-time transmission of oceanographic data • Tidal observation stations and equipment damaged by port operators (Maputo, Beira and Pemba) • Lack of updated software and equipment for the observation, processing and validation of oceanographic data • Weak command of oceanographic instrumentation; • Lack of availability of coastal flood models taking into account the threats of mean sea level rise caused by global warming	• Promote ongoing awareness campaigns among the targeted operators, including surrounding communities, on the importance of installed stations and the offense represented by their vandalization under the law • Continuous training of personnel in various aspects such as observation, data processing and validation and mastery of instrumentation, including its maintenance and operability	INAHINA
Climate and environmental observations	• Shortage of human resources in the area of climate parameter observations • Weak laboratory capacity for diagnosing climate-sensitive diseases (other than malaria and diarrheal diseases).	• Continuous training of staff in various aspects such as observation, processing and data validation • Increased volume of projects to expand laboratory capacity in climate-sensitive disease diagnostic equipment, including staff training	ONS

Research and s. observations	Constraints	Capacity development needs	Target group
		to ensure its maintenance and operability	

Table 6.9: Actions at the ministerial level to be included in the implementation of the Nationally Determined Contribution (NDC) of Mozambique.

Gov. Ministry	Actions to be included
Ministry of Land and Environment (MTA)	• Support to the development of the First Nationally Determined Contribution - NDC of Mozambique (2020 - 2025); • Support to the development of the National Adaptation Plan of Mozambique NAP; • Strengthening sector coordination and hiring a national coordinator; • Strengthening of existing coordination mechanisms between government institutions and development partners; • Support the development of incentives to attract the private sector and civil society to participate in the development of initiatives that contribute to climate change adaptation and mitigation; • Support in the updating and operationalization of the National System for Monitoring, Reporting and Verification of actions and support, within the framework of transparency of the Paris Agreement; • Strengthening of skills and tools for sectors with responsibility for data collection and reporting; • Formulation, management and implementation of projects related to climate change; and, • Strengthening of technical and institutional capacity for the formulation, management and implementation of projects related to climate change; and, • Supporting dissemination, awareness and public awareness programs on NDC and climate change issues in general. • Support in the design of Indicators for Measurement of Greenhouse Gas Emissions in the main sectors.
Ministry of Economy and Finance (MEF)	• Strengthening the capacity of the Designated National Authority - NDA in the design, analysis of projects and strategies for resource mobilization; • Support in the alignment of NDC performance indicators, National Strategy for Adaptation and Mitigation of Climate Change, National Adaptation Plan, Green Economy, Sustainable Development Objectives, among other relevant ones; • Support in the development of the Planning and Budgeting Subsystem - SPO a Reform in Progress on a single platform; • Support the development of a system to track extra budget in flows and expenditures for climate change actions; • Support the capacity to mobilize resources from various funding sources for Climate Change in the Mitigation and Adaptation component; • Strengthen capacity to integrate cross-cutting issues into budget processes at all levels, including climate change (mitigation and adaptation), food security, gender, disaster risk reduction, Central, Provincial and Local, through the development of a tool consistent; and • Strengthen the capacity of sectors to plan and budget for development actions, integrating climate change.

Gov. Ministry	Actions to be included
Ministry of Mineral Resources and Energy	• Identification of a tool that allows coupling to existing generators in order to obtain the average gas emissions in terms of Evaluation and Monitoring; • Communication System that alerts and informs about the occurrence of events or disturbances in the electrical infrastructures; • Intensifying the creation of opportunities for greater access to electricity to reduce the use of woodfuels; • Monitoring the implementation of good environmental practices and the use of appropriate technologies for mining production; • Assessment and monitoring of the release to atmosphere of carbon in coal mining production; • Strengthen coordination between the MIREME sector, EDM, Private Sector and MITADER; • Raising awareness in the sector on the importance of collecting data on mineral resources and climate change. • Training in: − Methodology for analyzing the emission factors of gases coming from different sources of energy generation, both diesel and gas; − Collection and processing of Information/data to feed the inventory of gases emitted into the atmosphere at country level; − Design of a database for generating balance sheets and forecasting greenhouse gas emissions (use of LEAP and GAGMO models); − Inspection, Inspection and Mining and Energy Audit; − Strengthen capacity in data collection tools, GHG inventory development and data management models;

Table 6.10: Sector-level actions to include in the implementation of Mozambique's Nationally Determined Contribution (NDC).

Sector	Actions to be included
Transport	• Develop capacities to identify and implement transport system options that reduce GHG emissions; • Support in capacity building for the development of project proposals; • Support to formulate and implement an MRV system for the transport sector, including the ability to calculate actual values for motor vehicle emissions; • Support to the sector in the collection, management and storage of relevant data to estimate emissions, as well as in the elaboration of the transport component in the national inventory of greenhouse gases; and • Support to design and implement climate-proof, low-carbon transport infrastructure.

Sector	Actions to be included
Transport: Municipality of Maputo City	• Creation of an air quality monitoring network and training of technicians for the management and use of the system; • Capacity building of the Metropolitan Transport Agency and Project implementation partners; • Assessment of the impact of reducing CO_2 emissions with the introduction of the Metro BUS project; • Revision of the Regulation on Mandatory Inspections; and • Support in the coordination of Spanish cooperation; EMU; MAEFP; ASF; WAZA; Municipality of Maputo; and Metropolitan Transport Agency.
Transport - Civil Aviation	• Support to the development of a Transport Action Plan - Aviation to reduce CO_2 and other GHG emissions; • Strengthen capacity in: Carbon Offset and Reduction Scheme for International Aviation (CORSIA) - ICAO, Aviation and Environmental Management, Green Airports initiatives - IATA; and general awareness of climate change; • Support to the design and financing of the implementation of mitigation measures to reduce GHG in Civil Aviation in Mozambique; • Support the development and operationalization of a sub-sector MRV system to monitor GHG emissions; and • Support for the greening of the existing airport(s) in Mozambique through the use of solar panels, LED lamps and tree planting.
Agriculture	• Support the massive production of basic seeds and release of drought, pest and disease tolerant varieties; ensure timely availability and ensure the use of fertilizers; • Full use of water to guarantee crop irrigation and livestock irrigation; • Mass production of feed, day-old chicks and hay to respond to the demand of the livestock subsector, as well as the health of the herd; • Support in the development of proposals and projects; • Support the development and implementation of an MRV system for the sector
Forests and REDD+	Training in: • Methodologies for estimating deforestation and forest degradation; • Climate negotiations; • Participatory MRV system, data collection, geographic information systems and database management; • Forest management; • Involvement of communities in forest management; • Research on technology techniques and REDD+ implementation policies and their impact on Society; • Project development and access to finance; • Strengthen inter-institutional coordination in the area of forests and REDD+; • Financial support for national and subnational inventories: • Provincial forest inventories; • Permanent Installments;

Sector	Actions to be included
	• Technology for forest monitoring and land use (Equipment, software licenses including technical capacity in programming); • Additional studies (alometric equations, methodologies for carbon estimation, diversity, botany, studies on the classification of biomes of Mozambique). • Updating of Land Use and Coverage Charts; • Strengthen inter-institutional coordination for the implementation of REDD+ and MRV for REDD+, which can be achieved with the production and approval of the institutional framework of MRV; • Support forestry initiatives including: community forest management; restoration of degraded forests; promotion of alternative energy to biomass; better access to energy alternatives to biomass; and small- and medium-scale forest plantations; • Measures to adapt to weather events in urban centers and coastal areas; • Data and knowledge sharing policy between different sectors; • Communication and advocacy for forests; • Exchange of experience with other countries; • Strengthening research capacity on technological techniques and policies for implementing REDD+ and its impact on society; and Support for designing • Support for designing ecosystem-based services projects that improve livelihoods and reduce vulnerability.
Energy / FUNAE	• Strengthening capacity in the design and implementation of renewable energy projects; • Technical assistance to develop a NAMA for the implementation of FUNAE's project portfolio; and • Capacity building for the development of renewable energy projects.
Other Land Cover Uses	• Preparation of the national territorial development plan; • Development and implementation of urban and coastal resilience programs. • Technology to monitor land use change and land cover/land change (equipment, software licenses, including technical programming capacity).
Waste	• Support in the development/revision of sectoral waste policies and waste management plans at the level of municipalities and districts, including regulatory instruments for recycling and selective collection; • Support for research in the waste sector, sector NAMA and capacity building for institutions in data collection, processing and systematization of information and creation of a database of studies in this area; • Capacity building to attract the participation of the private sector and civil society in the development of waste management projects; • Training and support in methodologies to define and analyze emission factors from different sources of waste generation; collection,

Sector	Actions to be included
	processing and systematization of sector information; and estimate greenhouse gas emissions from the waste sector; • Installation and maintenance of a waste database (computer equipment and database management) and technology for monitoring waste management (software licenses including technical capacity to use the tool); • Capacity building for monitoring, reporting and verification (MRV), including the effects of policies, strategies, plans and projects in the waste sector; • Training in the formulation and management of projects that compete with climate finance and in the implementation of financial mechanisms to leverage actions in the waste sector; • Capacity development for coordination, planning, integration and accountability of sectors in the implementation of approved strategies and policies in the waste sector; • Public awareness campaigns on waste; • Environmental impact studies, economic feasibility studies and design of executive projects for the construction of waste management infrastructures; • Study on selective collection and flows of recyclable materials in Mozambique; • Sealing of legally granted spaces for the construction of waste management infrastructure; • Monitoring and inspection in the implementation of legislation on waste management and on extended producer responsibility; • Promotion of sustainable waste management practices, including selective collection, the adoption of measures to reduce, reuse and recycle (3 Rs); • Adoption of prevention and precautionary principles, that is, application of corrective, mitigating or compensatory measures for the reduction/elimination of waste and the respective GHG; • Coordination, planning, integration and accountability of sectors in the implementation of approved strategies and policies in the waste sector; • Sharing data and knowledge between different sectors; • Inter-institutional coordination and involvement with all stakeholders; • Communication and partnership facilitation; • Exchange of experience with other countries;

Table 6.11: List of projects to be developed and financed and included in the implementation of the Nationally Determined Contribution (NDC) of Mozambique.

Sector	Actions to be included
Renewable energy: hydroelectric	• Construction of Tsate Hydroelectric Power Plant (Located in Sofala Province, with a generation capacity of 50 MW) • Lúrio Hydroelectric Power Plant with a generation capacity of 120 MW • Ruo Hydro Power Plant with a generation capacity of 135 MW • Pavue-Pungue Hydro Power Plant with a generation capacity of 120 MW • Messalo Hydropower Plant with a generation capacity of 50 MW • Construction of the 1500 MW Mpanda Nkua Hydroelectric Power Plant, located in the province of Tete • Construction of the Lupata 200 MW and 150 MW Boroma Hydroelectric Power Plant, located in the province of Tete • Construction of the Alto Malema Hydroelectric Power Plant in Nampula Province
Renewable energy: Solar	• Cuamba Solar Power Plant with a capacity of 100 MW • 500 MW Gaza Solar Power Plant with 500 MW capacity • Maputo Photovoltaic Plant with a capacity of 150MW • Maluana-Manhiça-Maputo Photovoltaic Plant with a capacity of 15 MW • Beluluane Photovoltaic Plant with a capacity of 30 MW • Namialo Solar Power Plants with a capacity of 15 MW • 200 MW photovoltaic plant in Gaza Biomass • Salamanga Biomass Plant with a capacity of 30 MW
Natural Gas	• 150 MW Temane Gas Plant, Located in Inhambane Province • Maputo combined cycle power plant. Located in Maputo City • Maputo, Matola and Maracuene Natural Gas Distribution Project • Oil and Gas Infrastructure Construction Project • Gas development project for vehicles
Forestry	• Support forestry initiatives including: community forest management; restoration of degraded forests; promotion of alternative energy to biomass; better access to energy alternatives to biomass; and small and medium-scale forest plantations.
Solid Waste	• Construction of waste management infrastructure (controlled landfills, waste sorting and transfer centres, recycling and composting centres).

6.3. Constraints related to the preparation of Second National Communication

The main constraints associated with the preparation of the Second National Communication (SCN) are fundamentally linked to several factors that can be organized into two main groups, namely:

- Poor access to essential information and data
- Need for a favorable working environment

Sharing information and data is a major challenge the technical team has been facing and foresee implications on reporting about country's progress as part of international obligations, in particular to the United Nations Convention on Climate Change (UNFCCC). Poor access to information and essential data for carrying out the work in the different components of the Second National Communication (SCN) greatly influenced the development of activities and effort needed to complete the tasks.

It remains unclear whether individuals or sectors are aware of the usefulness of such information and data in both national and international contexts of the work. It should be noted that the SNC is a key national document which report on the various aspects of the country's socioeconomic progress in fulfilling its obligations to the UNFCCC. This should be understood as an essential product which enable institutions and society be prepared to deal with challenges brought by climate change. In fact, deficient flow and access to information represent the most serious obstacles to the implementation of several actions, including the timing for preparation and delivery of this Communication. Flexible mechanisms must be found to enhance the information access and flow among key sectors, individuals and other stakeholders taking into account the dimension and relevance of the document.

At the same time, progress could be made in reviewing or adapting the instruments that regulate the access rights to information and data in the country. For example, the basic statistics for carrying out inventories of GHG emissions are specific and must comply with a certain uniform and systematic standards. However, despite this, these statistics have, at the same time, broad application in characterizing the country's economic and environmental performance. This feature is sufficient to justify its integration in the sectoral statistics produced systematically and annually in Mozambique.

Regarding to the work environment, the recommendation is to define an appropriate format for sectoral statistics (activity data) and technical training (human and material resources) and technology for these sectors, so that they produce statistics for their sectors using a model that allows for a multiform use, while enabling a oriented treatment of inventories by a specialized team. This team could be created in a specific Office, preferably at the institution responsible for producing the National Communication and the same would limit itself in use of activity data and extracting the emissions.

This arrangement would allow for the consolidation of inventories in a short time (between 2-3 months only) based on data on the activity of the sectors that would be available to the public either through publication on the internet pages (websites) of these sectors or economic performance magazines and/ alternatively, through its inclusion in the annual publications of the National Institute of Statistics.

On the other hand, universities could play an important role in the search for local emission factors, through research in works of master's thesis or doctoral theses co-financed by funds from interested institutions and supervised by senior academics with experience in greenhouse gas inventory issues.

Nevertheless, several efforts are underway to address the problems associated with access to information and essential data that could support the preparation of NCs on a continuous and fast way. Particular emphasis goes to NCCAMS's proposal (to be approved) for the establishment of a Climate Change Knowledge Management Center (CGCMC) and the Climate Action Transparency Initiative – ICAT to establish the legal institutional arrangement in Mozambique.

According to NCCAM, the CGCMC is an entity to be hosted at the Academy of Sciences of Mozambique (ACM) with the purpose of bringing together knowledge about CC available in different institutions in order to function as a generation centre, repository and vector of transmission of knowledge to various actors. The center will work through the climate change network that includes key thematic areas (while making room for other themes), namely: coastal zones, fisheries and tourism; climate modeling; communities and local knowledge; water resources management; biodiversity and ecosystems; human health; food and nutrition security; agriculture, livestock and forests; cities; economics and finance; industry; energy; and waste.

The Climate Action Transparency Initiative – ICAT, Phase 2, funded by UNEP – DTU aims to help Mozambique in establishing the legal institutional arrangement for transparency activities based on the Phase I roadmap and recommendations; and, ensure sustainable capacity building efforts in the country, through the formulation of training programs involving the Climate Change Network and focusing on monitoring NDC policies and actions and GHG inventories and reporting on received and required support.

Both the establishment of the CGCMC and the ICAT initiative must be seen, at present, as the main ways that Mozambique must promote and give urgent attention and action to overcome the challenges listed in this report, in particular, guaranteeing access to essential information and data and a favorable working environment for carrying out national communications within the recommended deadlines and periodicity.

6.4. *Comparison between the First and Second National Communications of Mozambique*

Mozambique submitted its First National Communication in 2003, being this its Second National Communication. Comparing the two documents, there is an evolution in the contents, as well as in the areas/sectors covered. The table below presents a summary of the comparison between the two documents.

Table 6.12: Comparison of the two national communications.

Areas covered in the First National Communication	Areas covered in the Second National Communication
National circumstances: scope of study, geography of Mozambique, demography, topography, economy, water resources, fisheries, agriculture, manufacturing industry, ports, mineral resources, Tourism and recreation parks.	**National circumstances:** geographic profile, data on population, economy, climate, relief, agriculture, forests, fisheries, energy, industry, biodiversity, health, tourism, national priorities, institutional arrangements and challenges.
National GHG Inventories: information on activity data collection; list of inventoried sectors including methodology used, emissions by sector and comparison between 1990 and 1994 emissions	**National GHG Inventories:** Adopted IPCC 2006 (in exchange for IPCC1996: recommendation) and consequent adjustment of sectors, including new FOLU data (FNDS, since 2000), indicating the key categories and uncertainties (1995-1999);
Vulnerability and adaptation: indication of the climatic events that occur in the country and the affected sectors; presentation of climate scenarios, vulnerability assessment of the following sectors/areas, coastal areas and resources, water resources. Agriculture, including pastures, forests and related adaptation measures	**Vulnerability and Adaptation Measures:** covered the following sectors/areas agriculture, livestock, water resources, fisheries, coastal zones. Forests, fisheries, energy, industry, biodiversity, health, infrastructure, waste, energy, health, infrastructure, waste, vulnerable groups and biodiversity, framework for adaptation and climate risk reduction strategies and measures (adaptation and NCCAMS's climate risk reduction and NDC Mozambique's adaptation contribution indicating policies, strategies, plans and programs that promote the implementation of strategic climate change measures and information on the NAPA)
Mitigation: presents a list of measures that include the need to create legal instruments	**Mitigation Options:** introduction, methodology, listing of commitments made

Areas covered in the First National Communication	Areas covered in the Second National Communication
and mechanisms to promote the mitigation of emissions and mitigation measures in the forest (reforestation), energy (renewable energy including sustainable lifestyle) sectors and the need to raise awareness	by the country in the Paris Agreement versus NCCAMS's mitigation and low-carbon development measures, including policies, strategies, plans and programs of which the implementation contributes to the fulfillment of assumed commitments and measures NCCAMS mitigation measures, information on Nationally Appropriate Mitigation Actions (NAMAs) in formulation.
Policies and measures relevant to achieving the UNFCCC objective: listing of existing policies; information on research and systematic observation indicating which institutions exist that carry out these actions and information on education and public awareness.	**Other information relevant to the Convention:** information on the process and results of the assessment of technological needs (adaptation: agriculture and resources and coastal zones) and mitigation: energy and waste); project ideas for technology transfer formulated; information on research and systematic observations that include, in the case of research, main institutions that carry out research in the area of climate change and main sources of research funding; and, in the case of systematic observations, listing of institutions that carry out meteorological and climatic, hydrological, agro-climatic, oceanographic observations and monitoring of the occurrence of fishery resources, health monitoring and surveillance; institutions using observational information/data and the current stage of observation in the country including description of networks; regional and international cooperation; formal education and public awareness and capacity building needs for national greenhouse gas inventories, vulnerability and adaptation assessment, mitigation, research and systematic observation; and, indication of the constraints in the preparation of the Second National Communication

7. References

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8. Annexes

Annex 8.1: CDM communications in Mozambique (Source: UNFCCC, 2022a)

PC ID	Prior consideration title	Host party	Reception date
NYMXQ0UW3EAT7IZKRG1PSCDFOLB4J6	Composting organic waste in the city of Beira (Mozambique)	Mozambique	16/11/2010
S8T0UKLVXPJMQB6HGNEZO2CR1DI97F	Lúrio Forest Plantation	Mozambique	11/02/2011
5VRU3FQTA29MGOEBLN6ZJS0DHX41Y8	Compressed air savings in Mozal aluminium smelter	Mozambique	18/02/2011
V1A58XGMHYJSO06CUZRNE3KQIBFLWP	Total Anode Voltage Drop energy efficiency project	Mozambique	18/02/2011
MDKI1386JZTNLXYCRE2S94PU5W7AGV	Pot control regulation system: New ALPSYS control system	Mozambique	18/02/2011
70W49QPX2TV6ZYKU1LSO3ENFI5HRAJ	New gas fired power plant at Ressano Garcia	Mozambique	16/06/2011
SKI9Y2X4J6E81B0PL7WQTNC3FZMHO5	Waste Heat Recovery for Power Generation in a Metallurgical Coke Processing Plant in Mc	Mozambique	23/06/2011
5DK4T1LSC0OZ9R3IHXEQNYVW8FPMG6	Cleanstar Mozambique - Maputo Ethanol Cookstove and Cooking Fuel Project 1	Mozambique	24/10/2011
PGSMRXILEQKO5HYUTFN9WV2C64B08J	Mphanda Nkuwa Hydroelectric power plant in Mozambique	Mozambique	12/12/2011
UBE9I5PQKVJT2SLD870CW3RANMOG64	Community Farm Forests in Rural Villages of Northern Mozambique	Mozambique	24/01/2013
XTCKIJDWZY784MGPQBN1E593OVA60S	Lurio Forest Plantation	Mozambique	08/03/2013
V86RFBU53HA1CIKL4GTDZ92YXP0J7M	Improved Cook-Stove Program for Mozambique	Mozambique	20/06/2013
6HB502JZCDQKF1WNOXG3EU4M9RTIPA	Photovoltaic power station in Tete, Mozambique	Mozambique	10/08/2017
82O7DRK1SQB0CTEAX6YWPHGLZ9JUF4	The Garner Sustainable Biomass and Renewable Energy Programme	Mozambique	24/09/2019

Annex 8.2: Activity Programs (PoAs) registered in Mozambique (Source: UNFCCC, 2022b)

CDM project reference number	Title	Ref. CPA	Inclusion date	CPA: Start of crediting period	CPA: End of crediting period	Reductions/year	HostParty	HostParty (ISO2)	Crediting type	CPAs which cannot be renewed	Reporting date
7359	CPA-MO-001 MAPUTO CITY	36	01/07/2013	28/05/2014	27/05/2021	37.384	Mozambique	MZ	Renewable	No	04Feb2022
7359	CPA-MO-002 MAPUTO PROVINCE	37	01/07/2013	28/05/2014	27/05/2021	26.853	Mozambique	MZ	Renewable	No	04Feb2022
7359	CPA- MO-003-MOZAMBIQUE	50	28/05/2014	28/05/2014	27/05/2021	98.581	Mozambique	MZ	Renewable	No	04Feb2022
9981	Domestic Cooking Stoves in Maputo (Mozambique)	1	17/10/2014	01/01/2015	31/12/2021	28.404	Mozambique	MZ	Renewable	No	04Feb2022
9981	Domestic cookstoves in Maputo (Mozambique), phase II	2	12/07/2016	12/07/2016	11/07/2023	38.512	Mozambique	MZ	Renewable	No	04Feb2022
9981	Improved Cookstoves in Pemba	3	01/08/2016	01/08/2016	31/07/2023	185.039	Mozambique	MZ	Renewable	No	04Feb2022
9981	Fuel-efficient cooking in Maputo Province, Mozambique by the entity SK Trading International Co., Ltd. (SKTI) in th	4	23/02/2021	01/03/2021	29/02/2028	212.035	Mozambique	MZ	Renewable	No	04Feb2022
10203	CPA-0001: 2014-2016 Action Plan for ''Off-grid renewable energy for rural electrification in Mozambique managed by	1	05/05/2016	05/05/2016	04/05/2023	16.419	Mozambique	MZ	Renewable	No	04Feb2022
10578	Garner Mozambique - BioEthanol Cookstoves Project CPA1	1	23/10/2020	02/11/2020	01/11/2030	96.658	Mozambique	MZ	Fixed	No	04Feb2022

UNFCCC, 2022b: https://cdm.unfccc.int/Statistics/Public/files/Database%20for%20PAs%20and%20 PoAs.xlsx

Annex 8.3: Program activities registered in the PoAs (Source: UNFCCC, 2022b).

CDM project reference number	**Unique project identifier (traceable with Google)**	Registration project title	**Type of CDM project: PA/PoA**	Project classification	Methodologies used at registration	Project type (UNEP DTU)	Project subtype (UNEP DTU)
7359	2Q6GWNY332XXRS81YOIEB6EW5G4U5Q	PoA for the Reduction of emission from non-renewable fuel from cooking at household level	PoA	SMALL	AMS-I.E.	EE households	Stoves
7676	7VIOEMF4O58MRP58K36FV02K2R53HQ	Southern African Renewable Energy (SARE) Programme	PoA	LARGE	ACM0002	Hybrid renewables	Solar & wind & other
7885	L056L9FZ8EAX89INYMLJLSV5VCVLW8	Southern African Solar Thermal Energy (SASTE) programme	PoA	SMALL	AMS-I.C.	Solar	Solar water heating

CDM project reference number	**Unique project identifier (traceable with Google)**	Registration project title	**Type of CDM project: PA/PoA**	Project classification	Methodologies used at registration	Project type (UNEP DTU)	Project subtype (UNEP DTU)
9595	OYV172CIS0LTXXUMBV1DJVQQSP6VLG	Cleanstar Mozambique - Maputo Ethanol Cookstove and Cooking Fuel Project 1	PA	SMALL	AMS-I.E.	EE households	Stoves
9747	HSPL79C8DBYFS5VBH8M68Z864IKJ4E	Niassa Reforestation Project	PA	LARGE	AR-ACM0003	Reforestation	Reforestation
9981	E6IB5VSYQIRALMN4NV1Z288S68XFZ4	Domestic Cooking Stoves substitution programme in Mozambique	PoA	SMALL	AMS-II.G.	EE households	Stoves
10053	PC01M3KDKFZNXLPE1VO319OXCFT980	Empowering DRC communities through the use of Improved Cook Stoves	PoA	SMALL	AMS-II.G.	EE households	Stoves
10203	3PUVISPZUYI57FVE40JRADONEU7R5G	Off-grid renewable energy for rural electrification in Mozambique managed by FUNAE	PoA	SMALL	AMS-I.L.	Mixed renewables	Solar & Hydro
10335	XG3NBVWVU411LQRCVXAYP77B4EJDHT	New gas fired power plant at Ressano Garcia	PA	LARGE	ACM0025	Fossil fuel switch	Coal to natural gas
10578	AK3CHFLMX7EN1S8NL3ZM1NN48B7FU4	Garner Sustainable Biomass and Renewable Energy Programme	PoA	SMALL	AMS-I.E.; AMS-II.G.	EE households	Stoves

UNFCCC (2022b): https://cdm.unfccc.int/Statistics/Public/files/Database%20for%20PAs%20and%20 PoAs.xlsx

Annex 8.4: Support received in the period 2010-2016.

Nº	Program/project name	Sector	Objective	Donor	Budget (USD)	Target area	Implementing Institution	Execution period
1	Local Climate Adaptive Living in Mozambique 2014-2023 (LOCAL)	AFOLU	Increase the climate resilience of districts by increasing access to climate change adaptation funding through performance-based climate resilience grants	EU/ UNCDF	15,000,000	Transversal	Government at different levels and United Nations Capital Development Fund (UNCDF)	2014 - 2023
2	Elaboration of Local Adaptation Plans in districts vulnerable to climate change	Transversal	Assessment of climate vulnerability and adaptive capacity of communities to extreme events; Identification and prioritization of concrete climate change actions; Integration of climate change aspects in the planning process at the level of different sectors	OE/DANIDA	14,206,128	Adaptation	MITADER	2011 - 2015
3	Support Program for the Environment Sector (PASA II)	AFOLU	Mapping of erodic areas in the country; Mapping of risk zones in the scope of the elaboration of the territorial planning instrument	Danida/EU Comission (Irish Aid)	75,902,196	Mitigation	MICOA, MTA, MADER and INGC support from more than 90 institutions at the central, provincial and district level	
4	Coastal Cities Adaptation Project: building resilient houses	Transversal		UN-Habitat	45,000	Adaptation	UN-Habitat4	
5	Involving the private sector in the development of renewable energy	Energy	The goal is to achieve a significant reduction in CO_2 emissions while supporting the growth of electricity demand. The involvement of private actors is crucial, given the amount of investments to be made.	AFD (co-financed: EU-Africa Infrastructure Trust Fund)	4,429,679	Mitigation	Electricity of Mozambique	Since 2016

Nº	Program/project name	Sector	Objective	Donor	Budget (USD)	Target area	Implementing Institution	Execution period
6	Climate Protection Program for Developing Countries	Transversal	In selected developing countries, the conditions for active participation in the climate regime after 2012 and the development of strategies, action plans and monitoring systems for climate protection have improved.	Germany	64,226,220	Transversal	German Federal Ministry for Economic Cooperation and Development (BMZ) GIZ	2011 - 2021
7	Cities and Climate Change Project	Transversal	The objective of the project is to strengthen municipal capacity for the provision of sustainable urban infrastructure and environmental management that increase resilience to climate-related risks	World Bank and KfW	120,000,000	Transversal	World Bank Group and the Government of Mozambique	2012 - 2020
8	PPCR Project - Hydromet (Transformation of hydrological and meteorological services in Mozambique)	Transversal	The project aims to strengthen meteorological and hydrological information services in order to provide reliable and timely climate information to local communities.	World Bank and Nordic Fund	25,000,000	Adaptation	DNGRH/INAM	2012 - 2019
9	Project for Value Chain Development in the Maputo and Limpopo Corridors (PROSUL)	AFOLU	Sustainable increase of small producers' income by increasing production volumes, productivity, quality improvement and market linkage, intervening in 3 target value chains (Horticulture, Cassava and Red meat), expecting to cover 20,350 families in 19 districts of Maputo, Gaza and Inhambane provinces.	IFAD/ Spanish Trust Fund/ Family Farming Adaptation Program	45,000,000	Adaptation	National Directorate of Rural Development	2012 - 2019
10	Adaptation to Climate Change in Mozambique			GIZ		Adaptation	INGC, MICOA/MITADER	2012 - 2017
11	Project for Promotion of Conservation	AFOLU	Raise awareness among producers about the importance of this type of	FAO, Austrian	13,540,159	Transversal	FAO	2012 - 2017

Nº	Program/project name	Sector	Objective	Donor	Budget (USD)	Target area	Implementing Institution	Execution period
	Agriculture (PROMAC) , financed by the Norwegian Embassy ... (https://ncbaclusa.coop/project/promotion-of-conservation-agriculture-promac/)		agriculture for food security and for reducing the adverse effects of climate change, by sharing knowledge and experiences in the country and in the southern region of Africa	Development Cooperation (ADC) and the Norwegian Embassy				
12	Artisanal Fisheries and Climate Change Project		The objective of the project is to improve community management of selected priority fishing areas.	World Bank	3,400,000	Adaptation	Ministry of Sea, Inland Waters and Fisheries	2015 - 2020
12	Artisanal Fisheries and Climate Change Project		The objective of the project is to improve community management of selected priority fishing areas.	World Bank	3,400,000	Adaptation	Ministry of Sea, Inland Waters and Fisheries	2015 - 2020
13	Sustainable natural resource management for resilience and equitable growth and development (SUNRED)	AFOLU	Sustainable and effective management of natural resources and disaster risk reduction benefiting all people in Mozambique, particularly the most vulnerable.	(EU, DFID, and UNEP pooled funds – Norway, SIDA, Spain)	1,059,000	Adaptation and Mitigation	MITADER	2014 -2018
14	Cities and Climate Change Initiative - CCCI	Transversal		World Bank		Adaptation	MAE and Municipalities	2012 - 2016
15	Coastal Zone Climate Change Adaptation Project			UNDP		Adaptation	MITADER	2012 – 2016
16	Climate Change Technical Assistance Project	Transversal	The objective of the Project is to strengthen the institutional and technical capacity of the Government of the Republic of Mozambique to mainstream climate change resilience into key economic sectors and improve the evidence base for future	World Bank	2,500,000	Adaptation	MITADER	2012 – 2016

Nº	Program/project name	Sector	Objective	Donor	Budget (USD)	Target area	Implementing Institution	Execution period
			development policy and planning.					
17	Lower Limpopo Climate Resilience and Irrigation Project	AFOLU	The goal is to increase agricultural productivity through the development of 3050 hectares for vegetable production (cereals and legumes) and provision of marketing and processing services for agricultural products.	African Developme nt Bank (AfDB)	44,000,000	Adaptatio n	Regadio do Baixo Limpopo (RBL) MASA	2012 – 2016
18	Municipal Capacity Development Program (PRODEM)	Transversa l	Prepared urban plans (for 10 municipalities) for resilience to MCs , focusing on erosion control, tree planting, water drainage, and adjustments to the cadaster.	Denmark, Ireland, Sweden, and Switzerland		Transversa l	10 Municipalities in the center and north of the country	2015 – 2017
19	Mozambique Coastal Cities Adaptation Project CCAP-USAID	Transversa l	The objective of CCAP is to strengthen Mozambique's capacity to build resilience to the challenges of climate change, especially in vulnerable coastal communities	USAID	19,900,000	Adaptatio n	Chemonics International	2016 – 2018
20	Climate Resilient Infrastructure Services Project (CRIS)	Transversa l		USAID		Adaptatio n	Municipal Council of Nacala City	2013 – 2015
21	Spatial data enhancement project for flood risk assessment (LIDAR)	Transversa l		World Bank	10,000,000	Adaptatio n	DNGRH	2014 – 2016
22	Assistance for strengthening institutional capacity in water-related disaster risk management in Mozambique	Transversa l		JICA		Adaptatio n	DNGRH	2014 – 2016

Nº	Program/project name	Sector	Objective	Donor	Budget (USD)	Target area	Implementing Institution	Execution period
23	Municipal Capacity Development Program (PRODEM)	Waste	Drafted 11 PGIRSU and three simplified landfill projects and carried out two landfill rehabilitations (Ministry of State Administration and Civil Service, 2018).	Denmark, Ireland, Sweden, Switzerland		Mitigation	26 Municipalities in the center and north of the country	2015-2017
24	Sustainable natural resource management for resilience and equitable growth and development (SUNRED)	AFOLU	Contribute to the objectives of sustainable development and efficient natural resource management by supporting the government in addressing the gaps related to insufficient coordination, capacity, funds and information that have been identified as the main problems in promoting sustainable pro-poor development in Mozambique	UNDP e PNUMA	2,118,000	Mitigation	MITADER	2015 – 2017
25	Establishment and operationalization of the Technical Center for Disaster Risk Management, Sustainability and Urban Resilience in Southern Africa - DiMSUR	Transversal	Train, build capacity and implement disaster risk reduction activities in cities and countries exposed to floods, cyclones, earthquakes and droughts	UN-Habitat	810,000	Transversal	UN-Habitat	Since 2013
26	Strategic Environmental and Social Assessment (SESA) under REDD+	AFOLU	Optimize the reduction in degradation and deforestation, and contribute to the goals of reducing greenhouse gas emissions	World Bank		Mitigation	MITADER	Since 2015
27	Adaptation to Climate Change in Coastal Zones of Mozambique (GEF-LDCF)	Transversal	Building capacities of communities living in coastal areas to manage Climate Change risks	GEF-LDCF	4,433,000	Adaptation	MITADER	Expected completion December 2016
28	Pro-poor Value Chain	AFOLU		The	16,300,000			2012-

Nº	Program/project name	Sector	Objective	Donor	Budget (USD)	Target area	Implementing Institution	Execution period
	Development Project in the Maputo and Limpopo Corridors (PROSUL)			International Fund for Agricultural Development (IFAD)				
29	Adaptation for Smallholder Agriculture Programme (ASAP) Trust Fund	AFOLU		Spanish Food Security Co-financing Facility Trust Fund	6,430,000	Adaptation		2012-
30	FFS (Farm Field School)	AFOLU	Strengthening the capacity of smallholder farmers to cope with the impact of climate change to improve food security through FFS approaches	FAO	6,000,000	Adaptation	Government ministries and civil society organizations relevant to agricultural associations	2016 – 2020
31	Support Program for Institutional Development of the Land Sector (GesTerra)	AFOLU	(i) Ensure the continuity and sustainability of DNTF's mandate in the land sector (ii) Strengthen DNTF in representing its role as the organization responsible for land management and administration.	Netherlands	11,646,086		National Directorate of Land	2013 – 2018
32	Land Sector (GesTerra)		representation of its role as the organization responsible for land management and administration.	Sweden	7,000,000			
33	Project for the Establishment of a Sustainable Forest Resources Information	AFOLU	Contribute to the establishment of the REDD+ system in Mozambique	Government of Japan	5,500,000	Mitigation	National Directorate of Forests	2013 – 2018

№	Program/project name	Sector	Objective	Donor	Budget (USD)	Target area	Implementing Institution	Execution period
	Platform for REDD+ Monitoring							
34	REDD+ Project	AFOLU	Reduce Emissions from Deforestation and Forest Degradation and increase stocks through sustainable forest management	World Bank	8,800,000	Mitigation	FNDS	2013 – 2018
35	Pilot Implementation of Local Adaptation Programs of Action - Pilot Implementation in Mozambique	AFOLU	Increase resilience to climate change impacts in 9 Mozambican localities through the implementation of Adaptation measures, allowing communities to be more resilient towards a green economy through the dynamization of local activities	Portuguese Carbon Fund	1,209,657	Adaptation	National Directorate of Environment	2013 – 2016
36	Climate Change Unit Project	Transversal	Support the Government through key sectors in planning climate change actions. Elaborate policies on climate change. Operationalize the Center for Knowledge Management on Climate Change.	World Bank	2,000,000	Adaptation	National Directorate of Environment	2014 – 2016
37	Mozambique Coastal Zones Adaptation Project	Transversal	Empower communities living in the coastal zone to manage climate change risks	UNDP	4,333,000	Adaptation	National Directorate of Environment	2012 – 2016
38	Project for Strengthening the Integrated System of Solid Waste Management (PROSIGRU)	Waste	Foster the environmental sustainability of the country's municipalities	Italian Ministry of Foreign Affairs	1,349,235	Mitigation	National Directorate of Environment	2014 – 2016
39	Program for Local Economic Development (ProDEL)	Transversal	Contribute to the poverty reduction of the rural population in the provinces of Gaza, Inhambane and Sofala through	European Development	32,500,000	Transversal	National Directorate of Rural Development	2012 – 2017

Nº	Program/project name	Sector	Objective	Donor	Budget (USD)	Target area	Implementing Institution	Execution period
			the support to the Local Economic Development (LED) based on micro, small and medium rural enterprises in the districts and municipalities of the three provinces.	Fund/European Commission (EDF/EC), Government of the Kingdom of Sweden				
40	Inclusive Finance and Markets Program (PFMI)	Transversal	Contribute to poverty reduction by promoting financial inclusion and the development of inclusive markets, promoting local economic development, with emphasis on supporting the creation and development of MSMEs at the local level by increasing the level of income and livelihoods of vulnerable groups, especially women and youth.	UNDP and United Nations Capital Development Fund (UNCDF)	6,000,000	Adaptation	National Directorate of Rural Development	2012 – 2015
41	Zambezia Rural Development Program - Phase 2 (PRODEZA II)	Transversal	Contributing to the reduction of poverty - especially women - in Zambézia Province	Government of Finland	9,283,820	Adaptation	National Directorate of Rural Development	2010 – 2015
42	Support Program for the Environment Sector (PASA)	Transversal	Strengthening the capacity of the environment sector to coordinate and implement environment and climate change policies and strategies	Kingdom of Denmark	36,211,699	Transversal	National Directorate of Planning and Cooperation	2011 – 2016
43	Operationalizing the Green Economy Transition in Africa	Transversal	Enabling African countries like Mozambique to translate national Green Economy strategies or roadmaps into concrete national development plans at local or district (sub-national) level	UNEP, GIZ	60,000	Adaptation	National Directorate of Planning and Cooperation	2016 – 2017

Nº	Program/project name	Sector	Objective	Donor	Budget (USD)	Target area	Implementing Institution	Execution period
44	Sustainable Management of Natural Resources for Resilience and Equitable Growth and Development (SUNRED) Phase I	Transversal	Enable local participation in planning and decision making processes for sustainability in favor of the most disadvantaged	UNEP, DANIDA and IPMA	1,059,000	Transversal	National Directorate of Planning and Cooperation	2014 - 2018
45	Mapping Project of the Zambezi Valley on the scales 1: 25 000, 1:50 000 and Tete City	Transversal	Institutional capacity building, technology transfer and production of systematic cartography at scales 1:25 000, 50 000 of the Zambezi Valley Region and 1:2500 of Tete City	Government of South Korea (KOICA)	4,500,000	Adaptation	CENACARTA	2015 - 2017
46	Aerial Gravimetric Surveys	Transversal	Production of the geoid model of Mozambique	Kingdom of Denmark	600,000	Institutional Capacity Building	CENACARTA	2014 - 2016
47	Mozambique Protected Areas for Biodiversity Development Project (MOZBIO) Phase I	AFOLU	Promote Conservation of the flora and fauna resources of the conservation areas and develop and create alternatives for income generation for the communities living within and adjacent to the conservation areas.	AIDA-International Association for Development	46,300,000	Transversal	National Administration of Conservation Areas	2014 - 2018
48	Mozambican Protected Areas System Sustainable Financing Project - PFSSAP	AFOLU	Catalyze the sustainability of Mozambique's conservation areas system, to ensure more productivity and efficiency in the use of available natural resources to promote equity and economic development, increased revenue generation and diversification of the revenue system in the conservation areas	GEF-	5,600,000	Transversal	National Administration of Conservation Areas	2013 - 2016
49	Resettlement Program of Parque Nacional do	Transversal	Resettle the Communities living within the Limpopo National Park	UNDP GEF-	18,867,925	Transversal	National Administration of	2015 - 2017

Nº	Program/project name	Sector	Objective	Donor	Budget (USD)	Target area	Implementing Institution	Execution period
	Limpopo						Conservation Areas	
50	National Park Wildlife Protection Project	AFOLU	Support the actions for the Protection of the Rhinoceros in Mozambique	KfW - German Bank	1,487,714	Mitigation	National Administration of Conservation Areas	2014 - 2019
51	Gilé National Reserve Co-Management Project	AFOLU	Reduce the deforestation and degradation of the miombo woodland of the Gilé National Reserve and its periphery to mitigate the pressure on the ecosystems	PPF- Peace Parks Foundation	6,640,106	Mitigation	National Administration of Conservation Areas	2013 - 2016
52	Construction of Landfill Site in Maputo and Matola	Waste	Build and expand sanitation infrastructure and reduce open dumps	AFD- French Development Agency	48,621,000	Mitigation	FNDS	2015 - 2018
53	Forest Carbon Partnership Facility (FCPF) REDD+	AFOLU	Contribute to the establishment of the REDD+ system in Mozambique	World Bank	8,600,000	Mitigation	FNDS	2013 - 2018
54	Mapping of eight provinces	AFOLU	Update the forest cover of the country	JICA	1,000,000	Institutional Capacity Building	National Directorate of Forests	2016 - 2017
55	National Forest Inventory	AFOLU	Estimate the Carbon Stock for the eight provinces of Mozambique and the qualitative and quantitative volumes of forest resources	World Bank	940,000	Mitigation	National Directorate of Forests	2016 - 2017
56	Capacity Building for Low Carbon Strategies	Transversal	Build institutional capacity to design, implement, measure, report and verify low carbon strategies adapted to a changing climate, properly aligned and integrated into recipient countries' poverty reduction strategies	Portuguese Carbon Fund	632,312	Institutional Capacity Building	National Directorate of Environment	2013 - 2016
57	Mainstreaming Climate Change Adaptation into Development	Transversal	Build capacity to integrate the response to climate change vulnerability into the policy and project design process by	Portuguese Carbon Fund	252,702	Institutional Capacity Building	National Directorate of Environment	2013 - 2016

Nº	Program/project name	Sector	Objective	Donor	Budget (USD)	Target area	Implementing Institution	Execution period
			building capacity to design policies and projects that are resilient to the impacts of climate change					
58	Second National Communication	Transversal	Prepare the Second National Communication (Report on the implementation stage of the United Nations Framework Convention on Climate Change	UNEP	410,000	Report	National Directorate of Environment	2011 - 2016
59	Adaptation Technology Needs Assessment	Transversal	Assess the technology needs for reducing vulnerability in the agriculture and infrastructure and coastal zones sectors and reducing greenhouse gas emissions in the energy and waste sectors and formulate the Plan for Technology Transfer including three project ideas for the transfer and diffusion of the three selected technologies in each sector	UNEP-DTU	28,000	Institutional capacity building	National Directorate of Environment	2015 - 2017
60	Projects for the formulation of Mozambique's Internationally Determined Contribution (INDC)	Transversal	Help the country to formulate its INDC	UNEP-DTU	200,000	Report	National Directorate of Environment	2015 - 2018
61	Small Scale Agreement for preparation of Green Economy Assessment Report	Transversal	Elaborate studies on the implementation of the Green Economy in Mozambique, on the Green Economy indicators and fiscal policies on Green Economy	UNEP	100,000	Adaptation	National Environment Directorate	2014 - 2015
62	Institutional Support to the Environment	Transversal	Support G-Ozono in the production of materials for public awareness and	UNEP	103,000	Vienna Conventio	National Directorate of Environment	2016 - 2017

Nº	Program/project name	Sector	Objective	Donor	Budget (USD)	Target area	Implementing Institution	Execution period
	(ISProject) Vienna Convention and Montreal Protocol		good environmental practices. Acquisition of equipment (computers, printers, fax, telephones, internet)			n Montreal Protocol/other convention		
63	Project on Phasing out Ozone Depleting Chemicals (HPMP) Vienna Convention and Montreal Protocol	Waste	Phase out ozone-depleting chemicals in the refrigeration and air conditioning sector	UNEP	350,000	Mitigation	National Directorate of Environment	2013
64	REDD+	AFOLU	Institutional strengthening Elaborate the National REDD+ strategy	Forest Carbon Partnership	3,800,000	Institutional Capacity Building	National Directorate of Environment	2012 - 2016
65	Project to Prepare Mozambique's First Biennial Updated Report (BUR)	Transversal	Assisting the country in meeting its commitment to ratify the Convention to prepare and submit every two years a Biennial Update report	UNEP	352,000	Report and Institutional Capacity Building	National Directorate of Environment	2016 - 2018
66	Participatory Research of Additional Methods to Reduce the Impact of Beach Trawling and Seagrass	Transversal	Identify current gaps in the management of beach net fisheries that lead to overexploitation of resources and	Mohamed bin Zayed Species Conservation Fund (MbZSCF)	12,299	Adaptation	National Directorate of Environment	2015 - 2016
67	National Facilitation Committee for GEF Dugong and Seagrass Conservation Project	Transversal	Build an effective and informed National Facilitation Committee (NFC) to provide country-level oversight of project activities to ensure that dugong and seagrass conservation considerations are integrated at the	Mohamed bin Zayed Species Conservation Fund (MbZSCF)	8,085,886	Adaptation	National Directorate of Environment	2015 - 2018

Nº	Program/project name	Sector	Objective	Donor	Budget (USD)	Target area	Implementing Institution	Execution period
			level of relevant national policy, regulatory frameworks and environmental planning					
68	Review of NBSAP and Preparation of 5º National Report	Transversal	Enable Mozambique to review the National Strategy and Action Plan and to prepare the 5º CBD Report	UNEP	220,000	Adaptation	National Directorate of Environment	2012 - 2016
69	Development of the information exchange mechanism for ABS and Taxonomy	Transversal	Assist Mozambique in monitoring the status of CBD implementation in the country and identifying weaknesses and constraints	UNEP	175,200	Adaptation	National Directorate of Environment	2011 - 2016
70	Technical Support Project for the recovery of degraded areas in Mozambique using sustainable management technologies (TCP/MOZ3502)	Transversal	Build institutional capacity to prevent and control soil erosion problems in the country	FAO	365,000	Mitigation	National Directorate of Environment	2014 - 2016
71	Project on National Inventory of chemicals under control of the Vienna Convention and Montreal Protocol and Framework Convention on Climate Change	Waste	Identify the quantities of chemicals under control of the two environmental conventions	UNEP	65,000	Mitigation	National Directorate of Environment	2016 - 2017
72	Technical Assistance for the Implementation of the Stockholm Convention	Waste	Bio Pesticides Management	UNEP	30,000	Mitigation	National Directorate of Environment	2016 - 2017
73	Update of the National Implementation Plan	Waste	Management, handling, use, transport and safe disposal of POPs	UNEP	70,000	Mitigation	National Directorate of Environment	2016 - 2017

Nº	Program/project name	Sector	Objective	Donor	Budget (USD)	Target area	Implementing Institution	Execution period
	(NIP) of the Stockholm Convention on Persistent Organic Pollutants							
74	Adaptation Project in Coastal Zones of Mozambique	Transversal	Empowering communities living in the coastal zone to manage climate change risks	UNDP	4,333,000	Adaptation	National Directorate of Environment	2012 - 2016
75	Joint Management Agreement and development of the Zinave National Park	AFOLU	Conserving biodiversity and maintaining the ecological integrity of the Zivane National Park through wildlife reintroduction, development of ecotourism products, and establishment of partnerships with local authorities		20,000,000	Mitigation	National Administration of Conservation Areas	2015 - 2020
76	PSAN - Program of Food Security and Nutrition, Gaza Province	Transversal	Improve the Local Governance process, Public Finance management and financing of small public infrastructures that contribute to the improvement of food security and nutrition	Belgian Fund /UNCDF	21,248,340	Transversal	SETSAN (FAO, UNCDF, PMA, FOS e DISOP)	2013 - 2019
				Total	825,241,363			

Annex 8.5: Constraints and gaps, and related to financial, technical and and capacity needs in the following initiatives: National Capacity Self - Assessment (NCSA) - NCSA - Thematic Report, National Adaptation Programmes of Action (NAPA), Nationally determined contributions (NDCs) and IP.

Constraints/Gaps	NCSA	NAPA	INGEE	Adaptation	Mitigation
Lack of a national action plan for institutions to implement the Convention					
Lack of a legal instrument that inserts the activities of the Convention into sectoral plans and budgets					
Weak intra and inter-institutional coordination					
Weak involvement of stakeholders (communities, development partners, private sector, academia and civil society) in the implementation of the Convention and other related instruments					
Weak standardization in data collection at udometric stations under the supervision of the Ministry of Agriculture, Fisheries, ARA's , INAM , World Vision, Plexus , and other organizations that operate in this area					
Poor accuracy of weather and seasonal forecasts, due to several factors, including: poor sensitivity of the personnel responsible for data collection, low density of meteorological stations, weak technical capacity and the obsolescence of equipment used in data collection					
Weak infrastructures for: collection, storage and distribution of water; sanitation; storage and conservation of agricultural and fishing products; and bus station					

Constraints/Gaps	NCSA	NAPA	INGEE	Adaptation	Mitigation
Inadequacy of the network of meteorological, oceanographic and hydrological stations to allow the acquisition of observed data for the initialization and calibration of numerical weather forecast models • Lack of maintenance and need to expand the radar network • Deficit of knowledge related to obtaining, processing and validating meteorological data obtained by satellites • Lack of an efficient data transmission system and meteorological, oceanographic and hydrological information in real time for national and international consumption • Absence of a model (rainfall, winds, etc.) adjusted to local conditions. Existence of hydrological models developed only for the Umbeluzi, Maputo, Incomáti, Licungo, Zambeze and Limpopo basins • Limited technical capacity at local and central level, for the implementation of SAP Flood activities or mapping at district or local level					
Limited financial resources including poor ability to access the financial, technological and capacity building resources established under the Convention and other associated instruments					
Weak knowledge about climate change, its impacts including extreme events and loss and damage on different sectors/areas, ecosystems and the economy, as well as on integrated adaptation and mitigation responses					
Weak multidisciplinary vision in research					
Weak disclosure of opportunities established under the Convention					
Weak research, education and public awareness actions					
Deficient access to data and information due to the strong departmentalization of					

Constraints/Gaps	NCSA	NAPA	INGEE	Adaptation	Mitigation
sectors and the lack of an instrument that allows data sharing					
High vulnerability of the country to climate change due to exposure to risk, poverty, illiteracy					
Weak network of extension services capable of providing technical assistance and transfer of technology necessary and adequate to the production system					
Lack of access infrastructure and rural market for buying and selling agricultural inputs and products in a timely manner					
Deficient sectoral statistics/databases including failure to stratify relevant data for climate studies					
Weak negotiation skills					
Lack of specific emission factors for national circumstances					
Deficient knowledge of GHG inventory techniques					
Lack of studies on climate change including updated and downloaded climate scenarios at local scale					
Disorderly occupation of space.					
Weak compliance with legislation and poor enforcement thereof					
Lack of qualified human resources					