REPUBLIC OF ANGOLA

MINISTRY OF CULTURE, TOURISM AND ENVIRONMENT
National Direction of Environment and Climate Action

SECOND NATIONAL COMMUNICATION

LUANDA – ANGOLA
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For more information, please contact:

Ministry of Culture, Tourism and Environment

National Direction of Environment and Climate Action

Luanda – Angola

Complex Administrativo Clássicos do Talatona, Rua do MAT, 4th Floor

Talatona Municipality

Email: dnnac@mcta.gov.ao

List of Collaborators

Coordination authors

Dr. Jomo Francisco Isabel de Carvalho Fortunato – Minister of Culture, Tourism and Environment.
Dr. Paula Francisco Coelho – Secretariat of State for the Environment.
Dr. Giza Gaspar Martins - National Director for Environment and Climate Action - Ministry of Culture, Tourism and Environment.
Eng. Ábias Huongo - Project Coordinator - Ministry of Culture, Tourism and Environment.
Eng. Julciléia Vasconcelos - Ministry of Culture, Tourism and Environment.

Energy Sector
Eng. Manuel Pinto - Ministry of Mineral Resources, Oil and Gas.
Eng. Paulo Correia - Ministry of Mineral Resources, Oil and Gas.
Eng. Milton Temo - Ministry of Mineral Resources, Oil and Gas.
Eng. Bernardo de Freitas - Sonangol Distribuidora.
Eng. Ana Manico - CHEVRON.
Eng João Fernandes - Ministry of Energy and Water.
Eng. Mikalvina - Sonangol.
Eng. Oliveira Beny - ENDE.
Eng. Paulo Kibela - Ministry of Energy and Water.
Doroteia - Ministry of Transport.
Eng. Winne Cadete – National Agency of Petroleum and Gas.

Industrial Processes and Product Use
Eng. Fonseca Quituxe – Consultant.
Eng. Manuel José - Ministry of Industry and Commerce.
Eng. Maria Madalena - Ministry of Industry and Commerce.
Eng. Falço Kiowa - Office for the Administration of the Cunene River Basin (GABHIC).
Eng. Ana Adão - Ministry of Culture, Tourism and Environment.
Eng. Ivone Pascoal - Ministry of Culture, Tourism and Environment.
Eng. Wilde dos Santos - Ministry of Culture, Tourism and Environment.

Agriculture, Forestry and Land Use Sector
Eng. Ouvídio Dala - Ministry of Agriculture and Fisheries - Forest Development Institute.
Eng. António Alfredo - Ministry of Agriculture and Fisheries.
Eng. Samba Canga - Ministry of Agriculture and Fisheries.
Eng. Jonas Eduardo- Ministry of Agriculture and Fisheries.
Eng. Pedro Panda Dias – Consultant
Eng. Edgar Faxa – FAO

Eng. Ernesto Escórcio – Ministry of Culture, Tourism and Environment.

Waste Sector
Eng. Belarmina Almeida - Ministry of Culture, Tourism and Environment.
Eng. Nara José - Ministry of Culture, Tourism and Environment.
Dr. Esperança Pembele - Luanda Cleaning and Sanitation Company (ELISAL).
Dr. André Luvenga - National Statistics Institute.
Otávio Papusseco – National Waste Agency - Ministry of Culture, Tourism and Environment.

Other consultants
Luis Constantino
Gualberto João
Fernando Pacheco
Vicente Pinto de Andrade
João da Costa Vintém

Reviewers

Internal Reviewers
Eng. Ábias Huongo – Project Coordinator, Ministry of Culture, Tourism and Environment.
Eng. Julciléia Vasconcelos - Ministry of Culture, Tourism and Environment.
International Reviewers
José Miguez - Lusophone Center
Thiago Araújo - Lusophone Center
Mauro Meireles – Consultant
Augusto – Consultant

List of Institutions, Ministries, and Organisations that participated on the elaboration of the National GHG Inventory.
Ministries

- Ministry of Culture, Tourism and Environment;
- Ministry of Agriculture and Fisheries;
- Ministry of Energy and Water;
- Ministry of Industry and Commerce;
- Ministry of Finance;
- Ministry of Telecommunications, Information Technologies and Social Communication;
- Ministry of Education;
- Ministry of Higher Education, Science, Technology and Innovation;
- Ministry of Economy and Planning;
- Ministry of Mineral Resources, Petroleum and Gas.

National Institutes

- National Institute of Environmental Management;
- National Institute of Biodiversity and Conservation Areas;
- National Waste Agency;
- National Institute of Meteorology and Geophysics;
- National Forest Development Institute;
- Regulatory Institute for Electricity and Water Services;
- Agrarian Development Institute;
- National Institute of Civil Aviation;
- National Institute of Water Resources;
- Geographic and Cadastral Institute of Angola;
- Office for the Administration of the Cunene River Basin;
- Civil Protection and Fire Service;
- National Statistics Institute;
- National Tax Agency;
- National Directorate of Traffic;
- Port Administrations;
- Angola Customs Service;
- National Institute for Education Research and Development.

Civil society

- Maiombe Network (*Rede Maiombe*);
- Angolan Ecological Youth;
- National ADRA;
- Green Foundation (*Fundação Verde*);

Companies

- Sonangol;
- Sonangol Distribuidora;
- Liquefied Petroleum Gas Angola;
- CHEVRON;
- National Oil and Gas Agency.

NGOs

- DW;
- European Union;
- World Bank;
- BAD.

United Nations Agencies

- UNDP;

- FAO;
- UNICEF.

List of abbreviations and acronyms

AC - Climate Change
AD - Activity data
AFOLU - Agriculture, Forests and land use
BAD – African Development Bank
BUR - Biannual update report
CH_4 - Methane
CO_2 - Carbon Dioxide
CO_2 e – Carbon Dioxide Equivalent
DOC – Degradable Organic Carbon
DW – Development Workshop
EF - Emission factor
EFDB - Emission factors database
ENDE - National Electricity Distribution Company
ELISAL - Luanda Sanitation and Cleaning Company
FAO - Food and Agriculture Organisation
FAOSTAT - FAO Statistics
FOLU - Forests and land use
FPSO – Floating production storage and offloading
GDP – Gross Domestic Product
GHG - Greenhouse Gases
GEF - Global Facility for the Environment
Gg - Giga gram
GWP - Global warming potential
HFC - Hydro fluorocarbons
IEA - International Energy Agency
IPCC - Intergovernmental Panel on Climate Change
IPPU - Industrial Processes and Product Use
KCA - Key Category Analysis
Ktoe - Tonne kilo oil equivalent
LPG - Liquefied Petroleum Gas
MCTA – Ministry of Culture, Tourism and Environment

MIREMPET – Ministry of Mineral Resources, Oil and Gas
MoU - Memorandum of Understanding
Mt - One million tons
MRV - Monitoring, reporting and verification
MSW – Municipal Solid Waste
Mtoe -Mega Tonne Oil Equivalent
MW - Megawatt
N_2O - Nitrous Oxide
NDC - Nationally Determined Contributions
NMVOCs - Non-methane volatile organic compounds
NOx - Nitrogen Oxide
PFC - Perfluorocarbons
GDP (GDP) - Gross Domestic Product
QA / QC - Quality Control / Quality Assurance
UNDP – United Nations Development Programme
UNICEF – United Nations Children Fund
UNFCCC - United Nations Framework Convention on Climate Change

Table of Content

Introduction

The Second National Communication is a document prepared by the Ministry of Culture, Tourism and Environment which aims to present a set of actions at national level within the framework of the various commitments assumed with the implementation of the United Nations Framework Convention on Climate Change. Among the various components of the National Communication and following the guidelines of the Conference of the Parties 2 COP/7 is the component on national circumstances, the national inventory on greenhouse gases, the creation of conditions for the establishment of appropriate measures to facilitate adequate adaptation and mitigation of climate change, the process of environmental technology transfer, research and systematic observation and the integration of climate change issues into sectoral plans and programs, as well as carrying out capacity assessment to deal with extreme climate events.

Of the commitments that Angola made when it acceded to the United Nations Framework Convention on Climate Change, the need to develop and periodically update, through the National Communication, national inventories of greenhouse gas emissions, by source and sector, those not controlled by the Montreal Protocol, the Biennial Update Reports (BUR), national adaptation plans and programs, as well as national contributions to achieving the targets contained in the Paris Agreement, should be highlighted. In addition, regular updating through the National Communication should also provide general indicators of the conditions in the country for the implementation of the Convention.

The process of drafting the National Communication also aims to increase transparency through the MRV, to assist in the implementation of the National Strategy for the Implementation of the United Nations Framework Convention on Climate Change (UNFCCC), in which the National Communication is one of the keyelements.

All components of the National Communication were developed on the basis of the guidelines of the Conference of the Parties to inform the Conference of the Parties on the steps and stages developed in the implementation of the Convention, as well as on the creation of national capacities for the implementation of all the commitments assumed to reduce greenhouse gas emissions in order to adapt the national territory to the adverse effects of climate change.

The drafting of Angola's National Communication required considerable effort, as issues related to climate change still present a difficult understanding within Angolan society. The moment of conflict that the country went through until 2002 has meant that the structural organisation of institutions has some weaknesses, making it difficult to obtain concrete data and information for the elaboration of the document, in which the weakness in terms of human resources to deal with the issue of climate change has been combined. During the preparation of the second national communication, some difficulties were overcome and others persisted for various reasons, including staff turnover, weak individual and institutional capacity, the difficulty of linking the causes and consequences of climate change to the various sectors, as well as the difficulty in obtaining data because many of them do not exist in many institutions and others are no longer available.

The preparation of Angola's national communication met the current needs established by the United Nations Framework Convention on Climate Change, in which it stimulates the involvement of national technicians in the elaboration of the components, the strengthening of the capacity of these human resources, as well as the institutional involvement of the various sectors of state administration, academic and scientific institutions, the private sector, as well as civil society organisations.

The integration of climate change aspects into country development policies and strategies is a crucial component of adaptation and mitigation and one of the key steps in the implementation of the UNFCCC commitments. It is therefore very important to identify the measures taken by Angola in this regard and their results, as well as to identify the most urgent needs in the short and medium term for the implementation of this integration

METHODOLOGY USED FOR DRAFTING THE NATIONAL COMMUNICATION

For the preparation of Angola's National Communication, priority was given to integrated intersectoral participation in accordance with the area of intervention of each institution, taking into account the guidelines for preparing the report, in some cases independent consultants were introduced and in general international consultants were used to review the document essentially with regard to drawing up the inventory.

In this way for issues related to Greenhouse Gas emissions the sectors whose activity contributes to emissions on Angolan soil have been integrated, such as the Energy, Industry, Agriculture, Forestry and Land Use and Waste sector. The tool used to calculate emissions was the software prepared by the Intergovernmental Panel on Climate Change for the 2006 Convention Secretariat. Training was provided for national technicians to use the tool and national consultants were employed through the Support Programme for National Communications and the Lusophone Nucleus.

For the analysis of vulnerabilities and adaptation mechanisms, sectors such as Territorial Administration, Agriculture, Industry, Civil Protection, Energy and Water, Fisheries, Hotel and Tourism, Health, Education were integrated. These are the sectors considered to be most vulnerable in Angola and the respective adaptation measures have been proposed. The situation in Southern Africa has been taken into account.

In relation to mitigation, a correlation was made between Greenhouse Gas emissions as well as the energy matrix, and using the tool called LEAP (Long-range Energy Alternative Planning System) - Long-term planning in the energy sector. Due to the lack of concrete information for the industry and transport sectors, little was targeted.

INAMET and related sectors with meteorological, hydrological and technological information gathering were involved in the research and systematic observation, gaps and opportunities in the sector were identified.

For the education and climate change component, the Ministry of Education and related institutions were involved, where a comprehensive survey of actions carried out in the formal and informal education sector related to climate change was made;

For the integration of climate change into development plans and programmes, all sectors have been integrated;

The methodology chosen to prepare the Second National Communication consisted of bibliographic review, interviews and, in many cases, estimates, taking into account the scarcity of information for many extremely important sectors covered by the Inventory.

Initially invitations were made for the participation of institutions covered by the Inventory (Energy, Industry, Waste, Agriculture and Forestry). The Ministries assigned to the respective areas indicated their representatives who attended several capacity building sections. At first, attempts were made to give more responsibility to the institutions, but some were not fully handed over, with the result that the consultants from the institutions were even left to prepare the components.

In general, international consultants have been involved in the training of national staff, given the rather technical nature of the various methodologies. For their part, the national consultants developed the various components, thus opening space to make the process of preparing the national communication sustainable.

Complexo Administrativo Clássicos de Talatona, Rua do MAT,
Building 4, 4th Floor
Talatona Municipality, Luanda
E-mail: dnaac@mcta.gov.ao

CHAPTER 1

1.1 National Circumstances and Institutional Arrangements

Within the scope of the commitments assumed by Angola at the time of accession to the United Nations Framework Convention on Climate Change, the Second National Communication appears as a document developed by the institution responsible for environmental issues.

The structure of the Second National Communication follows the guidelines agreed during the negotiations between the Parties. The work has been developed based on the research of secondary sources, such as guiding documents from the Executive, books published by national and international institutions, newspapers and some websites with relevant information about the Angolan context, as well as the collection of some information from primary sources fundamentally in vulnerability analysis, capacity assessment and information technologies.

These sections present the main characteristics of the territory of the Republic of Angola. The general characterisation of Angola can be found in Table 1:

Parameter	Description
Territory	1.246.700 Km2 being the 23rd largest country in the world in surface.
Political-administrative division	It is divided into 18 provinces, 164 municipalities, 44 urban districts and 518 communes[1], the capital of the country being Luanda.
Population	29,250,009 inhabitants[2] being the 46th largest country in the world in population terms[3]
Population density	20.7 inhabitants[4] per Km^2
Climate	Tropical rainy, dry steppe, dry desert and temperate.
Water Resources	Angola has large water resources, the largest river basins being the Congo, Zambezi, Kwanza, Queve, Cunene and Cubango rivers[5].

Table 1: General characterization of Angola

1.1.1 Physical characterisation

[1] INE (2016). Final results of the 2014 Angola General Census of Population and Housing.
[2] INE (2016). Final results of the 2014 Angola General Census of Population and Housing. INE estimates the population at
[3] AMCham and AIPEX (2018). Investor Guide "Angola is Now".
[4] INE (2016). Final results of the 2014 Angola General Census of Population and Housing.

[5] AMCham and AIPEX (2018). Investor Guide "Angola is Now".

Geographically, Angola is an African and Atlantic country located between the parallels 4° 22' and 18° 02' South and the meridians 11° 41' and 24° 05' East. It has an area of 1.246.700 Km2, with a maritime coast of 1.650 km and a land border of 4.837 km.

It is limited to the North by the Republic of Congo and the Democratic Republic of Congo, to the East by the Democratic Republic of Congo and the Republic of Zambia, to the South by the Republic of Namibia and to the West by the Atlantic Ocean. Its political-administrative division comprises 18 provinces.

The *relief* is characterised by three main configurations. A coastal plain, with variable width, larger in the north and near Luanda where it reaches 200 km and narrowing in the central region, around Benguela, up to 25 km. In an easterly direction are the abrupt escarpments, which constitute the transition zone to the sub-planet and plateau, very rugged. In central Angola is the highest point in the country, Morro do Moco, at 2,619 metres. To the east are the plateaus, among which the most significant is the Bié Plateau, better known as the Central Plateau, where the altitude often exceeds 1,500 metres and even reaches 2,000metres.

The climate is strongly influenced by the cold Benguela current and the altitude, in addition to other factors such as the latitude and the river basins of the large rivers. The average annual temperature decreases with increasing latitude and altitude and decreases as the distance to the sea increases. The annual range of temperature variation is very small. The lowest values (15 to 20ºC) are found in the higher regions or in the extreme southwest, while the highest (25 to 27ºC) are located on the banks of the Zaire River and in the northern coastal strip.

The highest levels of rainfall (1500 to 1700 mm) are found in northern Cabinda, the Uige highlands, Lunda Norte and the central massif of the Marginal Mountain Chain; the lowest (less than 300 mm) are found in the coastal strip south of Luanda, particularly in the Namib Desert (50 mm). Rainfall determines two seasons: rainfall lasting from four to seven months (September or October to April), which is warmer and with higher relative humidity, and drought or cacimbo (May to August), which is colder.

Hydrography: The main river basins are (north to south and west to east) those of the Congo, Zambezi, Kwanza (the largest), Queve, Cunene and Cubango. Most of the rivers originate in the central highlands, following west into the Atlantic Ocean, north into the river Zaire or southeast where they infiltrate the interior of the continent. Two of the rivers that originate in the central plateau stand out: the Kwanza and the Cunene. The Kwanza is about 1,000 km long and is the largest river entirely within the territory. The provinces of Lunda Norte and Lunda Sul contain riverheads which are important for other countries in the region, particularly the Zaire and Zambezi basins. Lakes and lagoons abound in Angola, the largest being Lake Dilolo in Moxico.

Vegetation: a great diversity can be found, from forests of various types (dense wet, humid, dry, open) to different meadows and the desert, passing through various mosaics (forest-savannah, woodland), savannahs, steppes and chanas. Due to its density and importance in climate and biodiversity, the Maiombe (Cabinda) forest stands out, while the Cumbira (Kwanza

Sul) forest is important for its birdlife. The vegetation has been under immense pressure, which has been accentuated by the wars in Angola, responsible for the displacement of a large part of the rural population to the periphery of urban centres, and by the peace increase in the pressure on forest resources through the recrudescence of agricultural, livestock and forestry activities for business purposes. The same is true for family farming and coal mining, both for self-consumption and for marketing.

The loss of biomass is also caused by the burning, which takes place during the period of cacimbo, which is carried out by the rural population to hunt small animals for self-consumption and sale and to open new pastures before the rains start. The loss of vegetation is causing very serious damage with the appearance of ravines, both in rural and urban areas.

1.1.2 Administrative and institutional characterisation

Angola has been an independent country since 1975. Its territory is demographically very unbalanced, with vast regions with very low population density (Cuando Cubango with 2.6 inhabitants per Km2) and others with high densities (Luanda with 368 inhabitants per Km2)[6]. The country is divided into provinces and these into municipalities, which in turn are subdivided into urban districts and communes. These are divided into towns and villages in rural areas. The main cities are Luanda (the capital), Benguela and Huambo.

The Government has the modernisation of public administration on the agenda, aiming at providing better services to the population at lower cost. As a result, there have been improvements in the functioning of the public administration, with basic services brought closer to the population and administrative procedures simplified, such as the Single Enterprise Counter (Guiché Único de Empresas), the Entrepreneur's Desk (BUE) and the Integrated Citizen Service (SIAC).

A process of state reform is underway, aimed at the consolidation of the democratic state and the rule of law and the separation of powers, as well as deconcentration and decentralisation and the establishment of municipalities.

The *Ministry of Culture, Tourism and Environment oversees* the implementation of environmental policies, in particular in the fields of biodiversity, environmental technologies and impact prevention and assessment, as well as environmental education. It is also responsible for the implementation of the Basic Law on the Environment (LBA), the United Nations Framework Convention on Climate Change (UNFCCC) and the objectives of Agenda 2063 of the African Union, in particular the Development of the Blue Economy (of the Oceans) in the country. With the adoption of the LBA in 1998, the first steps towards the building of Environmental Law were taken, consolidated with the elaboration of legislation on environmental or related issues. According to the 2010 Constitution, the protection of the environment and natural resources is a fundamental task of the State and its implementation is divided between the State and the Municipalities.

[6] INE (2016). Final results of the 2014 Angola General Census of Population and Housing.

The National Development Plan (PDN) 2018-2022 operationalises the response to the transversal concern of the Long-Term Strategy Angola 2025, translated into the overall objective of "ensuring the existence and maintaining the quality of nature's resources (natural capital), guaranteeing their healthy use for current and future generations, through an appropriate legal and institutional framework and adequate management, involving strong participation by society".

Within the framework of environmental sustainability, the NDP 2018-2022 presents as priority programmes those on climate change, biodiversity and conservation areas, marine spatial planning and ecosystem health, and risk prevention and environmental protection. In conducting environmental policy, the NDP advocates that environmental governance co-ordinated by the Ministry of the Environment may involve various entities from the Public Administration and the private sector. The marine environment falls under the competence of the Ministry of Fisheries and the Sea.

The Climate Change Programme should achieve the following objectives: i) Implement the National Climate Change Strategy 2020-2035; ii) Adapt the national territory to the effects of climate change; and iii) Strengthen the fight against drought and desertification, namely through the creation of institutional mechanisms for coordination, participation and action between the different sector

1.1.3 Demographic, ethnolinguistic and cultural characterization

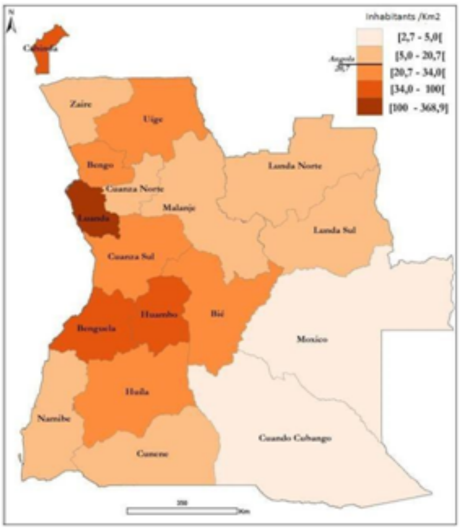
Demographic characterisation

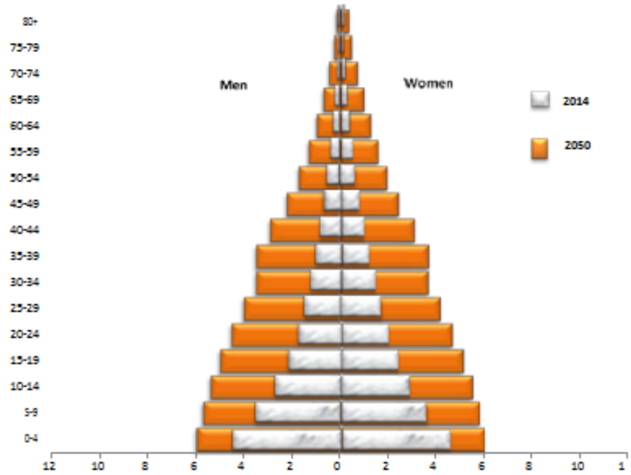
According to the final results of the General Census of Population and Housing (RGPH 2014), the total Angolan population was estimated at 25.8 million, of which 52% are women and 48% men. Population projections from the National Projection 2015_2050 (PN2016), indicate that the population in 2020 will amount to 31 million and in 2050 to almost 68 million inhabitants.

Luanda, the country's capital, is the most populous province, with around 27% of the population (6.5 million people in 2014, projected to reach 8.5 million in 2020 and 17 million in 2050). It is followed by the provinces of Huila, which is made up of 10% of the total population, Benguela and Huambo with 8%, Kwanza Sul with 7% and Bié and Uíge with 6%, according to chart 4. The distribution does not change in the projections. In total, these 7 provinces concentrate about 72% of the total population living in the country, and most of the population (62.3%) is concentrated in urban areas; the projection for 2050 puts the urban population share at 59%.

Complexo Administrativo Clássicos de Talatona, Rua do MAT,
Building 4, 4th Floor
Talatona Municipality, Luanda
E-mail: dnaac@mcta.gov.ao

Cartogram 4 - Population density by province, 2014





Population distribution by province (left) and Age structure of the population by gender, 2014- 2050 (right)
Source: National Projection 2014_2050, INE (2016)

Angola's demography is characterised by a high annual population growth rate, in 2015 the growth rate was 3% and INE's projection indicates that it will decrease to 2% in 2050. IIMS[7] 2015-2016 estimates the fertility rate at 5.7 children per woman. On the other hand, the infant mortality rate is 50/1000, the 20th highest in the world[8]. The population is quite young with the average age of 21 years. The under-15s represent 47% of all residents and the elderly only 2%. The percentage of women of reproductive age (15-49 years) is 44%. Average life expectancy is low (60.2 years), for men aged 57.5 and for women aged 63.

According to the Human Development Index, Angola registered a figure of 0.574 in 2019, representing a slight decrease from the previous year, which corresponds to 149th place in the *ranking of* 189 countries. On the other hand, Angola's gross national income (GNI) *per capita* rose twice between 2000 and 2014 and has since fallen 14% to 5555 (2011 PPP $). When Angola's HDI value (0.581) is adjusted to the inequality factor, the HDI falls to 0.392 and simultaneously loses nine positions in the HDI ranking.

The economically active population is less than 50%, with many dependents on the state and families. On average, each household has 5 people and 38% of households are headed by women.

[7] INE (2016). Data from the Multiple Indicators of Health (IIMS) Survey 2015-2016 - a new IIMS is currently under way in 2020.
[8] https://data.worldbank.org/indicator/SP.DYN.IMRT.IN?most_recent_value_desc=true

Ethnolinguistic and cultural characterization

The word Angola derives from "*Ngola*", the name given to a dynasty of the Ambundo peoples. It is a multicultural and multilingual country, with almost the entire population of Bantu origin. There are other non-Bantu peoples, such as the San, the Ovakwando (Kuisi) and the Ovakwepe (Watua or Koroca), confined to small groups in the eastern and southern areas.

The main ethnolinguistic groups are: Bacongo, Ambundo, Ovimbundo, Cokwe, Ganguela, Nyaneka-Humbe, Ovambo, Herero, Okavango, San. Angola, unlike other peoples in Africa, has not experienced ethnolinguistic conflicts.

In 1970 the national languages in decreasing order of number of speakers were Umbundu, Kimbundu, Kikongo, Ucokwe, Olunyaneca, Nganguela and then the rest. In 1975, Portuguese was adopted as an official language and from 2006 it became a national language. Today Portuguese is the most common language, spoken by 71% of the population (85% half urban and 49% half rural), followed by Umbundo spoken by 23% of the population, Kikongo (8.2%), Kimbundu (7.8%) and Côkwe (6.5%). There are six other languages spoken by more than 2% of the population each and other languages spoken by a total of 4% of the population.

1.1.4 Social characterisation

Poverty situation

Data from the 2019 National Statistics Institute (INE) on the Angolan Multidimensional Poverty Index indicates that one in two people (54.0%) in Angola live in multidimensional poverty and suffer on average about half of the sixteen deprivations related to health, education, quality of life and employment. In the urban area the incidence rate of multidimensional poverty is 35%

- More than one in three people is multidimensional poor, while in the rural area around 88% of the population (or 9 in 10 people) live in multidimensional poverty. This index goes beyond the concept of income poverty, i.e., it represents poverty in terms of consumption of goods and services such as access to water, electricity, education and health.

Looking only at monetary poverty, the Poverty Report for Angola 2020: Expenditure and Income Survey (IDR - 2018/2019) indicates that the incidence of poverty in Angola is 41%, which means that 41 out of every 100 Angolans have a level of consumption below the poverty line (12,181 kwanzas per month). Of the total poor population 56% live in rural areas and 44% in urban areas. The depth of poverty index, i.e., the average consumption deficit per person below the poverty line is 10%. The severity of poverty is 4%.

Also, according to the 2020 Poverty Report, the 20% of the population with the highest revenues holds 63% of all revenues, while the 20% of the population with the lowest revenues holds 2%. This means that the average income of a person in the richest quintile is 31 times higher than the average income of a person in the poorest quintile. Urban inequality is similar to national inequality, while rural inequality is less severe, with the richest population's average income in these areas being 20 times higher than that of the poorest population. This means that there is less inequality in rural areas than in urban areas.

In NDP 2018-2022 the government plans to reduce the poverty rate from 36% to 25% and the Integrated Programme for Local Development and Fight Against Poverty (ICPD) plans to lift three million people out of extreme poverty.

The *Local Development and Poverty Programme* outlines a set of actions to improve the well-being and quality of life of families and to reduce inequalities and poverty: i) Municipalizing social action services, through the creation of Integrated Social Centres; ii) Promoting the integration of people in situations of vulnerability and poverty with work capacity, in socio-economic projects (productive inclusion); iii) Assigning social benefits in cash or in kind to families in situations of extreme poverty; iv) Promote targeted assistance, with a focus on improving housing conditions; v) Implement the National Programme for the Delimitation and Subsequent Concession of Land and Bonds in rural areas; vi) Ensure primary health care in all municipalities; and vii) Ensure the supply of drinking water and electricity to the population and to the productive sector (water and light for all).

Education

After independence the main objective of the government was the creation of a new society, based on the so-called "new man". Education became compulsory and accessible to the entire population. Free education through exemption from any payment for enrolment, attendance at classes and school material, and easy access, combined with the fact that education was defined as a priority in the tasks of the state, led to an explosion in schooling, with a high number of pupils and a great shortage of infrastructure, teachers and school material. According to the 2010 Constitution, the state promotes access to education and literacy for all citizens within the framework of their economic and social rights.

The Basic Law of the National Education System includes the principles of compulsory and free of charge. The education and teaching system is unified and composed of six subsystems and four levels of education. The general education subsystem is structured in primary and secondary education. According to IIMS 2015-2016, only 13% of the population aged 18-24 have completed upper secondary education.

Literacy and school lag: in Angola 66% of people aged 15 and over are literate, of which 80% are men and 53% women. In the 2014 census, around 4,676,900 people over the age of 15 (34% of this population) could neither read nor write. It is difficult to estimate the need to catch up on schooling, but given that only 19.9% of the population aged 18 and over have completed primary school, the need will be extremely high. The NDP 2018-2019 aims at increasing literacy with a focus on women and rural areas.

Primary and secondary education: according to IIMS 2015-2016, 71% of children aged 6-11 years, both sexes, were in primary education that year. The Profile of the Child (2018) indicates that individuals aged 6-17 who have never attended school is 25%.
For secondary education, the net school attendance rate is 40% (43% male and 37% female).

The school enrolment rate in secondary education shows a higher gender imbalance than in primary education, the Gender Parity Index (GPI) being 1.02 in primary education and 0.85 in secondary education. That is, for every boy there is one girl in primary education and for every ten boys there are eight girls in secondary education. Children in urban areas are more likely to attend primary school (78% compared to 59%) and secondary school (50% compared to 14%) than children in rural areas. The NDP 2019-2022 foresees that the allocation to the education sector will gradually increase from 12.4% to 20% of total expenditure.

Higher Education: this level of education was implemented in Angola in 1963, with the creation of the General University Studies of Angola (EGUA). The Catholic Church had created its seminary in 1958, with higher studies in Luanda and Huambo. After the establishment of EGUA, courses were created in the cities of Luanda (medicine, sciences and engineering), Huambo (agronomy and veterinary) and Lubango (letters, geography and pedagogy). EGUA gave way to the University of Luanda, which in 1976 was renamed the University of Angola and in 1986 Agostinho Neto University (UAN) until 2009. UAN was then split into 7 regional universities, limited only to Luanda and Bengo, while units in the other provinces were allocated to the other six new state universities.

In 2017 there were 24 public and 41 private universities, in addition to autonomous public and private institutes and colleges. Between 2002 and 2011, the number of students in undergraduate courses at higher education institutions increased to 140,016. The 2014 Census indicates that the population over 18 years of age who have completed higher education is 2%. The NDP (2018-2022) includes measures to expand higher education, such as increased investment in infrastructure, in addition to measures to overcome the shortage of teachers and their low educational qualifications, low flexibility of curricula, low pay and the absence of appropriate public policies.

Health

The national health system has made progress in key areas such as maternal and child health, the fight against malaria and the fight against communicable diseases. For example, the Municipal Programmes for Rural Development and the Fight against Poverty (PMIDRCP) have contributed to the improvement of primary health care in rural communities. But challenges still exist in these key areas and with maternal and child mortality.

Malaria is a major public health problem and the primary cause of demand for health services. According to the National Directorate of Public Health (DNSP), it accounts for 56% of reported morbidity, 35% of curative care, 20% of admissions, 40% of perinatal death and 25% of maternal death. Data from IIMS 2015-2016 indicate that malaria is the leading cause of death, illness and absenteeism from work and school. The main measure to combat and prevent malaria is the use of insecticide-treated mosquito nets, with 37% of households having at least one net (treated or untreated), 31% having at least one ITN[9], and 29% having at least one ITNLD[10]. The average number of nets (treated or untreated) per household is 0.6.

Water and sanitation

According to IIMS 2015-2016, just over half of households (53%) have access to appropriate drinking water sources, 67% of them in urban areas and 33% in rural areas. In urban areas, 22% of households have piped water at home or in the backyard (appropriate water sources) and 21% obtain it for drinking from tanker trucks, tank wagons or three-wheeled motorbikes (inappropriate water sources). On the other hand, 39% of households in rural areas obtain their drinking water from a lake, pond, stream or irrigation canal (unsuitable water sources). At national level, it can be observed that 67% of households do not treat water, 52% of which in urban areas and 91% in rural areas.

Also, according to IIMS 2015-2016, only about one third of households (32%) have some type of appropriate, un shared sanitation facility and the proportion is higher in urban areas (46%) than in rural areas (11%). The study considers appropriate sanitation the use of a toilet, toilet or latrine connected to the public sewage system or septic tank, or connected to the open pit.

Despite some progress, challenges remain: (i) Water supply and sanitation infrastructure has not kept pace with population growth; (ii) There are technical difficulties in ensuring regular water supply in the vast majority of the country's cities; (iii) Irregularities in water supply and lack of access to the public network led the population to seek alternative sources, many of them with poor water quality.

Employment and vocational training

Employment and unemployment indicators are highly volatile in Angola. According to INE data, in the third quarter of 2019 the unemployed population aged 15 and over rose 5.3% (214,836 people) compared to the second quarter of 2019. The unemployed population was estimated at 4,271,105, corresponding to a rate of 30.1%, 28.6% for men and 31.5% for women, and in the urban area (40.0%) more than twice as high as in the rural area (16.5%). The unemployment rate for young people aged 15-24 was estimated at 54.2%, 55.3% for men and 53.0% for women.

In the same period, the employed population aged 15 and over was estimated at 9 931 548 people, 4 924 531 men and 5 007 017 women, and significantly larger in rural areas (76.7%) than in urban areas (50.3%). Around 35.8% of 15-24-year olds were in the labour market, with no significant difference between men (35.1%) and women (36.6%).

Despite employment and unemployment figures, the majority of the working age population is active[11]. The economically active population aged 15 and over has been estimated at 14 202

[9] Insecticide-treated mosquito nets
[10] Long Lasting Insecticide Treated Mosquito Pests
[11] Did any income-generating activity in the 7 days preceding the survey.

653 people, 6 895 631 men and 7 307 021 women. This corresponds to a rate of 87.1%, which is higher in rural areas (91.9%) than in urban areas (83.9%) and higher among men (88.4%) than among women (85.9%). These trends are observed in all age groups.

The economically inactive population aged 15 and over has been estimated at 2,100,719, of whom 902,106 are men and 1,198,613 are women. The inactivity rate is estimated at 12.9%, twice as high in the urban area (16.1%) as in the rural area (8.1%). The highest figures are found in the 15-24 age group (21.8%), where many are still students, and in the 65-plus age group (41.4%), which includes retired people and others unable to work due to advanced age.

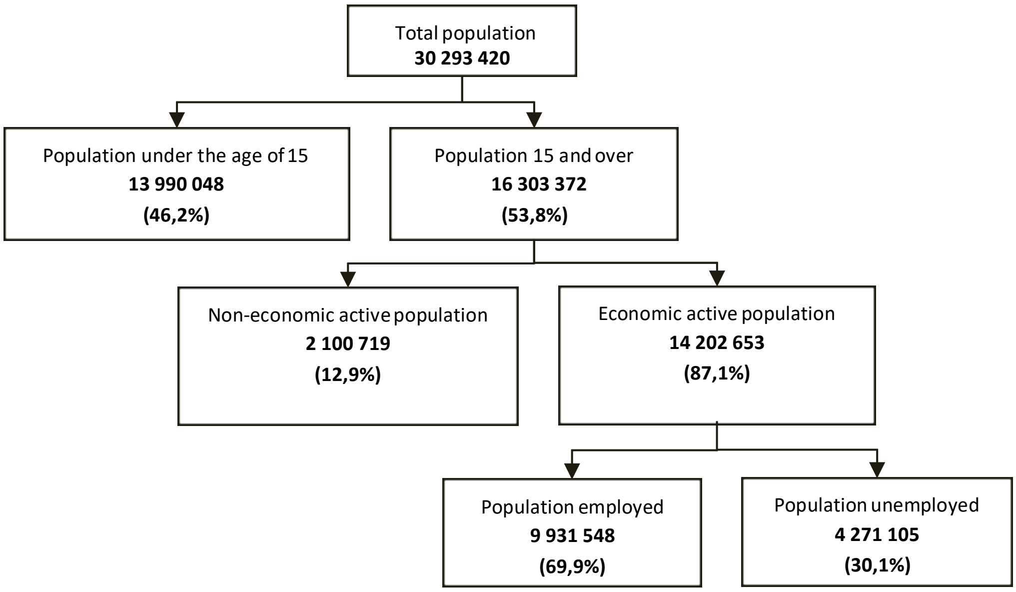


Figure 1: Distribution of the population according to activity situation
Source: Quick Information Sheet (FIR) of the Angolan Employment Survey (IEA) in the 3rd quarter of 2019.

Although activity and employment figures are more favourable in rural areas, they sometimes do not reflect the quality of employment. After the end of the war in 2002, several programmes with a rural focus were carried out, particularly those for the reintegration of ex-military personnel, mine clearance, encouraging the return of the population to their areas of origin, and extension and rural development. Despite these efforts, this environment has been marked by many challenges, which explains why the population of some of the most important agricultural provinces has been declining. For example, in Malanje the population has declined by 33% since 1990, as has Kwanza Norte (23%), Bié (20%) and Huambo (19%).

According to the NDP 2018-2022, the training capacity of the National Vocational Training System is around 50 thousand trainees. In 2014, the National Vocational Training System had

Complexo Administrativo Clássicos de Talatona, Rua do MAT,
Building 4, 4th Floor
Talatona Municipality, Luanda
E-mail: dnaac@mcta.gov.ao

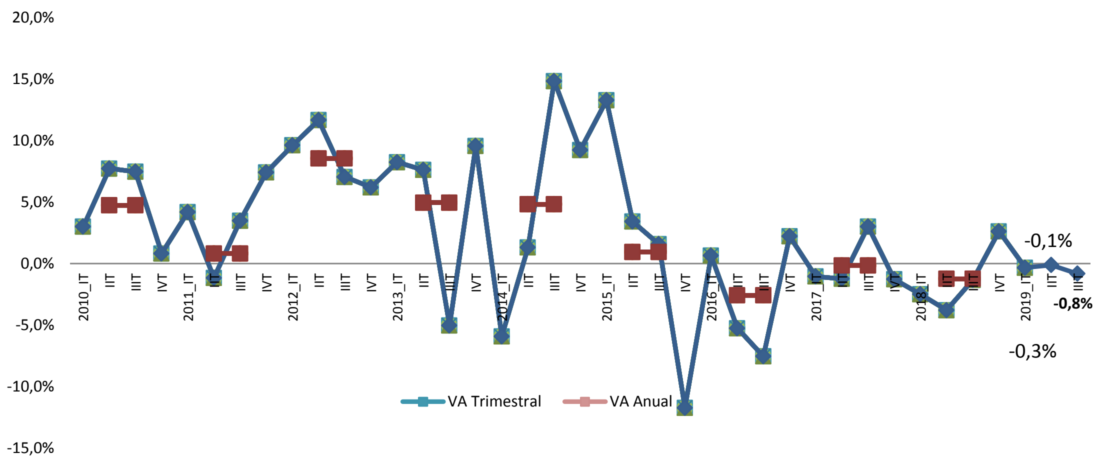
more than 550 training units in operation, of which 139 (25%) were run by the National Institute for Employment and Vocational Training (INEFOP), 35 by other bodies and the remaining 69% by private entities, including vocational training centres, mobile units and arts and crafts pavilions.

In Public Administration, a Network of Public Administration Training Institutions (RIFAP) was created, which includes the National School of Administration (ENAD), the Institute for Public Finance Training (INFORFIP), the Higher Institute of International Relations (ISRI), the National School of Public Health (ENSP), the National Institute for Staff Training (INFQE) and, specifically for the decentralized levels of Administration, the Training Institute for Local Administration (IFAL)

The NDP defines as objectives to satisfy the demand for middle managers in the labour market in strategic areas, through the training of middle managers in quantity and quality and to guarantee a greater exchange between students and companies, promoting insertion in the labour market, through the dynamization of the Insertion in Working Life Offices (GIVA) of Middle Technical Institutes and increasing the participation of students in curricular internships. The targets are to increase (60% compared to 2017) to 16.2% by 2022 the rate of participation in the technical-vocational education subsystem, as well as the number of students graduating from the technical-vocational education courses (from 29,650 in 2017 to 46,500 in 2022). It is also intended that by 2020, all students will have vocational guidance through the Insertion into Working Life Offices and that in 2022, 60% of final year students in the Middle Technical Institutes will participate in supervised curricular internships. The NDP also intends that by 2022, half of the young people and adults completing primary adult education should be sent to Vocational Training Centres.

Economic characterisation

Angola's economic growth over the last decade has had two very marked periods: until 2014, the economy grew at an average annual rate of over 5%, with growth even exceeding 8.5% in 2012; in 2015 GDP grew by only 0.9% and since 2016 Angola's GDP has fallen by an average of 1.2% per year, with a 2.6% drop in 2016.



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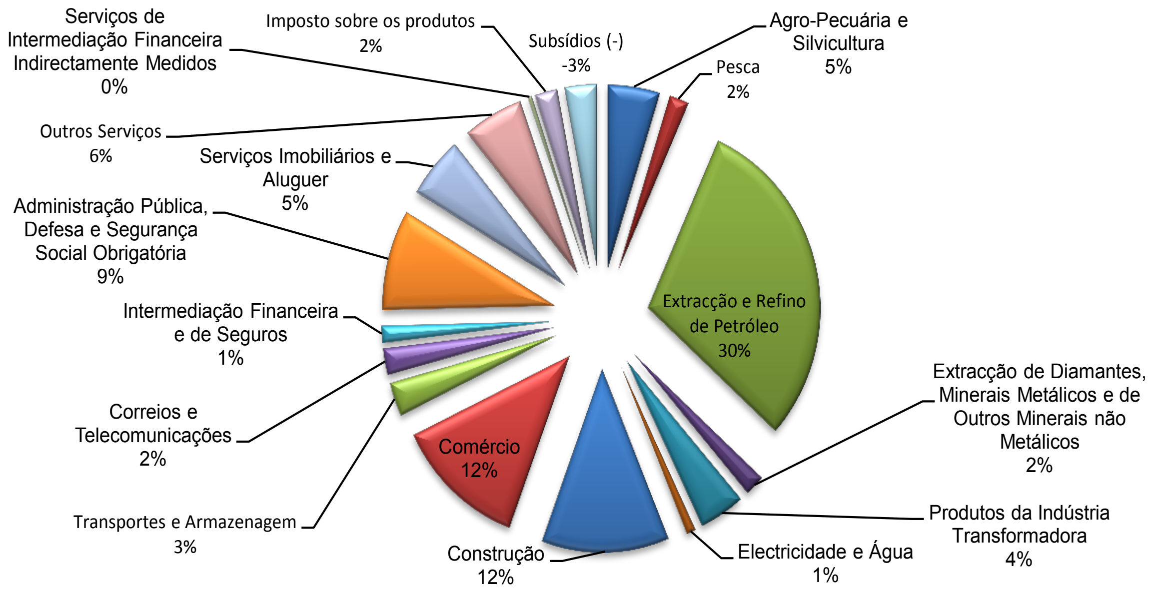
Talatona Municipality, Luanda
E-mail: dnaac@mcta.gov.ao

Figure 2: Angola's economic growth in the last decade.

The dramatic fall in the price of a barrel of oil from 2014 onwards was largely responsible for this change. The oil sector contributes on average about 33% to GDP, but more than 65% of government revenues, and is responsible for more than 95% of Angola's exports. With the fall in oil prices, there was a sharp deterioration in income and fiscal sector indicators, which resulted in a contraction of public consumption expenditure and, in particular, public investment. The slowdown in implementation of projects included in the Public Investment Programme (PIP) had a major impact, as public investment has in recent years been an important driver of economic growth in the non-oil sector of Angola's economy. The figure below shows the composition of GDP.



Fonte: *Departamento de Contas Nacionais e Coordenação Estatística*

Figure 3: Share of activities in GDP in the third quarter of 2019. Source: INE Press Release - Gross Domestic Product, 3rd Quarter 2019.

Angola's GDP in 2014 was estimated at US$145.2 billion, becoming the 3rd largest economy in Africa, fell to US$85.8 billion in 2019 and is now the 8th largest economy in Africa.

The impact of lower oil revenues also had an impact on other sectors. In fact, the significant reduction in Net International Reserves[12], i.e. access to foreign exchange, has created constraints on access to raw materials and capital goods and generated galloping inflation. The national currency fell from around 125Kwz/Eur in early 2015 to 680Kwz/Eur in 2020.

Oil production has been falling since 2018 and is currently at 1.49 million b/d, with a downward

[12] According to the NDP 2018, the coverage of months of imports fell from eight in 2013 to around five at the end of 2017.

trend mainly due to lack of investment. Manufacturing has kept its average share below 4% of GDP since 2002, with a fleeting episode in 2015 at around 7%. One of the biggest constraints in this sector is the availability of raw materials.

It should be noted that Angola's rural economy is basically made up of poorly developed agriculture and the country imports a large part of its food. Only about 10% of Angola's arable land is cultivated (5.2 million hectares out of a total of about 56 million). The growth rate of the agricultural sector is low and in some years negative. The share of the sector in GDP is still around 5%. The NDP 2018-2022 provides for an increase in family production for the market through the construction of economic and social infrastructure and an increase in technical assistance capacity for family producers from the Agricultural Development Stations (ESDPs) and other partners.

Under these circumstances, the inflation rate according to the National Consumer Price Index published by the National Institute of Statistics has been very high. In 2018 it was 18%, in 2019 it was 16.90%, and is expected to be above 20% by 2020 (23% by September 2020).

The Long Term Development Strategy (ELP 2025) aims to respond to the major challenges facing the country by 2025 and pursues the following objectives: a) To promote the Human Development and Welfare of Angolans, eradicating hunger and poverty and promoting the educational and health level of the population; b) To promote Sustainable Equitable Development, ensuring the efficient use of natural resources and the fair distribution of national income; c) To ensure a high rate of Economic Development, with macroeconomic stability and structural diversity.

ELP 2025 is operationalised through national development plans (NDP). The second planning cycle of the National Development Plan 2018-2022 is currently in force. These new generation NDPs ensure better integration of environmental considerations into sectoral plans, programmes and policies.

NDP 2018-2022 is forward-looking and multi-annual and covers the national, sectoral and provincial planning levels. The objectives of PDN 2018-2022 are: i) To ensure the harmonious development of the territory and to elaborate the fundamental instruments for this; ii) To develop an urban, qualified and sustainable network; iii) To integrate the national territory, favouring the circulation of populations and of goods and services.

The NDP 2018-2022 is in line with Angola's *Macroeconomic Framework,* which was recovering and was again affected by the OVID pandemic19. With the serious economic crisis that had devastated the country since 2015, the executive carried out a diagnosis of the macroeconomic and social situation that assessed the main factors of economic growth and concluded that, as a result of ineffective monetary and fiscal policies, a segmented foreign exchange market and a concentrated and inefficient banking system, the Angolan economy had reached a state of "near stagflation. The diagnosis gave rise to the *Interim Plan* with policy measures and actions to improve Angola's economic and social situation and the *Macroeconomic Stabilisation*

Programme (MES) with objectives and initiatives on foreign exchange policy, government spending and revenue, debt, monetary policy investment and diversification and the financial sector. which stems from the situation and recovery efforts.

The main sectoral priorities of the country, which could influence adaptation capacities and mitigation measures in relation to the phenomenon of climate change, are described below.

Diversification of the Economy: in order to accelerate the diversification of the economy, the Executive established *PRODESI - Programme of Support to Production, Diversification of Exports and Import Substitution*. It aims to accelerate the diversification of national production and wealth generation in a set of specific products and value chains to be integrated in clusters with greater potential for value generation and export and import substitution. For the operationalization of PRODESI, the *Credit Support Project* (PAC) was launched for investment projects that contribute directly or indirectly to the production of goods.

The *Privatisation Programme* (PROPIV) is also aligned with PDN 2018-2022 and is part of the Public Finance Reform, with a view to reducing the State's participation in the economy, as a direct producer of goods and services, and promoting favourable conditions for private initiative, foreign investment and the acquisition of *know-how* and specific skills, which must be the guidelines for restructuring and resizing the Public Enterprise Sector.

Population *growth and fertility rate*: according to a UNFPA study, population growth in 50 years was over 330%, rising from 6.6 million people in 1970 to 31.8 million in 2019. As the fertility rate is quite high, according to IIMS 2015-2016 it is 6.2 children per woman and according to INE's population projection, with a population growth rate that varies between 2.9 in 2014 and 2.0 in 2050, the Angolan population is expected to reach 67.9 million people in 2050.

Birth Registration: through a Presidential Order the Massification of Civil Registry Programme was launched in 2013, which aimed to register eight million Angolans over a three-year period. At the end of the programme there were almost 12 million Angolans without birth registration, demonstrating the inefficiency and inefficiency of the programme. A new campaign was recently launched which should end at the end of the current legislature.

Deconcentration and Decentralisation: Despite some progress since 2002, there are still some unresolved issues to be resolved in order to achieve some of the objectives of the strategy launched at the time. In 2018, the new President of the Republic announced a commitment to hold the first local elections in 2020. In the meantime, new sectors would be progressively localised, based on the experience of health, in order to implement deconcentration and decentralisation. There are recent advances, such as the experiences of municipalisation of social action, but rapid progress needs to be made with municipalisation, for example of the agriculture and education sectors.

The main aim of *Local Authorities* is to ensure efficiency and effectiveness in the provision of quality public services. The question of gradualism is discussed, that is, whether the process should be simultaneous in all municipalities or in stages. But there are problems such as the approval of municipal legislation, the training of managers, financial autonomy and the assumption of municipalities as an area of participation of local authorities. Local authorities, rather than the solution, must be the way to various solutions, a process that requires the involvement of citizens, civil society organisations, businesses, political parties, government and the state.

Education *including literacy, vocational training and research*: in addition to the Basic Law of the Education System, education has a set of programmes and plans aimed at achieving national and international objectives and targets. But the creation of laws, programmes and plans for education are not enough. More investment is needed to ensure the conditions of access and the quality of education. In the period 2013-2017, the General State Budget (GSB) included different programmes and projects for the education sector, and provided social assistance to students at school, including school meals programmes.

Regarding literacy, classes are offered by churches, associations, cooperatives and political parties in collaboration with the state. In the past these organisations were present in all the communes, but in 2018, as a result of the difficulties in paying literacy subsidies, they had to abandon many of them and there is no offer of literacy in the most remote areas. The NDP (2018-2022) aims to increase literacy with a focus on women in rural areas, but the targets set and do not reflect the seriousness of the specific situation in rural areas.

Vocational training: the Government, through the Executive Training Policy (PNFQ), specifically in technical vocational training, is committed to the development of human resources. In 2008, the AfDB and the OECD estimated that 94% of individuals in the 15-19 age groups were unskilled workers, compared to 74% in the 20-24 age group; and 68% in the 25-29 age group. Despite investments in expanding vocational training provision, particularly in physical infrastructure, the expected results were not achieved. This creates a number of challenges that the country needs to face in the area of basic and medium vocational training.

Scientific research *and development* (R&D): Scientific research faces two major obstacles: shortage of researchers and lack of funding. There is a need to reflect on investment in education and the role of the state in the implementation of higher education, research and university extension policies. The government plans to provide scholarships in the coming years to some of the best universities in the world to create a nucleus of qualified researchers.

Rural Exodus and Urbanisation: According to data from the 2014 census, around 62% of Angola's population lives in urban areas, mainly in the peripheral areas of large cities. Among the reasons for this phenomenon of population concentration in the urban environment is demographic growth and rural exodus. The concentration of population in cities and their peripheries (*musseques*) leads to the collapse of sanitation infrastructures, water distribution, energy, urban mobility, but also puts pressure on the economic fabric and on the education and health systems, causing a worsening of poverty levels in the population, and a consequent need for an urban planning and housing policy based on cross-cutting urban planning, including tackling problems such as traffic and mobility, public transport, access to clean water and energy, sanitation, collection and treatment of solid urban waste, as well as a social policy promoting access to decent housing for the poorest and most vulnerable. It is also essential to combat rural exodus by designing and implementing public policies for the development of rural areas, creating employment opportunities and ensuring access to basic services of quality and quantity.

Land: Angola has an area of 1,246,700 km², being the 3rd largest country in sub-Saharan Africa, with extensive areas of arable land. In 2018 the "My Land" programme was launched, initially in 18 pilot municipalities selected by provincial governments, which aims to provide land titles in favour of rural communities, agricultural associations and cooperatives. A number of challenges are raised for land issues in Angola: a) The problem of conflicts of competence in the area of granting land for various purposes; b) The illegal occupation of land; c) The land conflict involving individuals and municipal administrations, as well as between traditional communities or authorities; d) The exorbitant prices of land, mainly urban and peri-urban; e) The lack of technical and legal instruments for the practical application of legislation; f) The problem of mines that has plagued the country since the war period; g) The negative impact of the disorderly exploitation of aggregates such as sand and 'burgau' that occurs in some areas of the country.

A draft revision of Law No. 9/04 of 9 November, "Land Law", has been under way since 2019:
(i) To create greater compatibility and articulation between the laws in force, so as to minimise possible overlaps with other laws regulating matters of a similar or supplementary nature; (ii) To facilitate the legal security of the agents involved and the effective application of the law.

Natural Forest of the East and Furniture Industry: The orderly exploitation of the forest in the East can contribute to the diversification of the economy, making the products derived from the extraction of wood part of the 54 prioritised by PRODESI. Public policies aimed at the timber sector can contribute to the creation of jobs upstream and downstream, thus broadening the state tax base. Other concrete interventions such as the rehabilitation of the national road linking Luanda to the east of the country; the facilitation of the import of machinery needed for the exploitation and subsequent processing of timber; support to small, legalised carpenters through access to credit and capacity building actions, are necessary to make the exploitation and processing of timber viable. The complementarity between forestry potential and the furniture industry is an example of a sector that, with good planning and policies, can contribute to the diversification of the economy, generate employment and wealth, and also enable the integration of the eastern region into the country's development.

Avocado *planting in urban centres*: avocados are the only fruit containing all the vitamins A, B, C. D and E together. It is also very rich in mineral salts and carbohydrates, its fat is easy for the organism to assimilate and brings practically no harm, besides containing 20 to 25% of an oil widely used in perfumery and cosmetics. In Angola, as a result of the high public health problems resulting from its poor sanitation system, associated with the daily lives of citizens in the big cities, which causes stress, as well as eating and living habits (obesity and diabetes), the planting and consumption of avocados can be seen as one of the development priorities, taking into account the above-mentioned advantages.

Transport: since 2002, the government has made investments in the transport sector, mainly in the reconstruction and upgrading of road, port, airport and rail infrastructures, improving the conditions of mobility within the national territory, for people and cargo, and stimulating the economy. Axis 3 of the 2018-2022 NDP comprises four policies: Transport and Logistics; Electricity; Water and Sanitation; and Communications. Transport covers four main sub-sectors, namely road, rail, maritime or port and air. Due to its strategic importance and connections with other segments of national development policy, transport also encompasses the National Network of Logistics Platforms.

For the transport sector, the Government has drawn up the following guidelines for 2018-2022: i) To provide the country with a transport network appropriate to the objectives of national and regional market growth; and ii) To consolidate a structured network of public passenger transport at municipal, provincial, interprovincial and city levels in the country. One of the challenges facing the sector is the implementation of the National Master Plan for Transport and Logistics in order to "ensure a growing contribution to the economic development of the country".

Port infrastructures: the main ports are Luanda, Lobito, Namibe, Cabinda, Soyo and Porto Amboim. It is hoped that the concession model for managing port infrastructure can be extended to other Angolan ports. The introduction of business management methods or the privatisation of port assets, together with private participation in their exploitation, may attract investment and increase efficiency. There is also a need to develop infrastructure capable of providing protection and safety conditions for the maritime environment, develop maritime hydrography and signage, promote the replication of international flag shipping, improve safety and maritime navigation.

Airport infrastructures: in 2019 ENANA - Empresa Nacional dos Aeroportos de Angola, which managed the airports and their air navigation services, gave way to Sociedade Nacional de Gestão de Aeroportos (SGA) and Empresa Nacional de Navegação Aérea (ENNA-EP). One of the major challenges is linked to the current state of most runways and air navigation aid equipment at national level, which is insufficient and poses operational and safety problems, such as: (i) The communications system that supports communications between the controller and the pilot at Luanda Airport was installed in 2005 and is therefore running out of time; (ii) Some of the systems that make up this equipment are obsolete and are analog technology, with state-of-the-art technology now being digital; and (iii) Transmissions or links between remote stations are made by satellites and there are delays in transmission, which is detrimental to air traffic control, so this link should be made by fibre optics.

The air sector, with construction of the New Luanda International Airport (NAIL) concluded, will be the great milestone and epicentre of Angola's entire aviation modernisation strategy, reinforcing the operational capacity of the national airline (TAAG). Current demand levels may increase for regional and intercontinental segments, particularly in terms of passengers, and careful planning is needed, taking into account the country's real needs and capacity.

Rail infrastructures: in Angola there are three railroad companies under the Ministry of Transport: Caminho-de-Ferro de Luanda, Caminho-de-Ferro de Benguela and Caminho-de-Ferro de Moçâmedes. According to the Basic Law for Surface Transport, the national railroad network is part of the State Public Domain, including the main and secondary networks. Meanwhile, the current challenges in the railway sector are related to the alteration of its current institutional model, characterised by the vertical management and integration of railway infrastructures, equipment and their maintenance, to a more disaggregated and specialised framework. Similar processes in other countries need to be analysed in order to safeguard the interest of the State and provide a quality and safe service to citizens.
Under the NDP, the rail transport sub-sector has problems such as a lack of rolling stock and equipment, and of means of maintenance as well as of infrastructure. The following priority actions are planned for improvement: a) Re-launching the rail transport network, implementing policies to reorganise the sector, promoting the installation of logistical platforms along the railway lines with a view to deconcentration of industrial development and distribution to the provinces, as well as the disposal of agricultural production to centres of consumption, the construction of railway branches for large industries; b) Draw up the executive project for the priority network to link the three railway lines to each other, with the aim of creating a single National Railroad Company and starting its construction; c) Draw up the executive project for construction of the "monorail", in Luanda, and start its execution.

Road infrastructure: as part of the reconstruction and rehabilitation of infrastructure, the road network, especially the main ones, has received a lot of investment in recent years. However, the results have been disappointing, as the lifespan of these works has been very short. Traffic density in Angola is still low and concentrated in and around Luanda. Data from the Road and Traffic Services indicates that in recent years the volume of traffic in the main cities, particularly in Luanda, has increased exponentially. The regional concentration of road use is also reflected in fuel consumption. On average, two thirds of total demand were sold in the Luanda area.

Regarding road traffic, it is essential that the State truly invests in the fight against road accidents and deaths, by investing in the training of managers for the sector and by increasing the rigour in the attribution of driving licences, by deepening the legal framework regarding the consequences of road traffic offences and crimes, and by investing in an improvement in the training of the National Police, especially those assigned to road surveillance. It is also necessary to reduce the number of unsafe vehicles to circulate, and to continue improving roads and signposting (including vertical and traffic signs). But none of these measures will effectively combat this problem unless we focus on the main factor causing road accidents, which is the human factor.

The future of road transport in Luand: today in and around Luanda the vast majority of people travel in collective taxis, known as "azulinhos" or "candongueiros". There are other small car and motorbike transports, also known as "gira-bairro" and "kupapatas", respectively. Despite the importance of the services, they provide (for their quantity and low prices), these taxis are characterized by lack of vehicle safety, excess passengers and violation of traffic rules. Given the chaotic traffic situation in Luanda, which has a negative influence on the population's quality of life, it is necessary to increase the quantity and quality of public transport, always bearing in mind the need to guarantee access to the most disadvantaged sections of the population.

Projects already planned, such as increasing the suburban rail network, creating the surface metro and restructuring the public bus transport service, are important steps towards improving the sub-sector and mobility in the large area of Luanda. An example is the project approved under the memorandum of understanding between the German company *Siemens Mobility* and the government of Angola for the construction of the surface metro, extending 149 km.

Energy and Oil: despite the efforts that have been made through high investments (new dams, distribution network) to improve the production and distribution of electricity, there is still a long way to go because in a significant part of the territory there is no electricity from the public grid. In recent years the upgrading of the Cambambe dam and the construction of the Capanda and Laúca dam have been carried out and the Caculo Cabaça dam is under construction. The Gove and Lomaum dams were also rehabilitated. Investments are also being made in renewable and sustainable energies where investments and projects in solar energy systems should be highlighted.

In 2018, Empresa Nacional de Distribuição de Electricidade (ENDE) had 1,478,836 customers in 76 of the 154 municipalities, corresponding to an electrification rate of 36% and a 4% increase since 2014. This rate is not homogenous across the country, as shown by the 75% in Luanda and only 8% in Bié. Of the 1,478,836 existing customers, only 385,702 are in the prepaid metering system. According to the energy sector programme in PDN 2018-2022, the pace of electrification in recent years has suffered from the financial crisis, as between 2015 and 2016 only 92,000 new customers were added to the public grid and in the first half of 2017 only 29,000 new customers. In terms of electricity supply from interconnected systems, a target is set to increase electrification to 60% of the population by 2025. With this target a total of 3.7 million customers are expected by 2025 (more than three times the current number), i.e., more than 18 million people are expected to benefit from electricity.

In line with the Angola 2025 strategy and international commitments, the priorities defined within the scope of electricity policy are: i) Increasing the average national electrification rate;
i) Increasing installed power, namely in new and renewable energies (solar, wind, biomass and mini hydro), with a view to replacing fossil fuels; iii) Replacing public investment in electricity

generation with long-term private funding, with public funding reserved for investments of a structural nature; iv) To enable the expansion of access to electricity to many municipal offices, through the establishment of partnerships between municipal administrations or ENDE and the private sector to manage dispersed and isolated distribution systems or using solutions for the rental or marketing of renewable energy; v) To contribute to the sustainable management of the sector, improving the efficiency of the service and substantially reducing the level of losses.

In line with the New Renewable Energy Strategy, 500 solar villages are planned to be installed in off-grid communes and other larger towns and the distribution of individual solar-based systems to the rest of the population. In the electricity sector, increased generation and distribution, improving the grid and the quality of services provided, tariffs that do not reflect costs, and an increase in the grid for rural areas are identified as major challenges. Challenges also lie in the reorganisation of public enterprises in the sector to ensure stability and investment capacity, professional management and the promotion of private investment to complement the major public investment programme in the electricity sector.

Regarding the oil and gas sector, the main challenges are to make the necessary investments in the sector, together with private partners, to ensure the recovery of the production capacity lost in recent years; to make investments in refining capacity, which will allow Angola to stop importing refined products, with savings in foreign exchange over time, and to be able to export; to build the permanent capacity of the sector's national staff to respond adequately to the challenges that are required and thus avoid the constant importation of expatriate labour; and to rationally exploit resources and take measures to protect the environment, the ecosystem and the people.

Water and sanitation: despite the investments made, levels of access to drinking water remain low and data show that no significant progress has been made in recent years. Among the major concerns are the lack of access to drinking water, sewage and latrine systems, wastewater discharge control, storm water treatment, as well as inoperative drainage ditches and poor solid waste collection. At the rural area level, efforts have focused mainly on the implementation of Community-Led Total Sanitation (STLC), with positive results but limited to some provinces and within these only a few municipalities and communes.
To improve this situation, it is imperative to invest in the extension and improvement of the sewerage system to continue waste water treatment projects; to create and implement a policy and system for collecting and treating solid waste, cleaning drainage ditches, treating waste water and reusing it, and to increase the number of latrines in rural areas. The significant increase in this sector can support the prevention and mitigation of emergencies, outbreaks and epidemics, saving thousands of lives (especially of particularly vulnerable groups such as children) and reducing emergency and disease costs.

Communications: in recent years there has been a considerable effort to invest in

telecommunications infrastructure, in the digitisation of the economy and society and in building digital and social inclusion infrastructure, but this investment has not yet had the expected impact, with the supply of low quality and high-cost communications services remaining. New strategies and guiding policies need to be defined: (i) effectively regulate the market preventing abuse by the dominant companies in the sector; (ii) advance with the implementation of the 4th operator, ensuring that it will bring more competition, better services and lower prices; (iii) expand the signal from Public Television and Rádio Nacional de Angola to the entire national area; (iv) develop a robust infrastructure capable of serving the entire territory and the entire population; (v) effectively integrate the dispersed investments that are being made; (vi) strengthen connections to international communication networks;
(vii) Support national emergency services; (viii) integrate ICTs with energy and environmental aspects.

Tourism: The exploitation of tourism resources in Angola has been conditioned by the economic and financial situation. The sector is characterised by a poorly diversified supply, unknown to the issuing markets, a much lower quality-price ratio than other tourist destinations in the region, constraints in terms of internal and external accessibility, poorly prepared human resources and low levels of private investment. According to the NDP 2018-2022, the Hotel and Tourism Development Programme seeks to intervene in the situations exposed and create the conditions for a structured change in the sector supported by private investment. The public sector will be involved in the infrastructure of the priority centres and the improvement of their accessibility, the facilitation of visas for foreign tourists, the implementation of a marketing and tourism promotion strategy. It is also fundamental to invest in the qualification of the sector, which must go through the increase of trained and professionalised human resources in Schools of Hospitality and Tourism.

Mitigation of climate change: The National Strategy for Climate Adaptation 2020-2035 has responded to the need to articulate objectives, instruments and institutions in pursuit of the most recent challenges facing the country, both in terms of the economy and of improving the living conditions of the population, and of the most recent global climate events arising from the Paris Agreement and the Sustainable Development Goals of Agenda 2030. Given the recent droughts in southern Angola, speeches and actions on climate mitigation have been more regular and incisive, but the challenges are still enormous and many of them practical, for example: a) *promoting the transition to a low carbon economy; b)* increasing the resilience of populations, namely pastoral and agro-pastoral populations; c) leveraging climate finance opportunities by fostering international cooperation on climate change; d) reducing soil erosion, halting the advance of deserts and empowering populations living close to these areas to be more resilient to climate change; e) strengthening national capacity for research, systematic observation and analysis; f) strengthening institutional capacities at national, provincial and municipal levels; and g) strengthening the national monitoring, reporting and verification system (MRV) .

Regional and international links that could influence the capacity to deal with climate change: one of

Angola's great potential is its physical geography, which provides strategic advantages. The South Atlantic is the strategic point through which important international trade flows circulate. Angola is a country endowed with resources both on land and at sea. On the ocean floor, Angola is rich in various hydrocarbons and metals, the cold Benguela current and the remaining characteristics of Angola's territorial sea give it a wealth of marine biological resources. On land, in addition to minerals, Angola is rich in water resources of regional importance, as well as on arable land. All of this wealth exploited in a sustainable way, preserving existing species and ecosystems, can provide competitive advantages.

The challenges of regional integration are diverse but not impossible to meet. Based on the Angolan reality, the literature puts forward some challenges: i) African leadership must demonstrate willingness for implementation; ii) the integration agenda, particularly that of SADC, must be included in the national agenda of each intervening country so that its citizens understand and can express their views on the reasons why their state has decided to be part of that bloc; iii) the time for implementation of each of the integration phases must be as realistic as possible; iv) the implementation of Angola's integration needs a strategic national plan with national acceptance and understanding, but it is essential that the people and their organisations be given the opportunity to express their opinion on these issues; v) this would allow the practical implementation of this agenda to be discussed and approached in a progressive manner and deviations from its implementation monitored; vi) a plan for legal harmonisation (tax laws, criminal law, commercial and other laws) is also needed, as this would allow arbitration issues to be resolved and would give citizens of the integration bloc confidence in the rules, laws and regulations that will govern their countries; vii) still on the export side, Angola has a great challenge in terms of transforming non-oil sectors for the sustainability of the economy, that is, diversifying it so that it can think about competitiveness in terms of exports, allowing it to take advantage of any Free Trade Area while minimising the worsening of unemployment and poverty of the populations.

Policies and legislation

Angola has extensive and diversified environmental and natural resource exploitation legislation. Angola has ratified important international treaties, such as the United Nations Framework Convention on Climate Change, the Kyoto Protocol, the Paris Agreement. At the national level, Angola has been adopting laws and regulations to protect the environment and natural resources in order to guarantee a better quality of life and the protection of resources that belong to everyone.

With the "Angola 2025" National Long Term Development Strategy, where the effort in the reconstruction programme has been noted, Angola has entered the phase of modernisation and sustainability of development, centered on stability and growth and the valorisation of mankind (literacy, schooling, training and technical-professional qualification and higher training for its staff).

On the other hand, it can still be noted that the development of the different sectors is limited by several types of critical weaknesses that must be overcome in order to ensure the sustainability and dynamics of the development process. Sectors should focus on a number of institutional weaknesses and facilitate the integration of climate change into the different sectors.

Among the most relevant difficulties are the following of a more cross-cutting nature:

➢ High unemployment rate;
➢ Existence of gender disparities in multiple dimensions;
➢ Low level of qualification of the economically active population, mainly in technical professions;
➢ High rate of illiteracy in rural areas;
➢ Shortage of qualified academic and professional staff;
➢ Shortage of university courses in engineering and technology;
➢ Insufficient supply of technical and vocational education;
➢ Poor knowledge and management of vast agricultural, fishing or mineral resources; Social and productive restructuring of rural communities due to lack of social and productive infrastructure, with emphasis on rural roads;
➢ Reduced infrastructure necessary for the installation of industries, mainly water, sanitation and electric power, aggravated by the absence of a specific policy of temporary protection for national industry, especially at source;
➢ Reduced national supply of local building materials, with a strong impact on costs;
➢ High context costs, in particular for the functioning of the public administration and the judicial system;
➢ Strong port and transport costs;
➢ Excessive presence of Public Enterprise Sector companies in various sectors of economic activity;
➢ Insufficient credit granted to the economy by the national financial system to meet the financing needs of the country's real economy;
➢ Degradation of environmental conditions, either through increased desertification or the frequent appearance of ravines.

On the other hand, there is also a set of Potentialities that can be used for the growth of the Country, capable of transforming weaknesses into strengths and overcoming possible threats that may arise. The fight against climate change can become an opportunity for Angola's sustainable growth, with the participation of all actors in the country's active life. Among Angola's potential, we highlight the following:

➢ Very young population;
➢ Abundant and diverse natural resources (soils of high agricultural aptitude and high

Complexo Administrativo Clássicos de Talatona, Rua do MAT,
Building 4, 4th Floor
Talatona Municipality, Luanda
E-mail: dnaac@mcta.gov.ao

biodiversity);
- ➢ Abundance of water resources and extension of territory;
- ➢ Extensive seafront with a considerable level of biomass;
- ➢ Large reserves of unexploited oil resources and the discovery of new production fields, including pre- salt;
- ➢ Several duly identified mineral occurrences and great diamond potential;
- ➢ High water, wind, solar and biomass potential;
- ➢ Existence of 47 main river basins;
- ➢ Suitable conditions for the establishment of development poles and industrial condominiums;
- ➢ Privileged location of ZEE Luanda;
- ➢ Several opportunities for Public-Private Partnerships identified;
- ➢ Main rail and road infrastructures rehabilitated;
- ➢ Logistics Platform Programme under implementation;
- ➢ Opportunities for tourist exploitation associated with new development poles;
- ➢ Increase in environmental and forest conservation areas, as well as the enhancement of the natural heritage and communities;

Growing demand for education, at all levels, with the arrival in the different subsystems of the generations born in this century, after the establishment of Peace in 2002;

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- ➢ Strong commitment to the development of technical and vocational education;
- ➢ Young population available for vocational training;
- ➢ Intense demand for higher education and the need to ensure the availability of Directors, Managers, Teachers and Researchers necessary for national development;
- ➢ Launch and structuring of the National System of Science, Technology and Innovation;
- ➢ Continuity of preventive health actions and health education;
- ➢ Creation of infrastructure in all the land reserves for the construction of social housing throughout the national territory;
- ➢ Implementation of Administrative Reform, at central and local levels, and Justice Reform; and Implementation, at national level, of the National Statistical System Framework Law.

Since 2012, Angola has had the National Implementation Strategy for Climate Change, which recognizes the country's vulnerability to climate change and is aware of the impacts the country has been suffering and the tendency for them to worsen. Floods, droughts, soil erosion and rising sea levels are common indications of the main effects of climate change in the country. The Strategy makes recommendations for the following sectors: Deforestation (logging, agricultural practices and forest fires, use of firewood and coal); Energy production and use; Natural gas burning; Transport system; Industrial sector (plan of measures to avoid GHG emissions; obligation to invest in less polluting technology and with greater efficiency in regeneration and energy use processes, projects that can be considered CDM); Solid waste treatment. In the process of updating the Strategy, through 5 pillars, which are mitigation, adaptation, capacity building, financing, research, systematic observation and analysis, ENAC establishes the vision of Angolan national policy for 2035, taking into account the need to articulate sectoral policies in terms of mitigation and adaptation to the impacts of climate change

In its MRV component to be institutionalised, the strategy aims to carry out inventories and reports on greenhouse gas emissions, produce programmes and projects with measures to mitigate the effects of climate change, develop technical and vocational training in the areas related to climate change, foster international cooperation in the field of climate change, particularly in the transfer of knowledge and experience, encourage and develop actions involving the transfer of technology and the use of clean technologies, coordinate actions to implement the commitments of the Convention and the Protocol, create an appropriate structure and instruments for the management of flexible mechanisms, among others

In the framework of fulfilling the obligations of the Convention on Biological Diversity to which Angola is a Party, the country has developed the National Biodiversity Strategy and Plans (NBSAP) since 2007 and whose implementation ended in 2012. Throughout its implementation, the NBSAP has set some goals and had a number of achievements

The National Strategy and Biodiversity Action Plan (NBSAP) of the Republic of Angola were formulated to serve as an integrated strategic framework within which the conservation and sustainable use of biodiversity in Angola can be organized and coordinated for a seven-year period (2019-2025).

It was developed in accordance with the requirements of the Convention on Biological Diversity, which provides details on how it should be developed and implemented. However, due to the challenges that Angola faces in terms of its economic and social development, the Strategy includes a broader vision for the conservation and sustainable use of biodiversity in Angola.

Biodiversity Conservation Action Plan to 2025 in Angola

The Action Plan gives us an outline of concrete activities in the strategic areas, in particular:

Biodiversity Governance; Subsistence based on biodiversity; Biodiversity for Economic Development; Biodiversity Management Systems; Biodiversity and Climate Change; Biodiversity and other Development Initiatives such as Energy and Mining. These activities are aligned with the National Biodiversity Strategy Targets and Objectives 2018-2025, including the Aíchi 2020 Biodiversity Targets and the Sustainable Development Goals.

The constraints and challenges in conserving biodiversity in Angola are still several, some of which can be highlighted, such as: high levels of poverty and unemployment among the population, low environmental awareness, the presence of invasive species, the man-animal conflict and the scarce human, technical and financial resources available to meet the challenges. These causes are associated with the over-exploitation of biodiversity resources such as the cutting of trees for charcoal and firewood production, the indiscriminate felling of animals for sale on major roads and in large nationalcities.

Many human activities interfere with biodiversity conservation efforts: poaching or bonding at major crossing points or watering of animals, breeding of domestic animals which in some cases mate with wild animals and causing hybridisation between domestic animals and wild animals (such as Donkeys with Zebras in the Iona National Park) and their occupation of the best grazing and watering places.

The Strategic Action Goals for reaching the General Objective are Specific Objectives until 2025: Reduce pressure on Biodiversity and promote its sustainable use; Strengthen the network of conservation areas including representations of the different Biomes and Ecosystems in Angola; Promote scientific research and dissemination of information on Biodiversity; Strengthen sustainability education and awareness; Strengthen the

Implementation of International Agreements on Biodiversity; Strengthen the role of local communities in biodiversity management; mobilise funds for biodiversity conservation; restore biodiversity in cities, towns, villages and neighbourhoods of the country; strengthen environmental institutions; strengthen the development of specific legislation and its implementation in line with international and SADC region agreements;

manage, coordinate and monitor actions for biodiversity conservation, (NBSAP); Restore degraded forests and ecosystem services:

The National Policy on Forests, Wildlife and Conservation Areas, approved by Resolution 1/10 of 14 January, recommends the drawing up of the respective programmes to implement the Policy, which should contain the specific actions duly quantified, to be undertaken in order to achieve the objectives.

The policy consists of the economic axis, which aims to promote ways of using and making economic use of forests, wildlife and land conservation areas and to promote the role and intervention of the private, community and cooperative sectors in the management and rational use of forest, wildlife and conservation areas.

The institutional axis which aims to create mechanisms for institutional capacity building in order to ensure efficiency, transparency, professionalism and confidence in the fulfillment of the mandate concerning the management of forest and wildlife resources as well as conservation areas. In addition, it has an environmental axis that aims to contribute to the conservation and protection of terrestrial biodiversity with a view to national sustainable development through the following specific objectives: i) improvement of systems for the protection, conservation and management of forests and wildlife in open areas, including integrated management of natural resources and with emphasis on ecologically sensitive areas and arid, semi-arid, wet and mangrove areas; and ii) the reclassification and rehabilitation of existing conservation areas, proposing the creation of others to include important ecosystems, *habitats* and species of high biological and cultural value that are not yet adequately protected; this includes, among other measures, the implementation of programmes to combat desertification, soil erosion, ravines and the mitigation of the effects of drought, with a view to the recovery of degraded areas, through reforestation and the management of the natural regeneration of forests, with the involvement of administrative authorities and local communities; introduction of alternative sources of domestic energy production, improvement of raw material sources and traditional systems of coal production, distribution and consumption, accompanied by the introduction of improved stoves, with particular focus on areas of fragile ecosystems and peri-urban areas; promotion of the use of natural gas and electricity for domestic consumption. This goes beyond the preparation of studies and inventories and environmental education of urban and rural populations on measures for the protection, conservation and sustainable use of the resources at their disposal.

The National Strategy for Food and Nutrition Security and its Action Plan, adopted by resolution 130/09 of 29 December, recognizes the right to food as a fundamental right and aims to create conditions to ensure lasting food security for all Angolan citizens, reduce the level of inequality in income distribution and structurally reduce extreme poverty. The objectives of action that can be related to climate change issues are: to increase and diversify agricultural and fisheries production in a sustainable manner to improve the population's food supply levels and living conditions; to create and implement national and local early warning systems, food and nutrition security monitoring systems, as well as mechanisms for communication and information to families; and to create an intersectoral platform for the coordination of food and nutrition security policies and actions with the participation of civil society.

In addition to the production diversification component, the Action Plan develops the following strategic axes: a) Strengthening social protection for children and vulnerable groups, family skills and community food and nutrition education, acting at the level of access to food, health and nutrition, food and nutrition education, water, energy and basic sanitation and family skills; (b) promotion of applied scientific research throughout the food and nutrition chain, where research and research activities, food safety, and (c) food and nutrition safety information system, which focuses on monitoring agricultural activities, agro-meteorological factors, availability of water resources, crop forecasts, vulnerability analysis of population groups and market price monitoring.

The Strategy for the development of biofuels in Angola, Resolution 122/09 of 23 December, considers biofuels as a renewable energy source for the future; reducing emissions of gases that damage the atmosphere and the environment; enabling the country to participate in the carbon credit market under the Kyoto Protocol. This, at the same time, contributes to the increase of cultivated areas, thus contributing to the re-launch of agriculture, as well as to the exploitation of the entire production chain, favouring the creation of upstream and downstream industries and increasing the supply of employment and the improvement of household income in rural areas. Aware that while the use of biofuels reduces the emission of substances that are harmful to the environment and allows the production of renewable and sustainable energy, it also involves risks, the strategy lists among its principles some of which are preventive and crucial. Thus, the principle of *environmental preservation and sustainable development* indicates that the production of biofuels should consider and balance its environmental, social and economic impact and that in order to determine this impact, it is necessary to consider the difference between the emissions that are avoided through their use and the gas emissions associated with the energy used in their production cycle, directly (e.g. emission from tractors in agricultural activities) and indirectly (e.g. emission from agricultural activities): destruction of forests, use of fertilisers); the principle of *non-competition with food production* the implementation of crops for the production of biofuels should not compete with the production of food for consumption and, on the contrary, projects to be implemented should include a component of production and supply of agricultural products thus complementing the supply of food and feed products; the principle of *Community energy autonomy should* provide rural communities and farmers with the means to generate their own energy, especially in regions of the national territory where, because of the precarious nature of roads, the transport of fuel for energy generation is very costly; the principle of *scientific and technical promotion* should be promoted the research and development of agricultural and industrial technologies appropriate to the productive chains of crops intended for the production of biofuels, which provide competitiveness, adding value to products and reducing environmental impacts; the principle of *adherence to environmental policy* the programmes for the production of biofuels should be in line with the International Conventions to which the Country has adhered in environmental matters and with national environmental legislation, giving priority to the reduction of greenhouse gas emissions in line with the provisions of the Clean Development Mechanism (CDM) of the Kyoto Protocol.

The Strategy also promotes the blending of biofuels into fossil fuels with a view to consolidating ethanol and biodiesel as complementary alternatives to the country's energy reserves and establishes that the priority is the supply of the internal market. The Strategy also recommends starting the programme in some regions of the country, from oilseeds that do not compete with food, involving areas that are more degraded and less concentrated with family farmers, in order to preserve the most fertile areas for food cultivation, to give the possibility of insertion in the market of small and medium enterprises, to define the technical and commercial specifications for biofuels.

Progress has been made in civil protection, with the approval of the National Plan for the Preparation, Contingency, Response and Recovery of Disasters and Natural Disasters, with the aim of defining the lines of force that guide a timely and concerted response, the conditions and means essential to minimizing the adverse effects of a serious accident or disaster affecting the Angolan population. The recommended response is given within the legal framework of Civil Protection and international standards. The involvement and participation of national and international partners, where necessary, should consist of supporting the Government's efforts to provide assistance, in a coordinated manner, to save lives at risk and meet the humanitarian needs of the population. The Plan outlines scenarios of 1. floods and floods that can be: localised - activate Provincial Plan; medium - activate National Plan; exceptional - activate National Plan, declaration of state of emergency and request for international assistance; 2. drought: Activation of provincial or national plans depending on the magnitude of the phenomenon.

LEGAL FRAMEWORK

The main vulnerable areas in Angola where actions to adapt to CA are required are Water Resources, Ecosystems, Agriculture, Forests, Coastal Zone, Infrastructure and Health, where the main areas for mitigation are Energy, Industry, Forests and Soil Degradation, Agriculture, and Waste.

The Decree on Environmental Impact Assessment (Decree No. 117/20 of 22 April) determines the standards, modalities and mandatory studies that identify the foreseeable consequences as well as mitigation measures for certain types of projects. Environmental impact assessment is a requirement for the approval of clean development mechanism projects and other initiatives within the implementation of the United Nations Framework Convention on Climate Change and improvement of the quality of life of populations.

The Water Law (Law No.6/02 of 21 June), which applies to surface water and groundwater, establishes the following general principles: i) water as a social good, renewable, limited and with economic value; ii) the right of the citizen and collective entities to water; iii) unity of the hydrological cycle, which presupposes the establishment of a single legal regime for its management; iv) unity and coherence in the management of the country's river basins; v) integrated management of water resources; vi) compatibility of the water management policy with the general policy of territorial planning and environmental policy; vii) institutional coordination and community participation; viii) promotion of appropriate forms of public and private sector participation in the management and development of water resources; ix) complementarity of water supply with liquid wastewater sanitation; x) the relationship between pollution and social and financial responsibility for repairing environmental damage.

Promoting the practice of efficient water use, as well as encouraging a private initiative for the rational use of available water resources are the main objectives of Angolan water policy. Integrated water resources management techniques and balanced management by basins (a major challenge in a vast country with diverse climatic regions) constitute good management practices that pave the way for adaptation to climate change in the sector. The law also makes it compulsory to draw up General Plans for the Development and Use of Water Resources in the Basins, which must be developed with the participation of the communities and in accordance with the principle of multiple uses; National Water Resources Plan which aims at the integrated management of water resources on a national scale and is drawn up in accordance with national interests, possible inter-basin flow transfers, and with the competition of the General Plans for the Development and Use of each Basin. To date only the Water Sector Development Programme has been published (Resolution 10/04 of 11 June). The law establishes the obligation of environmental impact assessment for all water works and prohibits any activities that involve the danger of water pollution or degradation or any change in the water regime that may jeopardise health, natural resources, the environment or national security and sovereignty. This allows the integration of climate change considerations into EIA and environmental audits.

The Land Law (Law 9/04 of 9 November) establishes that the occupation, use and enjoyment of the land are subject to the rules on environmental protection, in particular those concerning the protection of landscapes and species of flora and fauna, the preservation of the ecological balance and the citizens' right to a healthy and unpolluted environment and must be exercised in such a way as not to compromise the regeneration capacity of arable land and the maintenance of its productive aptitude. It defines as partial reserves, where activities may be carried out under license, among others: the bed of inland waters, the territorial sea and the exclusive economic zone; the strip of sea shore and the outline of islets, bays and estuaries, measured from the line of high tide, observing a protective strip towards the interior of the territory; the strip of protection bordering water sources; the strip of protective ground bordering dams and reservoirs.

The Regional Planning and Urban Planning Law (Law 3/04 of 25 June) assigns to the State the duty of spatial planning, with local authorities being obliged to intervene in the areas under their jurisdiction and rural communities being empowered to participate in actions aimed at spatial planning and the elaboration of territorial plans. Private individuals have the right to information on the contents and changes to plans, both at the stage of prior dissemination of projects and after their publication. The guiding principles for State intervention in this field are, *inter alia*: protection of the environment; rational use of natural resources; sustainability and public participation.

The planning of the occupation and use of the spaces included in the territory is promoted through territorial plans at national, provincial and municipal level. Decree No. 2/06 of 23 January 2006 approves the General Regulation of Territorial, Urban and Rural Plans, with which territorial plans and other territorial management instruments must conform. Among the principles that should be included in all plans are: making rational use of the land as a finite resource, through the correct location of productive and non-productive activities, as well as the qualification and classification of soils according to their characteristics; and using natural resources, preserving nature as well as protecting and rehabilitating the natural and urban environment to achieve sustainable development, preventing natural and technological disasters. In this sense, climate risks must be contained in spatial planning instruments. The Decree establishes that special types of territorial plans are subject to special regulations. These include planning and protection areas for natural reservoirs or coastal areas.

Complexo Administrativo Clássicos de Talatona, Rua do MAT,
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Decree No 4/01 of 2 February (repealed by Presidential Decree 31/11 of 9 February) regulated the preparation and approval of Coastal Zone Plans (POOC) made up of maritime and inland waters and their beds and banks with a maximum "land protection area" of 500 metres in width, to be defined in each plan. The Decree stipulated that the POOCs should define the constraints, vocations and dominant uses as well as the location of the infrastructures to support those uses and guide the related activities to be developed in each area with the following objectives, among others: protection of the biophysical integrity of the area; enhancement of the existing resources on the coastline; conservation of environmental and landscape values; protection of localpopulations.

The legislation in force in the Forests, Wild Fauna and Conservation Areas sector, namely Law 6/17 and Presidential Decree 171/18, establish the precepts aimed at protecting the soil, flora and fauna.

The Basic Law on Agricultural Development (Law No 15/05 of 7 December), which includes forestry as an integral part of agriculture, integrates the principle of sustainable development and incorporates environmental considerations explicitly. The law aims at the rational use of natural resources in order to achieve a sustained and sustainable increase in production and productivity, having as fundamental principles the safeguard of the productive capacity of soils (respect for regenerative capacity), the preservation of the availability and quality of water resources and the conservation of biodiversity associated with fauna and flora. The law gives the State the duty to support the development of activities associated with agricultural exploitation, especially in areas with harsh conditions or specific ecosystems. This implies the activities of adaptation to climate change. The law establishes, inter *alia,* incentives for agricultural enterprises to carry out actions that promote environmentally friendly agricultural practices; it provides for compensatory benefits for the possible negative effects on income of production activities subject to restrictions (in production methods and techniques) aimed at maintaining biological diversity; it encourages a policy of remunerating farmers for the provision of services aimed at the conservation of resources and the preservation of the landscape in rural areas, based on the adoption of technologies and production systems and activities compatible with those objectives. The law also establishes that agrarian research should be geared to solving concrete problems, including those concerning the sustainable use of natural resources and environmental protection. Although it does not explicitly refer to climate change, Law 15/05 provides for the necessary actions and incentives for adaptation. The law lacks regulation in which it is possible to include financial considerations and mechanisms focused on adaptation and mitigation of climate change.

The Law on Industrial Activities (LAI) adopted in Law No. 5/04 of 7 September, aims *inter alia to* implement the prevention, reduction and elimination of risks inherent in industrial activities (Art. 2) on people, flora, fauna, property and the environment (Art. 14). The law establishes environmental protection as one of the reasons for denying authorisation to engage in industrial activity - necessary for any industrial activity regardless of its nature and nationality - (Art. 5). The classification of industrial establishments, taking into account among others the environmental impact and the degree of risk to people, goods recommended in the LAI was published in Decree 44/05 of 6 July on Industrial Licensing. The LAI holds industrialists responsible for the prevention of risks to people, goods, working conditions and the environment - provided for in specific regulations and in the standards and rules defined by the manufacturer of equipment or materials - as well as for taking the measures they deem appropriate to avoid or correct anomalous situations (or increased risk of occurrence) and for suspending the activity if necessary, until the situation is resolved. The LAI promotes public participation, since it provides for complaints by duly identified third parties regarding risks, accidents, or damages related to the industrial activity, with the entity that supervises the activity, or with the provincial governments, municipal administrations or municipalities. The drafting of regulations may provide a good opportunity to include climate change considerations.

The Petroleum Activities Law (Law No. 10/04 of 12 November) defines the rules for access to and exercise of petroleum operations. This law contains concrete provisions for the protection of the environment, establishing that in the exercise of their activities, licensees, the National Concessionaire and its associates must take the necessary precautions for environmental protection. To this end, the operating agreement, which must be approved by the governments of the countries concerned, must contain among other standardised health, safety and environmental management systems. The law is regulated by Decree 37/00 of 6 October on the processing (except refining), storage, distribution, transport and marketing of petroleum products are regulated by Decree 39/00 of 10 October to ensure the preservation of health, water, soil and subsoil, air, flora and fauna, ecosystems, landscape, atmosphere and cultural values, by Decree 1/09 Regulation on Petroleum Operations, by Decree 38/09 of 14 August Regulation on Safety, Hygiene and Health in Petroleum Operations. Petroleum activities are subject to licensing. The EIA process obligations for the execution of petroleum activities in new installations and for modifications to any existing installation that may significantly affect the environment are set out. Licences are valid for 10 years and may not be renewed if there is a systematic violation of hygiene, health, environmental protection and public and worker safety standards. Licensing bodies are obliged to monitor compliance with technical standards for environmental protection and safety by the competent authorities - the Technical Commission. The Concessionaire and its associates will have to draw up and update a Spill Prevention Plan and will be obliged to inform "*all spills that cause damage to the environment*" and the operator will be responsible for *"taking all effective measures to control, combat and clean up the spill"* individually or in collaboration with the other oil companies operating in the country if it does not have this capacity. Failure to comply with these legal obligations constitutes an infringement punishable by a fine between a minimum and an ancillary sanction of temporary suspension of operations as well as the charging of the reparation costs to the offender in accordance with the Law on the Environment. The safety, hygiene and health plan include plans for the safety and monitoring of operations. However, the oil sector legislation does not cover the monitoring of atmospheric emissions in a far-sighted way.

The Law on Geological and Mining Activities, Law No 1/92 of 17 January 1992, establishes that the protection of nature and the environment are obligations of the entities holding exploitation rights which include powers of extraction, operations to treat mineral resources and marketing as well as alterations to the natural configuration of the soil, the subsoil and the continental shelf. Damage caused by geological and mining activities is defined as "damage to life or health of humans, animals, things, soil, vegetation, surface water and groundwater, and other natural elements" subjecting licensed entities to legal sanctions and an obligation to compensate. Geological and mining activities are subject to inspection and monitoring by the competent Angolan State body, according to the rules set out in Executive Decree 38/92 of 21 August - which does not include any environmental considerations. Nor does the law on diamonds - Law No 16/94 of 7 October 1994 - contemplate any environmental considerations. Although Order 23/06 of 5 July established the Technical Commission for the revision of the Law on Geological and Mining Activities and the Law on Diamonds, it has not yet materialised. Measures to adapt water resources and combat ravines can be included in the legislative reform to take place.

Inert extraction is also very poorly regulated. Resolution 41/03 of 19 December approved the measures of recommendations on the exploration of sands in the Coastal Zone of the country, with particular focus on the Province of Luanda. The recommendations go in the direction of elaborating feasibility studies, controlling and limiting the extraction of aggregates (license holders, with capacity to operate only in delimited areas, regulate the market, etc.). However, implementation of the Resolution has been limited. The preparation against disasters is governed by the Basic Law of Civil Protection, Law 28/03 of 7/11 as an activity developed by the State and the citizens with the purpose of preventing collective risks inherent to situations of serious accident, disaster or calamity, of natural or technological origin and to mitigate or eliminate its effects and rescue people and their property in danger. In addition to defining the institutional framework for civil protection, the law establishes the following objectives for the sub-sector: a) to prevent the occurrence of collective risks resulting from serious accidents, disasters, natural or technological calamities; b) to mitigate collective risks and limit their effects, should they occur; c) to rescue and assist those affected or in imminent danger. The law establishes that civil protection activity is carried out in the following areas: a) surveying, forecasting, evaluating and preventing collective risks of natural or technological origin; b) permanent analysis of vulnerability to risk situations resulting from human or natural action; c) informing and educating people, with a view to raising their awareness, knowledge and instruction for prevention, with regard to self-protection and collaboration with the authorities; f) studying and disseminating appropriate forms of protection for buildings in general, monuments and other cultural goods, installations for essential services, as well as the environment and natural resources. This goes beyond the planning of emergency solutions, aiming at search, rescue, relief and assistance, as well as evacuation, housing and supply of populations; and inventorying the resources and means available and those most easily mobilized, at local, provincial and national levels.

The law also establishes that emergency plans, depending on the territorial extent of the situation targeted, are national, provincial or municipal and, depending on their purpose, are general or special. Emergency plans are subject to periodic updating and must be the subject of frequent exercises in order to test their operability. The national emergency plans are approved by the Council of Ministers, with the prior opinion of the National Commission for Civil Protection. Provincial and municipal emergency plans are approved by the National Civil Protection Commission, subject to the prior opinion of the respective Governor.

The National Implementation Strategy of the UNFCCC and the Kyoto Protocol (Resolution No. 235 of the UNFCCC).No. 52/2008) recommended in the legislative area: to elaborate, review, improve and complete the country's system of air quality standards and to take into account international standards; to elaborate the system of specific standards for the preservation of the climate, taking into account international standards in the agricultural, industrial, transport, energy and oil production sectors; to establish economic and financial mechanisms (fiscal stimuli, imposition of taxes and credit lines) and legal control (preventive systems and civil, criminal and administrative sanctions), as well as access to information and participation (information, citizen participation, education and research). There is also no legislation on energy efficiency and renewable energy.

The National Climate Change Strategy 2020-2035 (ENAC 2020-2035) arises from the need to articulate objectives, instruments and institutions in pursuit of the latest challenges the country is facing, both to address the challenges the country is facing from the effects of climate change, and to improve the living conditions of the population and the latest global climate events arising from the Paris Agreement[13] and the Sustainable Development Goals of Agenda 2030[14]. As a response to the challenges of climate change and the commitments set out, ENAC sets out the vision of Angolan national policy for 2035, taking into account the need to articulate sectoral policies in terms of mitigation and adaptation to the impacts of

[13] UNFCCC (2015). Decision 1/CP.21.

[14] ONU (2015). Resolution adopted by the General Assembly on 25 September 2015.

climate change. Through ENAC a number of other integrating initiatives may emerge, among which we highlight the development of the National Emissions Plan (NAP) and the National Plan for Adaptation to Climate Change (PNAAC).

The country has experienced recurrent cycles of drought and flooding affecting several regions of the country, with environmental, social and economic consequences and with a greater impact on the regions to the south[15]. Angola's National Adaptation Programme of Action (PANA), submitted to the UNFCCC in 2011, identifies agriculture and food security, forestry and biodiversity, fishing, water resources, human health, infrastructure, coastal areas and energy as the main sectors affected by climate change. It identifies the main threats and expected impacts of climate change as floods, droughts, soil erosion and rising sea levels.

ENAC also aims to promote the transition to a low carbon economy, creating conditions for adaptation throughout the country to the impacts of climate change. The Government recognises that it is essential to strengthen the technical skills of different actors (from State and Government institutions, especially ministries, government agencies, public institutes, society, and private entities), and priority technologies for an effective implementation of ENAC 2020-2035.

The Strategic Plan for Conservation Areas (PLENARCA) has the overall objective of implementing a system of conservation of national biodiversity that is capable of leading to ecological stability, resilience to climate change, and human well-being.

PLENARCA makes proposals for criteria to assess the effectiveness of biodiversity conservation in the current network of Conservation Areas and recommends their adoption, in response to the master lines of the "National Biodiversity Strategy and Action Plan of Angola (NBSAP)".

The ultimate objective of the Plan is to achieve a national biodiversity conservation network leading to ecological stability, resilience to climate change and community well-being.

In November 2015 the country submitted its proposal to the UNFCCC for a national contribution to reduce GHG emissions ("Intended Nationally Determined Contribution (INDC) of the Republic of Angola"), where it proposes to unconditionally reduce its GHG emissions by 35% by 2030 compared to the baseline scenario (base year 2005), and also, through international funding, reduce a further 15% of its GHG emissions by 2030. One of the factors that contributed to the success of COP 21 was the commitment of countries to develop and

[15] ONU (2016). Angola: Drought. Office of the Resident Coordinator Situation Report No. 1.

submit their INDCs in a timely manner.

CHAPTER – 2

NATIONAL INVENTORY OF GREENHOUSE GASES

Complexo Administrativo Clássicos de Talatona, Rua do MAT,
Building 4, 4th Floor
Talatona Municipality, Luanda
E-mail: dnaac@mcta.gov.ao

2.1. Introduction

In ratifying the United Nations Framework Convention on Climate Change, the country was subject to a number of obligations related to its implementation at the national level, including the periodic publication of inventories.
The GHG inventory is produced through software designed by the Intergovernmental Panel on Climate Change (IPCC) for the following five main thematic areas
Energy - Fuels. energy. transport and biomass; Industry -
Existing industries and main features;
Agriculture - Agricultural activity in the country and its main characteristics;
Deforestation - Levels of deforestation and coal production;
Waste - production and treatment of waste as well as the sewerage system;

In its first inventory Angola used the 1996 IPCC guidelines. In its second inventory it opted for the 2006 guidelines (2006 IPCC Guidelines for National Greenhouse Gas Inventories[16]) because they offer greater reliability in terms of results. The methodologies used for the quantification and elaboration of this greenhouse gas (GHG) inventory followed the guidelines of the Intergovernmental Panel on Climate Change (hereinafter IPCC):
In fact, the 2006 Guidelines establish an evolutionary approach that allows the experiences of the 1996 Guidelines to be incorporated and helps to ensure continuity. At the same time, they incorporate new scientific information in order to make the process more comprehensive, integrative and capable of providing more approximate responses as regards the estimation of emissions.

It is important to note that the base year adopted by the Conference of the Parties is 1994 for the first national communication and 2000 for the second national communication. For the inventory years the emissions have been calculated in Gigrams (or 1,000 tonnes) of carbon dioxide equivalent, which is obtained by multiplying CO_2 emissions by 1, CH_4 emissions by 21 and N_2O emissions by 310, according to the Global Warming Potential (GWP) established by the IPCC and adopted for the inventories. For the 2000 inventory, CO_2 emissions were 13243 Gg, methane 15953.39 Gg CO_{2eq} and nitrous oxide 13944.01 Gg CO_{2eq}; for the 2005 emissions, the emissions for CO_2, CH_4 and N_2O were 29261, 20158.32 and 14098.37 Gg CO_{2eq} respectively.

The responsibility for carrying out the Greenhouse Gas Inventory is coordinated by the

[16] https://wwwipcc-nggipigesorjp/public/2006gl/indexhtml

Ministry of Culture. Tourism and Environment through the National Directorate of Environment and Climate Action and with the active and direct participation of the Ministry of Natural Resources Oil and Gas, Ministry of Agriculture and Fisheries, Ministry of Industry and Trade, Ministry of Transport, Ministry of Economy and Planning, Ministry of Finance, Agostinho Neto University, independent consultants and some private sector companies.

For the second inventory, the year 2005 was recalculated and a series was carried out until 2018 in order to obtain details of the variation in emissions. as well as the activities associated with Greenhouse Gas emissions.

2.2. Limitations of analysis and identification of improvements to be implemented in future inventories

The limitation of data production and analysis capacity, as well as the challenges related to data availability, pose obstacles to the efficient and permanent implementation of greenhouse gas inventories. These findings indicate the need to improve the legal and institutional framework for regular inventories.

In this inventory there are contradictory data, IPCC emission factors are used that in certain cases are not compatible with the reality of Angola. This is the case with LULUCF, which could have had significantly different results if Angolan emission factors had been considered. The improvement of these aspects should continue in future inventories in order to present more coherent data on the type of activities that are carried out in the country.
Based on the constraints encountered in the preparation of this inventory, aspects for future improvement are identified:

➢ Action plan to overcome all difficulties and constraints in order to facilitate the implementation of the MRV process and the transparency mechanism for subsequent inventories;

➢ Elaborate and propose a model so that the relevant institutions can systematically produce an energy balance each year;

➢ Assess legislative needs for regular greenhouse gas inventories and propose specific recommendations in the next greenhouse gas inventory;

➢ Propose a formal legal mechanism to hold sectors accountable for the production and availability of data to facilitate the establishment of greenhouse gas inventories;

➢ Engage Agostinho Neto University in the process of Elaborating National Emission Factors to reduce the use of standard factors;

➢ Continue to work on the designation of a general data collection entity. which should also be involved in the inventory process. Preferably linked to the national statistical institute.

2.3. Methodology in the Preparation of the Greenhouse Gas Inventory

A set of combined methodologies were used to draw up the National Greenhouse Gas Inventory. Given the great difficulty of directly using the software, the spreadsheets it contains were used, as well as the emission factors due to the fact that Angola has no emission factors of its own to date. All the guidance for filling out the spreadsheets, analysing the data and calculating the emissions was taken from the IPCC manuals which guide the preparation of greenhouse gas inventories.

For the calculation of national GHG emissions in the energy sector, the Tier 1 calculation method was used. The information needed for the calculation was gathered through consolidated reports of activities in the oil and gas sector. The GHG emissions are calculated by knowing the activity data (consumption or fuel burning) for each source and its respective emission factor, according to the following formula:

E=DA * FE[5]

Where:

E: GHG emissions;

DA: Activity data (consumption or fuel burn);

FE: Emission factor

For the other sectors with the exception of land-use change, the same approach was used for the collection of sectoral information, complemented with certain specific information from primary sources.

For the land use change, land use change and forestry sector, also called LULUCF, it was decided to adopt the guidance provided on the use of three IPCC approaches[6] to land classification and stratification. Approach 1 identifies the total area of each individual land use category but does not provide detailed information on the nature of conversions between land uses. Approach 2 introduces the tracking of conversions between land use categories. Approach 3 extends the information available in approach 2 by allowing land use conversions to be tracked in a spatially explicit manner. For this method a combination of approaches for different regions can be used over time, and attempts can be made to make the best use of available data and reduce possible overlaps and omissions in reporting. It is important to note that the methodology proposed in this second inventory differs from that presented in the first inventory (2000-2005 inventory), which used an approach (foreseen in IPCC 1996) that does not adopt explicit representation, i.e., it used method 1/approach 1.

2.3.1. Energy

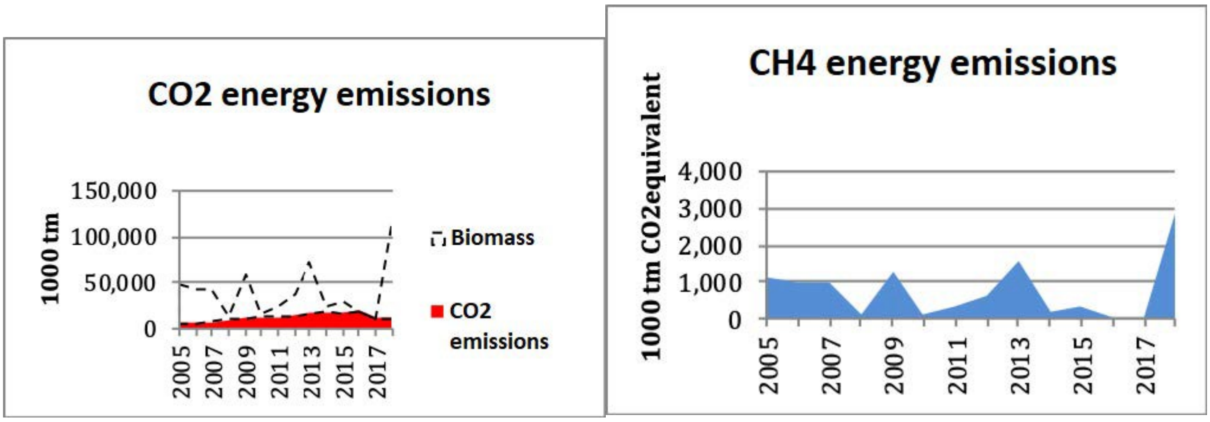
For this sector, gas emissions were inventoried from the adoption of the *Bottom-up* methodology (or sectoral approach) in which Greenhouse Gas emissions are calculated from final energy consumption. The sectoral approach made it possible to identify where and how emissions occur.

CO_2 emissions are dependent on the carbon content of fuels and can be estimated at a high level of aggregation and with reasonable accuracy. For non- CO_2 gases (i.e. CH_4 and N_2O) the IPCC default values were used.
The *top-down* methodology ("*Reference Approach*") was also used, which estimates CO_2 emissions considering only energy supply, without detailing how this energy is consumed. The estimates are based on the balance sheet involving domestic primary fuel production, imports and exports of primary and secondary fuels, international *bunkers* and the domestic change in stocks of these fuels. In the case of secondary products, domestic production is not considered as it comes from the primary source already considered.

In the period 2005 to 2018 there was a considerable increase in national hydrocarbon production levels. Fugitive emissions increased fourfold from 2005 to 2015, but then fell sharply by over 60% from 2015 to 2018. The production of associated natural gas (natural gas that exists in solution with crude oil) increased considerably from 2005 to 2018.

Complexo Administrativo Clássicos de Talatona, Rua do MAT,
Building 4, 4th Floor
Talatona Municipality, Luanda
E-mail: dnaac@mcta.gov.ao

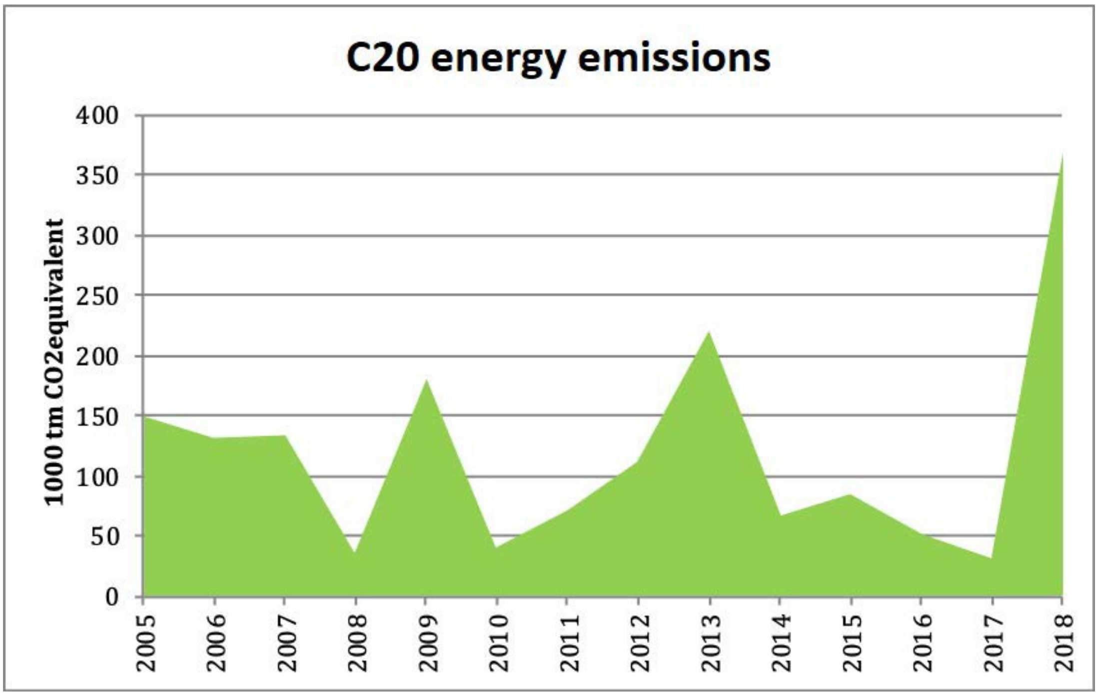
Graph 1: CO_2, CH_4 and N_2O emissions in the energy sector



Source: Own elaboration Includes biomass and fugitive emissions in oil production

Complexo Administrativo Clássicos de Talatona, Rua do MAT,
Building 4, 4th Floor
Talatona Municipality, Luanda
E-mail: dnaac@mcta.gov.ao

N_2O EMISSIONS IN THE PERIOD 2005-2018



Source: Own elaboration

2.3.2. Industry

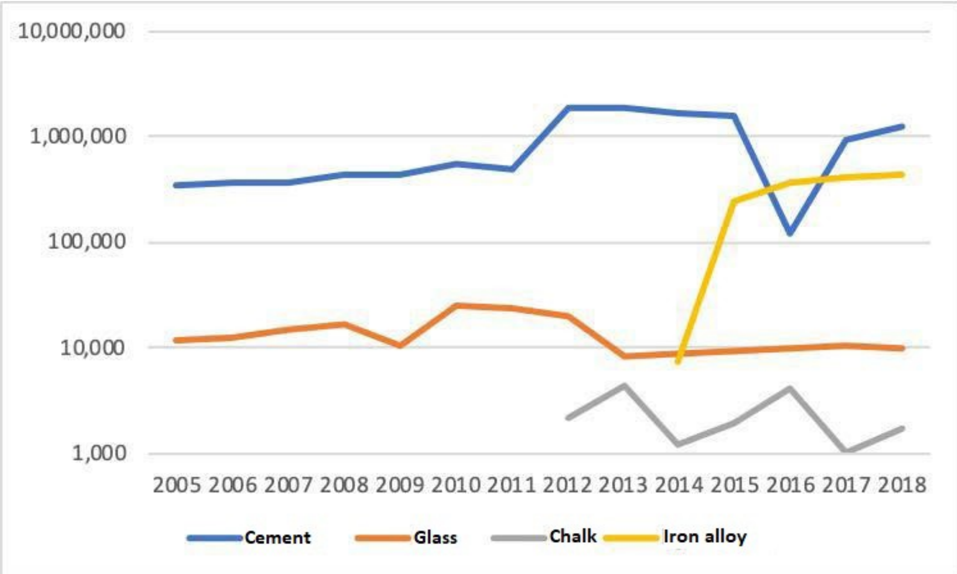
The industry sector in Angola accounts for around 8% of gross domestic product, estimated at around US$100 billion in 2019. The production of sugar, beer, cement and wood, as well as oil refining, were also noteworthy. The industrial park is fed by five hydroelectric power plants, which have greater energy potential than their consumption capacity due to the fact that there are still problems in distribution. It should be noted that due to the electrical instability the industries are obliged to have alternative sources of energy.

The industry sector is responsible for part of the CO_2 emissions, for burning fossil fuels, for example in cement production, which are handled in the Energy sector. There are other sources of greenhouse gas emissions from the industry sector, for example in the area of ceramics, glass production, steel, among others. The industry sector is expanding, particularly in agro-industry, fertilizers, electrical material, and petrochemical industry, among others.

Complexo Administrativo Clássicos de Talatona, Rua do MAT,
Building 4, 4th Floor
Talatona Municipality, Luanda
E-mail: dnaac@mcta.gov.ao

Emissions from cement production accounted for over 95% of the sector's annual emissions in the period 2005 to 2014. From that year onwards, emissions from the ferro- alloy industry become more relevant, but still about ¼ of the industry's total emissions.

Graph 2: Greenhouse Gas Emissions in Industrial Processes and Product Use (1000 tm CO_2 equivalent)



Cement, - Glass, -Cal/Chalk, - Iron alloy

Source: Own preparation

2.3.3. Agriculture

In the agricultural sector the main GHGs of interest are CO_2[17], N_2O and CH_4. The *agricultural* area includes all emissions related to enteric fermentation, handling of animal manure, rice cultivation, burning of agricultural waste, agricultural soils and liming.

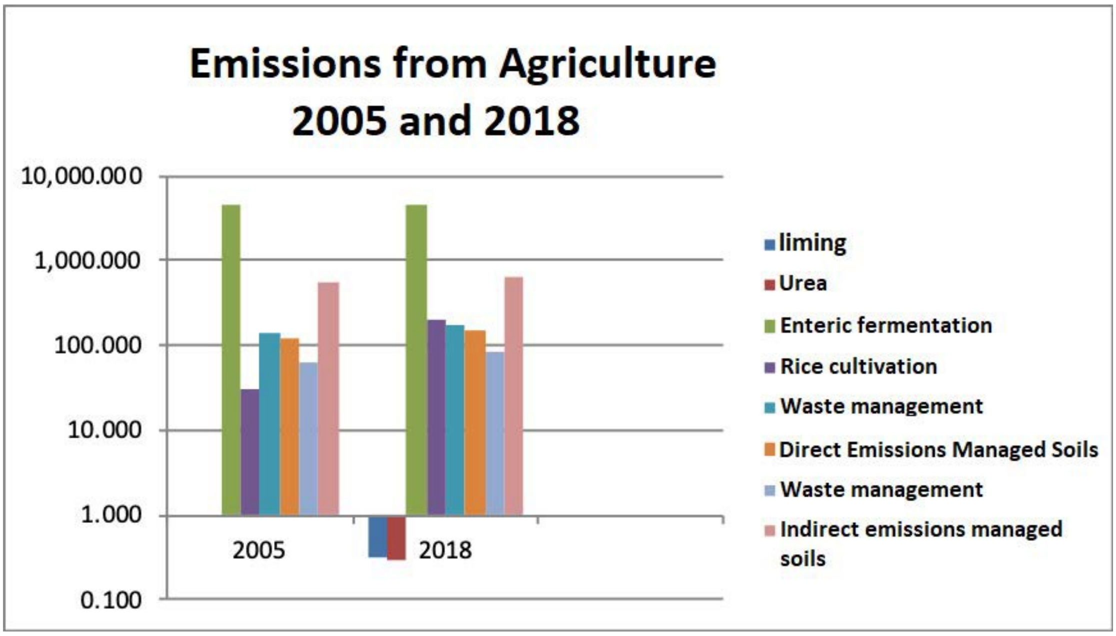
The subcategory *GHG emissions from the burning of biomass in agricultural crops for* the

[17] Other gases of interest are nitrogen oxides (NOx). ammonia (NH3). non-methane volatile organic compounds (NMVOC) and carbon monoxide (CO). since these are precursors for the formation of Greenhouse Gases in the atmosphere. The formation of greenhouse gases from precursor gases is considered an indirect emission. Indirect emissions are associated with the leaching of compounds (in particular. NO3- losses) from soils, some of which can be converted to N_2O by denitrification (IPCC. 2006)

category Aggregate sources and non- CO_2 sources of gases on land were not included in the Emissions by sources and removal by Angolan GHG sinks, given the low representativeness of these activities in the territory.

Emissions in the agriculture sector showed a relative growth trend over the period of this inventory from 2005 to 2018 with average emissions of 5,537,788 Gg CO_2e, with minimum Gg CO_2e emissions of 5,322,952 Gg CO_2 e in 2005 and maximum of 6,608,453 Gg CO_2e in 2015

Graph 3: Comparative Emissions for the Agriculture Sector in 2005 and 2018



Graphics: Own preparation

2.3.4. Land use, Land use change and forests

The inventory contains information on forests, land use and land use change. In terms of classification, sampling area data representing various land use categories is required to estimate carbon storage, GHG emissions and removals associated with activities in which the IPCC 2006 guidelines synthesize the Agriculture, Forestry and Other Land Use (AFOLU) sectors. The classification presented formed the basis for estimates of GHG emissions and removals, which represent land use categories and conversions between land use categories, to be applied in the most appropriate and consistent manner possible in inventory calculations.

Complexo Administrativo Clássicos de Talatona, Rua do MAT,
Building 4, 4th Floor
Talatona Municipality, Luanda
E-mail: dnaac@mcta.gov.ao

Although the IPCC considers agriculture to be land use, agricultural activities, in particular activities emitting gases other than CO_2, are presented separately in the section on Agriculture. Therefore emissions/absorption from agricultural land are treated separately from emissions from agricultural activities.

To conduct their inventories, countries use various methods to obtain data, including annual inventory, decennial forest inventories, periodic surveys and remote sensing. Each of these data collection methods produce different types of information (maps, spreadsheets), at different reporting frequencies and with different attributes. Together they allow the **calculation of emissions for the sector.**

In Angola, an attempt has been made to update the data in order to remain minimally consistent with the material in Angola's first national inventory (2000 and 2005). Modis soil cover database[18] were used in 2005, 2010 and 2015. For each transition, from 2005 to 2010 and from 2010 to 2015, a map representing the areas that were changed is created. For each type of change, called land-use transitions, there are associated factors that help calculations of emissions. There is thus a discontinuity from 2010 to 2011.

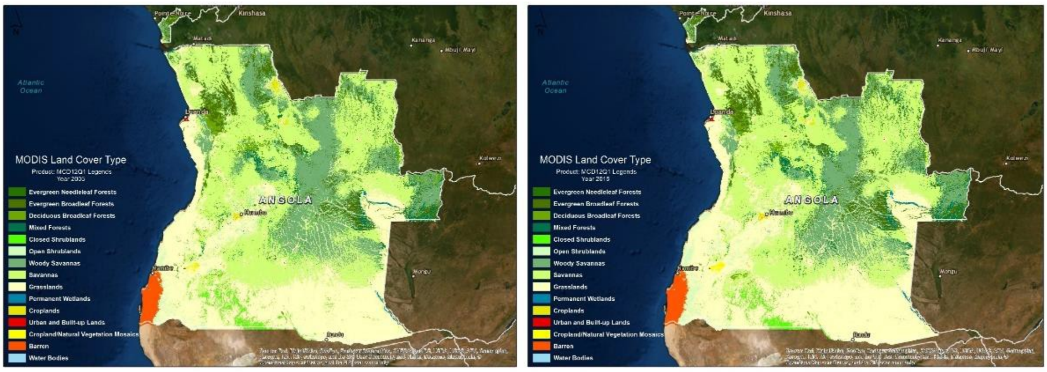


Figure 4: Land use classification of Angola in 2005 (left) and 2015 (right)

[18] https://modis-land.gsfc.nasa.gov/

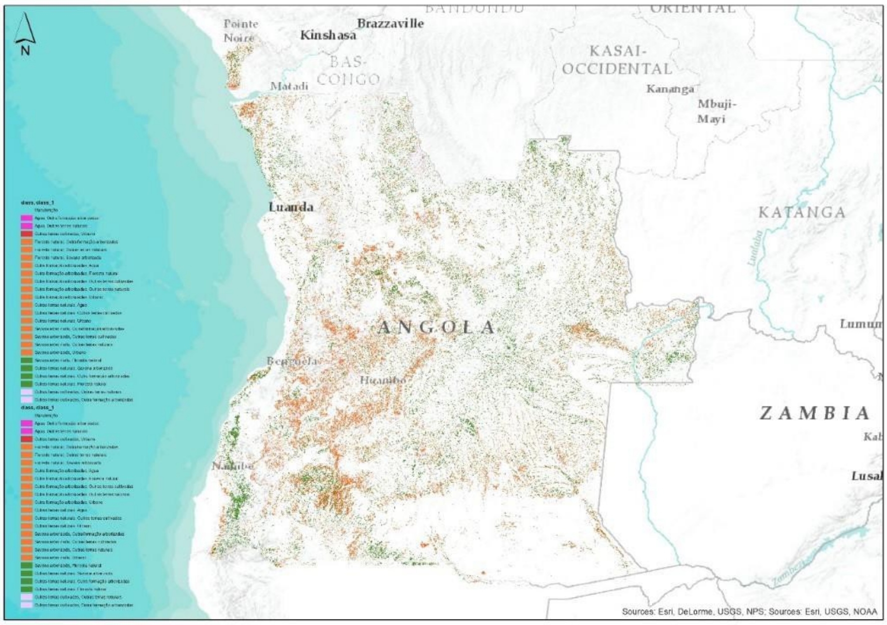
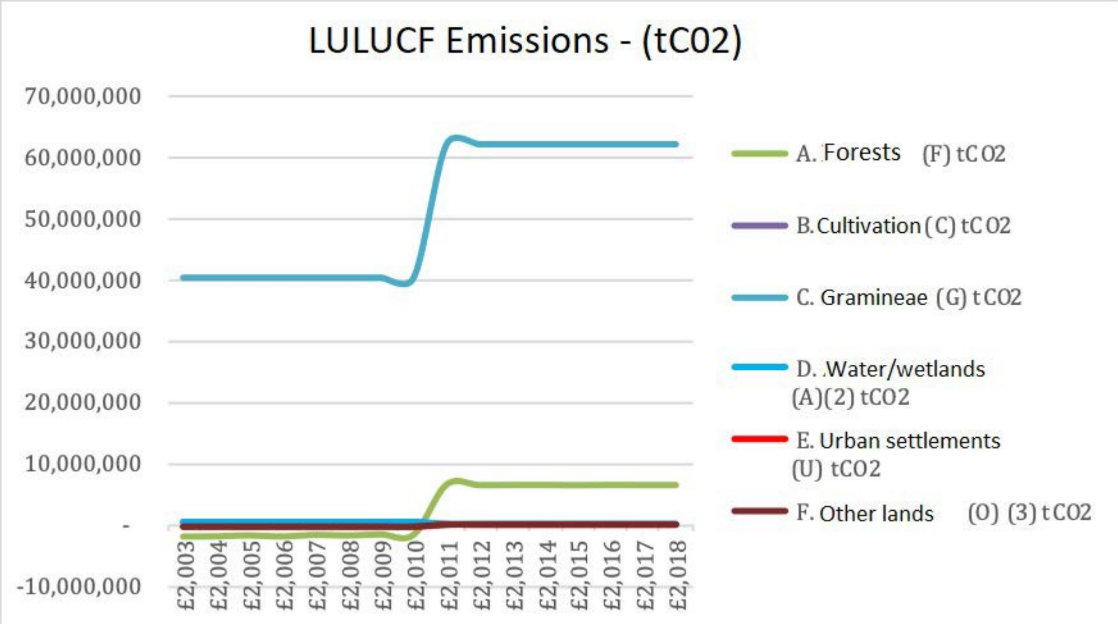


Figure 5: Overlap of transitions between 2005 and 2015 Source: Own preparation

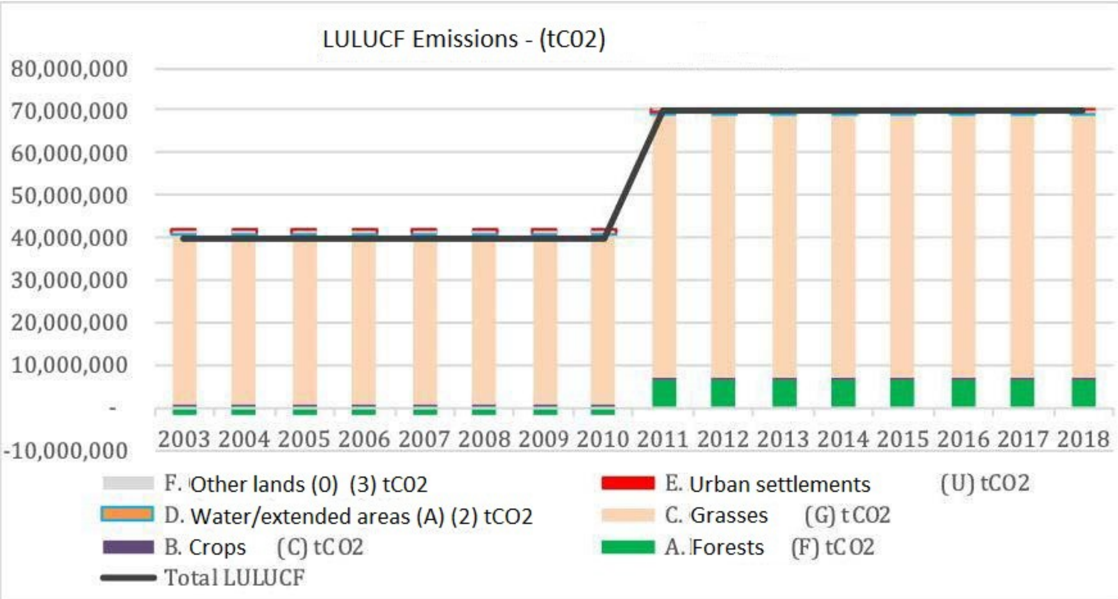
It is interesting to analyse the differences between 2003 and 2018. In that period the forests had a net loss of 200,000 hectares which was now occupied with more than 200,000 hectares of grass. There was also a 7% loss of flooded areas during the period analysed. Urban areas increased by 3.3% from 2003 to 2018, while the area under agriculture grew by 5% in this period.

The area deforested by fires in the reference period was 609,157.53 ha (2000-2015) and counting on the extension of estimates with the calculations of 5-year moving averages for 2016, 2017 and 2018, a total of 783,500.76 hectares was reached, with an annual average of 43,527.82 ha.

The results found when adding up emissions and removals for the period 2003 to 2010 were a total of 314,232,178 t CO_2 or an annual average of about 39,279,022.25 t CO_2. Between 2010 and 2018 there was an increase in emissions totaling 553,516,255 t CO_2 , representing an annual average of 61,501,802.777 t CO_2 .



LULUCF Emissions - (tC02)
70,000,000
60,000,000
50,000,000
40,000,000
30,000,000
20,000,000
10,000,000
-
-10,000,000
£2,003
£2,004
£2,005
£2,006
£2,007
£2,008
£2,009
£2,010
£2,011
£2,012
£2,013
£2,014
£2,015
£2,016
£2,017
£2,018
A. Forests (F) tC02
B. Cultivation (C) tC02
C. Gramineae (G) tC02
D. Water/wetlands (A)(2) tC02
E. Urban settlements (U) tC02
F. Other lands (0) (3) tC02



LULUCF Emissions - (tC02)
80,000,000
70,000,000
60,000,000
50,000,000
40,000,000
30,000,000
20,000,000
10,000,000
-
-10,000,000
2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
F. Other lands (0) (3) tC02
E. Urban settlements (U) tC02
D. Water/extended areas (A) (2) tCO2
C. Grasses (G) tC02
B. Crops (C) tC02
A. Forests (F) tC02
Total LULUCF

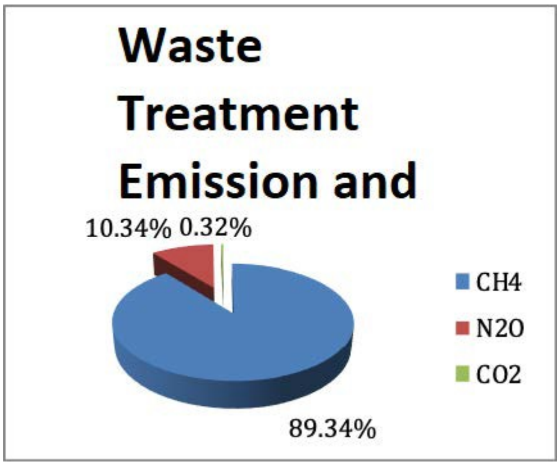
2.3.5 Waste

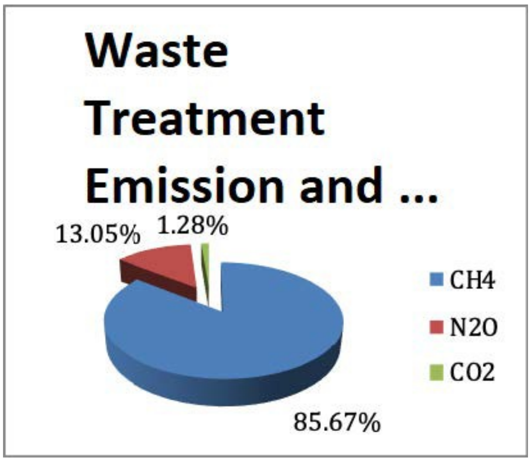
The waste sector includes CH_4, CO_2 e N_2O emissions from the final disposal and incineration of solid waste and waste water treatment in the Republic of Angola for the period 2005 to 2018, based on the application of the 2006 IPCC Methodological Guidelines. Calculations of emissions from the disposal of municipal solid waste have been carried out on the basis of national data as a priority; where not available, standard IPCC data have been used. The parameters used for the calculation were: population, degradable organic carbon, and gravimetric composition of waste, rate of waste generation per inhabitant, oxidation factor, methane recovery and standard IPCC data.

Emission results by waste and effluent sector category indicate a predominance of emissions from the household effluent category representing 50.73% of the sector's emissions, followed by the solid waste disposal at unmanaged sites category representing 45.96% of the waste sector. The results highlight the relevance of the solid waste disposal category in relation to the other categories, as well as the growth of these emissions category which represented more than 67% of the total emissions of the Waste and Effluent sector between 2005 and 2018.

Waste Incineration emissions accounted for about 2% and Industrial Effluent emissions contributed 1.34% of total emissions from the Waste sector. There was also a continuous upward trend in emissions from the Waste and Effluent sector during the reporting period 2005 to 2018.

Graph 4: Waste and effluent emissions by gas in 2005 and 2018





Source: Own preparation

Complexo Administrativo Clássicos de Talatona, Rua do MAT,
Building 4, 4th Floor
Talatona Municipality, Luanda
E-mail: dnaac@mcta.gov.ao

2.4 Inventory of Anthropogenic Emissions and Greenhouse Gas (GHG) Removals in ANGOLA - Global Values

The results of emissions and removals were presented separately by the IPCC sector (2006) in the previous section. This section presents total results and the balance gas, category, most emitter categories and year-on-year changes in emissions. All emissions are reported in $GgCO_2e$ (thousand tons of CO_2 equivalent).

Most of Angola's GHG emissions from 2005 to 2018 were CO_2 (carbon dioxide), followed by CH_4 (methane) and N_2O (nitrous oxide), respectively. The following tables show total emissions. The emission figures are presented considering the Land Use, Land Use Change and Forestry (LULUCF) sector and without considering it.

CO_2 accounted for more than 83% of emissions in all inventory years, and between 2005 and 2018 there was an increase in emissions of more than 37658 Gg CO_2 (an absolute increase of 82%). Excluding LULUCF, Angola's total emissions rose overall by 14131 Gg

CO_{2e}between 2005 and 2018 (an absolute increase of 88%), with CO_2 also being the main reason for this increase; CO_2 emissions rose by 7529 Gg between 2005 and 2018 (an absolute increase of 119.6%).

Table 2: GHG emissions by gas in Angola (total emissions) 2005-2018. Considering and not considering the LULUCF sector ($GgCO_{2e}$ emissions)

Total with LULUCF	CO_2	CH_4	N_2O	Total	CO_2	Land Use and Forest Change
Year	thousand ton CO_2 eq				%	thousand t on
2005	45966,60	8698,434	1405,84	56070,883	81,98%	40062,605
2006	46783,34	8435,315	1366,35	56585,021	82,68%	39907,397
2007	47811,80	8840,216	1469,09	58121,110	82,26%	40153,357
2008	50496,17	6899,419	1287,51	58683,112	86,05%	40065,406
2009	51687,90	9983,113	1662,23	63333,244	81,61%	40233,866
2010	52907,19	7623,838	1353,54	61884,581	85,49%	40189,886

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Talatona Municipality, Luanda
E-mail: dnaac@mcta.gov.ao

2011	82867,17	8344,765	1437,23	92649,173	89,44%	70552,361
2012	85968,6	8945,308	1538,2	96452,129	89,13%	70392,155
2013	88370,1	10906,89	1753,2	101030,23	87,47%	70417,382
2014	90015,6	8824,184	1594,6	100434,48	89,63%	70432,479
2015	88801,7	9542,122	1711,8	100055,77	88,75%	70360,442
2016	90581,6	8821,502	1603,2	101006,31	89,68%	70430,964
2017	82973,6	8608,853	1569,4	93151,938	89,07%	70406,684
2018	83624,9	14585,58	2338,5	100549,05	83,17%	70409,590

Source: Own preparation

Total without LULU	CO_2	CH_4	N_2O	Total	CO_2
Year	thousand ton CO_2 eq				%
2005	6295,791	8400,046	1312,441	16008,278	39,33%
2006	7267,742	8255,133	1309,957	16832,832	43,18%
2007	8050,237	8472,711	1354,054	17877,001	45,03%
2008	10822,561	6598,898	1193,447	18614,905	58,14%
2009	11845,826	9554,292	1527,998	22928,116	51,67%
2010	13109,103	7228,512	1229,799	21567,414	60,78%
2011	12996,225	7825,799	1274,788	22096,813	58,81%
2012	16177,767	8487,349	1394,858	26059,974	62,08%
2013	18566,661	10439,325	1606,871	30612,857	60,65%
2014	20204,643	8350,870	1446,489	30002,002	67,34%
2015	19026,795	9096,239	1572,297	29695,331	64,07%
2016	20771,357	8348,765	1455,230	30575,351	67,93%

2017	13175,500	8145,361	1424,393	22745,254	57,93%
2018	13825,388	14120,983	2193,098	30139,468	45,87%

Source: Own preparation

GHG emissions per gas in Angola (percentages) 2005-2018, considering and not considering the LULUCF sector (emissions in $GgCO_{2e}$)

Total with LULUCF	CO_2	CH_4	N_2O	Total
2005	81,98%	15,51%	2,51%	100,00%
2006	82,68%	14,91%	2,41%	100,00%
2007	82,26%	15,21%	2,53%	100,00%
2008	86,05%	11,76%	2,19%	100,00%
2009	81,61%	15,76%	2,62%	100,00%
2010	85,49%	12,32%	2,19%	100,00%
2011	89,44%	9,01%	1,55%	100,00%
2012	89,13%	9,27%	1,59%	100,00%
2013	87,47%	10,80%	1,74%	100,00%
2014	89,63%	8,79%	1,59%	100,00%
2015	88,75%	9,54%	1,71%	100,00%
2016	89,68%	8,73%	1,59%	100,00%
2017	89,07%	9,24%	1,68%	100,00%
2018	83,17%	14,51%	2,33%	100,00%

Source: Own preparation

Total without LULUCF	CO_2	CH_4	N_2O	Total
2005	39,33%	52,47%	8,20%	100,00%
2006	43,18%	49,04%	7,78%	100,00%

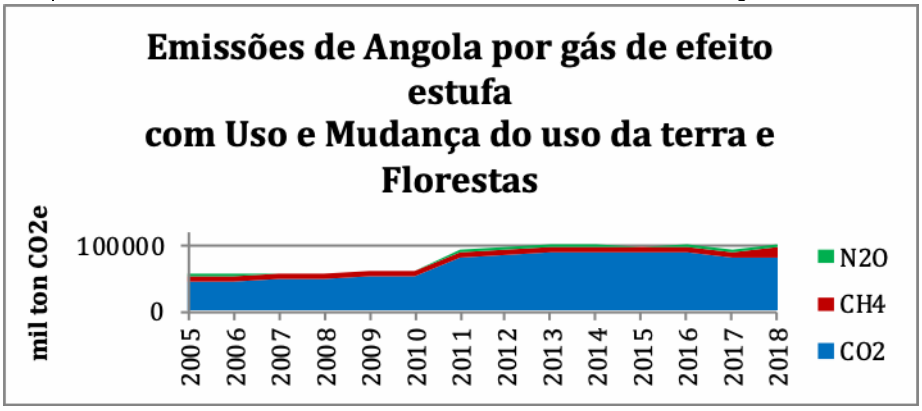
2007	45,03%	47,39%	7,57%	100,00%
2008	58,14%	35,45%	6,41%	100,00%
2009	51,67%	41,67%	6,66%	100,00%
2010	60,78%	33,52%	5,70%	100,00%
2011	58,81%	35,42%	5,77%	100,00%
2012	62,08%	32,57%	5,35%	100,00%
2013	60,65%	34,10%	5,25%	100,00%
2014	67,34%	27,83%	4,82%	100,00%
2015	64,07%	30,63%	5,29%	100,00%
2016	67,93%	27,31%	4,76%	100,00%
2017	57,93%	35,81%	6,26%	100,00%
2018	45,87%	46,85%	7,28%	100,00%

Source: Own preparation

The following graphs present the emission results for each greenhouse gas in each year of the inventory coverage, considering or not the LULUCF sector.

Angola's Greenhouse Gas Emissions with Land Use and Forest Change

Graph 5: Emissions of GHG with land use and forest change



Source: Own preparation

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Talatona Municipality, Luanda
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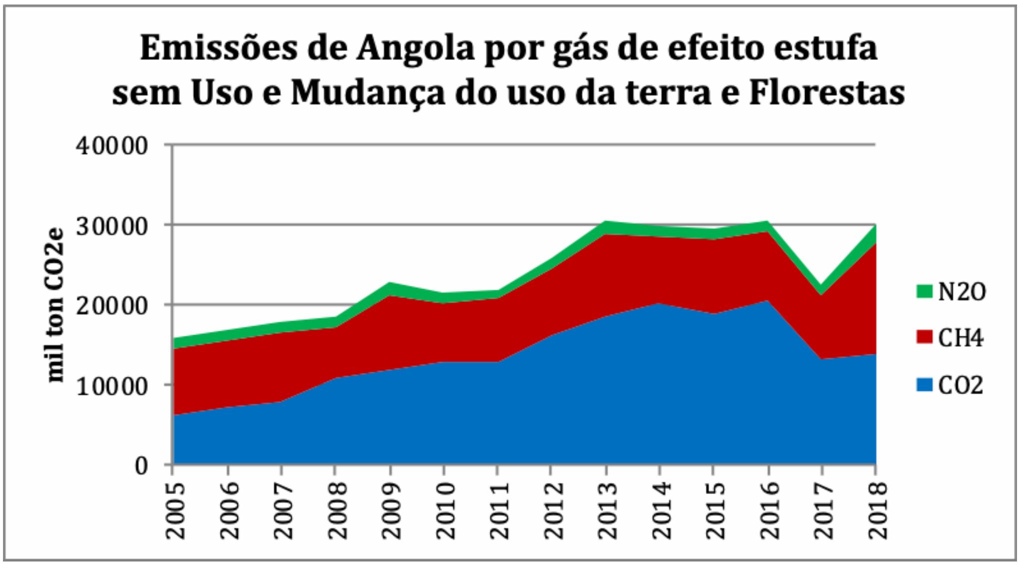

Graph 6 - Greenhouse gas emissions without Land Use and Change and Forests

Source: Own preparation

2.4.1. Emissions by Sector in Angola

The results of total Angolan emissions considering the total with LULUCF by sector indicate a predominance of emissions from the Land Use sector. Land use change and

Forests followed by Energy, Agriculture and Livestock, Waste and Wastewater and Industrial Processes and Product Use (IPPU) sectors.

In terms of representativeness when all sectors are added together, LULUCF presented more than 65% of Angola's total emissions over the inventory period, making it the most relevant in relation to the other sectors. The Energy sector accounted for over 50% of Angola's total emissions over the inventory period.
In 2011 LULUCF representation was the highest in the period, with 76.20%. The Energy sector reached 22.91% of emissions in 2009. In turn, the IPPU sector is the sector with the smallest share of greenhouse gas emissions in Angola, despite being growing throughout the period analyzed.

The tables and graphs below show, by way of illustration, the reduction achieved with the use of renewable energies (white background) and also the emissions from international aviation and ships *(*dotted *bunker fuels).* Both emissions are not included in the inventory according to the UNFCCC guidelines.

Complexo Administrativo Clássicos de Talatona, Rua do MAT,
Building 4, 4th Floor
Talatona Municipality, Luanda
E-mail: dnaac@mcta.gov.ao

Table 3: GHG emissions by sector for Angola in 2005- 2018 Emissions in Gg CO_2e

Sector	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Energy	8638,891	9230,566	10036,75	10718,18	14454,77	12881,31	13433,31	15917,13	20255,030	19088,695	18115,62	19424,871	11983,55	18820,386
Agriculture and Livestock	5291,684	5455,248	5624,551	5511,237	5978,877	5950,088	5921,523	5987,375	6033,433	6231,905	6544,911	6051,210	5691,062	5650,619
Waste	1685,496	1761,174	1816,491	1889,989	1993,139	2094,430	2168,886	2267,018	2392,688	2966,758	3151,339	3357,458	3554,708	3776,480
IPPU	360,940	366,312	376,475	453,752	441,529	578,663	507,415	1818,068	1857,274	1638,805	1819,919	1550,973	1349,917	1693,582
LULUCF	40062,605	39907,397	40153,357	40065,406	40233,866	40189,886	70552,361	70392,155	70417,382	70432,479	70360,442	70430,964	70406,684	70409,590
Total Angola	56039,61	56720,69	58007,62	58638,56	63102,18	61694,37	92583,49	96381,75	100955,80	100358,64	99992,23	100815,47	92985,93	100350,65
Renewables	43532,84	37541,76	37732,02	4399,755	48723,02	4506,947	13932,47	23897,04	56742,111	6769,011	13179,42	1863,364	1738,548	109482,68
Bunker Fuels	424,431	658,432	982,231	0,000	755,692	928,265	1224,346	1405,946	523,107	732,419	660,835	740,932	700,245	914,575

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Table 4: Greenhouse gas emissions by sector in Angola (percentages) 2005-2018

Sector with LULUCF	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Energy	15,42%	16,27%	17,30%	18,28%	22,91%	20,88%	14,51%	16,51%	20,06%	19,02%	18,12%	19,27%	12,89%	18,75%
Agriculture and Livestock	9,44%	9,62%	9,70%	9,40%	9,47%	9,64%	6,40%	6,21%	5,98%	6,21%	6,55%	6,00%	6,12%	5,63%
Waste	3,01%	3,10%	3,13%	3,22%	3,16%	3,39%	2,34%	2,35%	2,37%	2,96%	3,15%	3,33%	3,82%	3,76%
IPPU	0,64%	0,65%	0,65%	0,77%	0,70%	0,94%	0,55%	1,89%	1,84%	1,63%	1,82%	1,54%	1,45%	1,69%
LULUCF	71,49%	70,36%	69,22%	68,33%	63,76%	65,14%	76,20%	73,03%	69,75%	70,18%	70,37%	69,86%	75,72%	70,16%
Total Angola	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%
Renewables	77,68%	66,19%	65,05%	7,50%	77,21%	7,31%	15,05%	24,79%	56,20%	6,74%	13,18%	1,85%	1,87%	109,10%
Bunker Fuels	0,76%	1,16%	1,69%	0,00%	1,20%	1,50%	1,32%	1,46%	0,52%	0,73%	0,66%	0,73%	0,75%	0,91%

Table 5: Greenhouse gas emissions by sector in Angola (percentages) 2005-2018

Sector with out LULUCF	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Energy	54,07%	54,90%	56,21%	57,71%	63,21%	59,90%	60,97%	61,24%	66,33%	63,79%	61,14%	63,93%	53,07%	62,86
Agriculture	33,12%	32,45%	31,50%	29,67%	26,14%	27,67%	26,88%	23,04%	19,76%	20,82%	22,09%	19,92%	25,20%	18,87
Waste	10,55%	10,47%	10,17%	10,18%	8,72%	9,74%	9,84%	8,72%	7,84%	9,91%	10,63%	11,05%	15,74%	12,61
IPPU	2,26%	2,18%	2,11%	2,44%	1,93%	2,69%	2,30%	7,00%	6,08%	5,48%	6,14%	5,10%	5,98%	5,66%
Total Angola	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00
Renewables	272,47	223,29	211,33	23,69%	213,06	20,96%	63,24%	91,95%	185,81	22,62%	44,48%	6,13%	7,70%	365,66
Bunker Fuels	2,66%	3,92%	5,50%	0,00%	3,30%	4,32%	5,56%	5,41%	1,71%	2,45%	2,23%	2,44%	3,10%	3,05%

Source: Own preparation

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Building 4, 4th Floor
Talatona Municipality, Luanda
E-mail: dnaac@mcta.gov.ao

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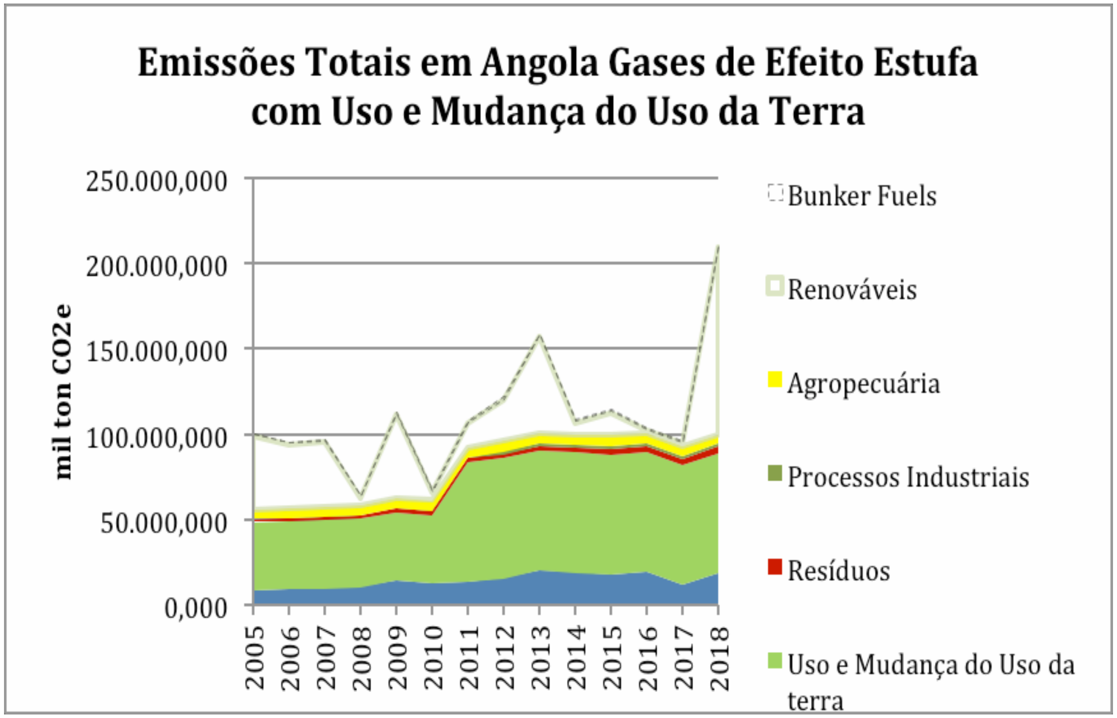
Building 4, 4th Floor
Talatona Municipality, Luanda
E-mail: dnaac@mcta.gov.ao

Total Emissions in Angola - Greenhouse Gases with Land Use and Land Use Change



Source: Own preparation

Chart 5: Total Emissions - Greenhouse Gases without Land Use and Land Use Change

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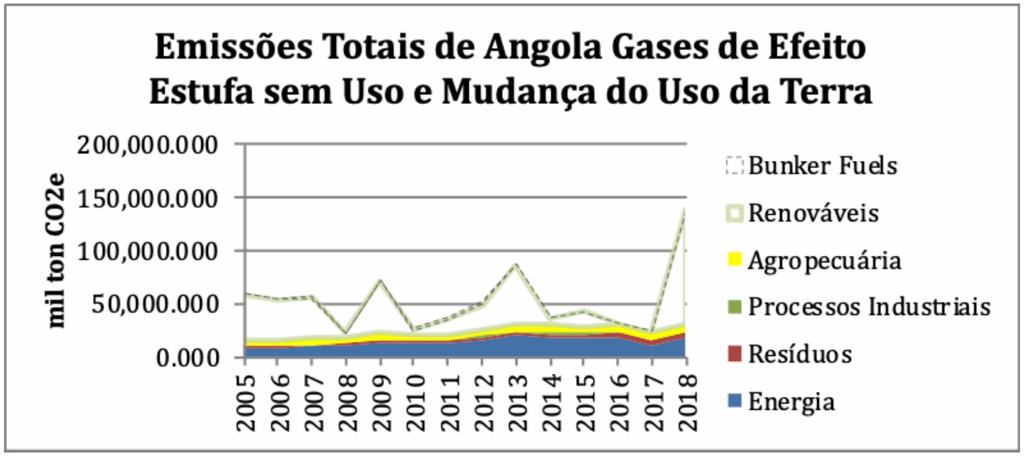


Source: Own preparation

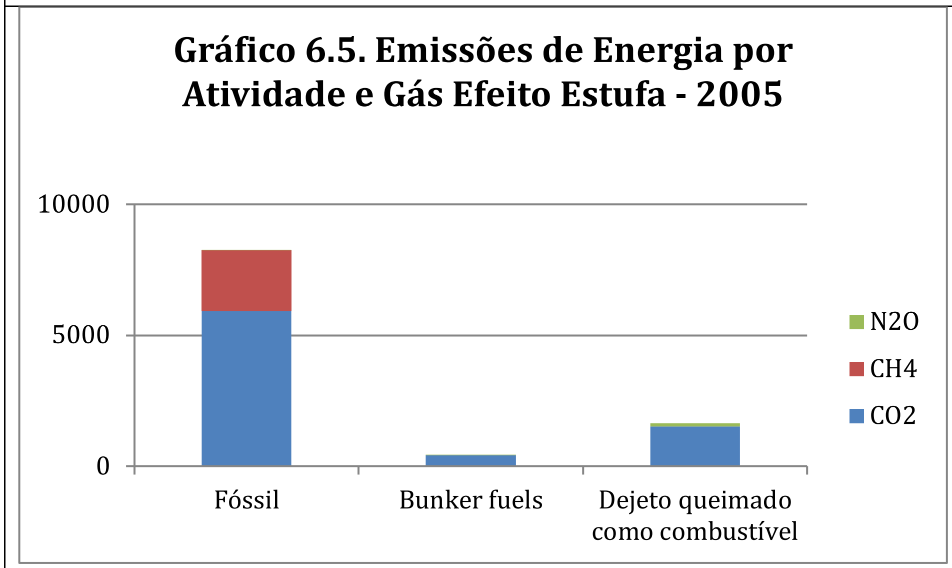
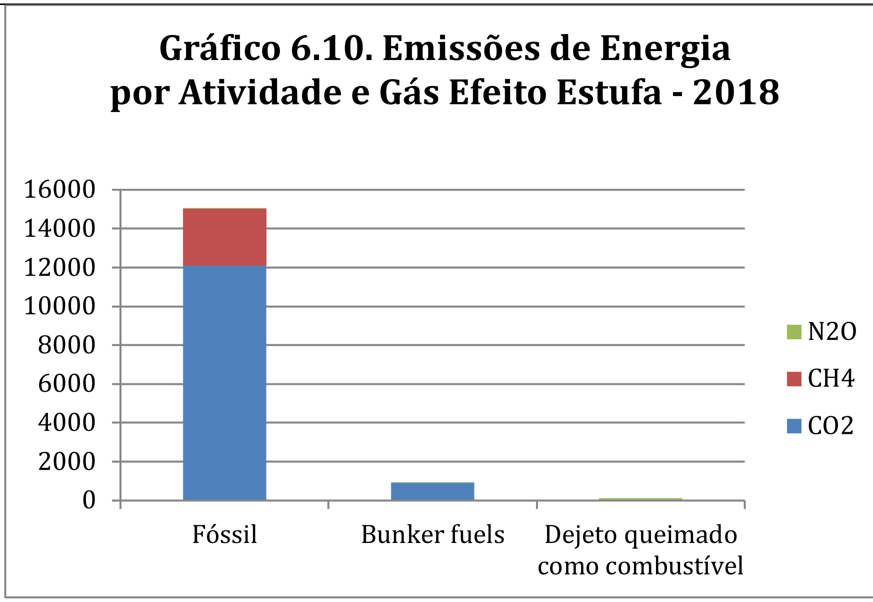
2.4.2. Comparative Emissions by Gas and Sector – General

The following graphs show the 2018 representativity of each greenhouse gas for each category by sector of the Inventory. The predominance of CO_2 is seen in the Energy sectors (categories Road and Air Transport), LULUCF (CH_4 and N_2O not yet estimated, but of lesser importance) and for the categories of Removal and Grasses, Industrial Processes and Product Uses (category of Cement Production); of CH_4 in the Waste sector (solid waste treatment category) and Agricultural (Enteric Fermentation) and of N_2O in the Agricultural sector (Managed Soil Direct Emissions).

In addition, the sectors that contributed most to the growth of emissions in absolute terms and removals (growth of 27.16%) were Road Transport (growth of 16.14%), Air Transport (growth of 79.92%), Cement Production (growth of 8.86%), Managed Soil Direct Emissions (growth of 21.02%) and Domestic Wastewater Treatment (growth of 32.92%).

EMISSIONS BY CATEGORY OF ACTIVITY IN EACH SECTOR AND GREENHOUSE GAS

Graph 6.5 Energy Emissions by activity and Greenhouse Gas - 2005

2005	2018
	

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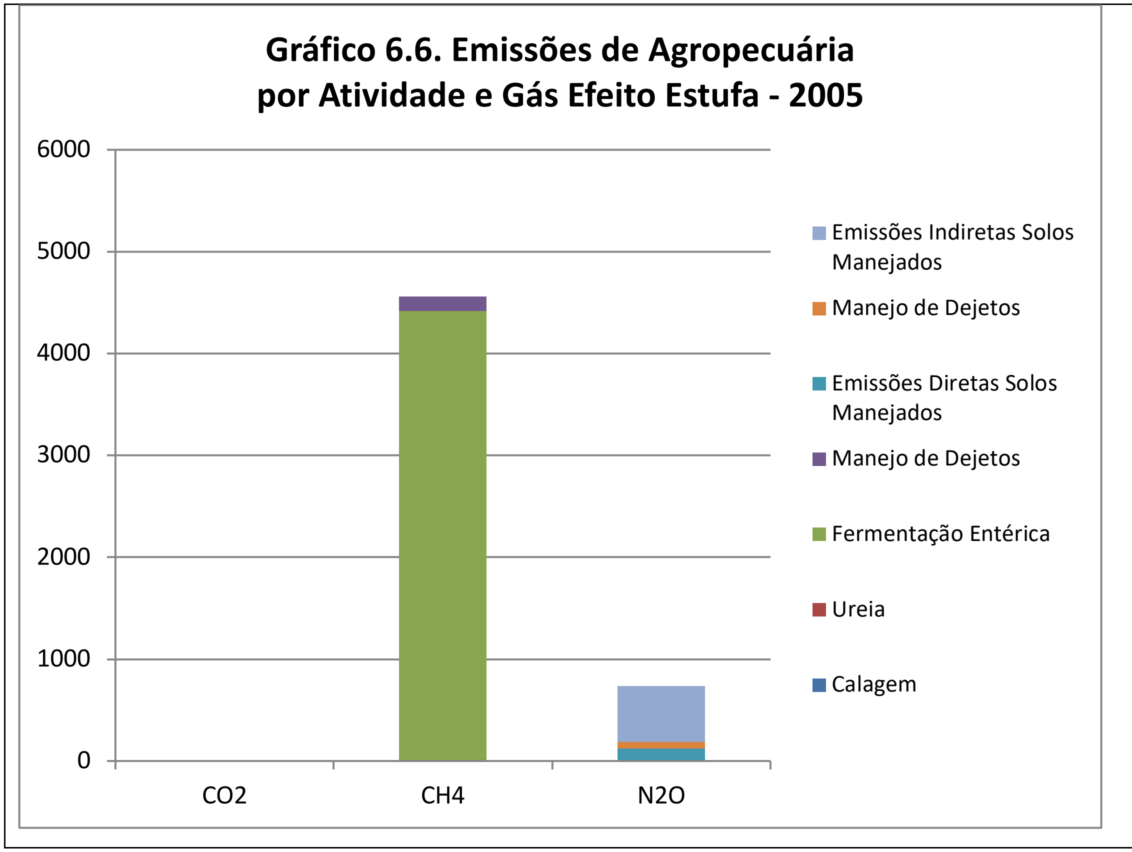

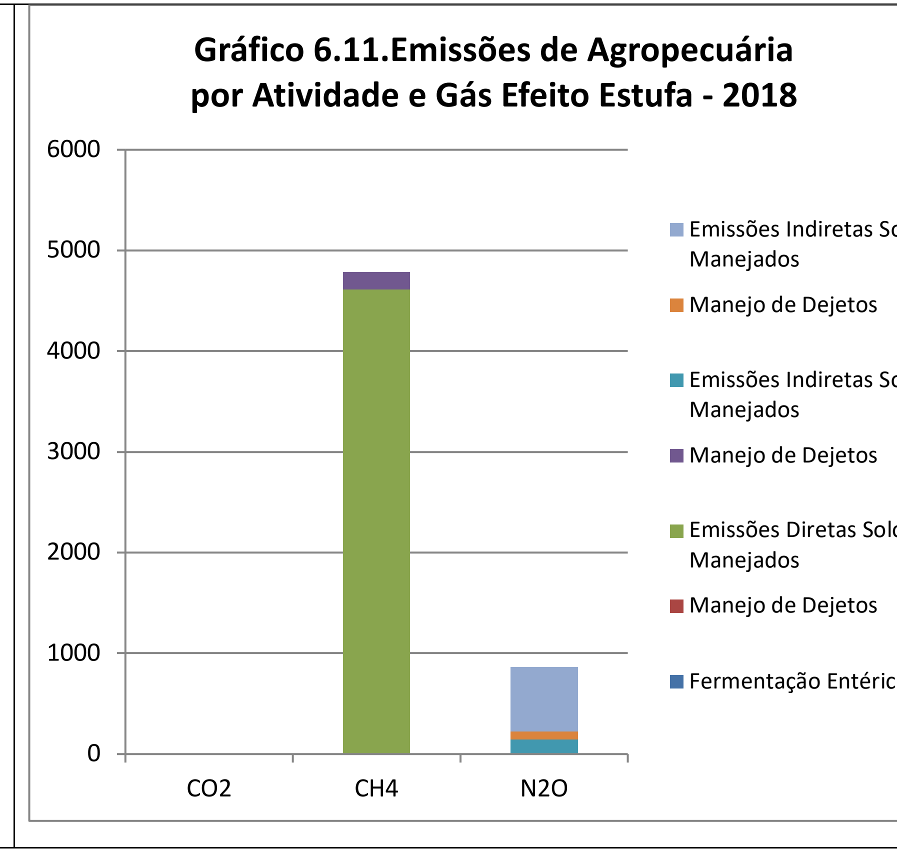

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Gráfico 6.7. Emissões de Resíduos por Atividade e Gás Efeito Estufa - 2005

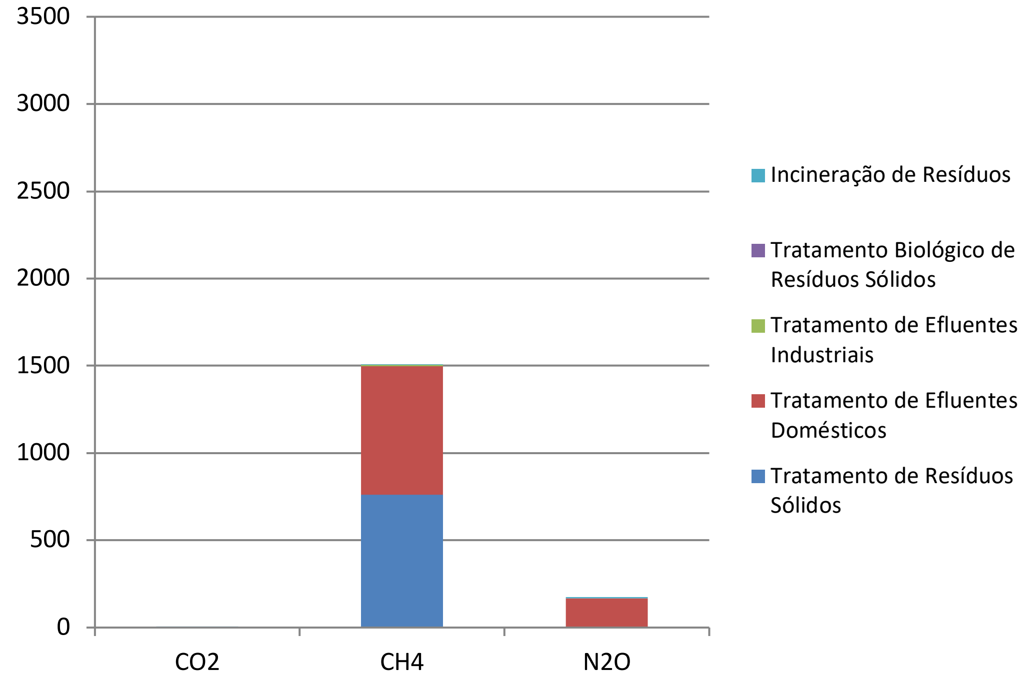
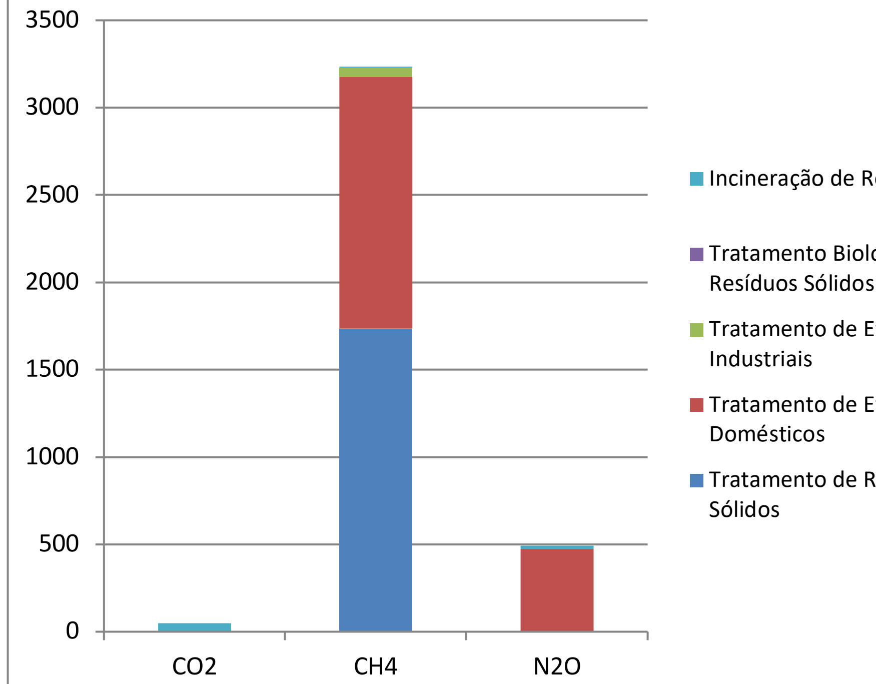


Gráfico 6.12. Emissões de Resíduos por Atividade e Gás Efeito Estufa - 2018



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Building 4, 4th Floor
Talatona Municipality, Luanda
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Gráfico 6.8. Emissões de Processos Industriais e Uso de Produtos por Atividade e Gás Efeito Estufa - 2005

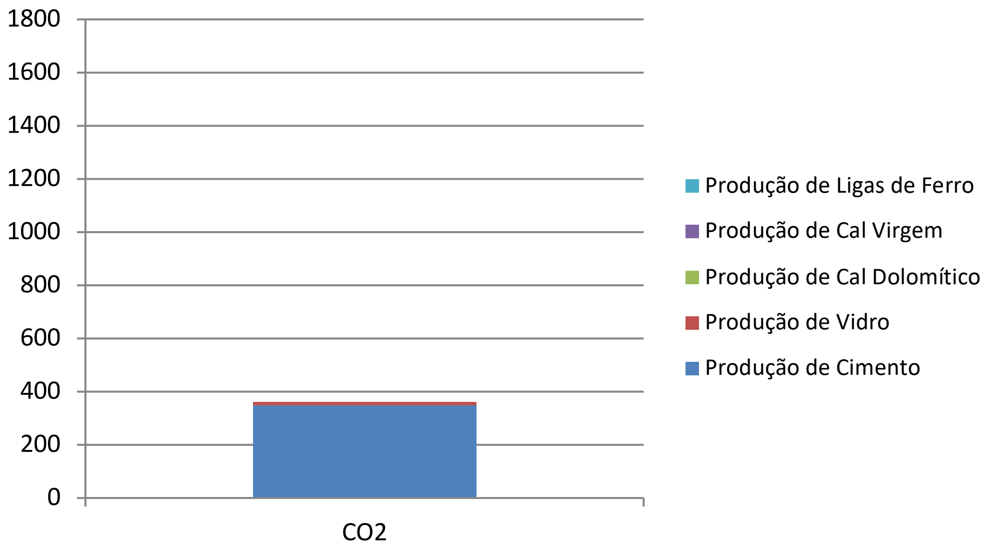
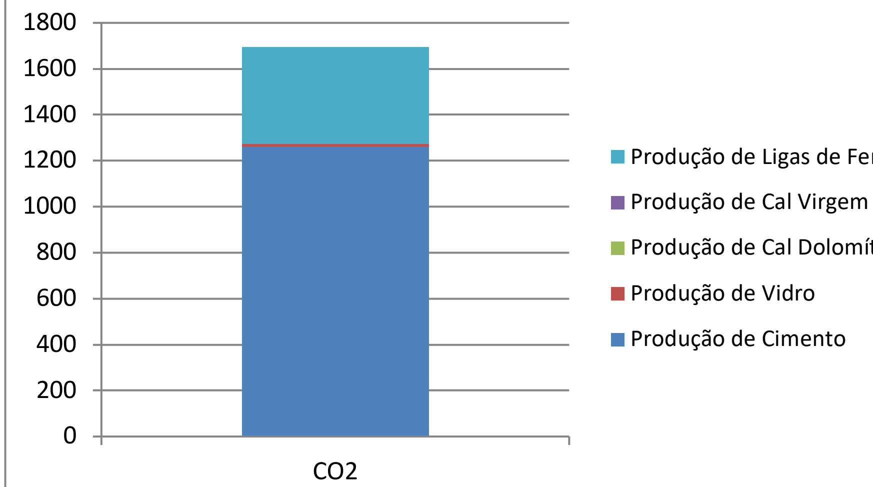


Gráfico 6.13. Emissões de Processos Industriais e Uso de Produtos por Atividade e Gás Efeito Estufa - 2018



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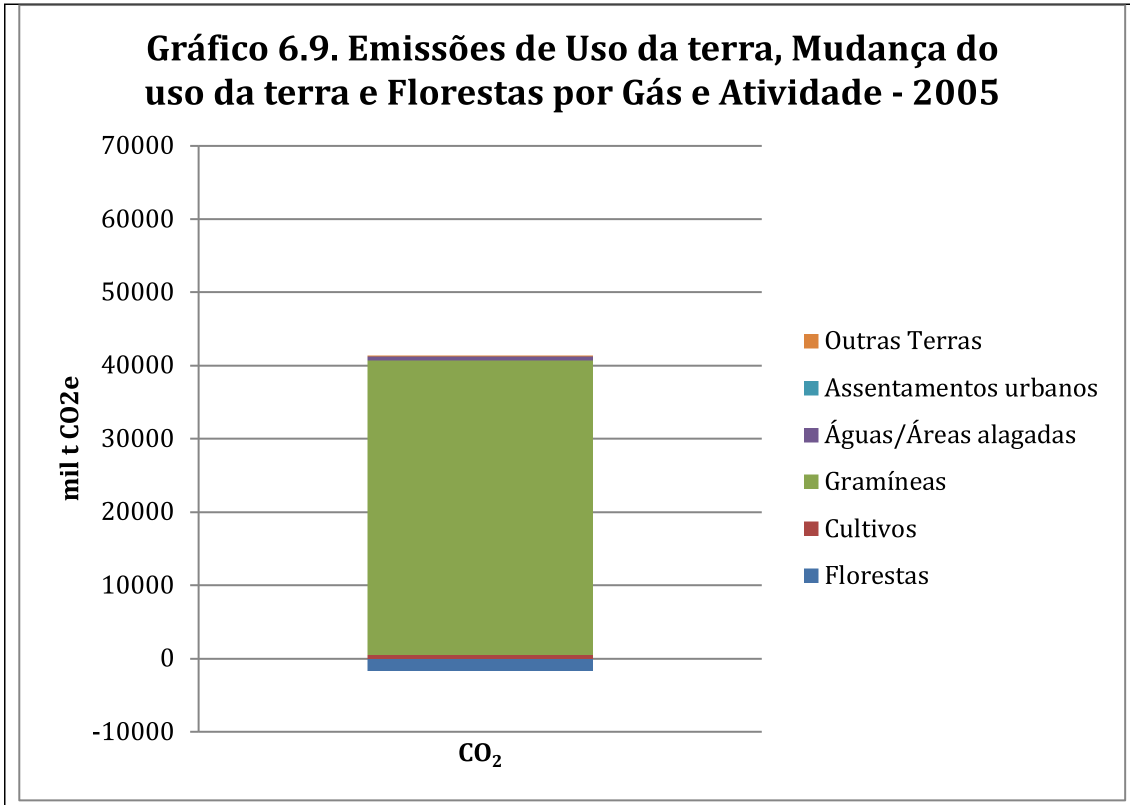


Gráfico 6.9. Emissões de Uso da terra, Mudança do uso da terra e Florestas por Gás e Atividade - 2005
70000
60000
50000
40000
30000
20000
10000
0
-10000
mil t CO2e
CO_2
Outras Terras
Assentamentos urbanos
Águas/Áreas alagadas
Gramíneas
Cultivos
Florestas

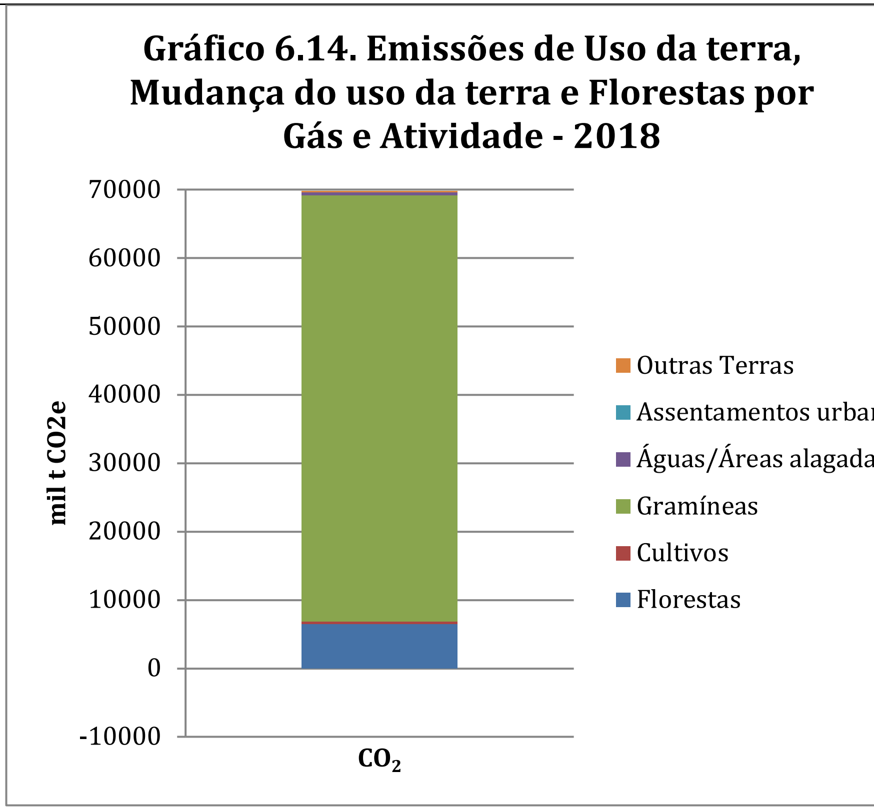
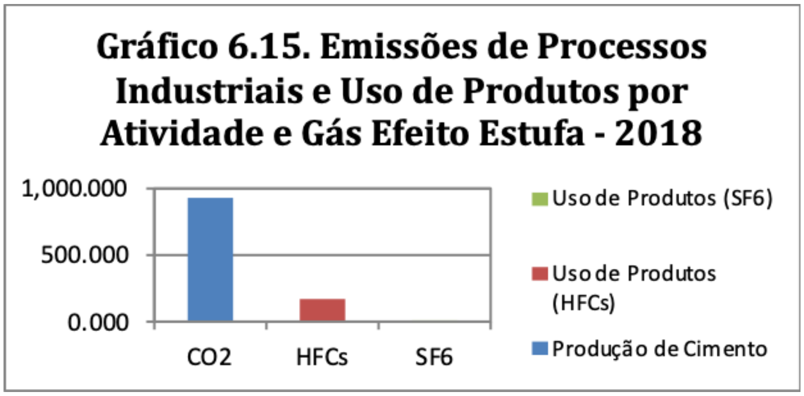
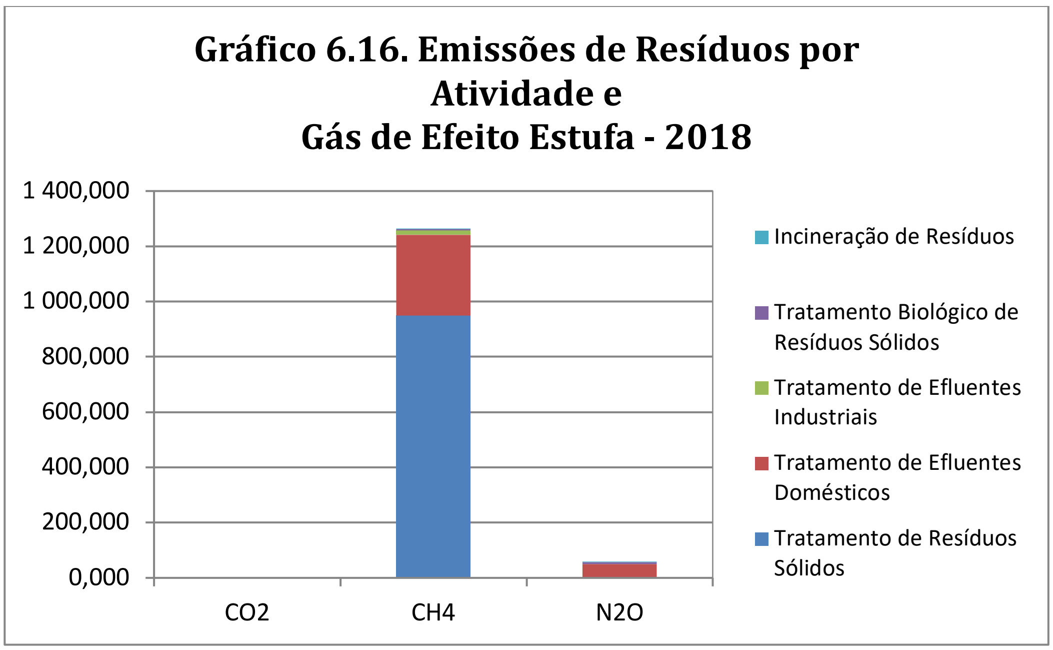


Gráfico 6.14. Emissões de Uso da terra, Mudança do uso da terra e Florestas por Gás e Atividade - 2018
70000
60000
50000
40000
30000
20000
10000
0
-10000
mil t CO2e
CO_2
Outras Terras
Gramíneas
Cultivos
Florestas

Apresentam-se mais alguns gráficos para emissões de 2018.





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Talatona Municipality, Luanda
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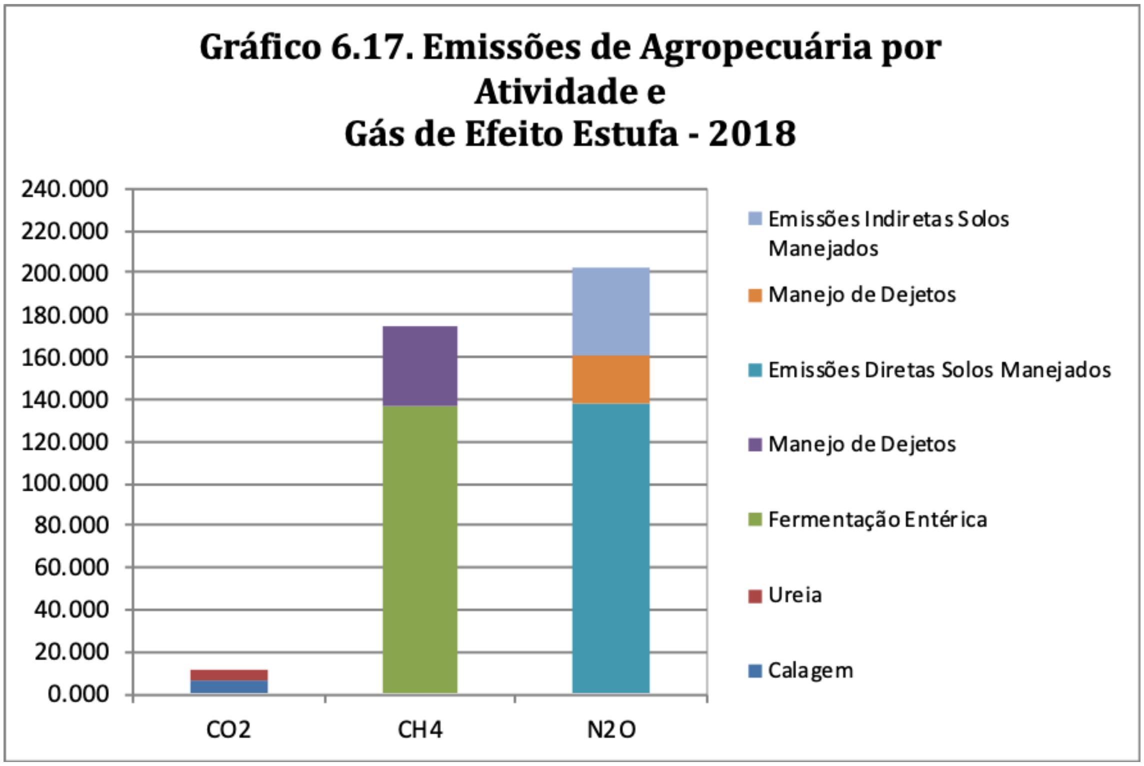
Gráfico 6.17. Emissões de Agropecuária por Atividade e Gás de Efeito Estufa - 2018
240.000
220.000
200.000
180.000
160.000
140.000
120.000
100.000
80.000
60.000
40.000
20.000
0.000
CO2
CH4
N2O
Emissões Indiretas Solos Manejados
Manejo de Dejetos
Emissões Diretas Solos Manejados
Manejo de Dejetos
Fermentação Entérica
Ureia
Calagem

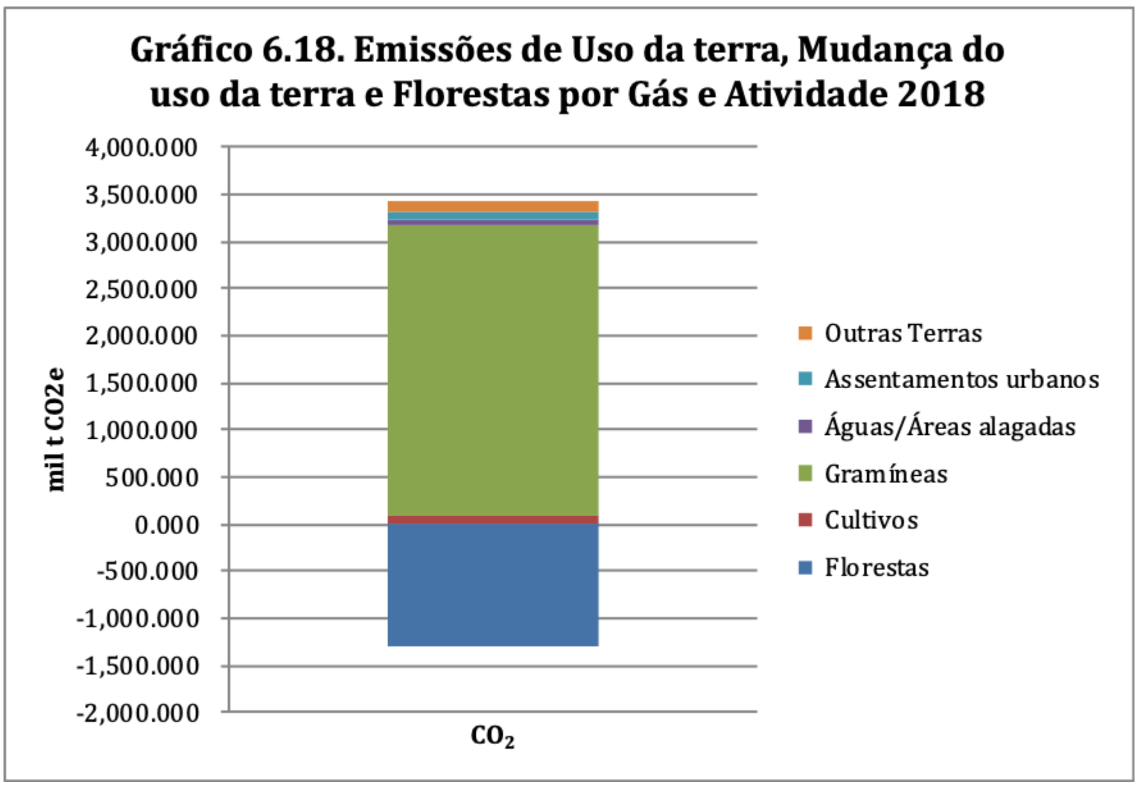
Gráfico 6.18. Emissões de Uso da terra, Mudança do uso da terra e Florestas por Gás e Atividade 2018
4,000.000
3,500.000
3,000.000
2,500.000
2,000.000
1,500.000
1,000.000
500.000
0.000
-500.000
-1,000.000
-1,500.000
-2,000.000
mil t CO2e
CO2
Outras Terras
Assentamentos urbanos
Águas/Áreas alagadas
Gramíneas
Cultivos
Florestas

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Talatona Municipality, Luanda
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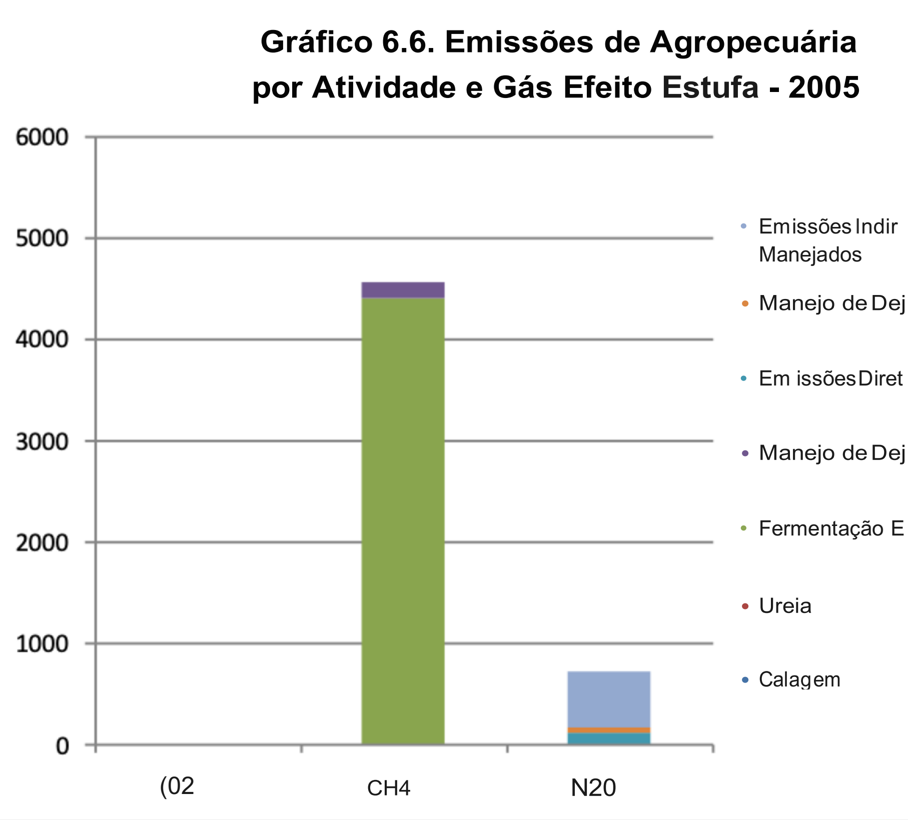
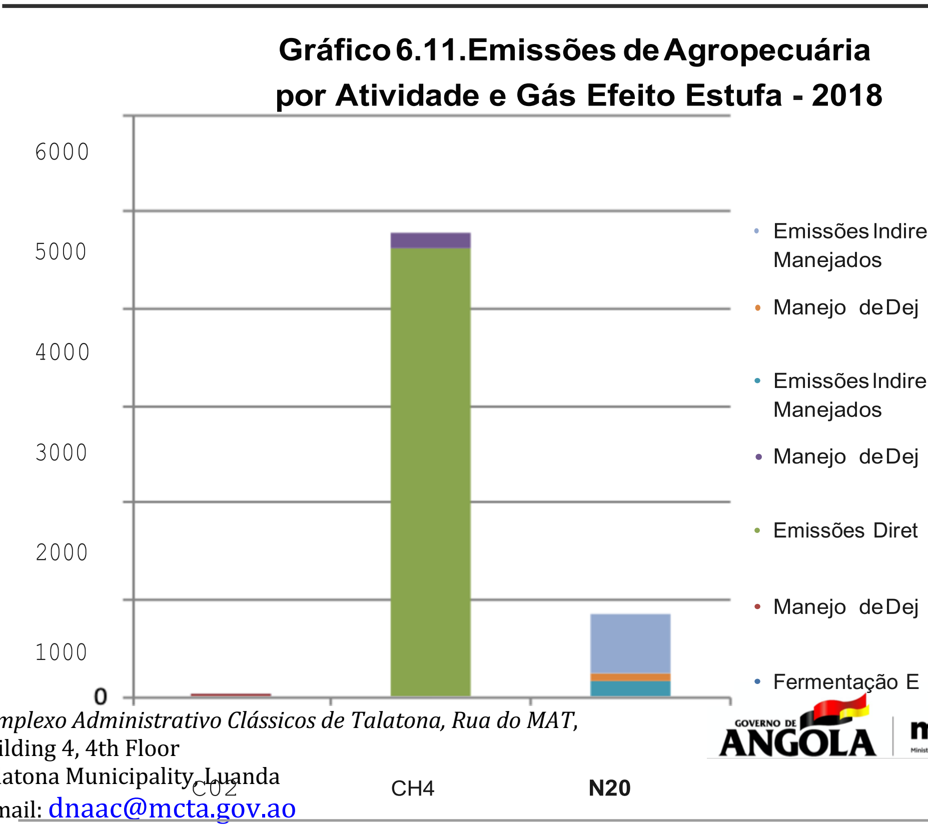
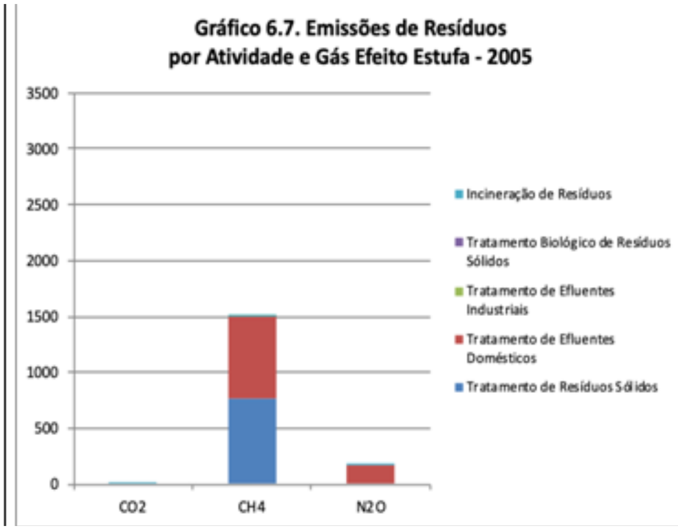
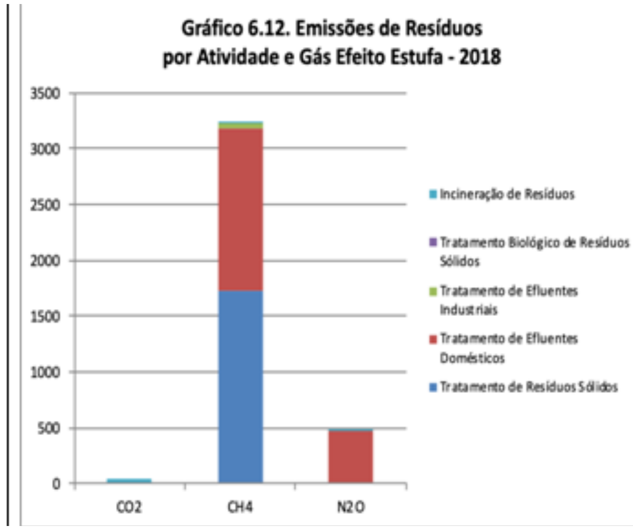
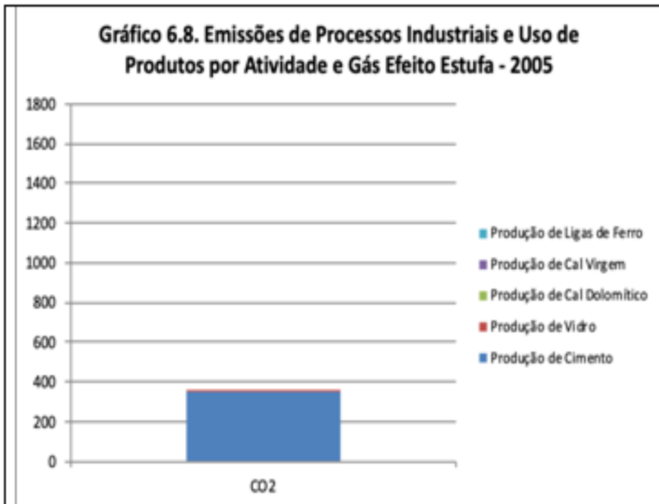


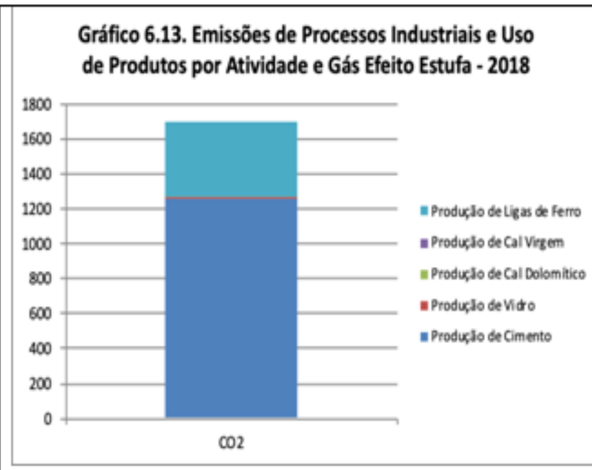
Graph 6.11 xxxx Emissions by activity and Greenhouse Gas - 2018











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Talatona Municipality, Luanda
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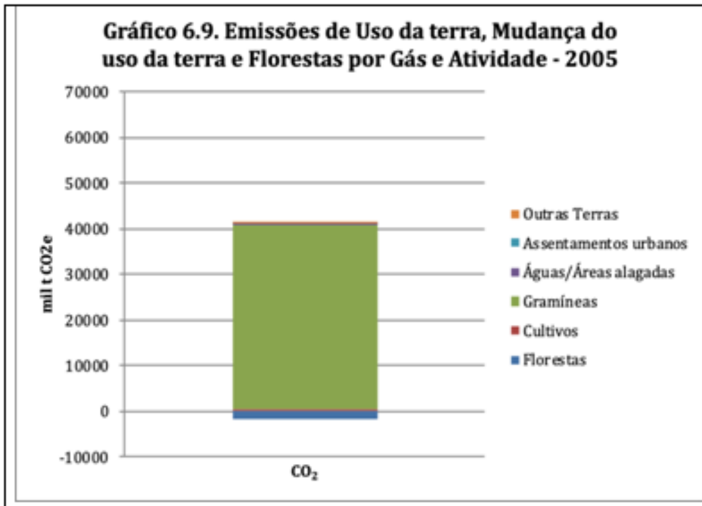
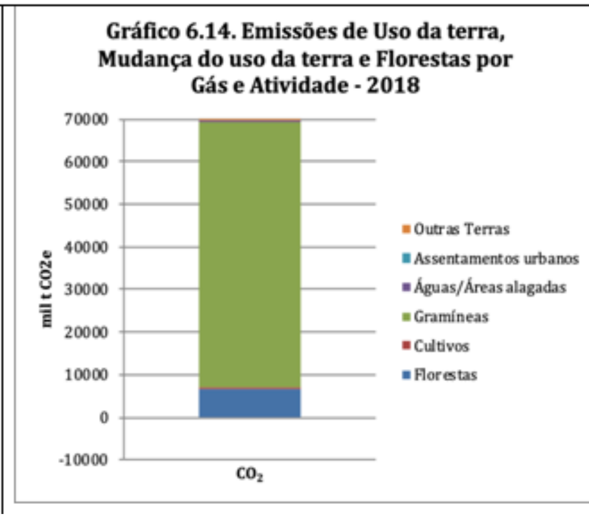
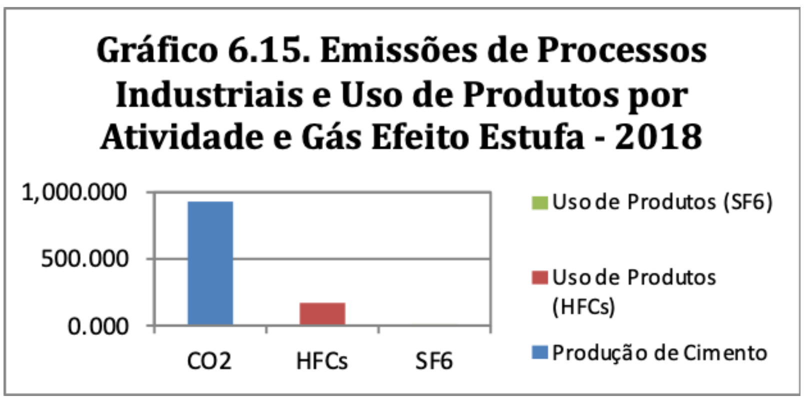




Apresentam-se mais alguns gráficos para emissões de 2018.



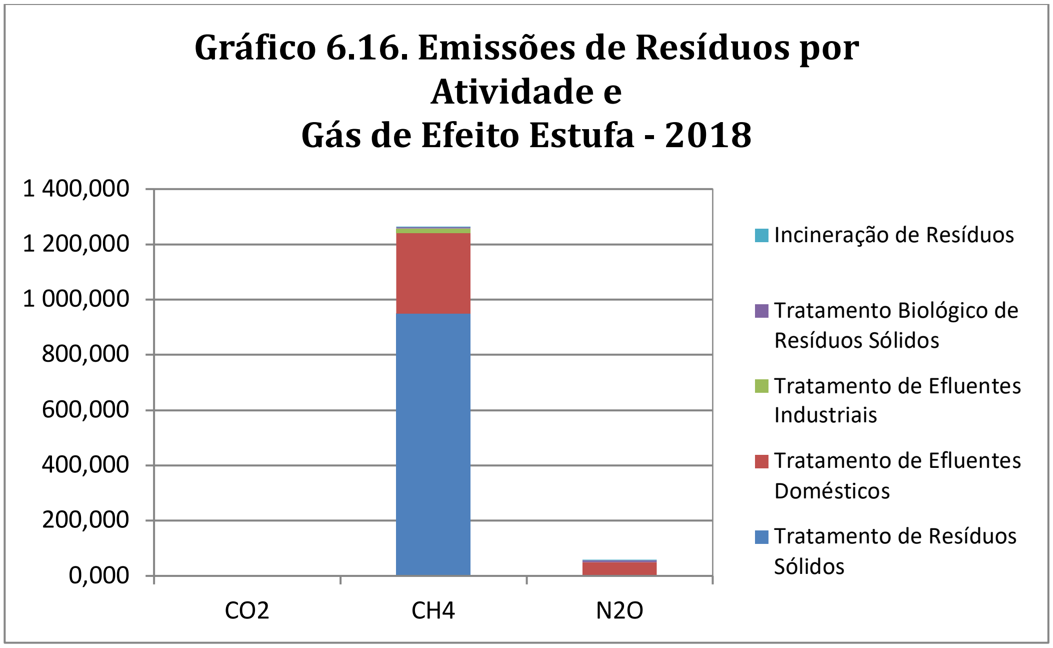


Gráfico 6.16. Emissões de Resíduos por Atividade e Gás de Efeito Estufa - 2018
1 400,000
1 200,000
1 000,000
800,000
600,000
400,000
200,000
0,000
CO2
CH4
N2O
Incineração de Resíduos
Tratamento Biológico de Resíduos Sólidos
Tratamento de Efluentes Industriais
Tratamento de Efluentes Domésticos
Tratamento de Resíduos Sólidos

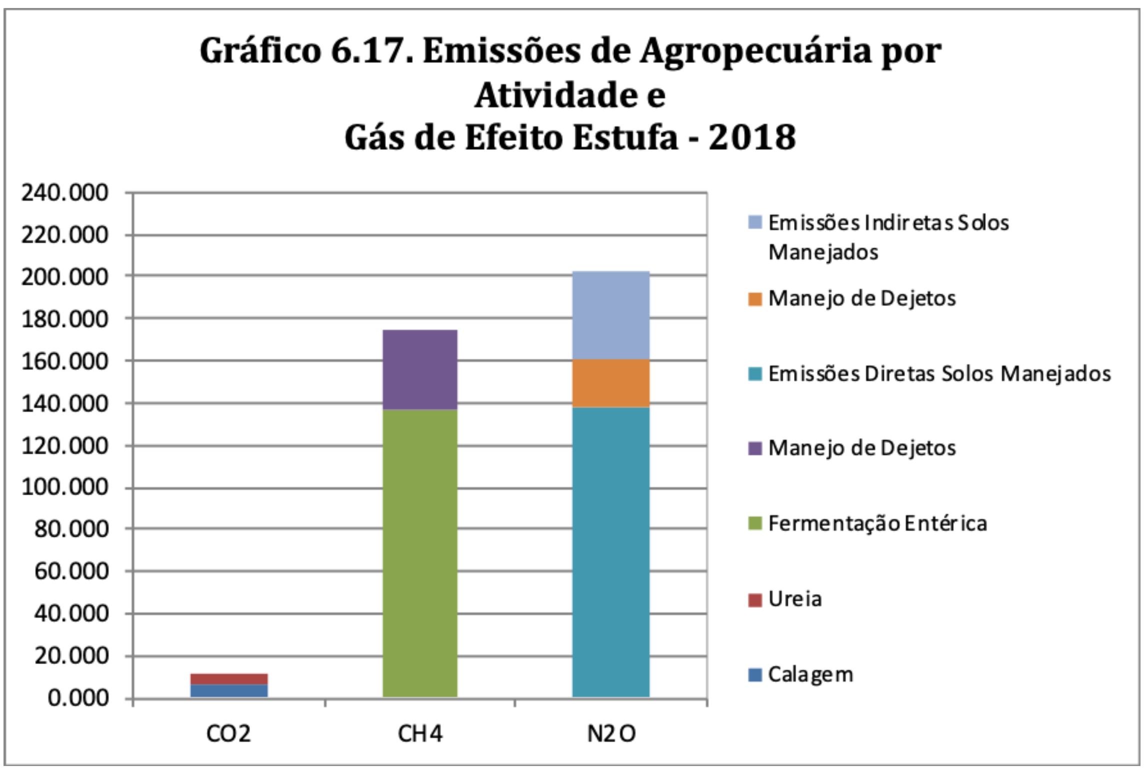
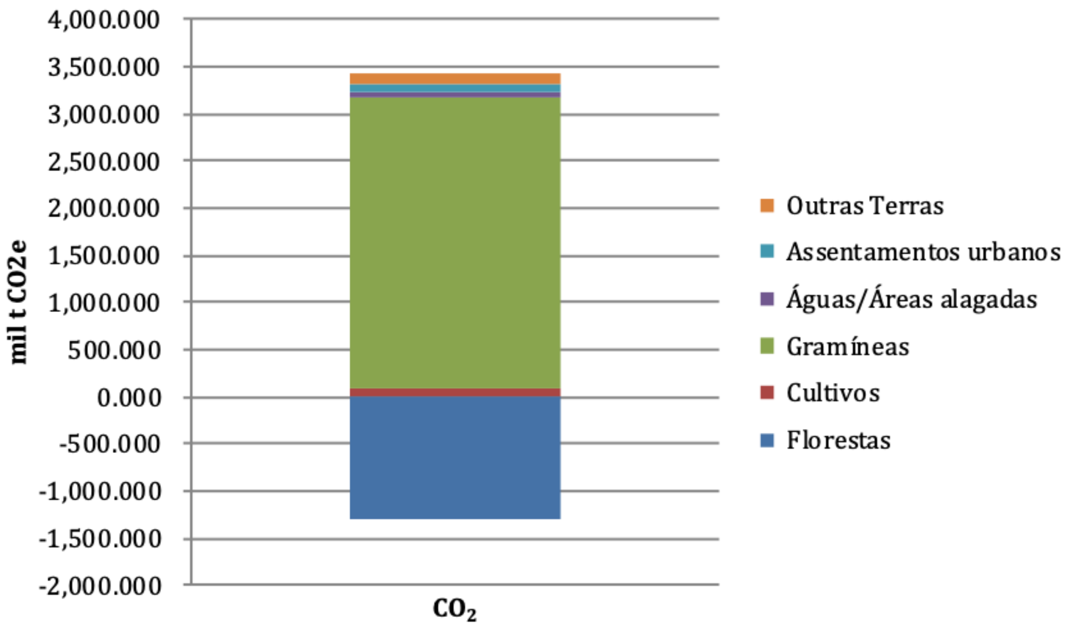


Gráfico 6.17. Emissões de Agropecuária por Atividade e Gás de Efeito Estufa - 2018
240.000
220.000
200.000
180.000
160.000
140.000
120.000
100.000
80.000
60.000
40.000
20.000
0.000
CO2
CH4
N2O
Emissões Indiretas Solos Manejados
Manejo de Dejetos
Emissões Diretas Solos Manejados
Manejo de Dejetos
Fermentação Entérica
Ureia
Calagem

Gráfico 6.18. Emissões de Uso da terra, Mudança do uso da terra e Florestas por Gás e Atividade 2018



CHAPTER – 3

CONTAINING MEASURES TO FACILITATE ADEQUATE ADAPTATION TO CLIMATE CHANGE PROGRAMME

Complexo Administrativo Clássicos de Talatona, Rua do MAT,
Building 4, 4th Floor
Talatona Municipality, Luanda
E-mail: dnaac@mcta.gov.ao

3.1 Introduction

This chapter presents some sectors and regions of Angola, on which vulnerability to current and future climate change-related scenarios has been characterised and assessed, which are provided by the Intergovernmental Panel on Climate Change (IPCC), and other relevant reports made for Angola and the SADC region.

The latest edition of the IPCC report signals increased risks of water scarcity, fire damage, permafrost degradation in the Arctic region and food instability, even if global warming is around 1.5 C. The report also shows that the populations most affected by greater impacts in this food insecurity scenario are low-income developing countries in the various continents, where Angola is located (IPCC, 2019).

It is recognised that the need for assessment of impacts, vulnerability and adaptation measures in relation to climate change are urgent tasks and should follow a nationally-oriented, gender-sensitive, participatory and fully transparent approach. Measures should take into account vulnerable groups, communities and ecosystems, should be based on and guided by the best available science and, as appropriate, traditional knowledge, with a view towards integrating adaptation into relevant socio-economic and environmental policies and actions, as recommended in Article 7(5) of the Paris Agreement.

Angola has been working on several fronts in order to build a scientific basis for understanding the country's vulnerability to climate change and proposing the most appropriate adaptation measures. These efforts are reflected in several documents submitted by Angola to the United Nations Framework Convention against Climate Change, in compliance with international commitments made within the scope of climate change, by carrying out actions at the national level that contribute to reducing greenhouse gas emissions into the atmosphere, as well as preparing a programme for mitigation and adaptation to the effects of climate change, namely the National Adaptation Programme (NAPA) in 2011, the First National Communication (PCN) presented in 2011 and the National Adaptation Strategy in 2017.

The National Adaptation Action Programme (NAPA) has identified a number of priorities among which we highlight: Promotion of renewable and alternative energies to reduce deforestation; promotion of sustainable land management to increase agricultural fields; ensuring the basis for access and monitoring of health services; studying the vulnerability of fishing activity to climate and current changes; extending electricity to rural areas; reviewing sectoral laws as a way to promote proactive adaptation; creating early warning systems for floods and storms; national institutional mechanisms for adaptation for integration and planning of adaptation; control of soil erosion through organic methods; diversification of plantations to less climate sensitive crops; assessment of technological needs, varieties adapted to local conditions; climate monitoring and data management system, study of implications of changing epidemiological (animal) parameters and water availability for livestock; increase of water availability at community level through boreholes and wells.

A number of projects are being implemented, in particular:

- Response to urgent coastal adaptation needs and capacity gaps in Angola
- Integration of Climate Change into Environmental Management and Sustainable Land Use
- Integration of Climate Resilience in agricultural systems
- Project promoting the development of climate resilience and strengthening the adaptive capacity to withstand risks in the hydrographical basin of the Cuvelai River.

In addition to the projects being implemented, other projects are in the start-up phase which should contribute to capacity building to respond to climate change and adapt the territory to phenomena which are already occurring.

However, for the adoption of adaptation measures that can minimize the impact of climate change in an area of interest, it is essential to know the possible climate changes that can occur in that region, which makes it mandatory to generate regional and local projections of the future climate in order to allow the assessment of the impacts of the expected change in each region or location based on climate models.

Climate models are based on well-established physical principles and are used to reproduce characteristic observations of recent climate, past climate changes and projections for future climate. Today, science has a diversity of climate models generated by the most prestigious institutions related to atmospheric sciences. However, due to the chaotic nature of the atmosphere, insufficiencies of the models themselves (which are more or less rough approximations and others based on statistics), as well as the initial conditions and boundary conditions assumed, different models can simulate different regional or local climate changes. Due to these uncertainties, it is difficult to know which of the models presents the best projections.

This chapter aims to assess climate change in Angola on the basis of benchmarking models with climate data from 1971-2000 and future climate projections for the periods 2021-2050 and 2051-2080, in order to serve as a basis for the process of identifying climate vulnerabilities and taking appropriate sectoral adaptation measures in Angola.

The vulnerability assessment also combines the work done in 2015 for the National Water Plan, in which a set of scenarios were identified to manage water resources, the climate profile of Angola made by the United Nations Development Programme, a set of research done at continental and SADC level, scenarios who are exposed to certain institutional and local contexts, integrated in the National Development Plan, without discouraging a number of extreme climate phenomena that have occurred in Angola in recent years.

3.2 Characterisation

The study area corresponds to Angola's territory, located between the parallels of latitudes 4° and 18° S and between the meridians of longitudes 11° and 25° E, with an area of 1,246,700 km2, Figure 1 shows the insertion of Angola's territory into the African continent. The proximity of the territory to the sea, the influence of the cold Benguela current and the relief are factors that determine the existence of four climatic regions (Figure 1), namely, dry tropical, humid tropical, desert tropical and temperate tropical climate due to altitude, and two zones with quite different weather conditions, the coast and the interior (Silveira, 1967).

The Northern Region is characterised by a humid tropical climate with an average annual rainfall of over 1600 mm. The Central Region has a temperate climate modified by altitude, which varies between 1000 m and more than 2 500 m above sea level and is characterised by an average annual rainfall between 1250 and 1500 mm. The Southern Region is largely characterised by a dry climate, ranging from tropical desert to dry and semi-desert, with low annual precipitation between 0 and 750 mm. The duration of the rainy season varies according to latitudes, decreasing as the distance from the equator and the sea increases (Figure 2).

Rainfall is strongly variable in space and time due to its convective nature. Northern Angola is part of the tropical wet zone of Africa. Rainfall increases from south to north, and from sea to inland. Rainfall generally occurs in the form of strong showers and can vary significantly from one year to another. It is difficult to identify climate change in a context where there is a high degree of variability from year to year. In some areas of the country, climate indicators also change rapidly over short distances. For this reason, the functioning climate observatory will be instrumental in alerting different sectors to trends in the medium term.

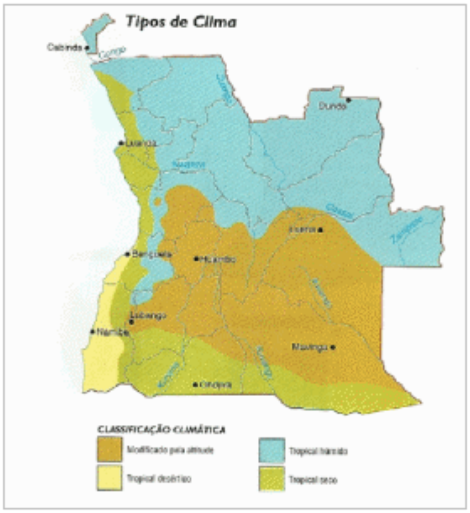


Figure 1. Climate distribution in Angola
Source : Atlas, 2005.

The average air temperature distribution varies spatially between 15C and 27C, the lowest values being in the high-altitude regions (Figure 2). The local annual variation of this element (thermal amplitude), is small at the coast at around 7C and grows as it moves away from the coast and increases the altitude, reaching 17C to 24C (Figure 3).

Complexo Administrativo Clássicos de Talatona, Rua do MAT,
Building 4, 4th Floor
Talatona Municipality, Luanda
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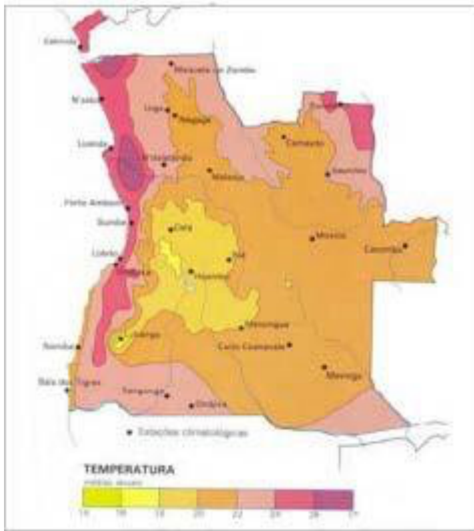

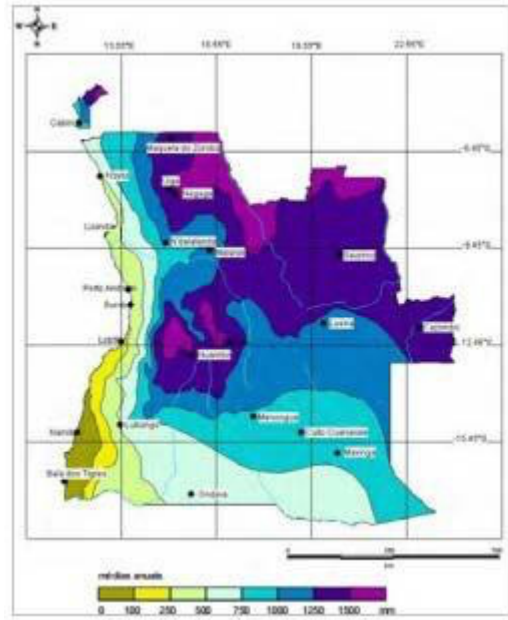

Figure 2. Spatial distribution of average air temperature in Angola (1961-1990)

Figure 3: Spatial distribution of total annual rainfall in Angola (1961-1990)

3.3. Climate models used in the study

3.3.1 Selected models

In order to adopt adaptation measures that can help to minimise the impact of climate change, it is essential to know what changes might occur. This requires the generation of future climate projections to allow the assessment of the impacts of expected changes in each region or location.

The climate on the planet results from the interaction of many processes that occur in the atmosphere, the oceans, the earth's surface and the cryosphere. GCMs usually give a good average estimate of climate parameters, e.g., precipitation and temperature, as well as their seasonal behavior in large regions. GCMs use spatial resolution of about 200-100 km, which is considered low for studies of regional or local scale impacts and vulnerabilities, i.e. they cannot represent smaller areas.

However, the impacts of climate change and the adaptation strategies needed to deal with it occur at more regional and national scales. The limitations of global models can be minimized by downscaling techniques, which allow to produce higher resolution regional

Complexo Administrativo Clássicos de Talatona, Rua do MAT,
Building 4, 4th Floor
Talatona Municipality, Luanda
E-mail: dnaac@mcta.gov.ao

climate projections from global climate projections and thus obtain a more accurate representation of localised extreme events. The IPCC Fifth Report (AR5) was the first to include information on regional climate models from the Coordinated Regional Downscaling Experience (CORDEX; GIORGI et al., 2009).

It is important to note that in addition to the physical representation of nature, it is necessary to consider a set of possible histories of societal evolution in various parameters, such as demographic, socio-economic and technological development dynamics. CORDEX has developed a protocol for carrying out simulations and projections with different regional models for various domains around the globe that includes information on regional climate models based on four Representative Concentration Pathway (RCPs) 2.6, 4.5, 6.0 and 8.5 W/m2 (Figure 4). It is important to realise that these scenarios are potential future alternatives and are not a prediction of what will happen.

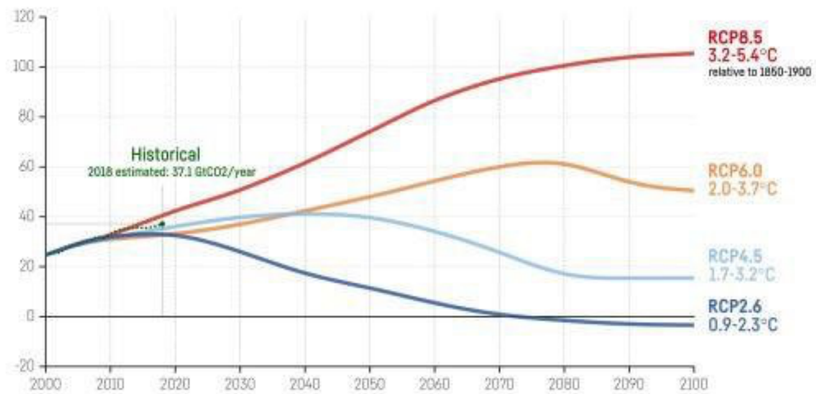

Figure 4. CO_2 emissions from fossil fuels and industry: RCP scenarios vs. historical Source: IIASA RCP Database, 2018.

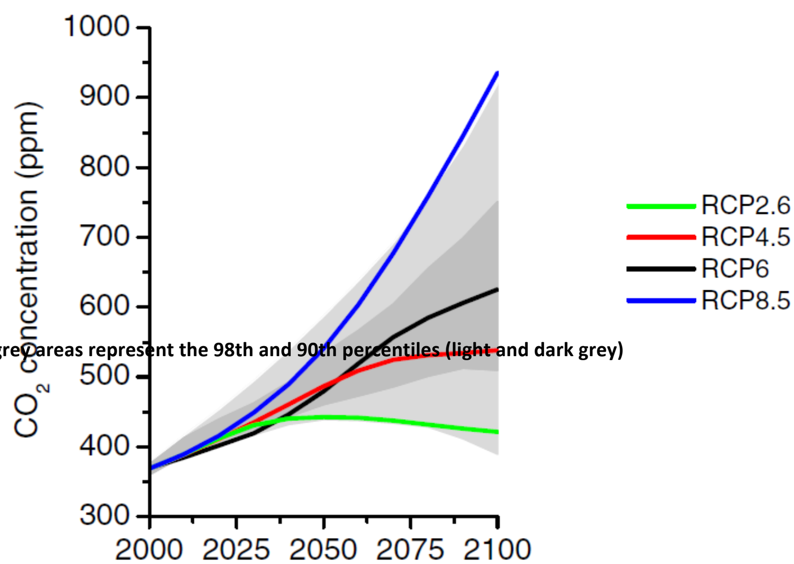

Figure 5- Representation of CO_2 concentration (ppm) by the four different RCPs over the century (van Vuuren et al. 2011)

RCP 2.6 assumes that strong mitigation policies will result in a peak in global annual GHG emissions between 2010-2020, with emissions decreasing substantially thereafter. Emissions in RCP 4.5 peak around 2040 and then fall. In RCP 6.0, emissions peak around 2080 and then decrease. In RCP 8.5, emissions continue to rise throughout the 21st century. RCP 8.5 combines assumptions about high population and relatively slow income growth with modest rates of technological change and improvements in energy intensity, leading in the long term to high energy demand and GHG emissions in the absence of climate change policies (Riahi et al 2011). From the set of RCPs, RCP8.5 has received more attention in the climate modelling community and corresponds to the path with the highest greenhouse gas emissions.

When this work was carried out, six (6) simulations were available for Cordex-Africa, of which the highest resolution projections[19] [9]are those of the RCP scenarios 2.6 and 8.5. Only the six existing projections for RCP 8.5 scenario were used, firstly because they correspond to the projections available with the highest resolution (mesh of approximately 25 km on the side) for the African continent and secondly because it is considered the most realistic scenario by the scientific community given the current path of greenhouse gas emissions.

This study uses a total of six (6) climate projections from the CORDEX experiment for the African domain, obtained from two (2) different regional climate models (RCM), the Climate Limited Area Modeling Community (CCLM5-0-15) in its 5th version made available in 2015 and the REMO2015 model made available also in 2015. The two RCMs (were nested in three global models: the Max Planck Institute for Meteorology-Earth system model (MPI-ESM-MR), and the Hadley Global Environment Model 2-Earth System (HadGEM2-ES) and the Norwegian Climate Centre (NCC) NorESM1-M model output collection (NCC-NorESM1-M), see Table 1.

Table 1. Regional (s) and global climate models (GCMs) used

Designation	Regional Climate Model (RCM)	Global Model (GCM)	RCM Climate Resolution	MCR Establishment
Modelo 1	CCLM5	MOHC-HadGEM2-ES	25 Km	Climate Limited Area Modeling Community
Modelo 2	CCLM5	MPI-M-MPI-ESM-LR25	25 Km	
Modelo 3	CCLM5	NCC-NorESM1-M	25 Km	
Modelo 4	REMO2015	MOHC-HadGEM2-ES	25 Km	Climate Service Centre Germany
Modelo 5	REMO2015	MPI-M-MPI-ESM-LR25	25 Km	
Modelo 6	REMO2015	NCC-NorESM1-M	25 Km	

Before projections for the future climate are made, the performance of climate models is evaluated by carrying out simulations for the past climate which are compared with observed data. In addition, future climate projections require scenarios, which are assumptions about human activities and natural effects in the future.

The observed climatic data used in this study come from the network of conventional meteorological stations of the National Institute of Meteorology and Geophysics (INAMET). Table 2, having selected monthly historical series of maximum temperature, minimum

[19] Projections – means results of numerical models for the future, which result from numerical models describing the evolution of climate variables in the future.

temperature and precipitation for the period 1971-2000.

Table 2 . Climate stations used for model validation

Station	WMO ID	Latitude	Longitud	Altitude
Cabinda	66104	5TH	12º 11' E	20 m
Huambo	66318	12º 48'	15º 45' E	1 700 m
Luanda	66160	08º 51'	13º 14' E	74 m
Lubango	66390	14º 55'	13º 33' E	1 763 m
Luena	66285	11º 47'	19º 55' E	1 375 m
Namibe	66422	15º 12'	12TH 9' E	20 m

Source: (INAMET, 2018)

3.3.2 Assessing the quality of climate projections

Evaluation of regional climate models performance

The performance of the regional climate models (RCMs) used in this study was assessed by comparing simulated variables for the recent past (1971-2000) with data observed at INAMET weather stations (Table 1) for the same period in order to ascertain the models' ability to reproduce past data. For each weather station, the nearest simulation grid point was selected for validation. The following statistics were used to assess the accuracy of the climate models: percentage bias (PBIAS) and mean absolute percentage error (MAPE).

PBIAS (Equation 2) is the percentage bias. The ideal value for PBIAS is zero. Negative values indicate overestimation, while positive values indicate underestimation of the data generated by the model. Table 2 shows the PBIAS ranking range proposed by Van Liew et al. (2007):

$$BIAS = \frac{\sum_{i=1}^{N}(M_i - O_i)}{\sum_{i=1}^{N} O_i} \times 100\ [\%]$$

Where:

Mi - Value simulated by the model;

Oi - Real value observed in the weather station;

N - Number of data observed and simulated.

Complexo Administrativo Clássicos de Talatona, Rua do MAT,
Building 4, 4th Floor
Talatona Municipality, Luanda
E-mail: dnaac@mcta.gov.ao

Table 3. Ranking interval of PBIAS results

Reference	Classification
%BIAS < 10%	Very good
10% < %BIAS < 15%	Good
15% < %BIAS < 25%	Satisfactory
%BIAS > 25	Unsatisfactory

Source: Van Liew et al. (2007)

The mean absolute percentage error (MAPE) is a statistic of widespread accuracy. According to Lopes (2002), the MAPE (Equation 2) disregards the error signal by considering its module. Thus, this precision statistic calculates the average of all absolute percentage errors, preventing the error from being decreased by the sum of values with opposite signs. Table 3 shows the classification interval for MAPE according to Lewis (1997):

$$MAPE = \frac{\sum_{i=1}^{N} |M_i - O_i|}{\sum_{i=1}^{N} O_i} \times 100\ [\%]$$

4: Ranking interval of map and results

Reference	Classification
%EMA< 10%	Very good
10% < %EMA < 20%	Good
20% < %EMA < 30%	Reasonable
%EMA > 30%	Imprecise

Source: Liew. (1997)

3.3.3 Determination of future climate change

Six projections were generated respectively for the periods (FP) and (FD) and the results compared with the respective reference period (PR) individually. Subsequently, the delta change factor was estimated for each future period by comparing the averages for the current period (AP) and the respective future period (FP). For the maximum and minimum temperature, the difference between the values of the future period and the current period was used according to Equation 1, while for precipitation the delta change is given by the percentage changes, as presented in Equation 2, proposed by mean absolute percentage error (MAPE)

Complexo Administrativo Clássicos de Talatona, Rua do MAT,
Building 4, 4th Floor
Talatona Municipality, Luanda
E-mail: dnaac@mcta.gov.ao

$$DeltaChange = \frac{PCF-PCP}{PCP} \qquad (4)$$

Complexo Administrativo Clássicos de Talatona, Rua do MAT,
Building 4, 4th Floor
Talatona Municipality, Luanda
E-mail: dnaac@mcta.gov.ao

Where:
PFC - Projection of future climate
PCP- Simulation of present climate (Reference period)
The end result of the work to subsidise climate change adaptation actions, is the average ensemble of six projections
Of the computational tools used in this study, mention is made:
NCL (Ncar Command Language) Interface for geoprocessing operations and drawing of diagrams, graphs, maps and tables.
NCO - Data processing and operation in NetCDF format.
CDO - Data manipulation in NetCDF format

Uncertainties associated with climate projections

The great uncertainty surrounding future climate change is related to barriers in adaptation planning. In Angola, little research has been done to determine vulnerability to climate change through climate models. Published in 2015, there is a study on climate change as part of the National Water Programme, carried out by the company Consultores de Engenharia e Ambiente, SA (COBA), recommended for the National Water Resources Institute attached to the Ministry of Energy and Water (MINEA). 3.3.4 Evaluation of the Quality of annual average maximum temperature simulations.

It is important to note that there is still another uncertainty, which is about how the Earth's climate system behaves in the face of changing emissions. The use of different regional models provides possible alternative representations of the Earth's response to these different emissions, also taking into account the intrinsic variability of the climate itself. By using different global models and different regional models, results on the various uncertainties are obtained giving the result some robustness.

Validation of maximum average annual temperature

Figure 5 illustrates the comparison of the time distribution of the maximum mean temperature simulated by the models and those observed by the weather stations, while Table 5 and Figure 6 illustrate the percentage bias (PBIAS) and mean absolute percentage error (MAPE) respectively. From the simultaneous analysis of the results, the uncertainty of the models can be clearly seen by the different simulations of the results at the same weather station.

In general, analyzing the results of PBIAS there was a tendency to underestimate the average maximum temperature at the stations in Cabinda, Huambo and Lubango by almost all the models, that is, the models simulated lower values than those observed, while in the Luanda, Luena and Namibe stations the tendency was clearly of overestimation. The best individual performance of PBIAS was obtained at the Luena station, it was 0.002% "very good" rating according to Van Liew et al. (2007) for the CCLM5 model, while the REMO5(NorESM) model obtained the "unsatisfactory" rating 28.0% at the Namibe station. The average performance per Huambo station was rated "very good" with -0.9% while Namibe was again rated "unsatisfactory" with 22.8%.

The analysis of the MAPE statistics, gives the same ranking values for the same models and locations.

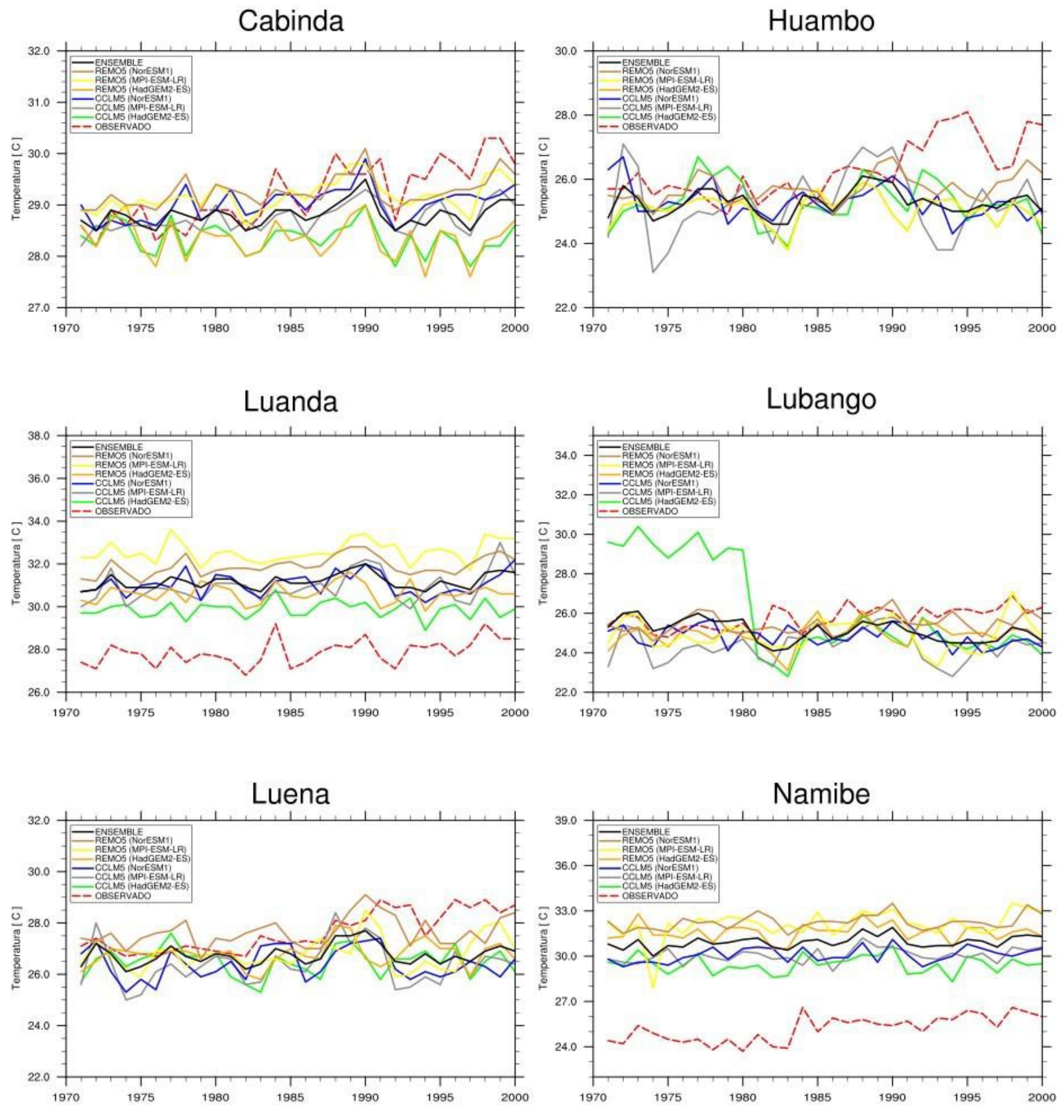

Figure 5: Time distribution of average maximum air temperature per station (1971-2000)

Tabela 5: Percentage of (PBIAS) and medium percentage error (EMPA) for maximum temperature for the period of 1971 - 2000

Station	Model	PBIAS(%)	MAPE (%)
Cabinda	CCLM5(HadGEM2)	-2.9	3.0
	CCLM5(MPI-ESM)	-1.6	1.8
	CCLM5(NorESM)	-0.6	1.5
	REMO5(HadGEM2)	-2.9	3.1
	REMO5(MPI-ESM)	-0.1	1.5
	REMO5(NorESM)	0.2	1.5
	ENSEMBLE	-1.3	1.7
Huambo	CCLM5(HadGEM2)	-0.9	3.0
	CCLM5(MPI-ESM)	-1.0	3.3
	CCLM5(NorESM)	-0.8	2.4
	REMO5(HadGEM2)	-1.7	2.7
	REMO5(MPI-ESM)	-1.9	2.9
	REMO5(NorESM)	0.8	2.2
	ENSEMBLE	-0.9	2.0
Luanda	CCLM5(HadGEM2)	7.2	7.2
	CCLM5(MPI-ESM)	10.9	10.9
	CCLM5(NorESM)	11.4	11.4
	REMO5(HadGEM2)	9.9	9.9
	REMO5(MPI-ESM)	16.9	16.9
	REMO5(NorESM)	11.4	11.4
	ENSEMBLE	11.3	11.3
Lubango	CCLM5(HadGEM2)	1.6	9.0
	CCLM5(MPI-ESM)	-5.5	5.5
	CCLM5(NorESM)	-3.6	4.0
	REMO5(HadGEM2)	-3.3	3.6

Station	Model	PBIAS(%)	MAPE (%)
	REMO5(MPI-ESM)	-3.2	3.4
	REMO5(NorESM)	-1.2	2.2
	ENSEMBLE	-2.5	3.3
Luena	CCLM5(HadGEM2)	0.0	0.0
	CCLM5(MPI-ESM)	-0.4	2.5
	CCLM5(NorESM)	-0.3	2.8
	REMO5(HadGEM2)	1.2	1.4
	REMO5(MPI-ESM)	1.2	2.7
	REMO5(NorESM)	4.4	4.4
	ENSEMBLE	1.0	1.6
Namibe	CCLM5(HadGEM2)	16.9	16.9
	CCLM5(MPI-ESM)	19.2	19.2
	CCLM5(NorESM)	19.4	19.4
	REMO5(HadGEM2)	25.4	25.4
	REMO5(MPI-ESM)	27.8	27.8
	REMO5(NorESM)	28.0	28.0
	ENSEMBLE	22.8	22.8

Legend:

PBIAS - Very good Good Satisfactory Unsatisfactory MAPE - Very good Good Average Imprecise

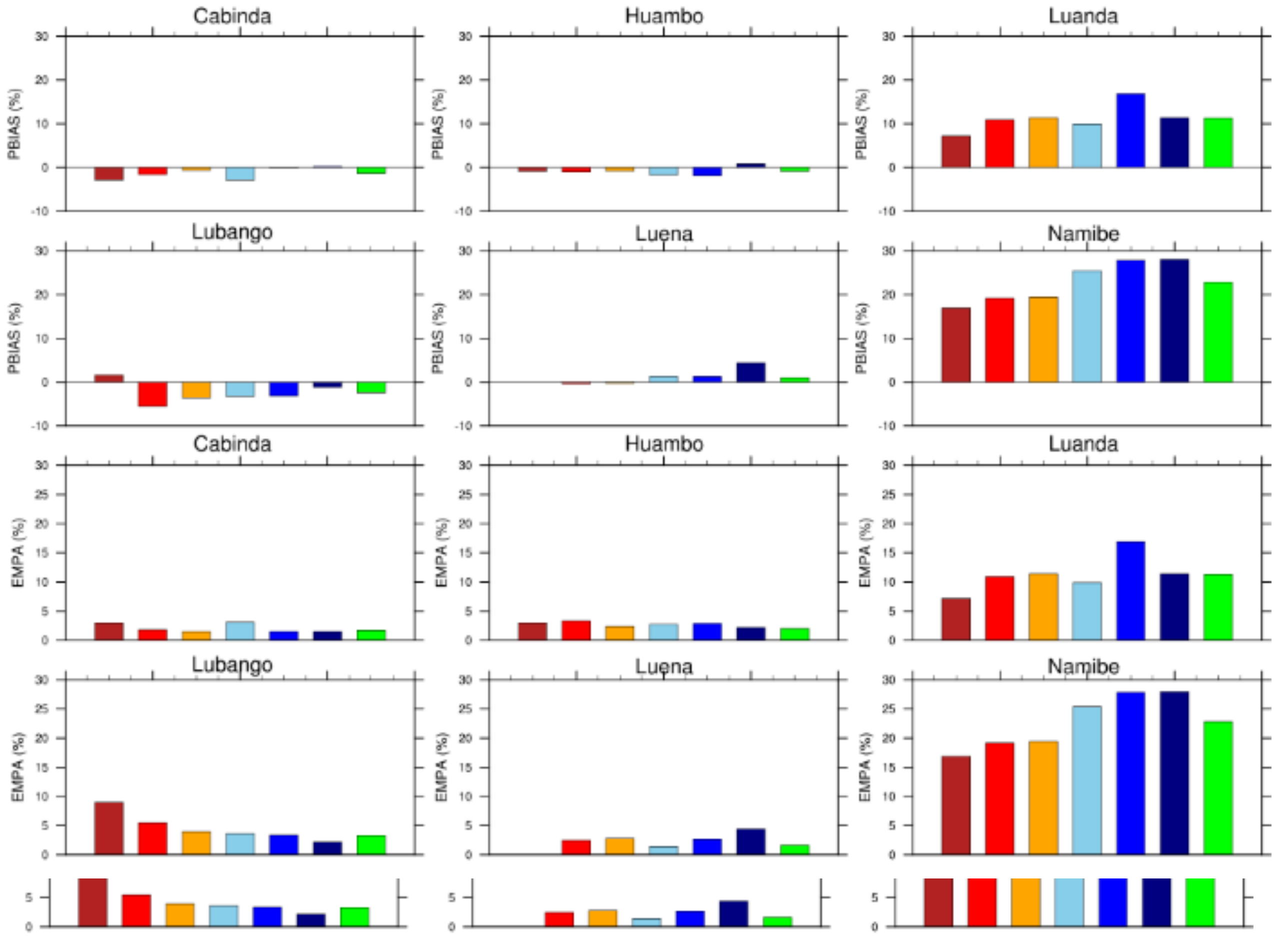

Figure 6. Percentage bias (BIPAs) and Mean absolute percentage error (MAPE), for average maximum temperature for the 1971-2000 period.

Simulation of the maximum average temperature of the present climate

Figure 7 portrays the spatial distribution of the maximum mean temperature variable simulated by the different models for the present climate (1971-2000) based on the RCP 8.5 scenario used in this study, while Figure 8 portrays the mean simulation (Ensemble) obtained by the spatial mean of the six models used. It can be seen that the simulations generated by the 6 models are unanimous in representing the lowest maximum temperatures in the central plateau region, which goes according to that region which has a temperate climate due to its altitude and the highest ones on the coast and the provinces further south.

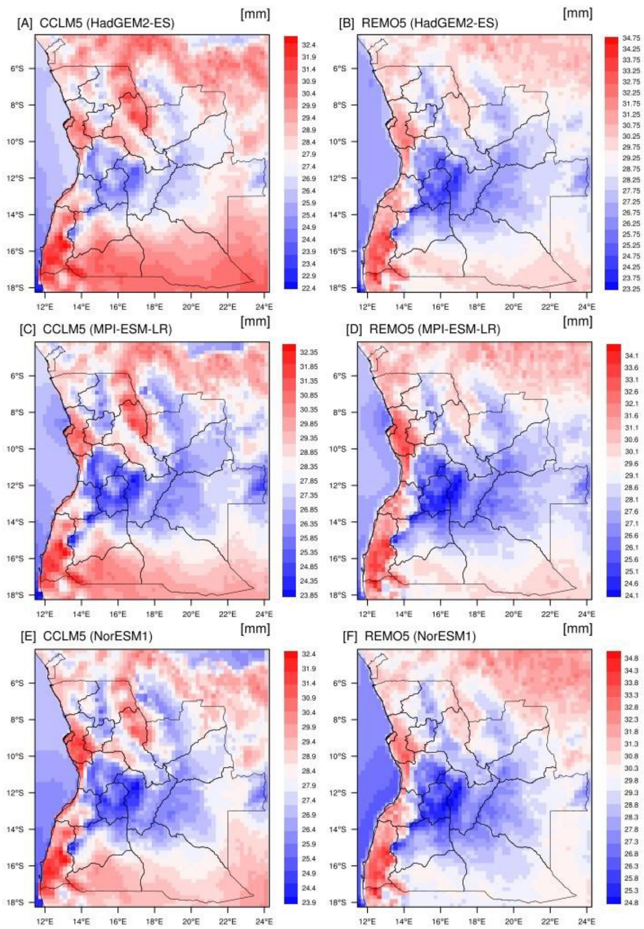

Figure 7. Simulation of the maximum average annual temperature by the different models for the present climate (reference period 1971-2000) based on RCP 8.5

The average of the six simulations is shown in Figure 8, the multi-model Ensemble simulation, which assigns values that vary spatially between 33.0C and 23.9 C, the average being 28.6C. Lower values are allocated in the provinces of Huambo or Bié and go up to the north south and east west. The highest temperatures are set along the coast with Bengo, Luanda and Namibe, as well as parts of Uige, Malanje and Cunene provinces. For this variable, Ensemble used this simulation as the present climate to detect the changes that will occur in the future.

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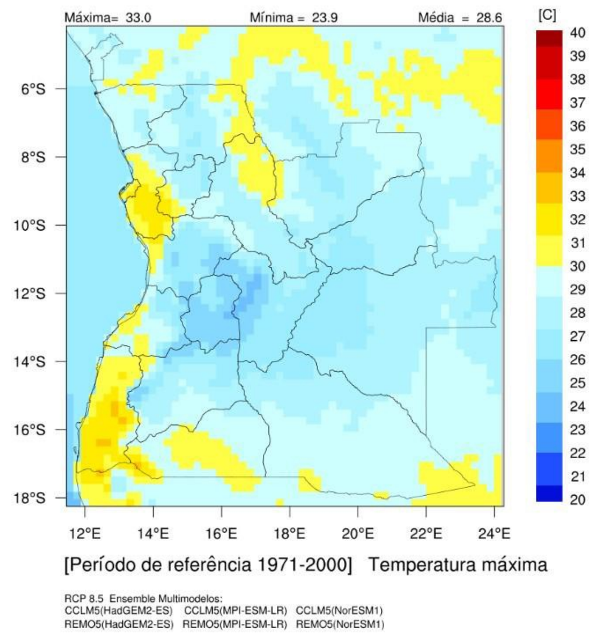

Figure 8. Simulation of the maximum average annual temperature by different Ensemble Multimodels for the present climate (reference period 1971-2000), based on RCP 8.5

Simulation of the average minimum temperature of the present climate

The spatial distribution of the average minimum temperature variable simulated by the different models for the present climate (1971-2000) based on the RCP 8.5 scenario is depicted in Figure 11. There is similarity with the average maximum temperature, as the lowest values are centred in the central plateau region and increases as it moves away from the same region. All models are unanimous in portraying the highest average minimum temperatures on the coast, especially in the provinces of Cabinda, Zaire, Bengo, Luanda and part of Namibe.

The Ensemble simulation that portrays the average of the six individual simulations is represented in Figure 12, which assigns values ranging from 26.1C to 12.7C, the territorial average being 18.5C, these values are in line with the Silveira study (1967) in his work Clima de Angola. The highest minimum temperatures are distributed in the provinces of Cabinda, Zaire, Bengo, Luanda, part of Kwanza Norte, Uíge, Malange and Lunda Norte, while the lowest are set in the central plateau.

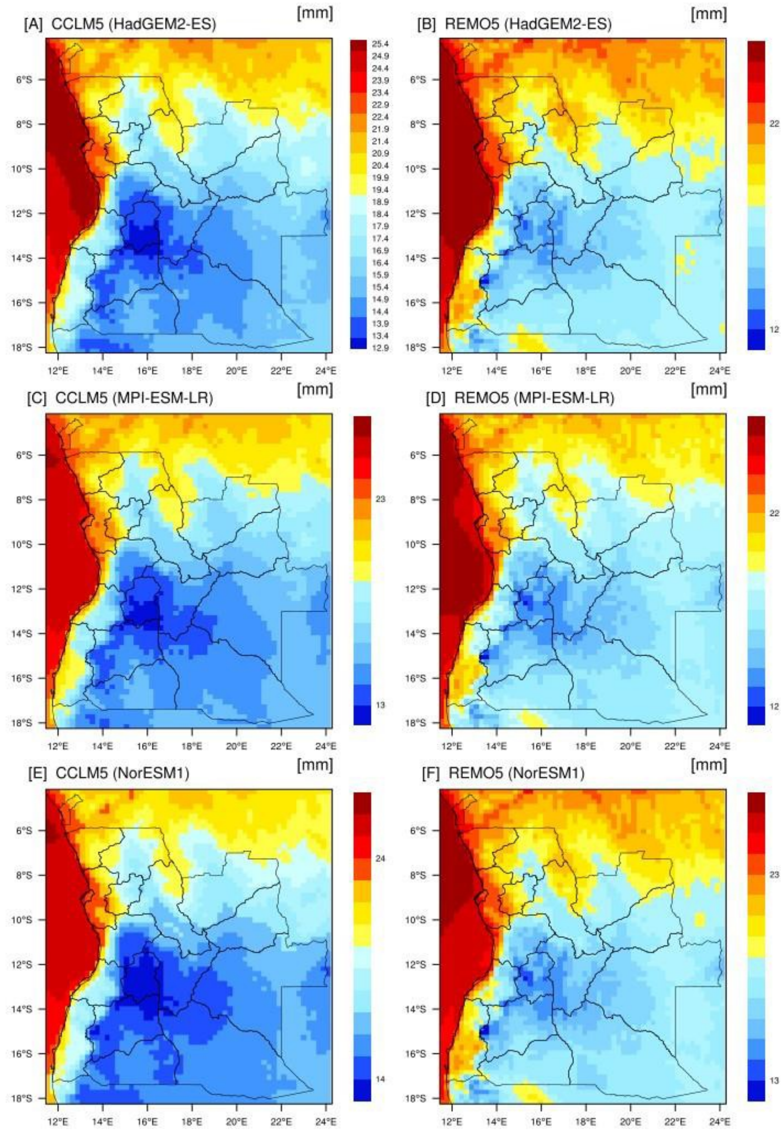

Figure 11. Simulation of the minimum annual average temperature by the different models for the present climate (reference period 1971-2000), based on RCP 8.5

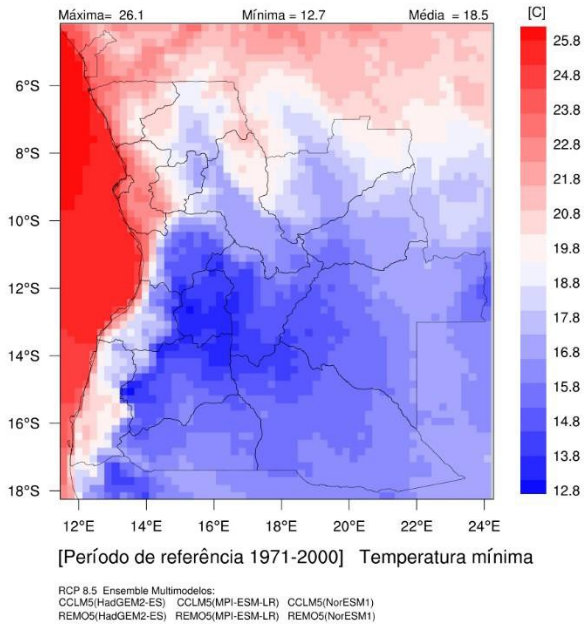

Figure 12: Simulation of the minimum annual average temperature by different Ensemble Multimodels for the present climate (reference period 1971-2000), based on RCP 8.5

Simulation of average annual precipitation of the present climate

Figure 15 portrays the variable spatial distribution of the average annual rainfall of the six models, taking into account the knowledge about the actual rainfall of the territory confirms the tendency of the models to overestimate this variable, with particularity from the region of Cabinda to Benguela. The simulations do not comply with the assumption in the territory of increasing as it moves away from the coast to the interior and complies with the decrease when it moves away from north to south.

According to Angola's climate assessment by the UNDP, through the National Communications Support Programme, there is concrete evidence, based on the analysis of minimum and maximum temperature standards, that the region is becoming warmer. The patterns are presented as deviations (or anomalies) from the 1961-1990 average. After the first half of the 1970s, these anomalies are almost all positive; approximately 0.8C above the 1961-1990 average over the last two decades. They are also higher in recent years, indicating that the rate of increase in minimum and maximum temperatures is increasing. This is consistent with increases in global annual surface temperatures and those in southern Africa since 1900.

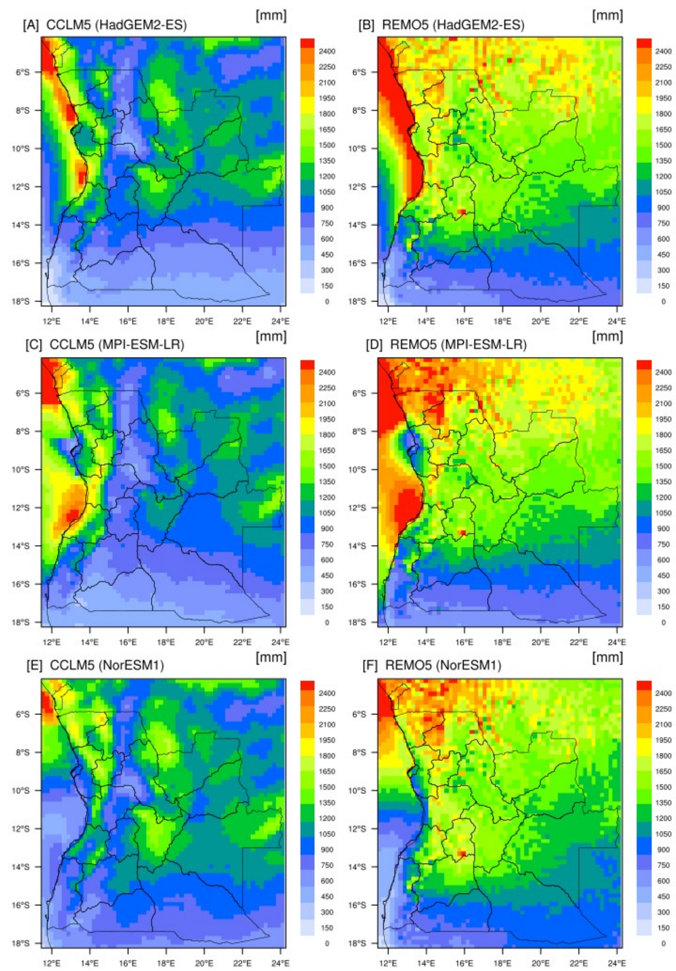

Figure 15. Simulation of total annual precipitation by the models of the historical period (reference period) 1971-2000, based On RCP 8.5.

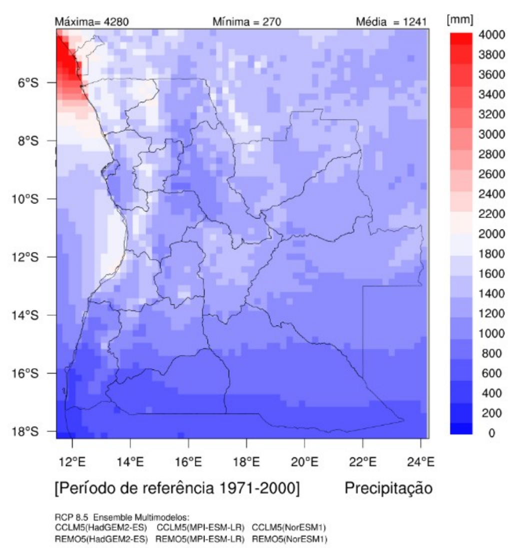

Figure 16. Simulation of average annual precipitation by the different models for the present climate (reference period 1971- 2000), based on RCP 8.5

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Building 4, 4th Floor
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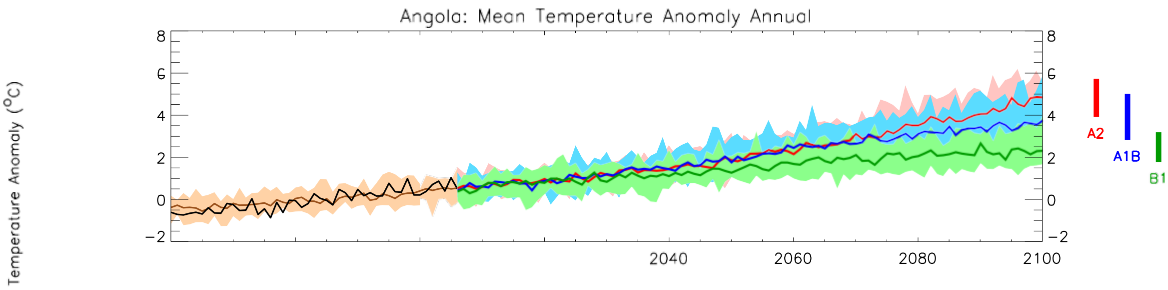
E-mail: dnaac@mcta.gov.ao

In Angola, for example, it is possible to see a projected increase in temperature over the next few years, as shown in the figure below.

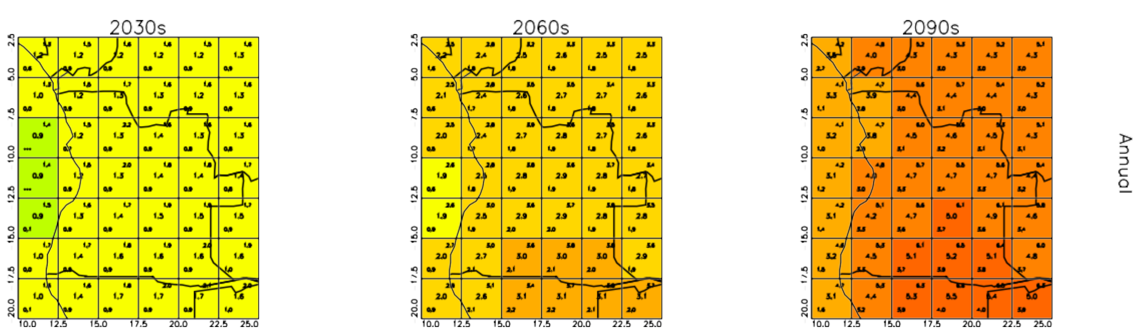


An analysis of temperatures indicates that in the region the minimum and maximum have increased at an average of 0.057C and 0.046C per decade respectively between 1901 and 2009. It is also noted that the fastest warming periods occurred after 1970, a period in which the rate of increase of both temperatures is statistically significant at the 95% confidence level.

After 1976, minimum temperatures began to rise by 0.27C and maximum 0.25C per decade. This confirms once again that temperatures have risen more sharply in the last years of the 20th century and the first decade of the 21st. Projections indicate that temperatures are expected to continue to rise as well as the rate of increase.

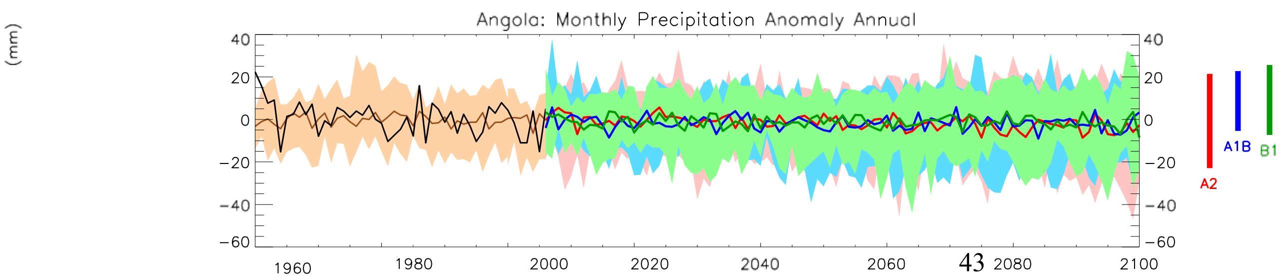
An analysis of rigorous temperature patterns also reveals changes. The lowest annual minimum temperature ever recorded rose gradually at an average rate of 0.162°C from 1901 to 2009, which is statistically significant at the 95% confidence level. The highest annual temperature ever recorded rose more gradually at an average rate of 0.075°C from 1901 to 2009, which is statistically significant at the 95% confidence level. The highest rate of increase in minimum temperatures was observed by Alexander et al., 2006, which suggests a general pattern in terms of less severe cold events. After 1995, the highest observed maximum temperatures started to rise at a statistically significant rate of 0.85° C, indicating that the frequency of warm years is increasing.

The following maps demonstrate the trend of temperature increase in Angola that coincides with the description of the projections made for the region. The differences are much more visible when the values are descriptive of changes for each month of the year.



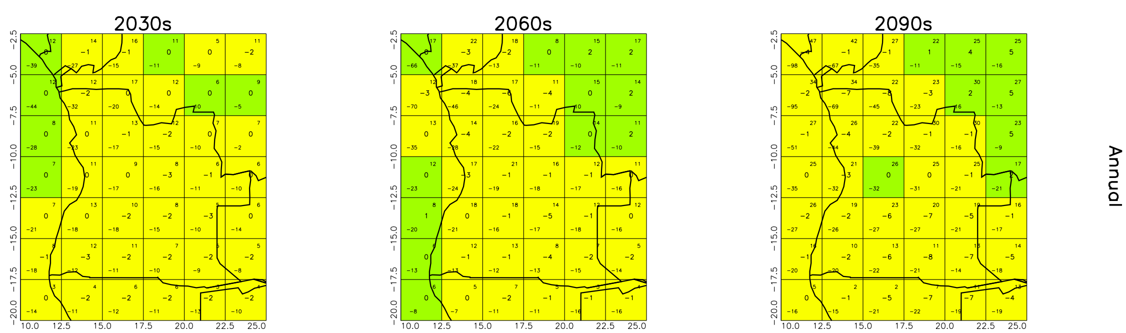
Precipitation

As can be seen in the figure below, rainfall in Angola seems to remain at the same levels when we look at the annual averages, noting only an increase in variability. Stability in annual rainfall levels does not mean exactly that these levels continue to occur with the same intensity and frequency in the same places.



Where there are records for long periods there is an increase in the number of extreme rainfall events (Solomon et al., 2007) and in southern Africa, studies show that the dry season duration and average rainfall intensity have been increasing (New et al., 2006). In addition, a study of changes in heavy rainfall events in South Africa (Mason et al., 1999) revealed that in 70 percent of the country there has been a significant increase in the intensity of these events from 1931 to 1960 and 1961 to 1990. Regional differences between the northeast and the center have also been noted.

The annual rainfall data seems to match most regional models, no significant annual variations can be noted.



If we analyze in detail the monthly rainfall and take the example of September, October and November as shown in the figure below, we will notice some differences concerning the reduction of future rainfall in some parts of the national territory.

Quality assessment of annual average rainfall simulations

From the analysis of the simulations it appears that the selected models presented results with

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Building 4, 4th Floor
Talatona Municipality, Luanda
E-mail: dnaac@mcta.gov.ao

deviations from those observed. It was noted that almost all models showed a tendency to overestimate the maximum annual average temperature as well as the minimum annual average air temperature. But the limits of the statistical results used convey confidence except for the desert region which is imprecise. For the variable annual mean precipitation all models showed a tendency to simulate more rainfall than observed and in the desert region the discrepancy is critical.

Although the errors reported are true, the models are the only type of tool that humanity has at its disposal at the moment to anticipate the knowledge of the climate that awaits us in the future (projection) for use in the planning of the different socio-economic and environmental activities.

The errors presented by the models tend to be systematic, i.e. errors relating to simulations (past) will continue in the future. Once these errors are known, the model results can be corrected. In addition, the difference between future and past simulation provide the trend of climate change (Delta change) since the systematic errors of the future and the past cancel each other out because they are the same. The Delta change in this work was computed by the difference between the future climate and the present climate according to Equation 3 as proposed in the methodology.

3.3.3 Future climate of Angola and its changes

Maximum average annual temperature - Projections for 2021-2050 and 2051-2080

Future projections for the same regional models (CCLM5 and REMO5) for the periods 2021-2050 (Figure 17) and 2051-2080 REM (Figure 18) are more similar to each other even when initiated by different global models.

All models tend to project the lowest maximum temperatures in the central plateau region increasing as you move away from that centre.

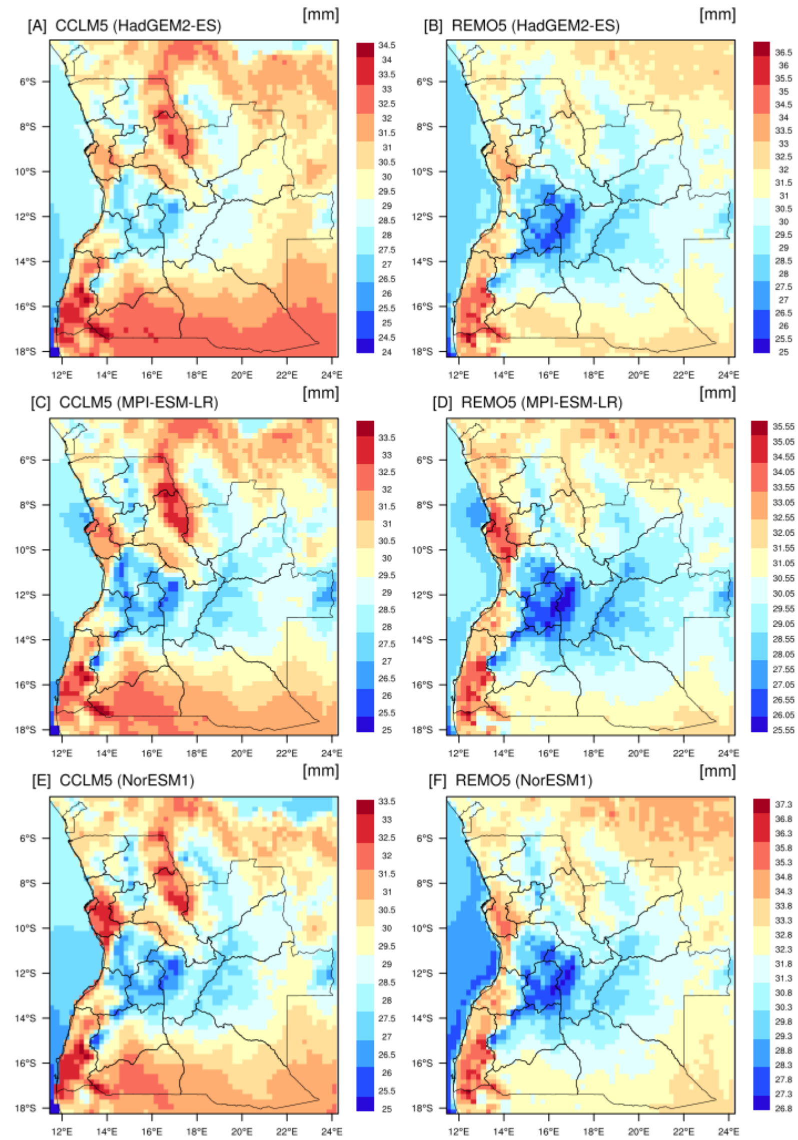

Figure 17. Projection of the maximum average annual temperature by the models for the near future 2051-2080, based on RCP 8.5.

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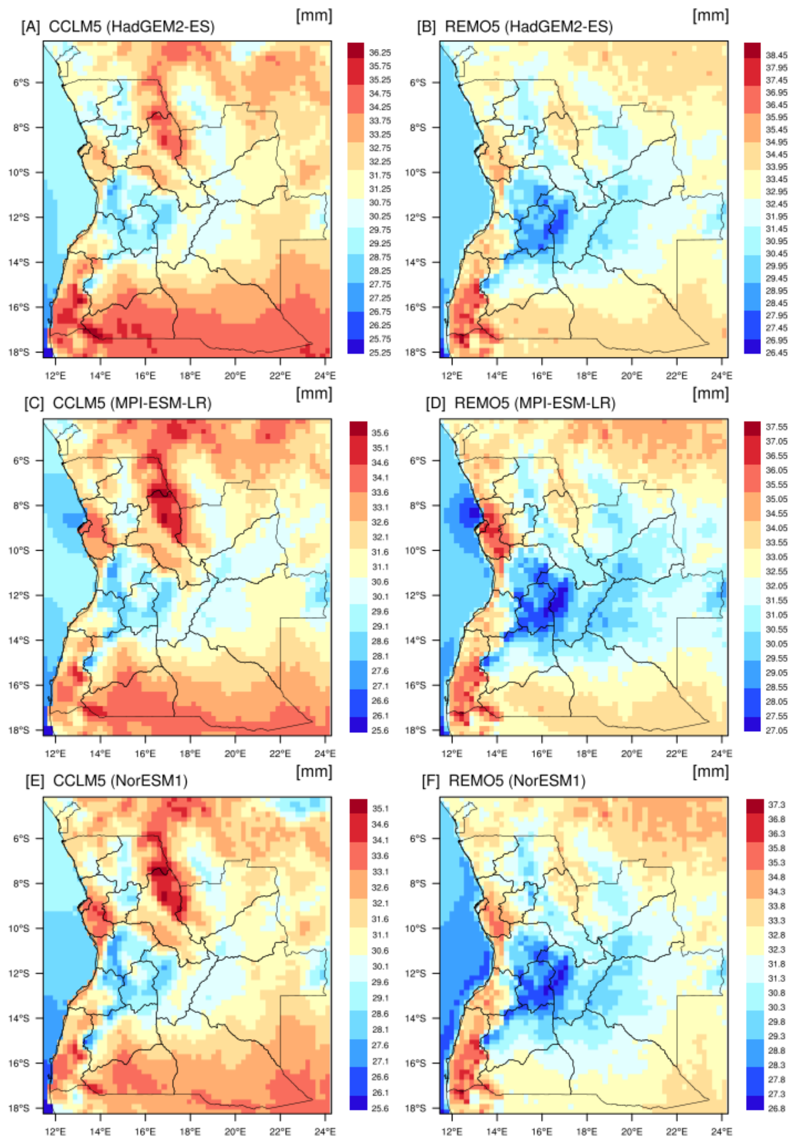


Figure 18. Projection of the maximum average annual temperature by the models for the distant future 2051-2080, based on RCP 8.5.

Change of temperature for maximum projected medium for 2021-2050 and 2051-2080

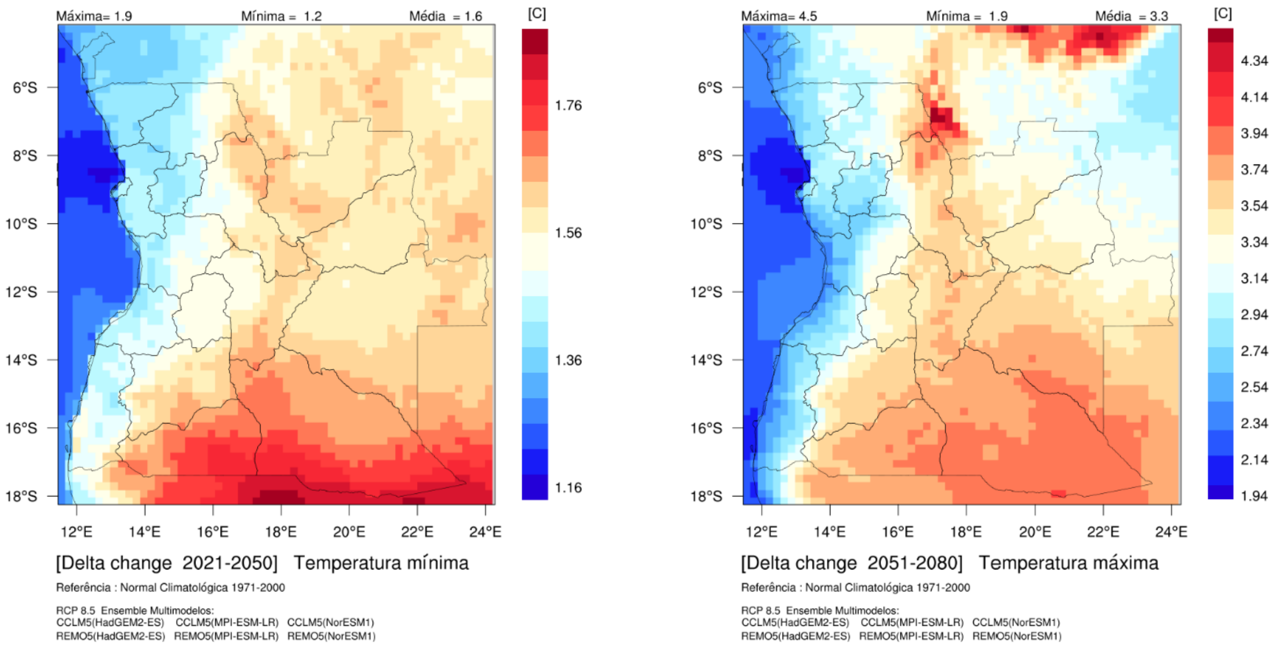


Figure 19. Projection of the Delta change to the maximum average annual temperature for the period 2021-2050 and 2051- 2080

Figure 19 portrays the projection of expected climate change trends (Delta change) for the periods 2021-2050 and 2051- 2080. In both future periods, temperature increases were projected for the whole of Angola compared to 1971-2000 within global warming patterns. In the first future period the minimum increase values in the order of 1.2 ºC are projected for the coastal region to increase as it moves inland and south, where the highest values may reach 1.9 ºC, with the average increase for the projected territory being 1.6 ºC. The provinces of Cunene and Cuando Cubango constitute the regions with the highest projected maximum temperature increase, which translates into heat increase in these regions.

For the second future period (2051-2080) the projected increase should range from 1.9 ºC to 4.5 ºC compared to 1971-2000, with an average increase of 3.3 ºC. Similarly to the first period, a heat increase is also expected for the whole of the most affected territory in the provinces of Cunene and Cuando Cubango.

Minimum average annual temperature - Projections for 2021-2050 and 2051-2080

Figure 20 portrays projections for the future climate for the minimum air temperature variable for the period 2021-2050. There is little variation between the different models and the tendency of the models generated by the RCM REMO to present higher temperatures.

Figure 21 illustrates the spatial distribution of the same variable in the 2051-2080 period with many similarities when the same RCMs are used, all of which attribute higher minimum temperatures in the provinces of Cabinda Zaire, Bengo and Luanda.

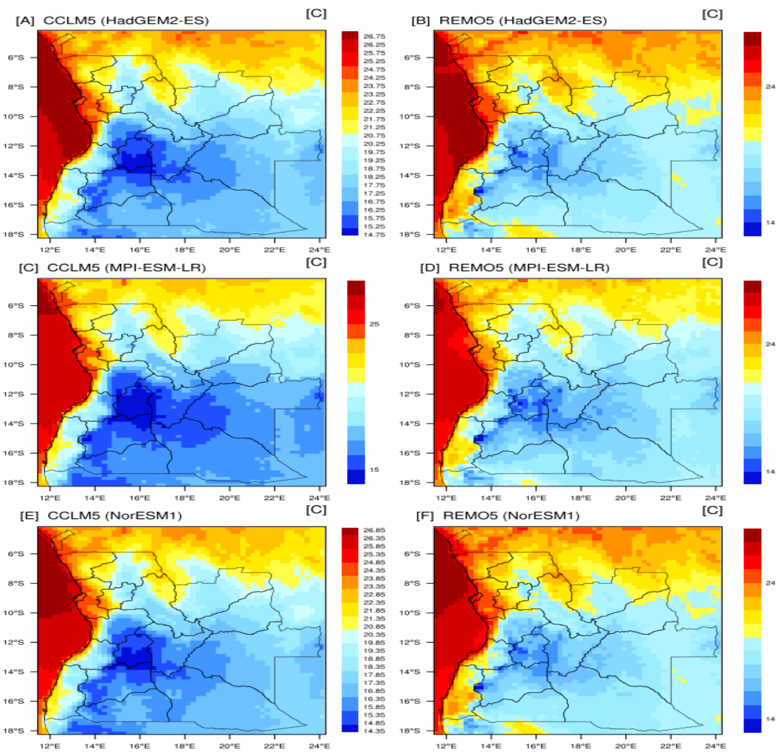


Figure 20. Projection of the minimum average annual temperature by the models for the near future 2021-2050, based on RCP 8.5.

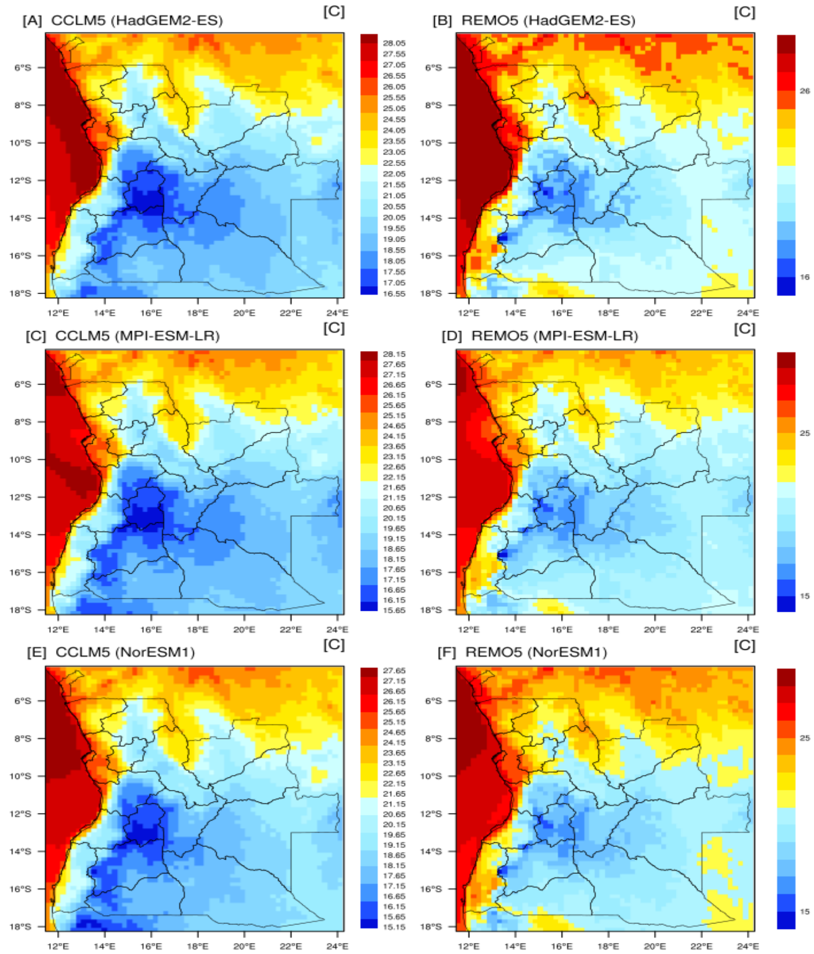


Figure 21. Projection of the maximum average annual temperature by the models of the distant future 2051-2080 based on RCP 8.5

Figure 22 illustrates the spatialization of the Delta change to the average annual minimum temperature for the two future periods where it is noticeable that the values of this variable have increased nationwide similarly to global warming patterns.

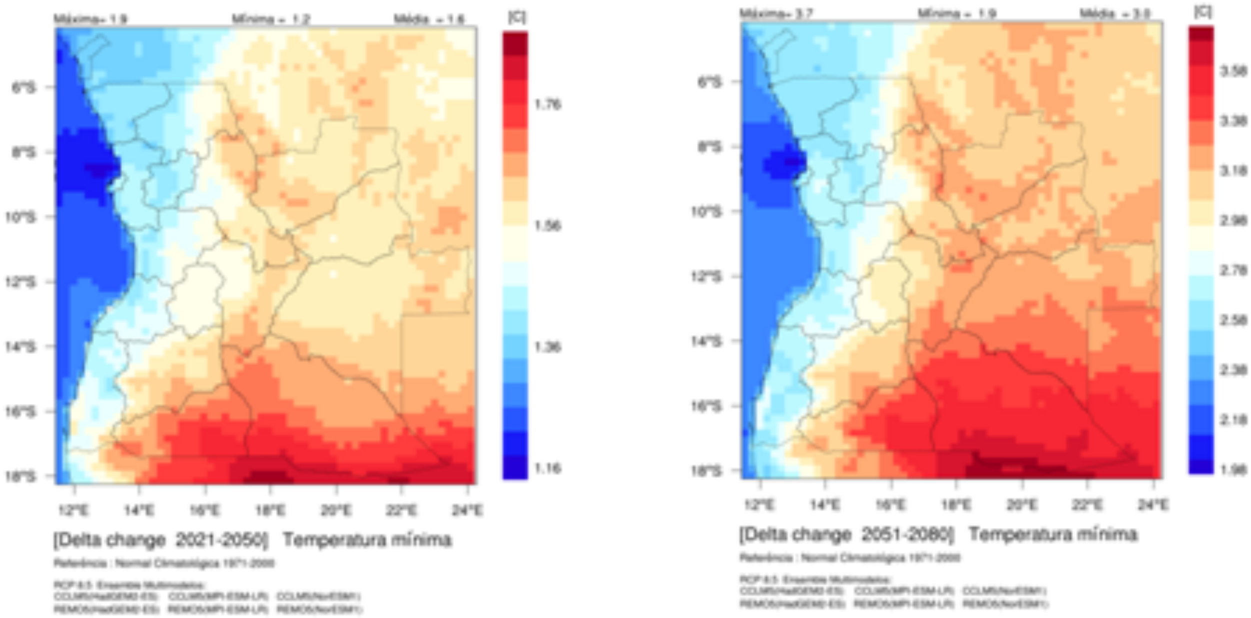


Figure 22. Projection of the Delta change to the minimum annual average temperature for the period 2021-2050 and 2051- 2080

Increases are similar to maximum temperatures, with the lowest on the coast increasing as it moves south and east, with the provinces of Cunene and Cuando Cubango most affected. In the near future 2021-2050 projections indicate variations between 1.2 ºC and 1.9º C with an average of 1.6º C, over the present period 1971-2000. In the future period 2051-2080 the projected increase is greater and may range from 1.9 ºC to 3.7 ºC with an average of 1.9 ºC.

Average annual precipitation - Projections for 2021-2050 and 2051-2080

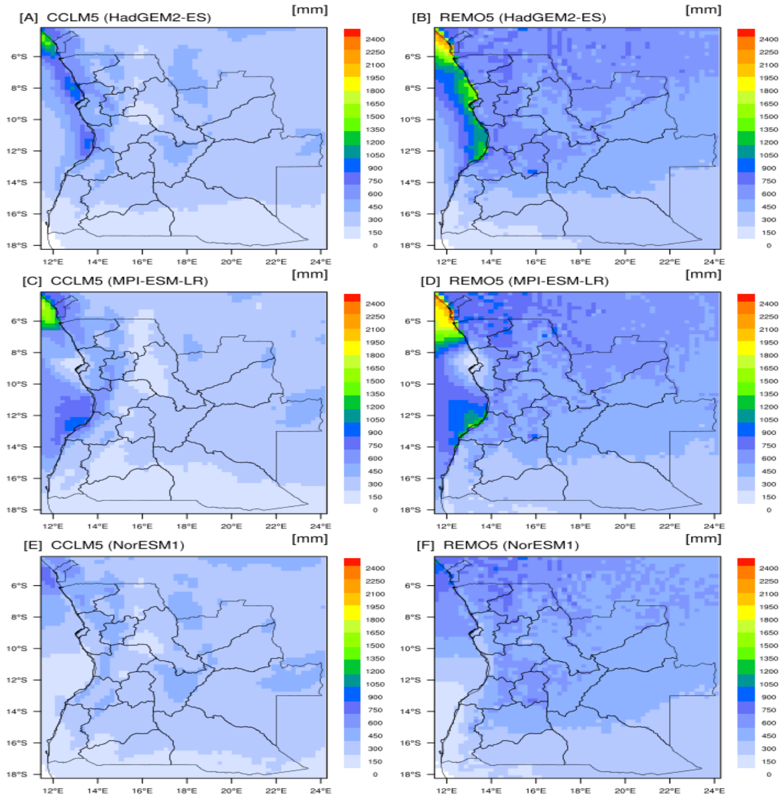


Figure 23 illustrates the spatial distribution of average annual rainfall for the period 2021-2050 while Figure 24 illustrates for the period 2051-2080. In both periods the regional REMO5 model projects higher values than the CCLM5 model regardless of the global models that were used for the respective initializations.

Figure 23. Projection of average annual rainfall by models for the near future 2021-2050, based on RCP 8.5.

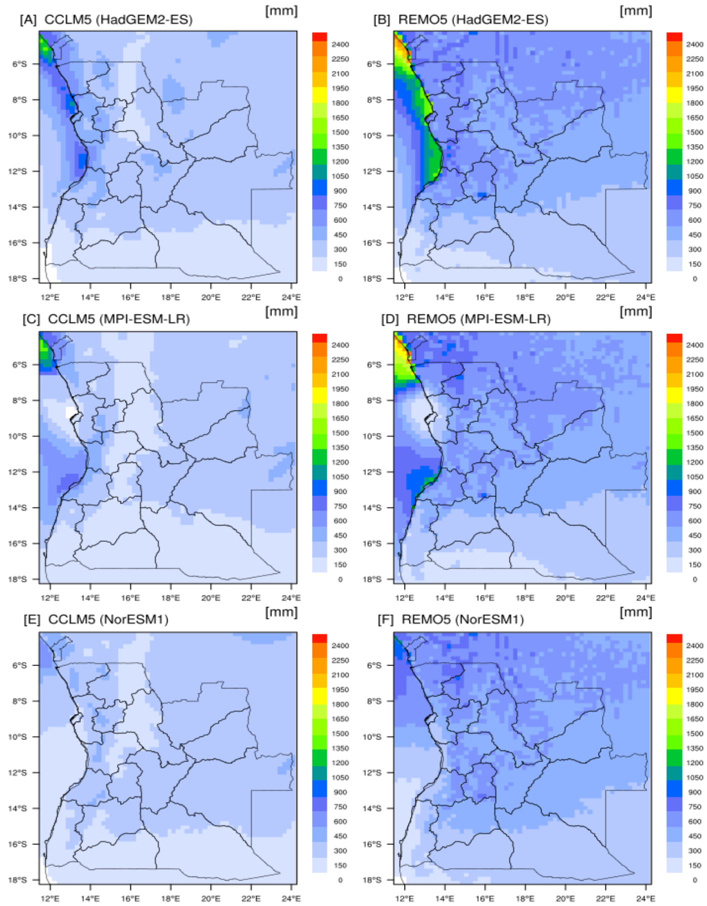
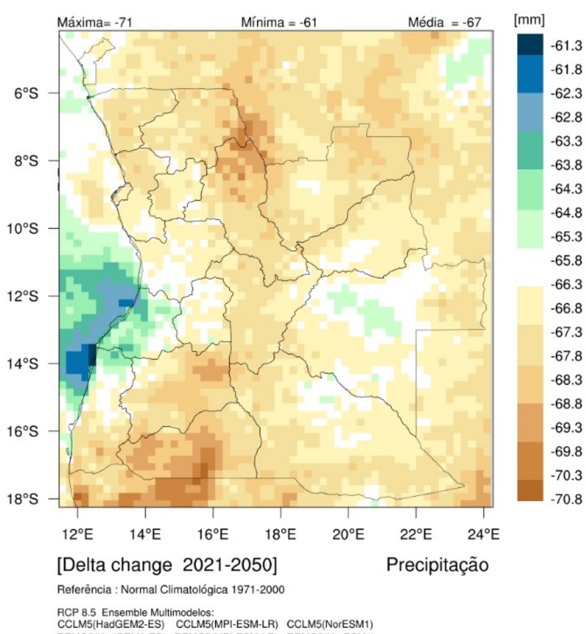
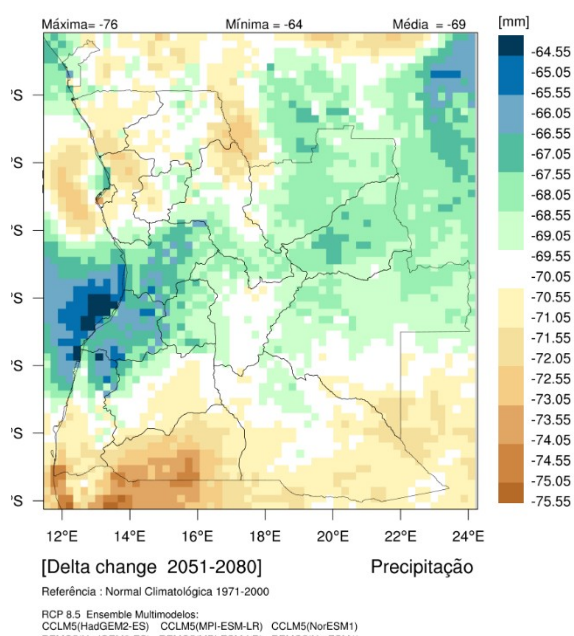


Figure 24. Projection of average annual precipitation by the models for the distant future 2051-2080, based on RCP 8.5.





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Building 4, 4th Floor
Talatona Municipality, Luanda
E-mail: dnaac@mcta.gov.ao

Figure 25. Delta change projection for average annual rainfall for the period 2021-2050 and 2051-2080

Figure 25 depicts the change in average annual rainfall for the two future periods, where both projections show fields of decreasing rainfall across the national territory which is in line with the IPCC global projections. In the period 2021-2050 rainfall loss should vary between 61 and 71 mm/year with Cunene province being the most affected. In the period 2051- 2080, the projections point to a loss of rainfall between 64 and 76 mm/year, with the province of Cunene also being the most affected. On the other hand, rainfall beyond the projected reductions should also change patterns, as the temperature increase should increase the frequency of convective cloud formation which normally causes torrential rainfall that can induce the highest occurrence of floods. Still in the same vein, the combined effect of rising temperatures and falling rainfall could intensify drought episodes.

3.4 ASSESSMENT OF VULNERABILITIES AND ADAPTATION MEASURES BY SOCIO- ECONOMIC SECTORS

The planning and implementation of adaptation will benefit from complementary actions between different types of actors. Governments can coordinate adaptation efforts of local and sub-national governments, for example by protecting vulnerable groups, supporting economic diversification and providing information, political and legal structures and financial support. Local government and the private sector have important roles in scaling up adaptation in communities, families and civil society, and in information management and risk financing. New institutions and coordination mechanisms will be needed to ensure the success of adaptation measures. It is essential that these mechanisms are for information exchange and knowledge management. Regional networks and partnerships are becoming increasingly important in this regard. In addition to administrative structures, it is also important to create institutional frameworks that allow the participation of other relevant actors.

Several climate models have projected that any increase in global warming will affect human health, with mainly negative consequences (high credibility). Lower risks have been projected at 1.5°C than at 2°C for heat-related morbidity and mortality (very high credibility).

There is limited knowledge and availability of data to assess with the necessary precision the extent of the impact on water resources, soil, natural systems, or coastlines, which in turn have implications for infrastructure. There is a glaring lack of available data and technical capacity in monitoring the climate system to enable long-term and medium-term projections, as well as for timely weather forecasting and early warnings in response to extreme events.

Effective risk reduction and adaptation strategies take into account the dynamics of vulnerability and exposure and their links to processes, sustainable development and climate change. In the short term, the integration of climate adaptation and disaster risk reduction will help to withstand shocks to human security and economic development. In the long term, governments, businesses and communities will need to become more resilient to more intense climate impacts and extreme events. Adaptation is site and context specific and there is no single approach to reducing appropriate risks in all settings. A coping strategy can help a person or household to maintain well-being in the face of a crisis, but it does not reduce their vulnerability if the crisis recurs[20].

Part of the difficulty with implementing adaptation measures is knowing exactly what is needed in practice. While autonomous adaptation is easy to observe in terms of responses to past climate phenomena, planned adaptation is more difficult because it involves early responses to a possible future phenomenon.

Building adaptive capacity is only successful if the socio-cultural context of the base is taken into account. The drafting of Local Adaptation Plans and the strengthening of personal and institutional capacity to respond at the local level contribute strongly to this purpose.

The use of combined strategies is possible, as prevention is usually a long-term strategy. There are risks with a strategy of building physical barriers to protect areas at risk because there may still be significant damage or catastrophic damage when floods exceed the height and strength of the barriers and the protective structures are destroyed. It is important to adapt the infrastructure of the most vulnerable areas to the specific type of threat in each locality, for example roads can be vehicles for evacuating excess water during the critical period and in certain localities.

Analysis of information on changes in climate patterns in the context of agricultural systems in various regions of Angola (especially those with greater agricultural potential), obtained through interviews and conversations with farmers and villagers. These sessions should include the collection of oral histories of elderly people in the selected areas and interviews with focal groups in the villages to capture at local level memories and perceptions of climate variability and climate change, environmental change in general, and human adaptation to these changes.

The report on Climate Risk and Vulnerability in Southern Africa estimates that about $1 to 2.6 billion per year would be needed for new water storage, wastewater treatment and electricity facilities to combat climate change. If climate change risks are not considered in project and programme planning, the effects of climate change may negate the positive effects of the initiatives (Vincent et al., 2008).

For the National Water Plan, for example, the greatest differences between model values and observed values that can interfere with vulnerability assessment occur in the months of June to September for stations located on the coast (i.e. Benguela, Cabinda, Luanda and Namibe and to a lesser extent Uige), i.e. in the months where there is a decrease in the maximum temperature at these stations. The models in general overestimate the maximum temperature in this period. Namibe is, as noted above, the season for which the models show the worst results, where for the months of May to September there is an overestimation of the maximum temperature of 12°C in some RCM models (CanRCA4 and CCLM).

[20] [1] For example, if a family's adobe house is damaged in a flood and then repaired with more adobe, this is a survival strategy. If, on the other hand, the house is rebuilt with bricks and cement, which can better withstand flooding, or on stilts, it would already be an adaptation mechanism.

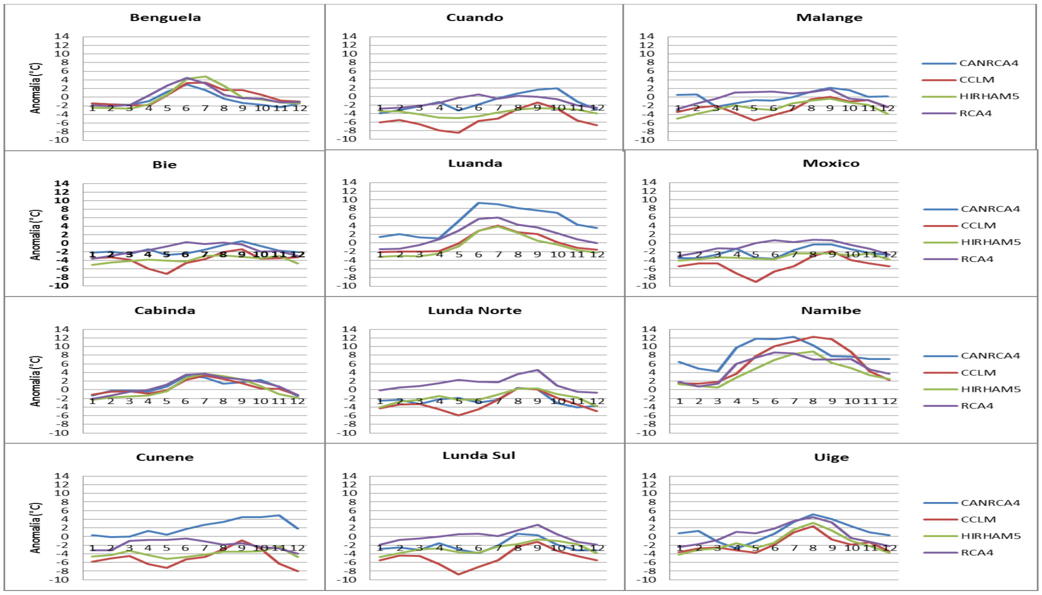
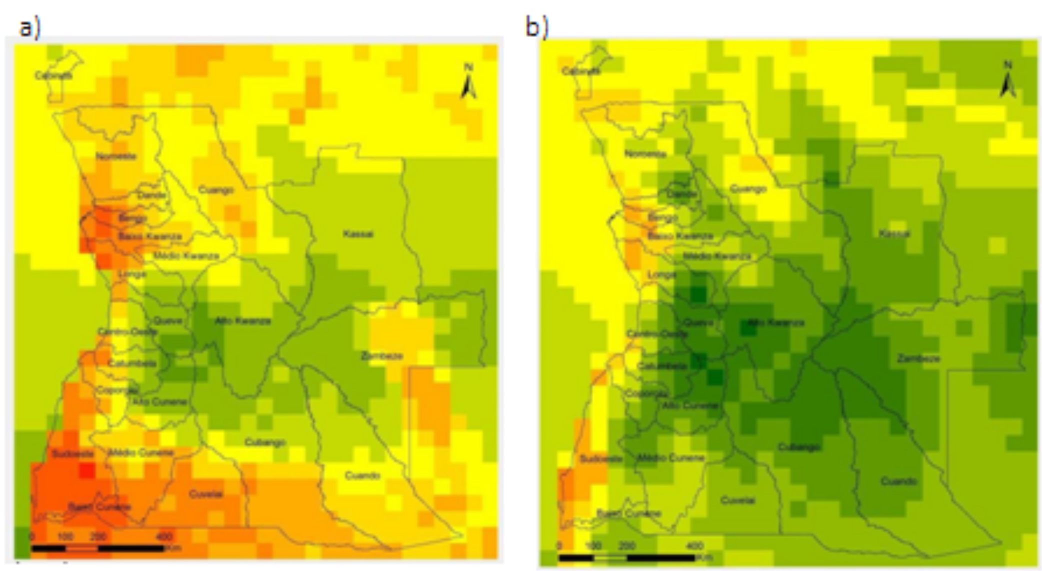


Figure A1 - Average monthly error of the maximum air temperature of the different models for the 12 stations

At the spatial level, all models present the central region of Angola as the area where the normal maximum air temperature is lowest, with the coast, mainly the southern coast, being the area where the average maximum air temperature is highest from 1958 to 1974. The Canadian CanRCA4 model generally the highest maximum air temperature standards, while the CCLM model has the lowest maximum air temperature standards. However, all 4 models have, in general, the same spatial pattern for maximum temperature.



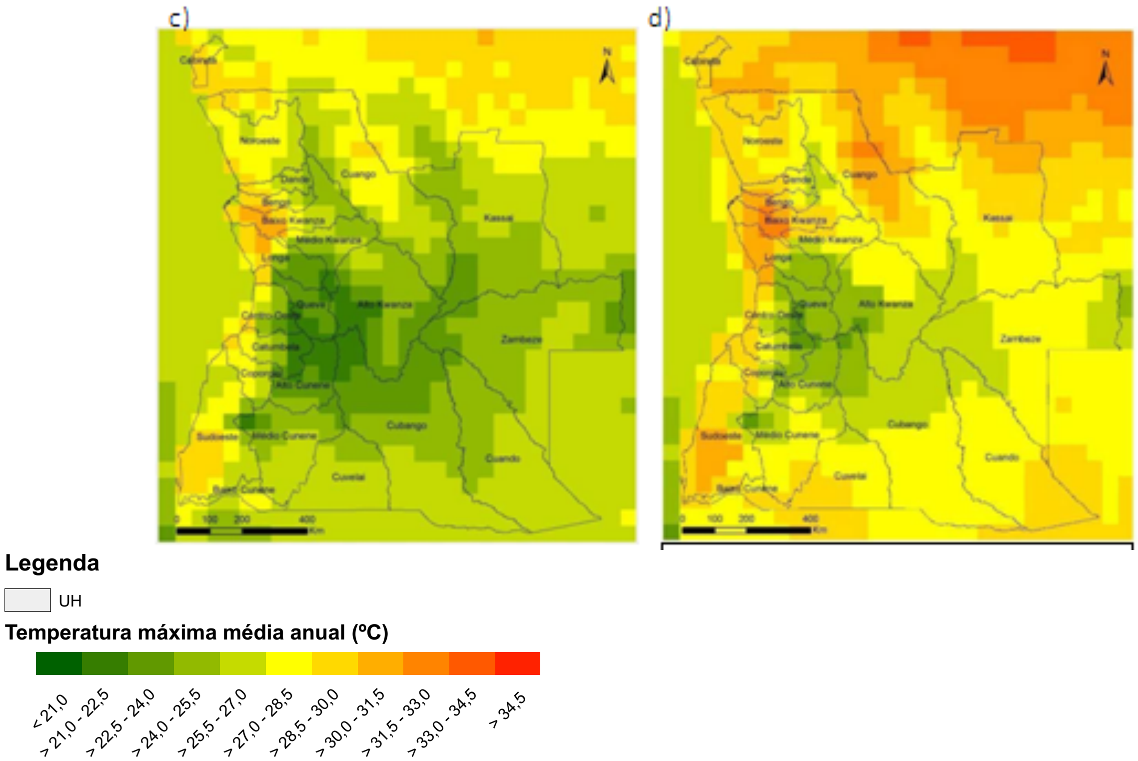


Figure A2 - Maps of maximum air temperature standards for the period 1958 to 1974 for the 4 models: a) CanRCA4, b) CCLM, c) HIRHAM5, d) RCA4

In general, we can conclude that the four models represented well the maximum annual and monthly temperature for the 12 stations analysed. However, the CanRCA4 and RCA4 models show a smaller average annual difference (<1°C) when compared to the other two models. All models have difficulties in correctly representing the maximum temperature in the coldest months of the coastal seasons.

The set of scenarios and models presented makes it possible to state with some certainty that, as a result of climate change, Angola's climate profile is no longer the same, hence the need to adopt a set of adaptation measures that make it possible to trigger a process of successive adjustments in order to create capacity and conditions for adaptation, in view of the climate vulnerability that the country is exposed to, and thus reduce or even cancel out a set of social and economic losses caused by climate change.

3.5.1. Framework

The concept of vulnerability is multidimensional. The word "vulnerability" was used by the first engineers in references to the levels of resistance of building materials to earthquakes, wind or water actions, having extended in the 1980s to include socio-economic and environmental issues (MAZZER, 2007). In the 1980s vulnerability was understood as a threat both to chemical agents and to the ecological status of communities compared to the degree or capacity to cope.

According to the IPCC, "vulnerability is the degree to which a system is susceptible or unable to cope with adverse effects of climate change, including climate variability and extremes. It is a function of the nature, magnitude and speed of climate change and the variation to which a system is exposed, its sensitivity and its ability to adapt" (IPCC, 2001). The interaction of these three factors can be summarized in Table 1 below.

A number of factors, including political, social, economic and environmental factors, intervene in relation to vulnerability. Vulnerability to climate change combines all these factors within a given social reality, sector or context. Hereinafter, we present the factors involved in risk to climate change.

Table 1. Factors affecting vulnerability and risk to climate change

The degree of exposure to threat	The sensitivity of the system	Capacity to Adapt
Exposure to climate variation is mainly a function of geography which leads to climate variability and uncertainty. What is at risk: The population Resources Property, Infrastructure For example, communities in semi-arid areas may be more exposed to drought. The changes to be faced: Sea level Temperature	Sensitivity is the degree to which a particular community or ecosystem is affected by climatic stress. Water Agro-industry Human settlements Energy demand Forests For example, a community dependent on rainfed agriculture is much more sensitive to changing rainfall	Adaptive capacity is a system´s [human or natural] capacity to adjust to climate change, to mitigate potential damage, to seize opportunities or to deal with consequences. Wealth Health Technology Education Institutions Information Infrastructure "Share capital"

Climate change is probably the greatest environmental challenge facing humanity today. Angola is part of the group of developing countries on the African continent and to date is still one of the 48 least advanced countries and is particularly vulnerable to the impacts of climate change.

Complexo Administrativo Clássicos de Talatona, Rua do MAT,
Building 4, 4th Floor
Talatona Municipality, Luanda
E-mail: dnaac@mcta.gov.ao

Climate change has already produced and continues to produce impacts on many communities globally, exposing them to increasing risks and making them more vulnerable. Recent international scenarios point to an increase in the frequency and intensity of natural disasters associated with climate change, and to the fact that the most disadvantaged, minorities, women, children and the elderly are often the most affected in such disasters.

Climate change poses additional obstacles to ending poverty and achieving social justice and can significantly interfere with the achievement of the Sustainable Development Goals, as well as with some targets in the five-year cycles of the National Development Plan (NDP) and other long-term planning. Rising temperatures, increasingly irregular rainfall, more frequent and severe floods, cyclones and droughts have significant consequences for the livelihood security of the most disadvantaged populations, and development professionals see firsthand the effects of a changing climate on their work around the world (Robert Chambers, 2009).

Angola's vulnerability and exposure to climate change has been felt over time in communities and ecosystems with frequent episodes of extreme climate phenomena such as drought, floods or sharp variability in temperature and rain in some areas of the country, with special focus on the coast, where most of the country's population is concentrated (MEP, 2018).

The excessive exposure of the person or group of people to vulnerability calls for adaptation. The Intergovernmental Panel on Climate Change (IPCC) defines adaptation as an adjustment in natural or human systems in response to verified or expected climatic stimuli or their effects, which moderates damage or exploits beneficial opportunities. The process of adaptation to climate change should be on the daily agenda of policy makers.

It is essential to give policy makers the certainty that planned adaptation is more effective than reactive measures decided upon in an emergency. The predictable impacts of a changed climate are likely to result in increased frequency and intensity of extreme weather events such as severe droughts, floods, uncontrolled forest fires, etc.

Methodology

There are several methodologies for vulnerability assessment, all of which are intended to support the development of adaptation policies, decision making and the development of educational awareness programmes.

All evaluation methods are based on the use of vulnerability indicators. The selection of these indicators will depend on each case of study, the scale of the analysis (individual, regional, and national), the information available and the specific characteristics of the place or sector of study. For this reason, much of the existing research is based on specific case studies. The number of indicators and measures of the analysis used should be large enough to capture the essential elements of a particular study, and at the same time restricted so as not to overload the analysis of the data. The selection of indicators should always be considered provisional until they have been proven with use.

In the methodologies for vulnerability assessment two trends can be identified. The first is the methodologies for assessing vulnerability to a specific threat, such as floods, droughts, rising sea levels, etc. In the second are the methodologies that analyse a set of threats. The latter trend considers variability and climate change as a threat. The methodologies that build and apply indices or "proxies", where vulnerability is expressed as a numerical value, are highlighted.

Applying the same tool in different places allows for objective spatial comparisons. In addition, repeating the evaluation in the same place allows for visualising the evolution of vulnerability in time. The methods and models used to assess vulnerability do not necessarily provide answers, but can serve as a guide for the formulation of policies and action plans.

In Angola, for the various ongoing projects that aim essentially to reduce vulnerability and build adaptive capacity, several methodologies have been used, and in many cases, a combination of methodologies. Among them we highlight

- The Disaster Risk Reduction Index (DRI) methodology- The DRI is a specific disaster risk index that allows measuring and comparing relative levels of exposure, vulnerability and risk between countries. The scale adopted is national, with global coverage. The risk model used associates demographic, socio-economic and environmental variables with the manifest risk of specific disasters. The approach used to construct the index is deductive;
- The Hotspots project methodology - maps critical areas at risk of multiple natural disasters on a sub-national scale with global coverage. The approach used is the inductive one. Risks associated with two types of disasters are mapped, namely mortality and economic losses. The focus is on six types of natural disasters, four of which are related to climate change - floods, landslides, droughts and tropical cyclones;
- The Tyndall Centre's vulnerability indicators methodology - The approach used is essentially deductive, it uses a database of indicators of vulnerability to climate change. The construction of vulnerability indicators aims to identify weak points where intervention is needed to reduce the possibility and intensity of the occurrence of adverse effects resulting from future disasters associated with variations and climate change.

In this National Communication, the sectoral and territorial approach was used to measure vulnerability, choosing a set of 7 sectors and areas that are predominant for the active life of the country, the vulnerabilities were assessed and some adaptation measures of the following socio-economic sectors were pointed out: water resources, agriculture, land use, forests and fishing; ecosystems and biodiversity, coastal areas, infrastructure and health. The proposed adaptation measures result from the application of the Pressure-State Impact Response (PEIR) methodology developed by UNEP (2007). This methodology makes it possible to identify the elements that put pressure on a given sector, causing changes in its state, revealing specific impacts that require responses for each situation.

3.4.1 Water resources

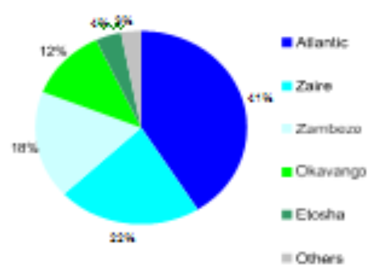
Southern Africa's hydrography is marked by the sharing of several river basins. Angola shares five of the region's major basins: Congo, Zambezi, Cunene, Cubango/Okavango and Cuvelai, and as such is obliged and committed to cooperation between neighboring States. Water scarcity situations can cause tensions between States. In Africa´s case and in the region under consideration, this situation is accentuated by historical vicissitudes, which led to arbitrary marking of border lines and are at the origin of current States. Several countries in the region face very adverse climatic and hydrological contingencies. Water perspectives require attention and measures.

In the regional context, Angola appears relatively loose in terms of water reserves, although with asymmetries within them. Angola has the third highest availability of renewable fresh water in the region after Congo and Mozambique. In general, the Northern, Central and Eastern regions are characterised by some excess water, while the Central and Southern regions are characterised by some limitation interms of surface water (Arid and Semi-Arid Zones).

According to the Water Sector Development Programme (Ministry of Energy and Water - MINEA), annual runoff is estimated at 140 million ^{m3} (140 km3) per year. As for potential groundwater availability, estimates range from 58 km3/year (FAO/ Aquastat 1995) to 72 km3 (INRH). About 95% of groundwater feeds directly into rivers, while 5% flows into the sea. Water resources are probably one of Angola's greatest assets.

There are around 47 river basins in Angola, which are directed towards 5 main strands:

Atlantic (41 %);
Zaire or Congo (22%);
Zambezi (18%);
Okavango (12%);
Etosha (4%); and
Others (3%)



Graph 1: Hydrographic Basins of Angola

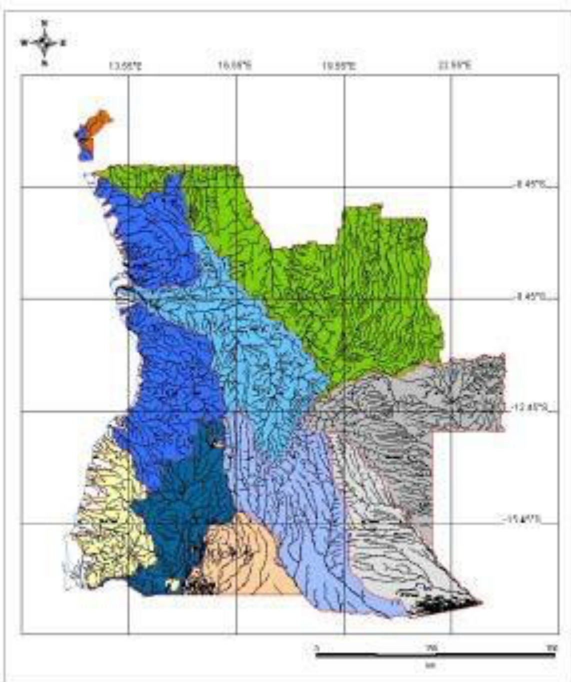


Figure 26 - River basins
(Source: Geographic Atlas, V 1, 1982 - Adapted)

In terms of the types of River Basins there are Ocean Basins (Kwanza, Queve, Longa, Catumbela, Cunene, etc.) and Endorheic Basins (Cuvelai Basin; Cubango / Okavango Basin).

The most relevant internal river basins at national level are Kwanza basin, Queve basin, Bengo basin, Dande basin, Catumbela basin, Balombo basin, Evale basin, Lucala basin, Longa basin.

The most relevant river basins at international level:

- Congo/Zaïre (shared with 10 other Central African countries)
- Zambêze (shared with 7 other SADC countries)
- Cunene (shared with Namibia)
- Cuvelai (shared with Namibia)
- Cubango/Okavango (shared with Botswana and Namibia)

The Zaire and Zambezi rivers are two of the most important watercourses on the African continent. These international rivers are located in areas where the level of rainfall varies between 400 and 1 200 mm and their flow rates depend, over 50%, on the rainfall generated in the upstream countries. They constitute Angola's main river basins.

The Cuvelai River basin is a cross-border basin that begins in the hills of southern Angola and ends in the Etosha Marsh in northern Namibia. It is home to a population of 1.2 million Angolans. During the rainy season, the water drains south from the hills, initially along small rivers and then to flat land, where it becomes a huge network of shallow channels called chanas. Most of the population lives along the drainage lines, with more clayey soils and very vulnerable to flooding.

The Cunene and Cubango Rivers complete Angola's international set of rivers. The Cubango River, with the Cuíto distributary, originates the Okavango Delta - of extreme ecological and economic importance - and the Cunene River is the only perennial watercourse that flows along Namibia's northwestern b o r d e r .

The origin of Angola's great surface water resources can be found in the high plains of Huambo, Bié and Moxico. The central plateau is traversed by various river systems that flow southwards towards the Cunene and Cubango rivers and eastwards towards the Atlantic Ocean through the rivers (Zaire, Kwanza, and Cunene). The Zambezi River (and the Cuando, a tributary of the Zambezi) flows into the Indian Ocean. The Cuando River produces Angola's third largest basin.

A complex network of small rivers flows along the coast, which are of great importance for the subsistence agriculture of coastal communities. The watercourses are seasonal (intermittent), particularly in the south and southeast of the country, depending on the amount of rainfall during the rainy season.

At least three of the ten main rivers have no direct perennial access to the sea and sandbanks form at the mouths of other rivers, such as the Sembe River.

Angola's groundwater resources have a potential of around 72 km^3 (72,000,000 m^3). The most productive aquifers are found in sedimentary rocks. The coastal aquifers have an average depth of between 5 and 30 metres, the central plateau region's aquifers have an average depth of between 10 and 30 metres, and the semi-arid (Cunene) aquifers have depths of around 200 metres or more. The country still has several sources of mineral water, but little information is available on these. Groundwater resources continue to be a reliable source of water supply for the population and for livestock in central and southern Angola.

The Zaire and Kwanza rivers still have mangrove fringes that extend towards the east for several tens of kilometres from the mouth. The importance of mangroves as a place of development of species and crustaceans, stabilization of the margins, and retention of nutrients is significantly documented.

The river basins considered as having a potential for the development of agriculture and poultry are; Cunene, Kuanza, Cubango, Cavaco, Catumbela, Queve, Longa, Bengo, Bero, Giraul, Curoca, Coporolo, Ngunza / Cambongo, Quicombo, Equimina, Cuvelai and Congo/Zaire.

The available information shows strong population growth in Angola. This demographic development will put pressure on water resources, contributing to a decrease in per capita water availability. According to FAO data from 2000 [Ferreira & Guimarães 2003], the volume of water per person per year will rise from 15,888 m3 in 2000 to 9,335 m3 in 2025, assuming a population of around 22 million.

Basic state of the sector

Water is a strategic resource for Angola's integrated economic development. The institutional responsibility for water resources at the level of the Ministry of Energy and Water is the responsibility of the Ministry, which has the mission of defining policies and legislation, as well as implementing concrete projects that envisage an adequate management of these resources.

At the level of water resources management, the National Water Resources Institute has the following priorities:

- ➢ Replacement of the National Hydrometric Network;
- ➢ Recovery of the National Hydrological Base;
- ➢ Beginning of Water Resources Registration at National Level;
- ➢ Formulation of General Master Plans for Major Hydrographic Basins;
- ➢ Training of National Executives.

Within the Government's program, the fundamental objective for water resources is to promote in a sustainable way the supply of drinking water to the population and the productive sector, as well as adequate wastewater sanitation services. The priorities and specific objectives for the Tutelage sector are defined as follows:

- ➢ Improving the quality of water service in both urban and suburban areas and in rural areas;
- ➢ Continue the construction of small systems and community water supply and sanitation points in suburban and rural areas;
- ➢ Ensure efficient management in the operation of the systems by continuing the creation of entities dedicated to this purpose and through the institutional development of the sector;
- ➢ Implement an appropriate tariff system to cover operating costs and protect the most vulnerable sections of the population by ensuring the sustainability of the public service;
- ➢ Ensure the integrated management of water resources, continuing with the establishment of priority basin management bodies and the framing of the respective master plans.

Projects are underway to draw up river basin plans for all the main basins in Angola (with priority for Namibe, Cabinda and the Northwest and Northeast), reservoir management plans and the rehabilitation of existing hydropower stations and the expansion of the national hydrometric network. These actions also aim to mitigate the harmful effects of drought in the country and launch the construction of water infrastructure to ensure water security in the provinces most affected by the drought.

Particularly in southern Angola, several water resource maximization systems are currently being built for some provinces, in which we highlight some of the solutions identified:

- ➢ Water collection from the section of Cafu (Cunene River), to the Shanas area,

specifically the
localities of Cuamato and Namacunde;

- Construction of Dam 71 on the Caúndo River, near the town of Ndúe, in the Cuvelai Basin;
- Construction of Dam 128 on the Cuvelai River, near the town of Calucuve.
- Construction of retention dams in the Bero, Giraúl, Curoca, Bentiaba, Inamangando and Carunjamba river basins. (Namibe)
- Construction of a Transfer of Flow from the Queve River or the Longa River and its Water Retaining Dam located in Baixa do Wamba (Cunza Sul).

Despite progress, there are still serious problems in the relationship between populations, territories and water resources, given that the majority of the Angolan population has continued to experience difficulties in accessing drinking water.

Vulnerabilities of the sector

Climate change has significant impacts on the temporal and spatial distribution of water availability, water quality and the risk of floods and droughts. In addition to these direct impacts there are indirect effects resulting from socio-economic changes and activities that increase pressures on the water environment through an increase in water demand or the pollution burden afflicting water bodies. The impacts on water resources are reflected in the various water-using sectors and also in aquatic ecosystems.

The predictions that the IPCC's fifth report makes for the African continent and the southern region in particular indicate changes in some parameters such as precipitation and, consequently, the availability of water resources. The impact of climate change on the water system will be felt in longer droughts, more intense floods and more frequent flooding.

To assess the sector's vulnerability to climate change, the Second National Communication uses the set of information contained in the National Water Plan (NWP, 2015). The NWP contains scenarios with global, regional and local trends in water resources. Thus, in this vulnerability document, the water resources sub-sector is studied with a different level of detail than the other scenarios. On the other hand, the 2015 NWP was based on the methodologies of the 4th IPCC report, while the other sectors used the methodologies of the 5th IPCC report.

Scenario-setting provides a set of measures and actions that contribute to adaptation to climate change in a context of uncertainty and assessment risks. The establishment of socio-economic forecast scenarios and the analysis of their influence on the regional water balance also allows the prediction of situations of competition and possible conflict generated by the pressure of uses. The sectors that are generally foreshadowed as those that compete most for water are irrigated agriculture and water-based energy, although in some situations a significant synergy between them can be identified.

The NWP carried out the water balance in about 22 Hydrographic Units, for the various planning horizons, considering the possible need for measures relating to the:

- Supply, essentially promoting works and support activities (studies and projects, construction management and supervision, operating consultancy, etc.);
- Demand, promoting legal/economic instruments and a rational use/optimisation of processes.

The approach taken assumes that energy production (not only hydro) depends and is dependent on the level of development of the rest of the economy. Equal interdependence exists between agricultural production and population consumption or the level of activity of the agro-food industry, for example. Development scenarios have not ignored these relationships. The NWP has therefore adopted the following methodological steps:

- Establishment of socio-economic development scenarios;
- Preparation of estimates of socio-economic developments;
- Measuring the impact of estimates on water resources by carrying out water balances for various hypotheses of evolution;
- Sensitivity analysis of results in the context of climate change.

The generation of medium and long-term socio-economic development scenarios is based on population projection studies and macroeconomic trends which, combined with exogenous factors such as climate change, demographic phenomena and environmental aspects, require sensitivity analysis and extreme scenario generation.

The socio-economic development scenarios considered in the NWP are:

Scenario 1 - Prevalence of production sectors - This scenario translates into competitive specialisation in the primary sector (agriculture, extractive industries, fisheries, etc.), with further internationalisation (export) and, to a certain extent, in the secondary sector (especially the agro-industry) essentially for the domestic market. The energy sector responds to the increase in demand in these sectors. Tertiarisation is showing a moderate development. Absolute employment is developing favorably.

Scenario 2 - Industrialisation - This scenario translates into competitive specialisation in the secondary sector (not only linked to the processing of agricultural products) with the development of domestic and foreign markets. The agricultural sector and the energy sector respond accordingly. Tertiarisation (supporting activities) shows a considerable evolution. More skilled employment is developing favorably.

Scenario 3 - Social development and tertiarisation - This scenario translates into the maintenance of growth trends in traditional productive sectors (primary and secondary) and competitive specialisation in the tertiary sector (commerce, transport, telecommunications, construction and real estate, financial intermediation, public services, etc.). The quality of life of the population and the consumption of "utilities", such as water and energy, increases. More skilled employment is developing favorably.

Scenario 4 - Multisectoral Scenario - This scenario holds characteristics from Scenario 1 until 2025, from Scenario 2 until 2035 and from Scenario 3 until 2040. It translates into a trajectory of configuration and specialisation of the Angolan economy (compressed into about 20 years, about one generation).

There is a relationship between the level of activity in a given sector and the use of water resources:

Typology	Relationship	User Sectors
Proportional	1:1	Agriculture (irrigation) and energy (hydropower)
Differentiated	1:X, wi th 0<X<1	Industry: function of the PPA, non-existent to proportional relationship (e.g agro- industry,) Agriculture (livestock): higher herd growth with lower consumption per head
More than proportional	1:Y, Wi	Population: depends on the number of inhabitants, but also on the evolution of the coverage rate of the service and of the capitation
Not significant	1:0	Others (e.g. municipal water distribution network managers)

The NWP was concerned with analysing the possible influence of climate anomalies in 2040 that could negatively affect the results of the water balance (availability vs. needs). If at the level of maximum and minimum temperatures in 2040 an increase between 1.1 and 1.5ºC is expected in the whole territory, different anomalies can be distinguished at the rainfall level:

- Positive rainfall anomalies: Cabinda; Long and Midwest
- Negative anomalies between 0% and -2.9% of rainfall: Kassai, Northwest, Dande, Bengo, Lower Kwanza, Catumbela, Queve, Coporolo and Southwest;
- Negative anomalies between -3.0% and -5.9% of rainfall: Cuango, Upper and Middle Kwanza, Upper and Middle Cunene, Cuvelai, Cubango and Cuando.

There is a poor knowledge or poor availability of data to assess with the necessary precision the extent of the impact on water resources, natural systems, soil, forests or coastlines, there is a glaring lack of data and technical capacity available in monitoring the climate system to provide timely weather forecasting, early warning to enable long-term projections.

In any case, the results of the scenarios, the measures presented below, emerge:

Proposed adaptation measures

- Deepen knowledge about the systems that can be affected by climate change, the vulnerabilities of these systems in all areas of risk and test strategies to reduce these vulnerabilities together with local communities;
- To make the most of the resource (about 140 km3) and to raise the levels of intervention needed according to the type of threat in order to implement the legislation in

force more comfortably;

- ➢ To deepen studies on factors contributing to flood risks as well as to improve knowledge of river basins and to develop pilot projects that reduce flood risks by taking into account knowledge of the contributing factors.
- ➢ Designing flood strategies can be of four types:
  - Prevention: actions against factors contributing to flooding such as the lack of natural vegetation cover
  - Protection: the construction of physical barriers to protect areas at risk
  - Accommodation: Creation of early warning systems in risk areas that will enable people to live with the risks, and create escape routes;
  - Back: Evacuation of risk areas.

- ➢ Improve the local governance system by supporting the ongoing municipal process with the creation of Local Adaptation Plans, once the specific vulnerabilities of each area have been identified, creating technical and institutional conditions for a proper response as well as the respective financial provision;
- ➢ Inclusion of climate change issues in the development or review processes of all spatial planning and management instruments and in environmental impact assessment or incidence studies;
- ➢ Mapping the hazards and risks affecting communities in order to understand the risks and the necessary health and sanitation training to reduce the spread of diseases caused by high water levels;
- ➢ Rationalisation of water consumption sites through adequate land use planning, Reduction of polluting loads on water resources.
- ➢ Establish a climate observatory to collect oral and written documentation to better understand climate variability and climate change in Angola;
- ➢ To improve the information and training of the populations living in or attending risk areas and of the teams and technical staff of the bodies responsible for managing these areas who must have training and some specialisation;
- ➢ Strengthen public and user participation in adaptation strategies and prioritisation of measures;
- ➢ Strengthening the effectiveness and monitoring of legal instruments that condition the occupation of territorial units in obvious situations of vulnerability to flooding and improving land use management to promote the recharge of aquifers (natural or artificial);
- ➢ Increasing the storage capacity and use of inland groundwater and flood safety and storage capacity through retention basins in urban areas, as well as strengthening protection structures in flood areas;
- ➢ Improving and rationalising shared management of transboundary water resources,
- ➢ Planting trees and preserving and restoring ecosystems in strategic areas with a view to reducing flood- related hoarding, silting up rivers and increasing the availability of precipitation;
- ➢ Reduction and control of water losses in supply systems;

- Use of lower quality water for less demanding uses (irrigation, refrigeration, floor washing), recycling and reuse of treated waste water.

Weather data in Angola is still scarce, with only a reasonable amount of data available for the period 1945 to 1975. A variety of methods will be used to provide additional information, particularly for the post-1975 period. The methods identified should include the following:

- Retrieval of information from food safety bulletins and the Ministry of Agriculture for the period 1990 - 2005. These contain information on rare climatic events. By grouping this information, creating maps and 15in a time series can reveal trends and changes in weather patterns;
- Where possible, recover information from the press. These contain information on heavy rainfall, flooding, erosion and drought. This information will be compiled and put on maps, and then put into time series;
- Recovery and analysis of meteorological data from the archives, from recent years and from colonial records in Angola and international archives;
- Recovery and analysis of weather data from local sources (such as agricultural stations and agricultural services, where data may have been collected but not centralised);
- Collection of documents such as press articles and scientific studies of the region on meteorological issues;
- Development of specific risk maps to assess the vulnerability of the location where these occurred;
- Increasing the spatial resolution of climate change impact assessment studies to intermediate scales between national and local through the development of specific response models;
- It will be necessary to introduce the economic and social dimension into exposure and vulnerability assessments arising from the simulation of future impacts;

PRESSURE	STATE	IMPACT	RESPONSE
Rising air Temperatures in Angola Maximum 2021-2050 1.1 °C to 2.2 °C 2051-2080 1.9 °C to 4.5 °C Minimum 2021-2050 1.2 °C to 1.9 °C 2051-2080 1.9 °C to 3.7 °C	Risk of floods and droughts Precarious housing in Rural and peri- urban areas very dense disorderly population clusters in some peri-urban areas Deficient urban planning through various practices	Loss of harvest; Hunger Inudations Social and economic losses	Improving knowledge about water management; Mapping the hazards and risks affecting communities; Sustainable and participatory management of water resources Increase / preserve water retention Promoting efficient use techniques Identification of the necessary training; Strengthening the education and targeted communication strategy;

3.4.2 Land use

As is well known, development planning relies heavily on sufficient data. Land use planning in Angola is so far rarely based on information on natural resources. There is little information on detailed (if any) land studies undertaken in Angola.

Studies are needed in such important areas as: characterization, classification, cartography, pedoclimate, pedogenesis, pedological taxonomy, chemical physics, mineralogy and soil micromorphology. Studies on land use and vegetation, trinomial degradation-conservation- recovery of soils, general soil technology, mineral nutrition of crops - soil fertility and laterites are also lacking. There is not a single complete study of any soil profile according to the methods modernly used in Pedology and this makes it difficult to assess the potential of land use for specific areas (F.R. Beernaert, R. Pinto Ricardo).

From 1878, Portuguese technicians began to worry about Angola's soils, but approached them only in a fragmentary, limited and even rudimentary way, or else considered without their direct knowledge. In 1946, the Higher Institute of Agronomy (ISA) set up an Agrological Mission to Angola, financed by the Cereal Export Board of the Colonies, whose main objective was to define the most appropriate areas for growing cereals on the central plateau (Costa & Azevedo, 1947). In 1954 the great project for the general Soil Charter of Angola began, a small-scale charter that was scheduled to be published on sheets corresponding to the respective districts of the then administrative division (generally, roughly equivalent to the current provinces of the Republic of Angola). That same year the work

Os Solos de Angola e a Agricultura was launched. Characteristics, Distribution and Technology of Some Soils of Angola (Azevedo, 1954b), which includes a Pedological Outline, on a scale of 1: 4 000 000, having used for this purpose all the information available at that time about the soils of Angola, "from detailed studies and agrological charts to general recognitions and simple observations of passage or comments made by this or that author about soils".
According to the General Charter of the Soils of Angola, the present situation is shown in the Figure below).

Províncias	Área km² (10³)	%	Escala	Ano
Cunene	77,3			1959
Huíla	79,3			
Namibe	58,0		1:1 000 000	1963
Uige	62,8			1972
Zaire	37,8			
Huambo	33,3			1961
Cabinda	6,9			1968
Benguela	39,1		1:500 000	1981
Cuanza Sul	55,7			1985
Malanje	83,9		1:750 000	1995
Bié	71,0	48		2002
Cuando-Cubango	199,2		1:500 000	
Lunda Norte	106,7			
Lunda Sul	77,6		1:1 000 000	
Moxico	200,8	47		
Bengo	33,5			
Cuanza Norte	24,0		1:500 000	
Luanda	2,3	5		
	1249,2			

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Complexo Administrativo Clássicos de Talatona, Rua do MAT,
Building 4, 4th Floor
Talatona Municipality, Luanda
E-mail: dnaac@mcta.gov.ao

Figure 27 – Present situation of the implementation of the General Soil Charter of Angola

In Angola there is a great diversity of soils. From the agricultural point of view, the best represented are the "psamitics of the humid and sub-humid regions", the "ferralics", the "psamitics aridics", the "para-ferralics and the fersialis". The former cover almost the entire province of Moxico, an area of the Lundas and the northern part of Cuando Cubango as far as Mavinga. Smaller patches also appear in the Uige and Zaire regions, in the southern half of Cabinda Province, in the Lunda associated with feralitic lands, and in the provinces of Huila and Cuando Cubango (Figure below).

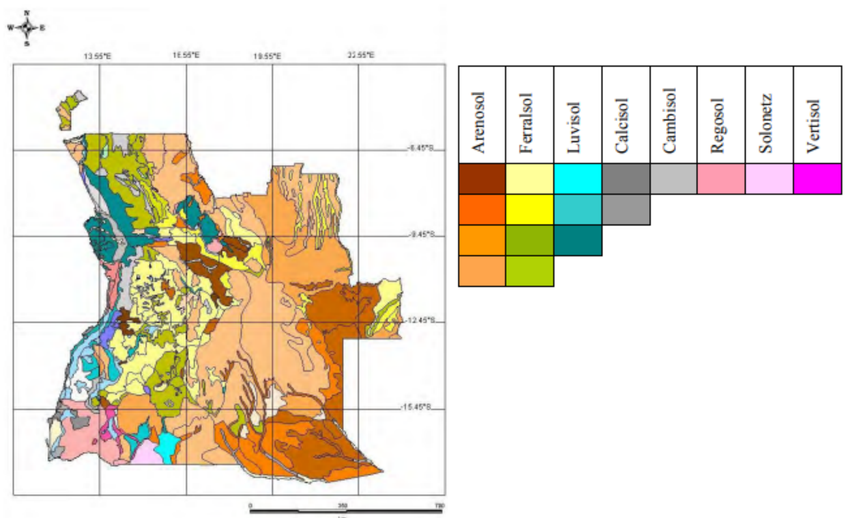

Figure 28 - Soil Charter of Angola and its Pedological Units

Source: General State of the Environment Report, 2006.

Infertile soils predominate in Angola. Angola's soils are of low fertility and only 10% of soils are considered to have potential for agriculture (IUCN Report, 1992). In total, only 2.8% of land is actually indicated as arable and suitable as permanent land, of which only 2.1% is under irrigation. It is estimated that about 85 percent of Angola's rural populations live off subsistence agriculture, with a lack of infrastructure and support services, roads, water sources for production, rural extension, permanent rural marketing and social services (LDN Final Report). For a sound perspective of Angola's agricultural potential, it is essential to prepare a systematic inventory of the natural factors that determine agricultural potential, for example, forms of land and soils.

According to studies prepared by the Ministry of the Environment in 2018, within the framework of setting national targets for neutral land degradation in the country by 2030, the analysis of the significant (negative or positive) change in land cover shows the trend of land use conversion with highlights from forest to pasture, forest to agriculture, pasture to forest and agriculture, pasture to urban area and other land, agriculture to forest and agriculture to pasture (Figure below).

Land conversion			Causes	
Base year land cover 2001	**Annual plant coverage target 2015**	**Total area changed (km^2)**	**Direct**	**Indirect**
Areas covered by trees	**Grazing land**	**8,480.06**	Improper crop management	Any other cause
Areas covered by trees	**Farming land**	**3,670.98**	Deforestation	Any other cause
Areas covered by trees	**Wetlands**	**120.14**	Any other cause	Any other cause
Areas covered by trees	**Artificial areas**	**125.49**	Urbanisation	Human pressure
Grazing land	**Areas covered by trees**	**16,053.69**	Overgrazing	Any other cause
Grazing land	**Farming land**	**1,623.89**	Over-exploitation	Any other cause
Grazing land	**Artificial areas**	**221.46**	Over-exploitation	Human pressure
Grazing land	**Other lands**	**2,694.08**	Improper soil management	

Farming land	**Areas covered by trees**	**1,451.91**	Improper management
Farming land	**Grazing land**	**205.76**	

Figure 29: Significant change (negative or positive) in land coverage.

Sector vulnerabilities

In Angola today, land tenure and land management, resource tenure, agricultural development and the integration of environmental sustainability are regulated and managed in a limited or inadequate way and need to be implemented/executed. Resource rights are essential to the promotion of sustainable land and resource management.

The fragile nature of soils and vegetation increases the risks of environmental degradation, due to population pressure and/or poor management of natural resources, such as overgrazing, deforestation for firewood production and land clearing.

Proposed adaptation measures

- Soil conservation;
- Reduction of erosion and restoration of soil fertility, mainly by maintaining cover vegetation;
- Reduce soil degradation and increase productivity through soil and water conservation management and soil fertility restoration;
- Stimulate a national liming programme for the recovery and rehabilitation of soil fertility;
- Use of sustainable solutions in agriculture and community environmental awareness.

Schematisation of climate change impacts in the Land Use sector based on the PEIR methodology.

PRESSURE	STATE	IMPACT	RESPONSE
Rising air temperatures in Angola	Increasing water demand in agriculture	Increase in evaporation rates and decrease in soil moisture Increasing water scarcity	Development of water conservation programs Construction of infrastructure for retaining, storing, recharging and providing water for all purposes, particularly for the supply of agricultural and livestock production.

PRESSURE	STATE	IMPACT	RESPONSE
Decrease in total rainfall in Angola 2021-2050 61 to 71 mm; 2051-2080 64 to 76 mm	Increased susceptibility to degradation, desertification and soil erosion Reduction of water availability for agriculture;	Possibility of considerable biomass losses Decrease in soil fertility Increasing ravines	Strengthening information and awareness on good land use practices including those related to sustainable agriculture and conservation Restoration of ecosystems degraded by irregular land use practices; Soil and water conservation management; Restoration of soil

PRESSURE	STATE	IMPACT	RESPONSE
Increase in drought in Angola 2021-2050 2051-2080	Increased susceptibility to desertification and soil erosion More and more impoverished soils; Reduction of productive potential	Possibility of considerable biomass losses; Decrease in soil fertility, Total loss of crops; Reduction in the yields of some crops.	Stimulate a national liming programme for the recovery and rehabilitation of soil fertility; Protect and conserve soil stains of high fertility; Reduction of pressure on ecosystems; Promote the restoration of degraded ecosystems and

Complexo Administrativo Clássicos de Talatona, Rua do MAT,
Building 4, 4th Floor
Talatona Municipality, Luanda
E-mail: dnaac@mcta.gov.ao

PRESSURE	STATE	IMPACT	RESPONSE
Intensification of flooding episodes due to increased convective rainfall on Angolan territory 2021-2050	More and more impoverished soils; Reduction of the productive potential of soils	Increased flooding Landslides Reducing the yields of some crops Increased hunger and malnutrition /food insecurity;	Improvement of climate prediction models Flood contingency plan Early warning system

3.4.3. Agriculture

The extension of the territory and the existence of natural conditions involving large areas of arable land, available water resources, and quality soils, in addition to the existing soil and climate diversity and biodiversity represent a potential for sustainable agricultural production.

Family farming is still an activity in Angola. The peasant family produces for self- consumption and supplies to the market some of its production surpluses, namely cassava, maize, beans, sweet potatoes and potatoes, as well as some vegetables and even fruit. This type of agriculture currently produces about 80% of cereals, 90% of roots and tubers and 90% of legumes and oilseeds.

On the other hand, business agriculture comprises medium and large scale, market-oriented and self-sufficient investments, which allow economies of scale to develop and ensure quality and competitive products, ensure the quality and regularity of domestic distribution and boost exports (PDN 2018-2022).

The agricultural sector is heavily dependent on the climate and much of the activity in Angola is still dry, with some initiatives for irrigated agriculture already beginning to emerge fundamentally along the coast and some sporadic areas of the interior. In recent decades, extreme climate variability has threatened the food security of rural populations, with crop losses due to extreme weather and a rural economy in transition but [21][10]vulnerable that is

[21] Woodhill, J., Hasnain, S. and Griffith, A. 2020. Farmers 70 and food systems: What future for small- scale agriculture? Environmental Change Institute, University of Oxford, Oxford.

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Building 4, 4th Floor
Talatona Municipality, Luanda
E-mail: dnaac@mcta.gov.ao

affected by these changes.

The Angolan government's policy measures and the objectives to be achieved are set out in the 2018/2022 National Development Plan (PDN 2018-2022). According to the plan, the agricultural sector's performance in this period will be the result of projected production in sectors directly linked to the population's diet: cereals (with an average annual production of 4,090.62 thousand tons), fruit (with an average annual production of 6,893.8 thousand tons) and legumes and oilseeds (with an average annual production of 1,004.2 thousand tons). The agricultural sector is expected to record an average real growth rate of 8.9% between 2018 and 2022, with the last two years of this cycle particularly noteworthy.

Basic state of the sector

Agriculture is the fourth largest contributor to Angola's GDP (around 7%), but employs most of the labour force. Family farming in Angola is the main source of food in both rural areas and large urban agglomerations. Peasants still continue to work for their self-sufficiency in food because of the poor conditions for modernising their working methods. As they are less profitable and more vulnerable to climate variation, crop surpluses to meet market needs are limited.

In the fields, depending on the agro-climatic characteristics of each region, we can find a diversity of crops, from cereals, tubers, legumes and various vegetables, constituting the staple diet.

Family farms, with a universe of about 2.5 million families, account for over 80% of the production of basic food crops (cereals, roots, legumes) and raw materials for the agro and allied industries, and have the largest livestock herds.

Figure 30: Family farms products (diversity of crops, from cereals, tubers, to legumes and vegetables).

Sector vulnerabilities

The agricultural sector is highly dependent on the climate and extremely vulnerable to climate change. At the same time, it is key to improving the general nutritional status of the population. In recent decades, extreme climate variability has threatened the food security of rural populations, with increased crop losses due to extreme weather.

The rainy season in southern Africa in 2018/19 was one of the driest in almost 40 years, particularly in southern Angola, north-western Botswana, western Madagascar, Namibia, southern Zambia and north-western Zimbabwe. The severe drought has resulted in below average regional cereal production and increased food insecurity (FAO EWEA Report).

The prolonged drought period, which has been experienced mainly in the south, tends to reduce water availability causing severe impacts on agriculture and livestock. Projections on temperature increase will have implications on the evaporation process and consequent decrease in soil moisture and yields of some crops. As a result, crop losses, increased hunger and malnutrition will be seen with consequences for human and animal health that become vulnerable and exposed to diseases.

The current trend related to land degradation could significantly decrease its productivity over time if the necessary adaptation measures are not taken.

Proposed adaptation measures

Applied research - vulnerability and adaptation studies:

- ➢ Carry out a study of the agricultural systems in the country and the meteorological aspects associated with each region and type of culture being practiced;
- ➢ Carry out a study on the impact of changes in the geographical distribution of animal diseases (infectious and parasitic) and in the availability of water on animal production levels in the country;
- ➢ Develop a system of pest risk analysis, including studies to prospect for the risk of pest and disease outbreaks as a function of climate change;
- ➢ Put together studies to improve and extend rural insurance and other instruments for the prevention and compensation of climate losses in agriculture;
- ➢ Expand the work related to the seed bank in order to preserve local varieties as much as possible;
- ➢ Apply the national collection of local seeds in programmes to improve and create adapted local varieties;
- ➢ Create an Agricultural Risk and Vulnerability Monitoring and Simulation System;
- ➢ Strengthen the climate modelling capacity of the different agricultural production systems;
- ➢ Strengthen forecasting, monitoring and warning systems so that activities can be planned in advance and resources are available in the appropriate quality and quantities;
- ➢ Create an early warning system, involving the Civil Protection and the National Institute of Meteorology and Geophysics of Angola, in order to support farmers in the development of crop protection actions and contingency plans against the adverse effects of extreme climate phenomena (such as droughts and floods)
- ➢ Create a Centre for Climate and Agricultural Observation and Modelling;
- ➢ Strengthen actions to contain, reduce and prevent drought and desertification, land management and sustainable land management and reforestation;
- ➢ Reinforcement of water storage conditions;
- ➢ Increase in irrigation capacity.
- ➢ Develop and/or adapt technologies that ensure the sustainable use and increase the efficiency of water use in agricultural production systems, with emphasis on efficient irrigation systems as well as the efficient use of rainwater;
- ➢ Develop new land and animal husbandry techniques, thus ensuring greater animal health and greater protection for food crops;
- ➢ Train managers and qualify technicians and producers for the adoption of systems and technologies that contribute to adaptation to climate change;
- ➢ Include the approach to climate vulnerability in field schools;
- ➢ Develop gender-sensitive capacity building programmes for small rural farmers;
- ➢ Facilitate family farmers' access to agrometeorological forecasts and advice;
- ➢ Transfer of appropriate technologies and farming practices (to be carried out in a participatory manner and with the active involvement of farmers);
- ➢ Collaboration and harmonization between agronomists and farmers in choosing the most appropriate varieties for their needs;
- ➢ Use of agricultural seeds resilient to drought;

➢ Encourage and support programmes for the conservation and sustainable use of genetic resources and plant and animal breeding, with emphasis on their adaptation to biotic and abiotic factors;
➢ Invest in the use of new and sustainable technologies that address integrated management of natural resources (including water).

Schematisation of climate change impacts on agriculture based on the PEIR methodology

PRESSURE	STATE	IMPACT	RESPONSE
1. Increase of the air temperature in Angola Maximum 2021-2050 1.1 °C to 2.2 °C 2051-2080 1.9 °C to 4.5 °C Minimum 2021-2050 1.2 °C to 1.9 °C 2051-2080 1.9 °C to 3.7 °C	Change in the variability of temperature patterns and extremely hot days and nights Increase in water demand in agriculture	Increase in taxes of evaporation and decreased soil moisture Increased water scarcity	Genetic improvement: seed development; Use of native seeds; Elaboration of drought management plans in agricultural areas; Development of water conservation programs; Improving the knowledge about the impacts on primary and secondary production; Develop and implement new agricultural techniques.
PRESSURE	STATE	IMPACT	RESPONSE

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Building 4, 4th Floor
Talatona Municipality, Luanda
E-mail: dnaac@mcta.gov.ao

2.Decrease in total rainfall in the territory of Angola 2021-2050 61 to 71 mm 2051-2080 64 to 76 mm	2.1 Decrease in water availability for agriculture; 2.1 Low soil fertility;	2.1.1 Possibility of decreased yields for some crops 2.1.2 Increase in hunger and malnutrition / food insecurity	Genetic improvement: development of seeds adapted to water restrictions and pests and diseases; Avoid productivity losses per hectare and regional productive migration
PRESSURE	STATE	IMPACT	RESPONSE
3. Increase the episodes of droughts in Angola 2021-2050 2051-2080	More empoverished soils; Reduction of water availability for agriculture; Reduction of the productive potential of soils Ravinas	Total loose of crops; Reduction of the yelds of some crops; Increase of the hunger and malnutrition/food insecurity Impact in human health and animals that become more vulnerable to diseases.	Effective use of water Design of a Draught National Plan Revision, reahabilitation or construction of networks and reservoirs; Diversification of the water sources for agriculture activities for food production; Construction of infrastrucure of retention, warehousing .
PRESSURE	STATE	IMPACT	RESPONSE
4. Intensification of inundation episodes due to the increase of heavy precipitation in the country is torrential	Increase of water availability Erosion and soil impoverishment;	Increase of the inundations Reduction of some income	Improvement of the forecasting climate models Floods Contingency Plans Early Warning Systems

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Talatona Municipality, Luanda
E-mail: dnaac@mcta.gov.ao

Angola territory 2021-2050 2051-2080	Soil Inundation	Hunger increase malnutrition/food insecurity;

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Talatona Municipality, Luanda
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3.4.4 Forestry, Ecosystems and Biodiversity Sector

The Strategy to Combat Poverty, published in 2004 by the Angolan government, recognises the importance of the forestry sector in the country's socio-economic development process and, in particular, in integrated rural development, given its multidisciplinary nature, capacity to produce goods to meet basic needs, high capacity to absorb labour and contribute to the food security of the population:

- About 38% of the population live in rural areas and have part of their main sources of subsistence and income from forest resources;
- According to the country's energy matrix, wood and coal energy consumption predominates over other energy sources, accounting for 56.8% of total energy consumption, compared to 41.7% for illuminating oil, 1.45% for electricity and only 0.1% for natural gas.

Angola has a very rich heritage from the point of view of flora, as well as fauna. The total area of land considered "forest land" covers approximately 53 million hectares, which corresponds to 43.3% of the country's territorial area. The dense humid forest, the most expressive from the point of view of cutting wood for industrial consumption, occupies an area of 2.4 million hectares, or about 2% of the national territory, (IDF 2010).

Forests are important for the provision of environmental goods and services, including rainfall, maintenance of soil fertility, soil protection, water conservation, flood retention, food, climate regulation, recycling of toxic gases, mitigation of climate change through carbon sequestration and maintenance of biodiversity.

In addition, forests are one of the main sources of livelihood for the majority of the Angolan population. They provide timber and non-timber forest products, medicinal plants, domestic wood energy, habitat for wildlife and other forest biodiversity (much appreciated by the lucrative tourism industry).

Biodiversity, being the diversity of all forms of life, is of vital importance to people and to the country. With more than 50% of its population living in rural areas, the components of biodiversity influence daily survival. Practically all activities carried out in rural areas depend on biodiversity: agriculture, livestock, artisanal fishing, subsistence hunting, the use of medicinal plants, housing construction, etc., are activities carried out using components of biodiversity (5th National Report 2007-2012 on Biodiversity in Angola).

The forestry sector must be managed in a balanced and sustainable way in order to participate in economic diversification. Forests can be the target of local exploitation, small processing industry, promotion of employment technological innovation, recycling. The application of the principle of compensation to the nature of what is extracted from it should be monitored and controlled (3rd REGA, 2017).

Basic state of the sector

Angola defines forest[22] as terrestrial ecosystems with coverage by trees, shrubs, or other spontaneous vegetation, including wild animals and the microorganisms in it. In this context, Angola has a forest area of approximately 53 million hectares, which corresponds to 43.3% of its land area.

The forest formations are quite different. The dense, high yielding humid forest, which corresponds to about 2% of the forest area. These formations are located in the provinces of Cabinda, Zaire, Bengo and Kwanza-Norte. The open forest or miombo occupies more than 80% of the forest area and is formed by mosaics of dry forest and savannahs of medium productivity and high social value in terms of wood fuel, building materials, pastures, food and medicinal plants. The remaining forest formations are of low productivity and are made up, among others, of meadows, herbaceous formations of floodable areas, steppes of the sub-desert and desert strips, desert herbaceous formations and mangroves.

In terms of plantations of exotic species such as Eucalyptus sp. and Pinus sp., Angola has a demarcated area of approximately 148,000 hectares, of which about 70,000 hectares is covered with plantations (AGRIC/MINAGRI CONFERENCE).

Forests are threatened by deforestation resulting from the conversion of forest land to agriculture, infrastructure and the development of human settlements, which account for about 80% of deforestation. Biofuel production, firewood energy, mineral extraction, timber extraction, climate change and pests and diseases aggravate the problem.

The rate of deforestation has fluctuated since 1990, with a drastic increase since 2000; between 1990 and 2000, Angola lost an average of 124,800 hectares of forest per year, rising to 1,872,000 hectares between 2000 and 2005, or 3.1%. The average annual deforestation rate has been around 0.8% (Baseline LDN, 2018).

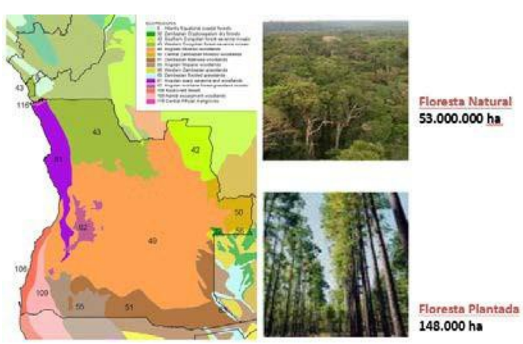

Figure 31: Potential of Basic Forest Resources

[22] Law no. 6/2017 of 24 January

Information on forest resources is based on estimates resulting from the few studies done in colonial times and on comparative data from other similar forests in the country. With the exception of forest inventories carried out during that period on small plots under exploitation and for commercial purposes, there is little information on the productive potential as well as on the conservation status of natural forests. There is an urgent need for a nationwide representative inventory in order to obtain up-to-date and reliable information on these resources (Baseline LDN, 2018).

The arid and semi-arid areas of the coast and south of the country, although not representative from the point of view of forest coverage, are important centres of production and consumption of firewood and coal, a factor which contributes to the destruction of existing fragile forest ecosystems, thereby accelerating the process of desertification (Baseline LDN,2018).

As for flora, some 10 million people have firewood and coal as their energy source. The circuit of this product involves many people from producers or manufacturers (usually rural inhabitants) to wholesalers who buy and transport the goods to the centres of consumption, retailers to final consumers. Part of the rural population and beyond finds survival in this trade (5th Biodiversity Report).

Angola has seen an improvement in biodiversity. The national policy on biodiversity conservation is based on the National Policy on Forests, Wildlife and Conservation Areas and bases its vision on four pillars: Environmental Sustainability, Social Integration, Economic Development and Institutional Cooperation.

As part of its compliance with the obligations of the Convention on Biological Diversity to which Angola is a Party, the country has developed the National Biodiversity Strategy and Plans (NBSAP) since 2007. The objectives of this Strategy are to incorporate them into the country's development policies and public investment programs implemented by the sectors, actions aimed at the conservation and sustainable use of biodiversity. The growth of the network of conservation areas, the drafting and application of legislation and the implementation of management plans have contributed to a positive evolution.

The network of conservation areas has grown to 12.5% of the country's total area. The country has a new National Biodiversity Strategy and one of the objectives of the new Strategy is that all the biomes of the country can be represented in the conservation areas.

According to studies carried out by various national and international research institutions linked to the study of biodiversity, it is estimated that there are approximately 8,000 plant species in the country, of which 1260 are endemic (making Angola the second most endemic country in Africa), as well as 275 species of large mammals, 26 species of antelope (including the giant sable antelope) and 915 species of avifauna.

However, the current situation of many species is unknown due to the lack of studies and updated data and, above all, the lack of national experts in this field and of institutions with the technical-human capacity to carry out relevant scientific work. Through the information gathered in the reports of the various sectors linked to biodiversity, an indicative "Red List" of mammals in critical condition in Angola can be proposed.

In general, Angola presents and benefits from a good ecosystem service. The ecosystems range from southern desert areas on the northern shores of the Namib Desert, to the north- western shores of the Zambezi Basin, and to the south-western shores of the tropical forests of the Congo Basin in the north of the country. The country has some 47 river basins. The Cunene province is the one benefiting from minimal ecosystem services, while the Uige and Cuando-Cubango provinces benefit from excellent ecosystem services.

Sector vulnerabilities

According to the 5th National Report 2007-2012 on Biodiversity in Angola, among the threats (direct and indirect) to biodiversity in Angola, the largest are:

Direct threats:

- Deforestation for itinerant subsistence agriculture;
- The uncontrolled felling of trees for the manufacture of coal and other purposes;
- uncontrolled forest fires for itinerant agriculture and hunting, and
- Commercial poaching;
- Mining prospecting.

Indirect threats:

- The lack of actions aimed at forest management such as forest inventory and planning;
- Poverty affecting much of the rural population;
- Unemployment, e;
- Weakness in implementing the specific legislation in force.

The maintenance of ecosystems and biodiversity depends on climatic conditions, temperature, precipitation. Variations in these regimes may overwhelm the pressure already exerted by humans.

Adaptation measures for the sector

- Survey the current state of biodiversity conservation and establish monitoring plans for its evolution, at national and provincial levels;
- Establish monitoring plans for the evolution of forest areas and ecosystems

and their conservation status, at national and provincial levels;

- ➢ Develop models to analyse the effects of climate change on biodiversity and ecosystems based on national and regional climate change scenarios;
- ➢ Improve the management of existing conservation areas and continue the process of creating new ones;

- ➢ Establish conservation plans with different climate patterns;
- ➢ Strengthen existing mechanisms for identifying and responding in a timely manner to biodiversity changes caused by climate change;
- ➢ Develop actions to reduce current rates of deforestation of native forests;
- ➢ Develop forest fire prevention actions;
- ➢ Promotion of Community forest plantations;
- ➢ Develop actions of sustainable management and preservation of forest perimeters along the national territory;
- ➢ Promotion of alternative sources of income and economic valorisation of forest plantations;
- ➢ Implementation of programmes that promote the consumption of gas at the expense of coal;
- ➢ Promote training on climate change that contributes to the enhancement of forests and ecosystems;
- ➢ Implement a climate change and biodiversity awareness programme.

Schematisation of climate change impacts on the Forest and Biodiversity sector based on the PEIR methodology.

PRESSURE	STATE	IMPACT	RESPONSE
1. Rising air temperatures in Angola Maximum: 1.1 °C to 2.2 °C 2021-2050 and 1.9 °C to 4.5 °C 2051-2080 Minimum: 1.2 °C to 1.9 °C from 2021-2050 and	1.1 Increasing the frequency and intensity of forest fires 1.2 Appearance of invasive species	1.1.1 Considerable biomass losses Carbon emissions Change in ecosystem structure and function	Study climate interactions with different types of ecosystems implementary monitoring systems Implementing fire prevention actions Promoting sustainable forest management initiatives Develop and implement measures to prevent

PRESSURE	STATE	IMPACT	RESPONSE

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Building 4, 4th Floor
Talatona Municipality, Luanda
E-mail: dnaac@mcta.gov.ao

2. Reduction of total rainfall in Angola 2021-2050 61 to 71 mm 2051-2080 64 to 76 mm 3. Increase in droughts in Angola	Alteration Of forest ecosystems and of flora and fauna which serve as a source of protein and medicines for human populations Deforestation and massive deforestation To obtain pasture and farmland Destruction of	2.1.1 Increased hunger and Malnutrition /food insecurity; 2.1.2 Change in ecosystem structure and function Possibility of considerable biomass losses Possibility of increased desertification Impact on tourism	Improving soil conservation structures ; Reducing deforestation; Promotion of Community forest plantations; Reducing the level of deforestation of native forests

PRESSURE	STATE	IMPACT	RESPONSE
4. Intensification of flooding episodes due to increased torrential rainfall on Angolan territory.	Destruction of fragile forest ecosystems. Emergence of invasive species.	Change in the structure and function of the ecosystem; Material damage, Change in forest composition;	Improvement of climate prediction models. Flood contingency plan early warning system.
PRESSURE	STATE	IMPACT	RESPONSE

5. Increase i n mean sea level	Destruction of ecosystems such as mangroves and other coastal forests Soil salinisation	Change in the structure and function of the ecosystem; Material damage, Changes in	Reorganisation of forest space with adapted forests Promotion and preservation of the mangrove forest

3.4.5 Fisheries

The State of World Fisheries and Aquaculture 2018 highlights the critical importance of fisheries and aquaculture for the food, nutrition and employment of millions of people, many of whom have great difficulty in maintaining reasonable livelihoods. Total fish production in 2018 reached a record 179 million tonnes[23]. The FAO also estimates that a large proportion (35%) of fisheries and aquaculture production is still lost or wasted. Most of the production (44%) of fresh or frozen fish is used for direct human consumption, thanks to the relative stability of catch fisheries production. A significant but decreasing part is still used for fishmeal for animal feed (including aquaculture) and fish oil (for human health).

Angola has a coastline stretching 1,650 km and a diverse biomass of fishing resources, as a result of the influence of two types of current: The South Equatorial Current (Angola Current) and the Benguela Cold Current; making the country one of the richest states in Africa in terms of fishing resources. The Angolan coast is divided into 3 distinct regions: the northern zone from the mouth of the Congo River to Luanda, the central zone between Luanda and Benguela and the southern zone (from Lobito to the mouth of the Cunene River, characterised as the most productive zone). Angola, as one of the three African countries that share the Great Benguela Current Marine Ecosystem, has a great responsibility in managing the use of the natural resources of this ecosystem. In addition, due to its wealth of water resources, Angola has good conditions for continental fishing.

Fishing in Angola is classified as industrial, semi-industrial, artisanal and subsistence fishing, depending on the size of the boats used, the technical means employed and the destination of the catches. The fisheries sector is of vital importance for sustainable food security for Angola, particularly small-scale fishing (which most fishermen practice) and aquaculture. Continental fishing (in rivers and other freshwater bodies in the interior of the country) is eminently subsistence, and some commercial artisanal - many fishermen are also farmers. Aquaculture is still taking its first steps in the country.

[23] http://www.fao.org/state-of-fisheries-aquaculture

Basic state of the sector

The share of the fisheries sector in the GDP in the last decade first rose from 1.7% in 2010 to 3.7% in 2016, but by 2019-2020 it was again around 2%. The NDP 2018-2022 called for an average annual real growth rate of 4.7% in the fisheries and aquaculture sector. The sector's performance would be the result of the remobilisation of 10 vessels, with an average production of 303,000 tons from industrial and semi-industrial fishing, 232,400 tons from small-scale fishing and 3,580 tons from aquaculture.

The small pelagics found in Angolan waters are sardinellas (Sardinella aurita and Sardinella maderensis) and horse mackerel (Cunene mackerel and Cabo mackerel). Among the pelagic species, Trachurus trecae and Trachurus capensis are pointed out as being the largest fishery resource in the area. Other important pelagic species are Engraulis encrasicolus and Sardinops ocellata. This is native to the more temperate waters of Namibia and has as its northern limit the Bank of Bianchi Tigers Bay (1986). Albacore tuna (Thunnus albacares) and bigeye tuna (Thunnus obesus) are the most important species of large pelagic fish. Shellfish such as shrimp and lobster also appear in abundance in Angolan waters and have been subject to high pressure, with closed seasons and other management measures.

The regulations on management measures for marine fisheries, continental fisheries, aquaculture have defined in recent years Total Allowable Catches (TACs) around 320,000 tons. In 2020[13], 60% of this quota being allocated to sardinellas (150,000 tons) and Cunene mackerel (40,000 tons). In 2020, 5,500 vessels were authorised for artisanal fishing; Luanda (32%), Benguela (23%), Namibe (18%) and Zaire (11%) are the provinces with the largest sea fishing. In industrial and semi-industrial fishing, the fisheries with the greatest allowable effort are about (120 vessels), tuna (100 vessels), 40 demersal and 7 pelagic trawlers and 25 for deep sea shrimp, among others.

Existing statistical information on continental fisheries is limited; the regulation on fisheries management measures for 2020 requires the introduction of effort and catch data collection systems. The most commonly caught species are Tilapia and Bagre. Aquaculture, which is still a nascent activity, has a high priority towards increasing fish production as the climate and market conditions in Angola are excellent.

Figure 32: Pelagic species caught on World Beach

There are more than 200 fishing communities located along the entire maritime coast and a considerable number in the interior. Artisanal maritime and continental fisheries contribute to food and nutritional security, fight hunger and reduce poverty as they contribute to job creation, income generation and economic growth in the communities. The country is not yet fully studied and, particularly in the interior, fishermen fish seasonally as they are also farmers.

In 2018 there were 20,000 fishermen registered by the Institute for Artisanal Fisheries and Aquaculture and over 85,000 people were directly and indirectly involved in the artisanal fisheries, including fishermen, processors, traders and other actors in the value chain. The catch of non-industrial fishing in recent years has been around 100,000 tons, which corresponds to about 30-40% of the country's total catch.

Sector vulnerabilities

The main vulnerabilities of the fisheries and aquaculture sector relate to the availability and distribution of the main fisheries resources as well as the existing technical and institutional capacity. These are impacted by changes in temperature and wind regime, as well as rising sea levels and decreasing freshwater levels in continental fisheries and aquaculture.

In the southern provinces of Benguela and Namibe, the coastal ecosystem is dependent on *upwelling,* which provides a nutrient-rich environment. Changes in wind regime have an impact on coastal upwelling, a decrease in wind intensity leads to lower nutrient availability and a decrease in available fish resources.

The provinces of Luanda, Zaire and Bengo could be impacted by the increased frequency and intensity of hot winds along the coast. These events have a strong impact on marine biodiversity and fishing productivity.

Continental fisheries and (inland) aquaculture are vulnerable to changes in water resources. Rainfall patterns, temperatures and rising sea levels (e.g. due to saline intrusion) have a potential impact on these activities.

Proposed adaptation measures

The following options for adaptation should be considered in the fisheries sector:

- Continue research activities within the Benguela Current Large Marine Ecosystem (BCLME);
- Increase knowledge about primary and secondary production;
- Carry out studies on the impact of climate change on fisheries productivity;
- Improvement of species life cycle information (spatial and temporal distribution of eggs and larvae, recruitment) and environmental life-cycle relations;
- Expand the capacity to develop climate modelling projects for the different fishing production systems;

- Study and update the fishing potential;
- Develop studies to define and improve economic instruments to prevent and compensate for climate losses in the fisheries sector, such as fisheries insurance, subsidies, funding opportunities linked to sustainable fishing practices, etc;
- Incorporation of environmental information in the assessment of the state of resources;
- Strengthen surveillance and control of the EEZ;
- Invest in strengthening the Namibe Academy of Fisheries and Marine Sciences - several of the studies and initiatives indicated above could take place in the academy as research programmes;
- Improve knowledge and availability of data/information on the main threats related to climate change;
- Create an IT platform containing all the necessary information regarding the ecology of species, their characteristics/environmental needs;
- Create an Innovation and Skills Centre with a broad scope of the Fisheries and Marine Resources Sector;
- Training and strengthening the technical and technological capacities of fishermen;
- Train executives and train technicians and fishermen in the adoption of systems and technologies that contribute to adaptation to climate change in fisheries;
- Develop training programmes for fishermen in the fields of artisanal and sustainable fisheries and include women in these training courses, as well as in the energy efficiency of fish conservation/processing;
- Place marine reserves as reference areas of the ecosystem reducing the influence of other pressures and improving their monitoring;
- Establish and implement pilot projects in order to develop and test preventive and response measures for the fishing industry;
- Define and implement fisheries management measures adapted to the vulnerability of

species, including conservation measures;

- Encourage and support programmes for the conservation and sustainable use of marine resources;
- Invest in the use of new and sustainable technologies that address the integrated management of marine resources;
- Review of fisheries support infrastructure.
- Schematisation of climate change impacts in the fisheries sector based on the PEIR methodology;

PRESSURE	STATE	IMPACT	RESPONSE
5. Wind and temperature regime Availability of water (inland fishing)	Changes in biodiversity and productivity. Changes in habitats at sea and in continental fisheries could lead to changes in the availability and distribution of major fisheries resources	Increased hunger and malnutrition/food insecurity; Impact on fish prices	Deepening knowledge on impacts and on primary and secondary production; Prepare studies on the impact of climate change on fisheries productivity and coastal economies Expanding the capacity to develop climate modelling projects for different fishing production systems Study and update the fishing potential; Incorporation of environmental

6. Increase in average sea level	Changes in the availability and distribution of the main fisheries resources, in particular continental fisheries	Increased hunger and malnutrition/food insecurity; Impact on fish prices	Review of fisheries support infrastructure; Incorporation of environmental information in the assessment of the state of resources; Implementation of fisheries management measures adapted to the vulnerability of species, including conservation measures; Conducting studies to assess the impacts of climate change; Improvement of species life cycle information (spatial and temporal distribution of eggs and larvae, recruitment) and environmental life-cycle

3.4.6 Coastal areas

Since 1990, coastal areas have been considered by the Intergovernmental Panel on Climate Change (IPCC) as particularly vulnerable to climate change, in particular to rising average sea levels. The coastal zone or coastal strip corresponds to the transition zone between continental and marine domain; it is a complex, dynamic, changeable strip subject to various geological processes. The high dynamism characteristic of coastal zones is reflected in their constant evolution. Some forms change, change position, some disappear and others appear.

The mechanical action of waves, currents and tides are important modelling factors of coastal zones, the results of which are forms of erosion or forms of deposition. The erosion forms result from wear and tear caused by the impact of wave movement on the coast, marine abrasion, being more noticeable on the cliffs. Deposition forms are the consequence of the accumulation of materials pulled by the sea or carried by rivers, when environmental conditions are favourable. The result is beaches or barrier islands.

The coastal zone is a system that is in a dynamic equilibrium, which results from the interference of numerous natural and man-made factors. Natural phenomena that interact with the dynamics of coastal zones may include alternation between marine regressions and transgressions, alternation between periods of glaciation and interglaciation, and the deformation of the margins of continents[24].

Among the anthropic factors affecting the dynamics of coastal zones, the following are highlighted:

- The often excessive occupation of the coastal strip;
- The decrease of sediments arriving to the coast by the construction of dams in large rivers;
- The destruction of natural defenses, which results from the trampling of dunes, the grubbing up of vegetation coverage, the extraction of aggregates and disorderly construction;

The IPCC Special Report on Oceans and Cryosphere in a Changing Climate (SROCC) indicates with high confidence that almost 50% of coastal wetlands have been lost over the past 100 years as a result of the combined effects of localized human pressures, rising sea levels, warming and extreme weather events (high confidence). Coastal ecosystems with vegetation are important carbon reserves; their loss is responsible for the release of 0.04-1.46 GtC per year (average confidence).

The same IPCC Special Report also indicates with high confidence that coastal communities are exposed to multiple climate-related risks, including tropical cyclones, flooding, extreme sea levels and heat waves.

The loss of coastal ecosystems increases the impacts of extreme events. A variety of responses have been implemented around the world, mainly after extreme events, but also some in anticipation of future sea level rise, for example in the case of large infrastructure.

The Angolan coastline extends 1,650 km and is represented by 7 provinces (Cabinda, Zaire, Bengo, Luanda, Kwanza Sul, Benguela and Namibe), with 8 major cities (Cabinda, Soyo, Luanda, Sumbe, Lobito, Benguela, Namibe and Tombwa). Sixty percent (60%) of the population and the main centres of political and economic decision-making are located on the coast.

[24] coastal zone in Infopedia [online]. Porto Editora, 2003-2020. [consult. 2020-04-27 18:41:02]. Available on the Internet: https://www.infopedia.pt/$zona-costeira)

Based on the criteria adopted by the Interministerial Commission for the Delineation and Demarcation of Maritime Spaces of Angola (CIDDEMA), which is responsible for the legal status of the various spatial aspects that make up Angola's coastal zone, the following divisions were defined for the Angolan coast:

From the mouth of the Congo River to Luanda, the coast is southeast facing and is supported by low cliffs (about 30 metres). In the region of the city of Luanda there is a sandbank, the island of Luanda, which forms a bay and to the southwest of the city, an extensive shallow lagoon protected by the Mussulo sandbank. From Luanda to Porto Amboim, with the exception of 20 km of sandy beach south of Ponta das Palmeirinhas, the coast is characterised by cliffs that reach in certain places, 100 meters high.

From Porto Amboim to Lobito, with the exception of the high promontory of Ponta do Morro, north of Porto Amboim, the coast of approximately 70 km to the Quicombo shows a low relief. From Lobito to Benguela, the coast of about 30 Km, coincides with the limit of the north coast of the Namib desert. The region of the mouth of the Catumbela River is remarkable for its complex of lagoons that supports a variety of waterbirds.

From Benguela to Namibe, the coast is arid and mostly rocky stretching southwest towards Cape Santa Maria and towards Namibe. From Namibe to the mouth of the Cunene River, the coast consists of sandy desert supported by sand dunes that move and is characterised by prisms of relatively small sandy beaches, with frequent outcrops of rocky substrate.

Angola's coastal zone contains several characteristic coastal geomorphological elements such as the islands of Luanda and Mussulo, lagoon systems, coasts and rocky bottoms, mangroves and marshes, sandy platforms, beaches (sandy and muddy) and cliffs, dunes and sandy cords, estuaries, coastal lagoons and various forms of marine water. In each of the ecosystems indicated, there is a specific diversity of biodiversity.

Basic state of the sector

The economic opportunities in Angola's coastal areas include traditional sectors such as fishing, maritime transport, and hydrocarbon exploration, as well as emerging sectors such as tourism, biotechnology, energy and information technology and telecommunications.

The available biological resources of the coastal zone represent a significant economic and development opportunity for present and future generations. In Angola's coastal zone, there are biomes of various ecosystems and an enormous diversity of flora and fauna. There are habitats, nurseries and nesting areas for several species of flora and fauna of ecological and economic importance.

The main flora in Angola's coastal area is mangrove swamps and salty grass, which develops on the sand beaches. The coastal fauna consists of several species of fish, mammals, sea and coastal birds, molluscs, crustaceans, etc. Sea turtles, sea and coastal birds, sea lions, dolphins and whales, humpback (Megaptera novaeangliae), blue whale (Balaenoptera musculus), are of great importance in terms of biodiversity. Still along the coast there are individuals of the reptile class, including turtles, lizards, snakes and crocodiles (Branch,1998).

The rare and endangered species of migrant flora and fauna defined by International Conventions have received the attention of authorities and some civil society organisations.

The coastal zone requires special attention as it is home to a great diversity of habitats and species and concentrations of human population and is the scene of socio-environmental conflicts in the appropriation and use of natural resources.

Figure 33: Namibe Coast

There have been a number of intervention programmes and projects in the coastal zone. The table below lists some. The Ministry of Culture, Tourism and Environment has institutionalised the Contingency Plan to mitigate marine pollution from oil spills. There have been attempts to strengthen the system of coastal spur defence, for example on the island of Luanda to protect against the waves commonly known as calemas.

Table 2: Adaptation Projects Developed on the Angolan Coastal Zone

Nº.	Project Name/Intervention	Intervention Areas	Year	State

Complexo Administrativo Clássicos de Talatona, Rua do MAT,
Building 4, 4th Floor
Talatona Municipality, Luanda
E-mail: dnaac@mcta.gov.ao

1	Coastal protection project: construction of five spurs to contain sea waters	Luanda	1st Phase: 2005; 2nd	Finalised
2	Works on the drainage networks in Tchizo, Missão, Lombolombo and 1 de Maio neighbourhoods (Cabinda)	Cabinda	2010	Finalised
3	Risk and disaster reduction capacity building project	Luanda	2012	Finalised
4	Drainage network works: creation of drainage ditches to receive	Luanda	2016	Finalised
5	Construction of a landfill and repair of the main access roads to the province's host	Benguela	2019	Foreseen
6	Luanda's new waterfront project	Luanda	2018	In progress
7	Namibe Academy of Fisheries and Marine Sciences	Namibe	2016	In progress
8	Responses to urgent coastal adaptation needs and capacity gaps in Angola	Coastal areas of Angola	2016	In progress
9	Support to continental fisheries and communal aquaculture project	Luanda, Kwanza Norte, Malanje	2015	In progress

Sector vulnerabilities

The Angolan coastline is particularly vulnerable to climate change, not only because of natural and climatic pressures, but also because of human pressure. The analysis of the vulnerability of Angola's coastal zone to the scenarios of sea level rise (NMM) and to extreme phenomena such as drought, flooding or sharp variations in temperature requires the consideration of several factors, such as the dynamics of the coast and its forcing processes, in addition to the socio-environmental conflict and the impact that comes from human activities and occupation.

The degree of vulnerability in Angola's coastal zone may be linked to its physical and biological characteristics, but also to rapid and often disorganized urban growth as a result of a sharp rural exodus, traffic and air pollution, and high waste production. The coastal zone has suffered a great impact and pressures have tended to worsen.

The choice of vulnerability parameters can be complex and depends very much on the analysis to be carried out. Vulnerability parameters can be selected such as: hydrographic network, distance to coastline, type of coastline, solid geology, land use, size of urban settlement, level of services, etc.

Proposed adaptation measures

Adaptation will involve the application of the Integrated Coastal Zone Management method, which builds on a better understanding of the functioning of the coastal ecosystem, to identify the main areas of likely impacts and measures to mitigate and adapt to those impacts. With this knowledge and the active listening of technicians, policy makers will be able to take their decisions more consciously.

Increasing investment in physical and social infrastructure is an essential condition for improving the resilience and adaptive capacities of societies. In this work, some adaptation measures are proposed, for some economic sectors considered a priority in Angola's coastal zones:

- Knowledge development: Continue to develop risk maps for flooding and erosion of the main coastal units at municipal level; Carry out studies to assess the impacts of climate change (sedimentation and coastal erosion, salinisation levels, drainage systems, biological changes in the different habitats) on the coastal zone; Assess the defense capacity of existing protection structures in areas at risk, including analysis of the feasibility of new investments to build protection structures at sea level rise;
- Urbanisation: Integrating risk maps into municipal territorial plans, revision of drainage and waste water treatment networks, construction of protection structures, updating of emergency management plans, movement of people and goods, reduction of soil sealing, increase in plant coverage;
- Transport (ports, roads and bridges): Stepping up programmes for drainage, adaptation and/or rehabilitation of port infrastructure; construction of protective infrastructure, altering the road network, paving roads with more durable materials, stepping up maintenance programmes;
- Water and sanitation: Expansion and adaptation of supply and drainage infrastructure,
- Construction of water storage infrastructure;
- Energy: Expansion and rehabilitation/adaptation of electricity distribution networks, focus on renewable energy and energy

efficiency;

- Fisheries: deepening of knowledge on impacts, training of fishermen, review of fisheries support infrastructure;
- Define a network of marine and terrestrial protected areas that serve to preserve habitats, especially dunes, mangroves and other ecosystems that provide important services;
- Carry out campaigns to raise public awareness of the risks of rising average water levels in coastal areas of urban centres, particularly in areas at high risk
- Create an early warning system, involving the Civil Protection and the National Institute of Meteorology and Geophysics of Angola, in order to support coastal communities and strengthen coastal contingency and emergency plans.
- Implement a system for monitoring the evolution of coastal space and the coastal system
- Strengthen monitoring so as to condition the occupation of territory located in areas at high risk of flooding in coastal areas.

Schematisation of the impacts of climate change on coastal areas based on the PEIR methodology.

Complexo Administrativo Clássicos de Talatona, Rua do MAT,
Building 4, 4th Floor
Talatona Municipality, Luanda
E-mail: dnaac@mcta.gov.ao

PRESSURE	STATE	IMPACT	RESPONSE
Rise in average sea level.	Loss/ removal of coastal ecosystems with vegetation; Increasing the frequency and intensity of extreme coastal drifting and erosion phenomena.	Decrease in carbon absorption; Material damage; Exacerbation of extreme sea Levels and coastal risks; Impacts on habitat and biodiversity; As well as on ecosystem functioning and	Review of drainage and wastewater treatment networks; Increase investment in physical and social infrastructure; Intensification of programmes for the drainage, adaptation and/or rehabilitation of port infrastructures; Deepening knowledge on impacts, training of fishermen, review of fisheries support infrastructure; Implementation of a system for monitoring the evolution of the coastal system and the use of coastal space;

PRESSURE	STATE	IMPACT	RESPONSE

Complexo Administrativo Clássicos de Talatona, Rua do MAT,
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E-mail: dnaac@mcta.gov.ao

Decrease in total rainfall in Angola 2021-2050 61 to 71 mm 2051-2080 64 to 76 mm Increase in drought in Angola	Reduction of water availability Changes in hydrological regime Changes in the distribution and availability of fishery resources (through	Changes in the structure of the estuaries Loss of coastal wetlands Increased vulnerability to saltwater intrusion Losses in	Construction of retention, storage, recharging infrastructures. Promotion of techniques to increase the efficiency of water use in agricultural production systems, with emphasis on the use of efficient irrigation systems and rainwater use Dredging of estuaries

PRESSURE	STATE	IMPACT	RESPONSE
Increased convective rainfall (torrential rains) in the territory of Angola 2021-2050 2051-2080	Acceleration of coastal erosion process Removal of vegetation cover	Destruction of natural defenses Increased flood risk, especially at high tide Increased risk of flooding Pollution of fresh water bodies	Implementation of a system for monitoring the evolution of the coastal system and the use of coastal space; Promotion of Community forest plantations; Reducing the level of deforestation of native forests; Urban planning

3.4.7 Health sector

Angola is undergoing a transition in health with a focus on demographic, epidemiological and nutritional indicators, while at the same time aiming to improve the country's epidemiological pattern in order to reduce the weight of diseases, decrease maternal and infant mortality rates and increase life expectancy at birth.

In demographic terms, the trend will be towards lower fertility rates, lower infant mortality rates, lower general mortality rates, higher life expectancy at birth and an intermediate age profile with children, young people and adults.

The epidemiological transition is characterised by the dual burden of communicable diseases (arising from poor drinking water supply, hygiene, sanitation and food conditions) and chronic diseases (arising from new lifestyles such as sedentariness, excessive consumption of alcoholic beverages, smoking, the use of other drugs and other risk factors associated with disease). The country has sought to focus attention on health promotion and protection measures, disease prevention, information and social mobilisation to ensure greater community awareness and participation in health interventions.

The country has also sought to improve responses to disease determinants as far as possible, and to prevent the risks of epidemics, pandemics and other disasters, thereby ensuring national health security and contributing to global health security.

For health projections, the climate has to be taken into account, as well as the economic context, characterised by the need to diversify sources of income and privatization, in addition to the immediate need for development by meeting the basic needs of the population.

Basic state of the sector

The analysis made for the health indicators for NDP 2018/22 showed a significant improvement of several indicators. The maternal mortality ratio rose from 1400 maternal deaths per 100,000 live births in 2001 to 460 per 100,000 in 2011. The neonatal mortality rate in 2001 was 98 per 1,000 live births, down to 42 per 1,000 live births in 2010 and 28 in 2019. Infant mortality has evolved from 150 deaths per 1000 live births in 2001, to 101 in 2011, to 50 in 2019. Under-five mortality rose from 250 in 2001 to 167 in 2011 to 75 in 2019. Adult mortality (15-60 years) in 2012 was 314 per 1000 population compared to the average rate of 383 per 1000 population in the African region.

Table: Principal health indicators in Angola and the African Region
Health sector contributions to NDP 2018 - 2022

Indicators	
Life Expectancy	62 years
Neonatal Mortality Rate	42 / 1000 NV
Mortality in children under 1 year of age	101 / 1000 NV
Mortality under 5 years of age	167 / 1000 NV
Maternal mortality	4,5 / 1000 NV
Mortality rate in adults 15- 60 years of age	314 /1000 Hab
Access to health services	44.6% Information not available

Source: NDPS 2012-2025

Despite the improvement in health indicators, the country still has a high rate of maternal, infant and child mortality, a high incidence of infectious and parasitic diseases, especially major endemics, respiratory and diarrheal diseases, a still high level of malnutrition in children under five, recurrent epidemics of cholera, rabies, measles and malaria, and an exponential increase in chronic non-communicable diseases, including road-trauma and violence. Communicable diseases account for more than 50% of deaths in the general population.

Between 2013 and 2016, the Epidemiological Surveillance System detected five epidemics, namely yellow fever (888 cases), malaria (3254270 cases), measles (27259 cases), rabies (230 cases) and cholera (6655 cases).
Current health problems are related to health determinants and the poor performance of the National Health System. Health services face problems in managing human, material and financial resources in addition to being under-funded, which is a huge challenge.

Among the main problems of the National Health System we highlight:

- Quality of care and health coverage still insufficient;
- Weak reference system and cross-reference between the three levels of the National Health Service;
- Insufficient human resources in terms of quantity and quality and poor distribution of staff in rural and peri-urban areas;
- Weaknesses in the Health Management System, including the information, logistics and communication system;
- Insufficient financial resources and inadequate funding model;
- Weak intersectoral collaboration in promoting health determinants such as access to safe water, energy, hygiene and sanitation.

Angola has the National Health Policy and the respective National Health Development Plan (NDPS 2012-2025) as fundamental guidance and management documents. They are aimed at ensuring the performance of the National Health Service, with the aim of improving the state of health and quality of life of the Angolan population. The state aims to guarantee the protection of public health through policies of social equity that eliminate inequalities in health and guarantee social protection. To achieve the general objective outlined, a series of actions were proposed that include but are not limited to the following main programmes:

- Organisation and management of the National Health System and disease prevention and control;
- Development of health research and the National Laboratory Network;
- Management of the medicines and medical equipment sector and strengthening of the Health Information System;

On the other hand, the strategic objectives proposed in the set of policies, strategies and programmes can be summarised as follows:

- To reduce the burden of disease through the promotion of health determinants and cross-sectoral collaboration to improve the quality of life with the aim of reducing maternal and child mortality and increasing life expectancy at birth;
- Developing institutional and human capacity in health sciences research and producing
  reliable and timely statistical data and information for decision-making ;
- Ensure sustainable financing of the National Health Service and develop intersectoral collaboration mechanisms to address social determinants of health;

The objectives are supported with a number of actions in which we highlight:

- Defining the role of traditional medicine and preventing and controlling immuno-preventable diseases;
- Prevent, control and eliminate Malaria and promote measures to prevent and control chronic diseases;
- Provide health care for maternal, child and child-youth survival including the fight against malnutrition and the fight against risk factors associated with chronic diseases;

The Environmental and Health Surveillance systems in Angola still have weaknesses and are not fully comprehensive for all priority areas or at all levels.

Malaria remains the leading cause of morbidity and mortality, accounting for more than 50% of the demand from health facilities in the country. In 2009, this disease was responsible for 23% of mortality among children under the age of 5, contributing also to maternal mortality. According to the World Malaria Report (2019), Angola is among the 10 countries with the most cases of malaria and the most deaths (4% of cases and deaths worldwide). Between 2015 and 2018, malaria cases increased 14% from 200 to 228 cases per 1000 people at risk. The death rate fell by 8% from 0.47 to 0.43,000 people at risk.

Acute Respiratory Diseases come second, in particular Pneumonia, which is a major cause of illness and death in children under 5 years of age. The third major cause of disease and death in the country is acute diarrheal diseases, including cholera, whose risk factors are associated with high population mobility, overcrowding, poor individual and collective hygiene and poor water supply and waste control in peri-urban residential areas (WHO 2005).

Sector vulnerability towards climate change

In terms of human health, climate change tends to lead to an increase in the number of deaths related to prolonged periods of high temperatures, an increase in diseases transmitted by water, food or other vectors and a worsening of the health problems associated with air pollution.

Rising temperatures and wetter conditions can have an impact on human health through a change in the geographical distribution of diseases. Vector-borne diseases are sensitive to climatic factors.

The IPCC projects a 5-8% increase in arid and semi-arid lands in Africa could increase transmission and favour the expansion of the meningitis area.

Dengue is transmitted by the bite of the contaminated female *Aedes aegypti* mosquito. The expansion of the urban environment, with poor sanitary infrastructure, is conducive to increasing the density of the vector population. If torrential rain and flooding are more frequent in the future, they may create more suitable conditions for Dengue fever, although there are several other factors.

Malaria is an acute or chronic infectious disease caused by protozoan parasites of the genus *Plasmodium*, transmitted by the bite of the *Anopheles* mosquito. The presence of the malaria mosquito depends on temperature, humidity, water and wind. There is a possibility that malaria could spread to areas of Africa where it is rare for climatic reasons. Higher temperatures may extend the range and seasonality of disease transmission caused by a vector, especially malaria.

In Luanda, with heavy rains and flooding in 2008, there was an increase in disease associated with contaminated water (cholera, gastrointestinal diseases and malaria). One consequence of climate change may be an increase in the number of extreme events that generally cause a peak in the incidence of diseases associated with the decline in personal hygiene as well as the lack of drinking water. High temperatures and humid conditions, even for short periods, can have an effect on food quality.

Frequent flooding can create risks of disease linked to poor sanitation. Variability in precipitation, or heavy rainfall, which implies changes in river basin parameters and flooding, soil erosion and sedimentation will have implications for infrastructure and transport that can be damaged by abnormal flooding.

Cholera is a disease caused by *Vibrio cholerae*, a bacteria that rapidly multiplies in the human intestine producing a potent toxin that causes intense diarrhoea. It only affects humans and its transmission is directly from faecal waste from patients by oral ingestion, mainly in contaminated water.

The IPCC Fourth Report concluded with certainty that human health in Africa could be negatively affected by climate change instability (IPCC, 2007). Changing temperature and rainfall patterns will alter the ecology of some disease vectors, thus altering the manifestation

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of certain diseases. Much research in this field has focused on malaria, but there are also risks of changes in the manifestation of dengue fever, meningitis and cholera. Some of the direct effects of climate change on health are floods, droughts and heat stress. Some of the indirect effects are the spread and/or increase in the incidence of infectious and vector-borne diseases, water-borne pathogens, water and air quality, and food availability and quality. The actual future impacts depend heavily on local environmental conditions, the socio-economic situation of the area and existing adaptation measures to reduce threats.

Vulnerability is the ability of a community or communities to adapt to health threats depend on their overall health status. In this respect, factors such as the prevalence of cardiovascular disease, HIV and TB, malnutrition or atrophy especially in children, level of education and awareness, economic status, general demographic profile, migration patterns and levels, level of development and maintenance of infrastructure, access to and availability of skilled medical personnel and facilities, and population density are taken into account.

The analysis of environmental risks to health and the environment in Angola focused on the importance of initially presenting the urban and rural environments and the main urban and rural human settlements prevalent in the country.

Between 2008 and 2010, Angola was the target of storms resulting from rainfall changes that could be a reflection of climate change with unusually heavy rains that motivated more than two hundred thousand environmental refugees and seven dozen deaths in addition to the death of livestock and the loss of biodiversity due to the accumulation of water resulting from abnormal rainfall.

The consequences of the rains that fell in this period in the provinces of Cunene and Cuando Cubango were also due to anarchic human settlements, poor water management, lack of urban planning and other factors, which characterize the state of vulnerability to which the populations are exposed.

The phenomenon of high urban temperatures is called an urban heat island. Urban heat islands cause discomfort in cities with a tropical and warm climate. Changes in air humidity, rainfall and wind are also associated with the presence of urban heat islands Heat islands aggravate heat waves (heat waves) with consequences such as sleep disturbance or health impacts.

If the climate warms, tropospheric ozone and airborne allergen levels may increase, contributing to the worsening of asthma and other respiratory diseases, potential risk of vector and rodent borne diseases.

The contamination of soils by urban solid waste that affects especially cities, due to the irregularity of household waste collection and cleaning of public places and consequently the proliferation of disease vectors (insects, rodents and others). The final disposal of waste done spontaneously, in the open air and in inappropriate places, can also cause the contamination of surface and groundwater.

Proposed adaptation measures

The proposed adaptation measures take into account the various climate scenarios proposed for the southern region of the African continent, the general conditions allow assessing the vulnerability of the health sector to climate change, the conditions that characterise the sector in terms of technical and institutional capacity. The results of the conference on health and environment in Angola held in 2010 contributed to the assessment process, in addition to the information content contained in the NDP for the period 2018-22.

Adaptation options that reduce the vulnerability of human and natural systems have many synergies with sustainable development, if well managed, such as ensuring food and water security, reducing disaster risks, improving health conditions, maintaining ecosystem services and reducing poverty and inequality (high confidence).

Increased investment in physical and social infrastructure is a fundamental condition for improving resilience and adaptive capacities, just as integrating climate change into Angola's development process may be fundamental in order not to jeopardize the development plans outlined.

The adaptation measures proposed for the health sector are as follows:

- Continue to collect more accurate information on the geographical distribution of human diseases and their occurrence in relation to rainfall and temperature and extreme events (such as floods and droughts);
- Operationalise a National Health Research Plan (PNIS):
- Create the National Commission for Scientific Research in Health (CNIS) to facilitate

studies and implement and monitor the PNIS;

- Deepen studies on the implications of climate change and interact with the climate observatory;
- To study the issues of transmission and spread of diseases resulting from extreme weather events and to conduct studies on tropical epidemics;
- Strengthening knowledge and monitoring of diseases associated with the aquatic environment (e.g. cholera, leptospirosis, schistosomiasis, giardiosis, cryptosporidosis, enteric viruses, campylobacteriosis, salmonellosis, hepatitis, malaria, onchocerciasis, arbovirus) and the development of corresponding contingency plans;
- To seek to identify the causes of the epidemics and their consequences for Angolan society;
- Identify possible changes in patterns of transmission of tropical diseases resulting from climate change;
- Map the dangers and risks of diseases affecting communities and define the climate profile for health in Angola;
- Create an emergency response plan for major epidemics resulting from extreme weather events;
- Monitor disease trends and variables related to disease prevalence to help prepare for periods of high risk.
- Improve communication with the population so that people can prepare for periods of high risk;
- Monitor environmental risks with human health implications at a country-wide level and produce statistical balance sheets that illustrate trends and enable early decision making in relation to extreme events and improve local response to site- specific conditions;
- Update the methodology for the elaboration of the National Plan and the Provincial Plans for the Development of Human Resources for Health;
- Develop in each municipality a plan for adaptation of health to climate change adapted to the conditions of the municipality;
- Establish a methodology to be used in each health unit for the periodic assessment of vulnerability and adaptation to climate change for the health sector in each location;
- Improve health system preparedness for more extreme and adverse climatic situations and events (exp. floods or heat islands in urban centres):
- Continue to restore the health and health surveillance system,
- Review the basic health care package and update the essential list of medicines, medical devices and other health products, taking into account the country's epidemiological framework;
- Restructure and create new careers in the integrated health sector the issue of adaptation to climate change and its integration into the general system of training and capacity building;
- Consolidate the process of municipalisation of health care at primary level and strengthen local technical and institutional capacity for the challenge of climate change;

- Regulating the development of the Private Health subsystem so that it can also respond to the general challenge and contribute to the adaptation process to climate change in the health sector;
- Promote post media specialization and post-graduate studies in health sciences, according to the specific needs of the different localities in Angola, integrating the climate conditions of each specific region;
- To build and equip the National School of Public Health and provide it with conditions that allow the integration of adaptation to climate change in the curricula;
- Adapting health system buildings to climate change. It will be important that health system buildings are out of reach of erosion and flood risks. The orientation, design and ventilation of health system buildings is especially important, patients are especially sensitive to heat waves;
- Encourage the national pharmaceutical industry to produce medicines and medical devices appropriate to the climatic conditions of each location;
- To work in partnership for the elaboration of the National Policy of Environmental Sanitation that will integrate the issues of environmental sanitation, waste management, environmental health, pollution, adaptation to climate change among other aspects related to the quality of life of the populations;
- Create a common structure between the Ministries of Culture, Tourism and Environment and Health for the implementation of actions under the Bamako Convention and the various African Declarations on Health and Environment and a set of other decisions and research results on climate change;
- Develop the Information, Education and Communication programme for Health and Environment, with a focus on climate change at all levels of education, strengthening the teacher training approach;
- Support Community participation through awareness raising and social mobilisation and the development and implementation of community-based adaptation programmes.

3.4.8 Infrastructure Sector

The development of infrastructure[25] in Angola is a key priority of the government for the reconstruction of the country and future challenges. Since the end of the armed conflict, the country has invested more than 110 billion in public works.

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[25] In sociology, Karl Marx described infrastructure as the economic phenomena that support any society. An infrastructure is the set of elements or services considered necessary for an organization to function or for an activity to develop effectively. In addition, infrastructure is also the basis of **superstructures,** which can be institutions or structures related to philosophy, religion, law, etc. The term **urban infrastructure** refers to the services or public works that are part of an urban environment, such as: electric power network, basic sanitation network, gas network, buildings used for public purposes, etc.

However, the effectiveness of the investment in many cases is questioned. Industry and agriculture, sectors considered strategic in the process of diversifying the Angolan economy, continue to fail to take advantage of public investment or the strengthening of electricity production and distribution.

The "Energy in Angola 2016 Report" noted that over US$8 billion (7.5 billion euros) had already been invested in the electricity sector alone in recent years. It also concluded that the electricity sector accounted for 1.2 percent of Angola's GDP in 2012, having fallen to 0.2 percent in 2015, to the equivalent of US$204 million (191 million euros). Also, according to the report, installed capacity in Angola at the end of 2015 was 2,354 MW, less than half that needed for national consumption estimated by the government. Of this total, only 916 MW were guaranteed through water use, while the remaining 1,428 MW resulted from thermal production, with the country having a transport network of 2,244 km, at various voltage levels.

On annual average, reconstruction activities account for about 10 per cent of GDP. The need of new infrastructure, public services and public buildings for the economic development is well documented and for these reasons the government has been internationally praised for its priorities. We also know, however, that the global construction sector is particularly exposed to excessive costs, poor quality and lack of maintenance. This is often caused by weak governance institutions and regulations.

The combination of rapid reconstruction and weak institutional capacity has increased the particular risk of corruption in publicly funded construction projects. Compared to many other countries in the region, the volume and outflow of investment from the country in the sector is impressive. Some major construction projects have been successfully completed in recent years, such as the rehabilitation and expansion of many provincial airports, the rehabilitation of major roads between major cities (Benguela-Huambo, Luanda-Malanje, Malanje-Uíge, etc.) which also included the construction of many large bridges and, less importantly, the reconstruction of Luanda, Benguela and Namibe railways. Several other projects of various dimensions in the field of water and sanitation, electricity and telecommunications, government buildings and public housing have been undertaken.

Despite the huge public investments that have already been made in Angola over the last decade, and the various construction projects successfully concluded, there is still an urgent need to build or rehabilitate houses, schools, roads and industries. Lack of housing is a chronic problem that has led to the expansion of musseke (informal neighbourhoods without access to water and sanitation services), especially in and around the capital, Luanda. Water supply and urban drainage systems currently reach only a small portion of the population, and the existing systems are at poor state of preservation. The rural environment lacks transport and production support infrastructure. Almost the entire road network, primary and secondary, is in poor or very poor condition. Port infrastructure operates below capacity due to obsolete equipment and outdated working practices. Less than 5% of the railway system is currently operational. Major airports require considerable improvements and/or repairs.

The challenge for the Government remains to respond to a number of urgent needs and to deal with annual population growth.

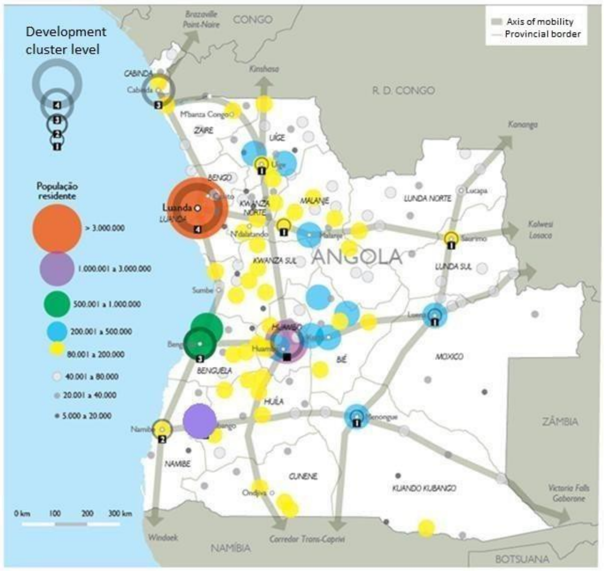
The market for building materials is in its infancy and therefore underdeveloped. There is a glaring lack of competence in both the building materials sector. With the scarcity of domestic materials production, construction companies in Angola now have to import most of their own materials and equipment. The most important players operating in the Angolan public works market are foreign companies.

In the area of infrastructure, the National Development Programme (NDP) for the period 2018/2022 sets out a series of actions to continue to address the development of infrastructure, taking into account the context in which the country lives. From the set of planned actions, we highlight the following priorities:

- Improving the movement of people and vehicles (requires continued investment in primary, secondary and tertiary roads);
- Promote investments in infrastructure, in coordination with the other sectors (This presupposes the development of integrated infrastructure, which in itself already contributes to the reduction of costs and consequent improvement of effectiveness and efficiency);
- To increase and improve the technical level of the national workforce linked to civil construction (presumes investment in human resources);
- Perform major engineering works (Technical and institutional improvement);
- Consolidate the legal and institutional framework of the construction sector;
- To contribute to the national construction effort by promoting the rehabilitation and construction of infrastructures appropriate to the needs of the country's development process.

The priorities presented fall within the following outlined programmes: Integrated infrastructure investment programme, Programme for the construction of social amenities and public buildings, Programme for the construction of new structural road corridors, Programme for the execution of major engineering works, Spatial Planning and Urbanism, Geodesy and Cartography.

Figure 34: Development cluster and mobility axes



Vulnerability of the sector to climate change

Since the mid-20th century, most of southern Africa has been experiencing an increase in average annual, maximum and minimum temperatures. The most significant warming has been in the last two decades. Minimum temperatures have increased faster compared to maximum temperatures inside southern Africa. There are also changes in precipitation observed in the second half of the 20th century. Seasonal rainfall patterns, such as the onset or duration of rains, the frequency of dry spells and the intensity of rains, as well as delays in the onset of rains, have changed. More frequent dry periods, together with more intense daily rains, have implications for the management of surface and flood risk water resources. An increase in storm activity and severity is likely to have the most visible impacts in areas already susceptible to erosion.

The extreme events observed for the region show that there are more warm days and nights, hotter days in the last decades, in line with the general warming up. The likelihood of summer heat waves in South Africa has increased from 1981-2000 compared to 1961-1980. Heatwaves were associated with a lack of rainfall during the El Niño events.

Recent climate-related extreme impacts such as heat waves, droughts, floods, cyclones and forest fires reveal the exposure and vulnerability of African infrastructure and economies to the climate. Ecosystems are also sensitive to extreme weather events, seasonal activities and migration patterns of many terrestrial, freshwater and marine species have changed as a consequence of climate change. The pace of change has been rapid.

The urban population in Africa is projected to triple by 2050. African countries have some of the highest urbanisation rates in the world. Many of the evolving cities are surrounded by informal settlements and poverty where housing and basic services are inadequate.

Luanda is one such example, where much of the population continues to live in informal settlements on the periphery where basic services such as electricity, water, roads are not insufficient and, in many cases, non-existent for the people living there.

Climate change is among many factors driving rural-urban migration. This means that changes in climate can affect rural and urban settlements. Most of the migrations caused by changes in the environment take place within each country. Small and medium-sized cities have limited capacity to cope with current or future climate risks. Although cities are generally better served than rural areas, for example with piped water, sanitation, schools and medical care, poor infrastructure can reduce life expectancy in the face of climate change. Many cities in sub- Saharan Africa not only have inadequate piped water and sewage, but also have very limited capacity to invest in improving these services.

The lives of people living in areas characterised by extreme population density, uncontrolled growth, high levels of poverty and limited access to employment and socio-economic services are considered most vulnerable to the physical impacts of climate change.
Those living in informal housing areas are regarded as one of the most vulnerable populations in the world. They are often areas vulnerable to water calamities such as floods and extreme storms, especially when they are located in flood plains and the water infrastructure is inadequate. In some cases, infrastructure built to cope with weather conditions associated with water will not be adequate for the intensity and instability of future phenomena. The events related to extreme weather events that have been experienced in Angola where housing and a number of other public infrastructures have been devastated, are an example of the climate changes that are already taking place and are tending to increase.

Rising sea levels due to climate change will push back coastal limits, while forcing people to migrate and destroying infrastructure, fauna and flora and very important habitats (such as mangroves and coral reefs) and threatening human health, infrastructure, fisheries, biodiversity and tourism industries. A quarter of Africa's population lives 100 km from the coast and urban areas account for half of the population living in low-lying coastal areas. Most of Africa's largest cities (such as Luanda, Lagos, Kinshasa, Cairo with several million inhabitants each) are located along coasts that are vulnerable to rising sea levels, coastal erosion, and extreme weather events.

In Angola, in terms of the energy sector we see a great effort in the construction of infrastructure such as hydroelectric dams in the Middle Kwanza region, such as the hydroelectric plants in Cambambe, Capanda, Lauca and the use under construction of Caculu Cabaça. There has been an increase in power and also stability in this supply. Like the country's dependence on oil, the energy sector is currently highly dependent on the Middle Kwanza region. This fact makes the sector vulnerable to the trends of increasing climate variability that the various models have shown for the region and the country. It should be noted that in August 2012, due to water scarcity, it was not possible to supply energy through these dams. This demonstrates what can be expected in the future if the climate projections come true.

Climate change will have an impact on the distribution and transmission of energy. Transformers will cool down more slowly: heat in transmission cables can be maintained if there is less opportunity for it to cool down. This will affect transmission efficiency. Extreme weather events can create damage to the most likely transmission lines. With the rise in sea level and the advance of the sea in low relief areas, there will be an effect on the power cables.

Floods and rising sea levels will have an impact on the surface infrastructure, and there may be erosion of the supports, at the base of the supports increasing corrosion due to salt water.

Higher temperatures may increase the degradation of building materials and structures. The impact of heat will include the expansion of rail tracks and the more frequent melting of asphalt. Other materials can be more easily damaged with higher temperatures and/or flooding.

It is likely that the design and planning of certain infrastructures today has been done on the basis of 20th century parameters which will be different in the future. Rainfall variability can cause river flow variability. Bridges and other overflow paths have been planned without taking into account an increase in maximum river flows. The capacity may not be sufficient to flow with the result that riverside areas are flooded or even infrastructure destroyed (which is apparently the case in Cunene Province in recent years).

Resources that could be used to expand existing transport networks may have to be diverted to strengthen and adapt infrastructure to the climate. An increase in extreme weather events can also influence the mode of transport, for example, when storms become more frequent, ships or aircraft may become less safe.

Proposed adaptation measures

In general, adaptation to climate change (based on current projections) needs to be integrated into policies and legislation as well as provincial strategies. Implementing these changes often requires relatively radical transformations in thinking and institutional architecture (O'Brien et al 2006). For example, encouraging dependence on a natural resource whose availability may change according to the projections is a waste (Klein, 2001).

In order to protect the vast investment made in infrastructure and reduce maintenance costs, climate projections should be considered as an adaptation strategy for Angola, when designing programmes and projects. It will be necessary to study the climate parameters used in the design of infrastructure and adjust their design. Where infrastructure is placed in flood risk areas (rivers or seas) it will be important to ensure that valuable and essential equipment is out of reach or can be moved, and to ensure that emergency and repair strategies are developed and practiced with stocks of tools, spare parts and other materials.

Other specific measures:

- Reviewing the capacity of bridges, drainage for the flow of higher river flows. Depending on the case, there will be a need to create protection of certain infrastructures against heat, extreme precipitation and flooding or ventilation and to build more resistant infrastructures in the future against extreme climatic events that tend to occur in the location where such a project will be developed;
- Review the construction and maintenance of dirt roads if the rains are more intense or erosion more severe. It may be necessary to review the specification of the materials used, such as the expansion of railroad tracks or metal building supports or that of cement;
- It will be necessary to adapt the parameters for future constructions and to study possibilities to adapt current infrastructures.

Specifically, adaptation measures:

- Carry out an in-depth study on the effectiveness and efficiency of infrastructure investment from 2002 to the present, and learn lessons and best practices to improve investments later with the inclusion of present and future climate scenarios
- Continuously update the territorial register;
- Continue to map human settlements at risk of flooding and erosion;
- To study the implications of high temperatures and heavy rainfall for existing housing and to rehabilitate settlements where possible or promote relocation;
- Review the climatic parameters (and of erosion and sedimentation) used in the construction of roads, railways, hydro-electric power stations etc. in order to adapt them to a changing climate and update the legislation so that future constructions already include them;
- Improve building codes and designs taking into account factors such as ventilation and exposure to natural light;
- Integrating the need for resilience to climate change into public infrastructure repair

plans, in order to avoid what has already happened with various infrastructures such as roads and bridges, which have recently been rehabilitated and/or built with large investments that have deteriorated rapidly due to their seizure by excess rainwater, erosion or sharp wear and tear due to climatic conditions;

- Assess the cost-benefit ratio for balancing the burden of preventing and repairing damage to the main infrastructure erected and to all infrastructure still to be built; Study possibilities of adapting (making more resilient) existing infrastructure;
- Inventory critical infrastructure and assess its conservation status and risks in the face of projections of extreme weather events;
- Ensure that the works are completed correctly and that maintenance plans are implemented and to avoid erosion and sedimentation etc. Implement regular drainage ditch cleaning campaigns in the vicinity of existing public infrastructure;
- Implement autonomous rainwater retention and infiltration systems;
- Testing the various materials in future (projected) climatic conditions in order to reduce maintenance and or replacement by wear and tear in relation to inadequate climatic conditions;
- Stimulate the private sector to create national capacity for the production of construction materials necessary for Angola and adapted to local conditions and reduce their early wear and tear;
- In the training and qualification of staff and workforce for the infrastructure sector advocated by the NDP, include climate change skills and the challenges of adaptation;
- Develop training actions in construction and resilient infrastructures both for the public and private level;
- Diversify the national electric matrix to Angola's conditions, namely through the development of solar, wind and biofuel sub-sectors, among others, so that in the reform of the energy sector within the scope of mitigation, for example, dependence on hydroelectric power alone is not created;
- Promote energy efficiency in the process of rehabilitation and construction of public infrastructure;
- In the design of cities and settlements, provide local wind conditions to minimize the effects of the heat island; Deepen knowledge about the effect of the heat wave event on the most vulnerable population in all areas susceptible to occur;
- Build and reinforce flood protections in the vicinity of[10] waste water treatment and waste storage systems;
- Studying the suitability of the territory for the construction of basements (underground occupation).

3.5 Cost-benefit analysis of the proposed adaptation measures

Angola was still recovering from the currency crisis when the global COVID 19 pandemic hit the globe. The pressing need for balanced public accounts, combined with the current international situation, presupposes that economic and financial policies aimed at stabilising the economy and reducing the public deficit will still be adopted over a long period.

This difficult economic and financial context means that, just as the State is limited in its financial capacity for public investment in the coming years, it is to be expected that private economic agents will have equal economic and financial difficulties. It is to be expected that there will be a lack of financial availability for the implementation of some necessary measures and that the capacity of public and private actors to intervene will be constrained.

The profound change in the production structure, particularly in the agricultural sector, is generating opportunities and creating conditions for new investments to place greater demands on aspects of efficient water management, with these demands being more stringent in investments co-financed by donors. The productive sector faces a strong need for recapitalization in order to increase competitiveness and thus contribute to economic growth.

In view of the above, investment in adaptation measures will have to take into account the following aspects:

- the assessment of the costs of the measures to be proposed (including Operation and Maintenance (O&M) and investment costs);
- financial programming of investments and assessment of the feasibility of financing plans;
- Consideration of the cost-benefit ratio of the measures to be proposed and assessment of the ability of the economic agents involved to bear the burden of the measures implemented.

In this context, it is essential to identify the conditions of viability for the investments foreseen in the Sectoral Plans and to evaluate their contribution to the adaptation objectives. On the other hand, it is also important to consider that Angola's failure to meet its commitments may have negative implications for the mobilisation of funding and the international image of Angola.

Cost-benefit or cost-effectiveness analysis (CBA) is a method that seeks to identify the contributions of projects/actions (quantified in physical terms) to a certain level of expected results (with which the objectives are achieved) in order to select those that optimise the necessary investments and costs.

The benefit or effectiveness of a measure is estimated according to the impact on reducing the distance between the existing situation (baseline) and the desired situation (objectives) that it generates. To make this estimation, what is called "gap analysis" is done.

The effectiveness of each measure therefore depends on the purpose of that measure. It is therefore important to distinguish between corrective measures aimed at directly modifying/creating something and preventive measures aimed at other activities, e.g. monitoring, surveillance, licensing, awareness raising and information.

The aspects to consider in a cost-benefit analysis are:

- Financial investment costs - how much the work, good or service costs, how much the amount to be mobilised (e.g. interest on loans, expenditure incurred in mobilising the fund);
- Financial costs of operation and maintenance - financing of long-term activity plus management and administration costs;
- Economic costs (if applicable) - corresponds to the cost of what you stop doing when you have to make a choice of any kind, i.e. corresponds to the benefit you would have had if you had chosen another option. In this case it will be the cost of *business as usual, i.e. the cost of* not making an additional effort corresponding to the adaptation.
- Other costs relevant to the implementation of the measure;
- Effectiveness in reducing pressures and/or increasing resilience.

As regards the estimation of the costs associated with the implementation of each new measure, the following must be accounted for on the basis of expert analysis:

- Investment expenditure, including in particular the purchase of land, the carrying out of studies and projects, construction works, extension and refurbishment, the purchase of equipment, technical assistance and other supplies and services;
- Operating, maintenance, monitoring and follow-up costs each year for the lifetime of the measure.

In order to make the various measures comparable, the following procedures have been adopted:

- The time horizon of 2035 was taken as a reference;
- Replacement investments were considered where the useful life of the measures is shorter than the time period considered;
- Residual values have been taken into account when the useful life of investments extends beyond 2035, for example in the case of investments in physical infrastructure;
- Operating and maintenance costs, where applicable, have been considered throughout the period under review.

In order to strictly fulfil its objectives, the cost-benefit analysis takes into consideration the following steps:

- Identification of vulnerabilities in the current state;

- Identification of the parameters responsible for this vulnerability;
- Quantification of the deviation between the current state and the state we intend to achieve (GAP analysis);
- Identification of specific technical measures with higher resolution potential;
- Evaluation of measures in terms of effectiveness in reducing pressures and/or increasing resilience;
- Qualification and evaluation of cost measures;
- Development of a league table of the most cost-effective measures.

All measures contribute to reducing the pressures caused by climate change or to increasing resilience. However, not all measures have an effective impact on reducing pressures or increasing resilience. Two main groups of measures can be identified here:

- Specific measures focusing on critical parameters for vulnerability. The effects of these measures, or part of them, may be immediate. The implementation of these measures may be developed by various public or private entities, which have the competence and/or the responsibility to improve the identified situation;
- Structural measures that have a general impact on society, contributing to a change in attitude, behavior and intervention. The effects of these measures are measurable in the medium and long term. These measures address the root (causes) of the problem. These measures cover (Awareness raising; Monitoring; Legislation; Licensing; Supervision; Management Instruments).

The following variables must be taken into account when choosing the packages of measures for cost-benefit analysis:

- Statutory[26] *versus* voluntary measures;
- Implementation priorities of the measure (the table below ranks the priority of the measures);
- Costs associated with the measures;
- Scope of the measures - a law has a wider scope than building a retaining wall in a dam for use by local farmers.

Measures	Priority
legally binding measures to be implemented in an aspect of high vulnerability, i.e. where the existing parameters are far removed from those targeted	5

[26] A measure that responds to a requirement in national legislation or some international commitment made by Angola.

legally binding measures to be implemented in an aspect of medium vulnerability, i.e. where the existing parameters are at some distance from those targeted	4
Measures required by law in certain areas of the country	4
Voluntary (Supplementary) measures to be implemented in a highly vulnerable area, i.e. where existing parameters are far removed from those targeted	3
Voluntary measures to be implemented in certain areas or in aspects of media vulnerability	2
Voluntary measures to be implemented in a low vulnerability aspect, i.e. where the existing parameters are at some distance from the targets	1

Table 4 - Ranking of priority of measures 1 corresponds to lowest priority and 5 corresponds to highest priority

Measures aimed at meeting the requirements of legislation or international commitments assumed by Angola and focusing on aspects of high vulnerability are more relevant. It is to these that the funds will be directed as a matter of priority, or that greater effort will be made to mobilise funds.

There are measures whose implementation is relevant (e.g. assessing the impact of climate change on reindeer potatoes) and which have often been underway for some time. However, they may have a lower priority because they are voluntary and sometimes affect less vulnerability. However, where these measures already have their own funding from the responsible entities (national or donors), there is nothing to prevent these measures from going ahead. Measures for which funding is already available or where co- financing is a dimension can also progress.

The cost-benefit analysis will focus on voluntary measures with priority 1 to 3. This cost-benefit analysis will take place during the evaluation process of the implementation of the measures. Only then will it be possible to assess the effectiveness of the measures in relation to the state of vulnerability to climate change.

CHAPTER - 4
PROGRAMMES WITH APPROPRIATE MEASURES TO MITIGATE CLIMATE CHANGE

Complexo Administrativo Clássicos de Talatona, Rua do MAT,
Building 4, 4th Floor
Talatona Municipality, Luanda
E-mail: dnaac@mcta.gov.ao

This section reports on Angola's mitigation potential as well as mitigation efforts. Given the limitations of information and mitigation planning and monitoring tools used in Angola, projections are made in the following thematic areas:

1. Energy;
2. Industrial processes;
3. Agriculture, forestry and other land use (AFOLU);
4. Land use, land use change and forests (LULUCF);
5. Solid
6. Waste.

The base year considered in these projections is 2018 and projections are made for 2030 and 2050. Angola's GHG inventory presented in Chapter 2 estimates 2005, 2010, 2015 and 2018 emissions for the sectors indicated above. GHG emissions in 2018 are estimated at around 100,350 Mt CO2eq, representing a variation of 78.5% compared to 2005. The breakdown of Angola's GHG emissions by sector for the year is shown in Table 1.

Table 1: GHG emissions for 2018 sectors.

GHG Emission Sources	CO_2 eq - Gg
Energy	18820,386
Agribusiness	5650,619
Waste	3776,480
Industrial Processes and Product Use	1693,582
Land Use, Land Use Change and Forests	70409,590
Total	100350,657

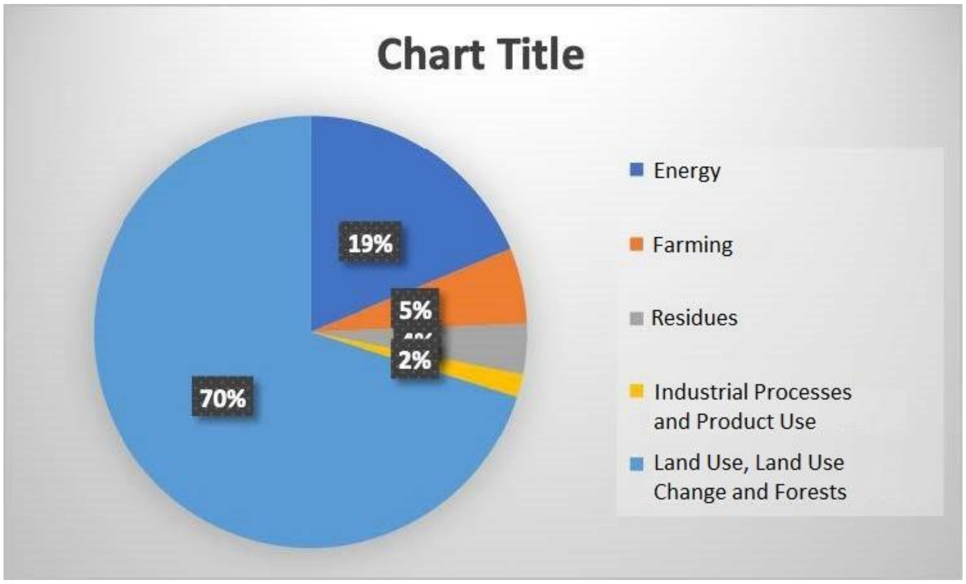


Figure 1 - Distribution of Angola's emissions in 2018 by sectors

In the inventory of the first national communication prepared using the methodology in force at the time, the largest percentage of GHG emissions in Angola came from the energy sector (49%), followed by emissions from the agriculture sector (36%). In the inventory of the second communication it was 19% and 5%, respectively.

This communication has referred to SNE 2018-2022. This plan comes from the Long Term Strategy Angola 2025 (which is being revised, to expand the vision until 2050), as well as from the process of Graduating Angola to Middle Income Country in February 2021. The country thus requires a transition strategy to overcome its specific and structural challenges and vulnerabilities, including Sustainable, Diversified and Inclusive Economic Development. Angola has also made other international commitments that imply increased efforts in low-carbon development, such as the African Union's Agenda 2063 (AU, United Nations Agenda 2030 for Sustainable Development and SADC's Strategic Indicative Regional Development Plan (revised for the 2015-2020 period).

Thus, the trend in emissions can be expected to evolve differently in the coming years. Angola has an opportunity to develop while keeping its ecological footprint under control, thus seeking to avoid the mistakes that other countries made in the past that led to the climate emergency we are experiencing today and improve its place in the climate risk index[27] (80th place in 2020).

[27] Global Climate Risk Index 2020, Germanwatch 2020. Values vary substantially from year to year.

4.1 Political, legal and institutional framework for mitigation

4.1.1 Strategic documents relevant to the mitigation pillar

Within the framework of the commitments established at international level to combat climate change, Angola is committed to integrating the mitigation pillar into its sectoral policies, thus contributing to global efforts to reduce GHG emissions. In the context of mitigation, the following strategic documents stand out:

- Long-term Development Strategy for Angola (Angola 2025), 2007, under review to extend vision to 2050;
- National Development Plan for 2018-2022 (NDP), 2018;
- National Climate Change Strategy 2018-2030 (ENAC), 2017;
- National Environmental Quality Plan (NAP), 2020;
- National Environmental Standardisation Programme (NNP), 2020;
- National Strategy and Biodiversity Action Plan 2019-2025, 2020;
- Angola Energy 2025 - Long-term Vision for the Electricity Sector, 2016;
- Atlas and National Strategy for New Renewable Energies, 2015;
- National Energy Security Policy and Strategy, 2011;
- Energy and Water Action Plan 2013-2017, 2015;
- Strategic Plan for Urban Waste Management in Angola (PESGRU), 2012;
- National Action Program to Combat Desertification (PANCOD), 2014

4.1.2 Institutional framework for mitigation

The Organic Statute of the Ministry of Culture, Tourism and Environment was approved in the Presidential Decree no. 162/20 of 8 June, in which it is attributed to this institution, to formulate, conduct, monitor, evaluate and implement the Executive's policy in the field of culture, tourism and the environment, as well as the conduct of strategies, programs and projects and the promotion of (...) environmental management. Among others, the Ministerial Department responsible for the Environment is responsible for:

- Coordinate national actions in response to global environmental problems through the implementation of recommendations of international conventions and agreements;
- Promote projects and programmes for the reduction and balancing of gas emissions as well as sustainability in order to stabilise greenhouse gases, promoting sustainability and low emission socio- economic development.
- Coordinate and ensure the implementation of programmes, strategies, plans and projects for adaptation and mitigation to climate change.

- Propose, evaluate, certify and implement development and exploitation policies in the area of renewable energies, in favour of the improvement of the life of the populations and environmental protection.

The MCTA has two National Directorates - the National Directorate for Environment and Climate Action and the National Directorate for Prevention and Environmental Impact Assessment. The latter is maintained in relation to the previous organic statute and becomes part of the Environmental Supervision Department. However, this department will be extinguished by virtue of Art. 27 of the referred DP n. º 162/20 and its competences absorbed by superintendent Bodies, in legislation to be published.

The National Directorate for Environment and Climate Action includes the Department of Mitigation and Adaptation to Climate Change, due to the extinction of the Office of Climate Change, and its mission is to develop and integrate policies aimed at promoting climate action including measures for mitigation and adaptation to climate change. With the integration of the environment portfolio in a ministry together with culture and tourism, some environmental aspects, namely climate change, lose some institutional weight - from Cabinet (headed by a director with the category of national director) to department.

They exist with various bodies overseen by the ministry that oversees the environment, which may be the subject of refurbishment. They are the National Institute for Environmental Management (INGA) and the National Institute for Biodiversity and Conservation Areas (INBAC). INGA is responsible for ensuring the implementation of national policy in the field of research, promotion, training, dissemination and dissemination of environmental management policy and support to environmental protection associations. INBAC is responsible for ensuring the implementation of nature conservation policy and the management of the national network of Environmental Protection Areas. There is also the Centre for Tropical Ecology and Climate Change based in Huambo, with the aim of carrying out applied research in the field of tropical ecology from the perspective of the management of natural ecosystems to support the development and implementation of policies and programs for the preservation of the environment rational use of water, soil and climate resources, and the Centre for Analysis of Pollution and Environmental Control with the aim of developing applied research studies, methodologies and analyses, monitoring, ecological modelling and evaluation of pollution caused by hydrocarbons and other forms of pollution. There is also an Environment Fund with legal personality, administrative and financial autonomy and its own assets, supervised by the Ministry of the Environment (administratively) and the Ministry of Finance (financially), with the aim of financing research, education, studies and programmes for the valorisation of natural resources, the introduction of clean technologies and public participation in environmental management. Part of the revenue of the Environment Fund comes from environmental licensing fees and the percentage of fees to be paid by companies using natural resources and charges for emissions of pollutants and other sources of environmental damage; the percentage of fines for breaches of environmental standards and compensation and compensation for environmental damage; the proceeds from the sale of the seal or certificate produced with clean technologies.

The Designated National Authority (DNA), created through Decree-Law No. 2/10[28] of 13 January, is the ministry that oversees the environment and has responsibility for implementing the Clean Development Mechanism (CDM) to maximise the benefits of the Kyoto Protocol's flexibility mechanisms. In this context, it is responsible for approving projects in accordance with international requirements, defining eligibility criteria, verifying and certifying the reduction of national emissions and also sending annual activity reports to the UNFCCC.

The environment minister also coordinates the Multisectoral Technical Commission for the Environment and the National Commission on Climate Change and Biodiversity (CNACB). The CNACB is composed of the Minister of Petroleum, Minister of Transport, Minister of Higher Education, Science and Technology; Minister of Health; Minister of Agriculture and Rural Development and Fisheries; Minister of Telecommunications and Information Technology. The CNACB carries out its tasks with the support of an Executive Committee made up of specialists from the bodies under its authority and from the following institutions: National Civil Protection Commission; National Institute of Meteorology; Institute of Marine Research; Institute of Hydrography; Institute of Forest Development; National Institute of Environmental Management; and Agostinho Neto University. The CNACB's tasks are to coordinate the programmes and harmonise the policies for the implementation of the national strategy on climate change and the strategy for the preservation of biodiversity; to create the necessary conditions for the implementation and execution of the national plan for climate change; to create a national investment plan that integrates issues related to climate change, biodiversity, drought and desertification; to create centres of excellence to carry out studies of calamities and systematic observation and research on climate.

Also relevant for mitigation is the Interministerial Commission for National Energy Security, established by Resolution 8/09 of 30 January, in order to coordinate all work related to the elaboration of the energy strategy and policy, as well as the energy security programme, define the institutional structure responsible for the coordination, monitoring and control of the implementation of these instruments and guide the elaboration of the energy balance and energy matrix. Coordinated by the Minister responsible for planning, the commission is made up of the holders of the portfolios of Petroleum, Energy, Finance, Agriculture, Environment, Geology and Mining, Science and

[28] Resolution 113/09 of 17 December had already designated the Ministry of the Environment as the designated national authority for the implementation of the Clean Development Mechanism (CDM) of the Kyoto Protocol.

Technology, Water. The members are also the Director of the Office of Special Works (GOE)[29], Economic Advisors to the President of the Republic, the Prime Minister6, Chairman of the Board of Directors of SONANGOL, Chairman of the Board of Directors of the National Electricity Transport Network (RNT) 7and the Director General of the Office of Medium Kwanza (GAMEK).

Some ministries and other public administration bodies relevant to mitigation are also highlighted.

Ministry of Agriculture and Fisheries, whose organic statute was approved by Presidential Decree No. 177/20 of 23/06, the State Secretariat for Agriculture and Livestock and the State Secretariat for Forestry, which is of great importance in managing land use and forests.

The National Coordination Committee for the Implementation of the National Action Programme to Combat Desertification (CNC-PANCOD) (Presidential Decree No. 150/19 of 15/05) is the multi-sectoral and inter-ministerial body for the coordination of Angola's efforts to implement the UNFCCC and which coordinates all national and international, public and private efforts to implement the PANCOD (Presidential Decree 46/14 of 25/02). The Minister of Environment is the Coordinator and the Minister of Economy and Planning is the Deputy Coordinator. It is also composed of the holders of the portfolios of finance, agriculture and fisheries, energy and water, trade, territorial administration, social action, family and promotion of women and spatial planning and housing. The PANCOD has a financial mechanism called the National Fund to Fight Desertification (FNLCD) which, among other functions, establishes partnerships with bilateral and multilateral cooperation agencies in order to attract the technical, material and financial support needed to implement projects and programs under the PANCOD.

The Office of Food Security (GSA) (Executive Decree 265/18, of 19/07), a body under the auspices of MINAGRIP, has, among others, the following powers: Define and monitor the implementation of policies and strategies to improve food security; prepare the food balance sheet and inform on the availability of food at the country level, carry out vulnerability studies and alert the competent bodies on the magnitude of the situation and manage the Early Warning System; prepare studies to promote actions to mitigate risks arising from natural disasters in order to minimize their impact on livelihoods; carry out studies on the use of food reserves and prepare contingency plans.

The National Directorate of Renewable Energies (DNER) (Executive Decree no. 16/19, of 11/01), is the direct executive service of MINEA responsible for the design, promotion, evaluation, implementation and monitoring of policies in the renewable energy sector such as: solar, wind, geothermal, hydrogen, biomass. It comprises the Department of

[29] The GOE replaces the former Office of National Reconstruction (GRN).

Studies and Projects, the Department of Regulation and Certification and the Department of Licensing, Supervision and Registration. The DNER has great importance in the mitigation of climate change, particularly with regard to reducing deforestation for the production of firewood and coal for domestic energy.

The Department for Monitoring, Promotion of the Environment and Safety in Industry which is an executive service of the National Directorate of Industry that promotes and ensures the implementation of national and sectoral policy on industrial safety, management, prevention and control of emergencies and environmental protection in mining, oil and biofuels activities.

The National Landfill Commission (Presidential Order 128/18), coordinated by the Minister of the Environment, ensures the involvement of the Provincial Governments in the process of listening to the landfill projects to be carried out, ensures that the legal processing of these projects of hazardous and radioactive waste landfills complies with a rigorous criterion and study of feasibility, implementation and monitoring, as well as environmental and social impact assessment.

From the point of view of climate research and monitoring and its impacts, the National Institute of Meteorology and Geophysics (INAMET[11]) assumes great relevance. Its mission is to promote and monitor the quality of services provided in the field of meteorology and geophysics and climate to decision-making structures and private operators in the adoption of policies that foster the accelerated and sustained development of the country. The Department of Applied Research in Meteorology and Climate stands out, developing research in all fields of meteorology and climate application with particular focus on the sectors of agriculture, construction, oil, air and sea navigation, atmospheric environment and climate, and collaborating in environmental impact studies on the climate side. Also the Centre for Applied Research in Environmental Geosciences and Natural Risk Management (GeoRisks Centre) which implements specialisation courses, including those of a higher level, in the areas of environmental geosciences and natural risk management, namely those related to natural disasters, oceanography, climatic risks, especially in agriculture and all those which may have interfaces with the meteorological and climatic component and in particular those related to variability, climate change, impacts and adaptation measures.

Also, of relevance in the context of mitigation are: the Angolan National Police (PNA), which collaborates with the competent bodies of the Executive in preventing and combating offences against the environment; the Directorate for Combating Corruption Crimes, which is the central executive service of the Criminal Investigation Service and includes the Directorate for Combating Illicit Trafficking in Stones, Precious Metals and Crimes Against the Environment.

This creates the institutional conditions for integrating climate change into the different sectors at national level.

4.1.3 Situation and Trends in the Economy

Angola's economic growth over the last decade has had two very marked periods: until 2014, the economy grew at an average annual rate of over 5%, with growth even exceeding 8.5% in 2012; in 2015 GDP grew by only 0.9% and since 2016 Angola's GDP has fallen by an average of 1.2% per year, with a 2.6% drop in 2016.

The dramatic fall in the price of a barrel of oil from 2014 onwards was largely responsible for this change. There was a sharp deterioration in income and tax sector indicators, which resulted in a contraction of public consumption expenditure and, in particular, public investment. The slowdown in implementation of projects included in the Public Investment Programme (PIP) had a major impact, as public investment has in recent years been an important driver of economic growth in the non-oil sector of Angola's economy.

The significant reduction in Net International Reserves9, that is, access to foreign exchange, has created constraints on the development of other sectors due to difficulties in access to raw materials and capital goods and has generated galloping inflation. The national currency fell from around 125Kwz/Eur in early 2015 to 680Kwz/Eur in 2020.

The National Development Plan 2018-2022 foresaw an average rate of 3% in real terms by 2022, but this did not happen in 2019 and the COVID-19 pandemic is expected to cause a 3% decline in global GDP by 2020. This is unprecedented, so the effects it will have on the global economy and on Angola in particular are unknown.

The NDP foresaw an acceleration of the non-oil sector (as a result of ongoing policy reforms) and the stabilisation of oil output. The NDP estimates that the main drivers of growth will be agriculture (average rate 8.9%), manufacturing (average rate 5.9%), fisheries (average rate 4.8%), construction (average rate 3.8%) and services - including tourism (average rate 5.9%).

4.2. Sectoral Situation and Trends

4.2.1. Energy

According to the country's latest GHG inventory, the energy sector was responsible for 18% of emissions on average from 2005 to 2017.

All emissions from the Energy sector to Angola come from fuel use. Emissions results indicate a predominance of emissions from gasoline, with a growth of 604.41% and from diesel, with a growth of 554.11% in the period 2005 to 2018. The biggest reduction in fuel consumption occurred in Other Kerosenes with a decrease of 97.18% followed by Aviation Kerosene with a decrease of 51.57%. In terms of absolute emissions, petrol increased by over 1,700 GgCO2e and diesel increased by around 5,300 GgCO2e from 2005 to 2018.

Angola has recent key documents for the energy sector: "Angola Energia 2025" (MINEA 2016) and the "Atlas and National Strategy for New Renewable Energies" (MINEA 2015).The NDP 2018 indicates that at the end of the first half of 2017, the National Electricity Company served 1.276m customers in 66 municipalities, corresponding to an electrification rate of 36%, with an electrification rate of 75% in Luanda province, to 8% in the province of Bié.

Electricity sub-sector

During the 2010-2020 period Angola posted growth in its power generation capacity from 1,375.44 MW to 5,635.85 MW. Generation by thermoelectricity rose from 594.94 MW to 2,258.73 MW and generation by hydroelectric source rose from 780.5 MW to 3,342.12 MW. Some 35 MW come from hybrid power stations. The table below presents the picture for 2020.

Source	Power 31 January			
	Installed [MW]	Percentage [%]	Available [MW]	Availble [%].
Water	3.342,12	59,30	3.060,98	91,59
Thermal	2.258,73	40,08	1.692,69	74,94
Hybrid	35,00	00,62	34,22	97,77
TOTAL	**5.635,85**	**100,00**	**4.787,90**	**84,95**

Table 2: Installed and available capacity at 31 January 2020 (1)

Angola's public electricity production park includes 59 power plants in 17 provinces, including 43 thermal power plants, 8 hydroelectric power plants and 8 hybrid power plants. The NDP 2018-2022 plans to reach installed capacity of 6.3 GW in 2022.

Angola's electrical system is divided into 4 regions: 2 interconnected systems (North and Centre) and 2 isolated systems (South and East). The region on the map called Luanda is added to the North region as shown in figure 7 below. Along with the development of large-scale energy projects, it is important to promote the electrification of Angola, which currently covers only 30%of the territory.

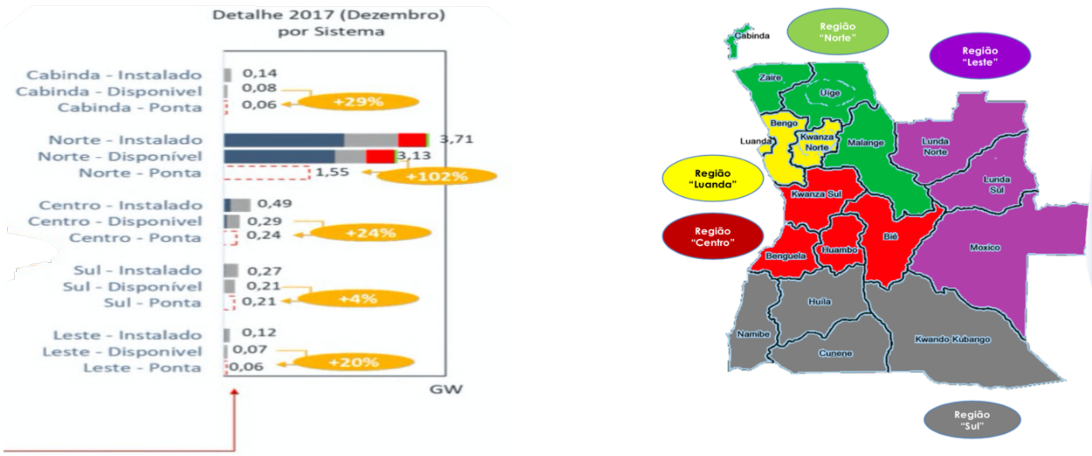


Figure 2: Division of Angola's electrical system and installed and available capacity by system (2017)

Production, 96.5% of which is provided by the public company PRODEL, is distributed as follows throughout the country:

Region	South	East	Centre	North	Cabinda	TOTAL
Installed Capacity	287,87	138,17	410,80	4 653,28	145,73	5 635,85
PRODEL	283,87	109,42	360,80	4 537,68	145,73	5 437,50
INDEPENDENT	4,00	28,75	50,00	115,60		198,35
Available Capacity	222,52	108,17	267,05	4 071,06	119,10	4 787,90
PRODE	218,52	79,42	227,05	4 001,06	119,10	4 645,15
INDEPENDENT	4,00	28,75	40,00	70,00		142,75
Energy produced 31 July 2019 to 31 January 2020						
Electric Power	422	180	124	7 040	262 110,52	8 029
PRODEL	418 473,86	144 189,27	39 043,41	6 897 113,56	262 110,52	7 760 930,62
INDEPENDENT	4 019,41	36 398,27	85 540,74	142 888,61		268 847,03

Table 3: Installed, available and produced power from 31 July 2019 to 30 January 2020 (1)

In electricity production from thermal sources PRODEL uses fuels such as diesel, Jet B and more recently natural gas (as per the table below) provided by the SONANGOL concessionaire and 100% subsidised by the Angolan government. The natural gas reserves exploited at the Angola LNG terminal in Soyo (Zaire province) made it possible to install a 720 MW Combined Cycle Plant (Soyo I) that began production in 2017-18.

Year	Liquid fuel [l]	Natural Gas [MMBTU]
2016	1 203 715 960,00	-

2017	716 017 750,69	-
2018	665 968 833,63	5 283 403,00
2019	539 496 644,00	14 220 113,85
2020	43 728 918,92	-

Table 4: Fuel Consumption in Electricity Generating Centers

As mentioned, the country's electrification rate is very low, around 30-35%. The extension of the country's electrification, of strategic importance for promoting the development of human capital and well-being of Angolans, will allow for the creation of wealth and job creation, being an important vector for the country's industrial and human development. Projections indicate that by 2025 there will be a large increase in energy demand of around 7.2 GW.

The "Atlas and National Strategy for New Renewable Energies" indicates that in Angola electricity production from hydroelectric power plants has a potential of 18 GW (with mini hydro plants of up to 10MW having a potential of 800MW) and from biomass and MSW has a potential of 3.7 GW. Solar energy has a potential of 17.3 GW and wind energy production has a potential of 3.9 GW.

Some 86% of Angola's hydrological potential is found in the Kwanza, Keve, Catumbela and Cunene basins. A programme of dams is underway that will include around 60MW and 117,400 more customers, corresponding to approximately 704,400 people. Locations have already been identified for the construction of dams that would increase the installed power by another 4.2GW.

Solar energy is Angola's largest renewable resource and the most evenly distributed. Among Angola's provinces, Luanda, Kwanza Norte and Kwanza Sul have greater project viability due to their greater capacity to absorb intermittent energy through the grid. 122 projects were identified, totalling 3.45 GW, that present conditions for connection to the grid. In a first phase 10 priority solar projects were identified, which will represent a total of 100 MW for the market and will result in construction of solar parks between the provinces of Benguela, Cunene, Huíla and Namibe. The Aldeia Solar programme is also underway, which aims to electrify by installing autonomous (isolated) photovoltaic solar systems in social infrastructures, namely: Schools; Medical Posts; Police Posts; Administrative Buildings; and Social Jangos, including solar Public Lighting Posts.

Biomass potential is high in the province of Benguela, as well as in the provinces of Malanje10 , Lunda Norte, Moxico, Huila, Huambo. Luanda has a high potential for converting MSW into energy.

The wind potential is limited by efficiency and demographic constraints and is located in the province of Namibe followed by the provinces of Huila, Kwanza-Sul, Malanje and Moxico. Along the Atlantic escarpment on a north-south axis, 13 projects totalling 604 MW have been identified that provide conditions for connection to the grid.

The natural gas produced in Soyo allows more power to be installed there, or in any other part of the country, provided the appropriate infrastructure is put in place. The government forecasts growth in the country's installed thermal power based on investment in more economical and less polluting combined cycle thermal power stations. Natural gas will accompany the installation of renewable energy projects on the fossil side, because besides being an endogenous source it is less polluting.

The electricity grid is in a phase of strong development, with plans to integrate the five main existing regional networks (North, Central, East, South and Cabinda) and to strengthen the stability of electricity supply to the main consumer centres, whether residential or industrial. In the near future it is planned to extend networks for rural electrification of some localities in 12 provinces.

This is a vast programme consisting of the construction of 31 substations of various voltage ratios, the assembly of 1,358. Transformer Stations of various power ranges the construction of about 1,000 km of 30 kV line and 10 km of 15 kV line, 2,000 km of low-voltage network and 1,000 km of public lighting network. The implementation of this programme will enable about 230,000 families (1,400,000 people) to be integrated into the electricity distribution and supply system, leading to an increase in the penetration rate of electrification of 5%.

Currently Angola has not systematized the calculation of the emission factor (FE) of its electricity grid. It will be a priority to develop it to allow a more accurate and updated calculation of emissions from fossil fuel combustion in the electricity sector and to serve as a tool for all participants in projects and programmes aimed at reducing emissions under the UNFCCC market mechanisms (CDM, PoA, NAMA or projects developed under a future market mechanism resulting from discussions on Article 6 of the Paris Agreement).

Transport Sub-sector

Angola's data do not provide emissions in the transport sector. Fuel is used in transport, but also in generators to produce electricity.

Although it is still starting the process of adopting low-carbon energy-based transport, Angola already has public and private projects underway for the dissemination of such transport throughout the country.

The Luanda Light Rail Network (RFLL) and BRT public transport projects are being implemented. In addition, at the end of 2019 the private taxi company T'Leva invested in importing 1,000 100% electric cars for its fleet, which helped to spread this type of vehicle in Angola.

Luanda's light rail network is expected to cover 70% of the capital's total population and includes the possibility of building public transport corridors and multi-modal systems made up of light rail transport (LRT - Light Railway Transit) and collective road transport (BRT - Bus Rapid Transit). Part of this network will run on electricity, thus raising the quality of the environment and the quality of life of the population. The project is expected to be completed by 2050. In one scenario there will be a 121.5 km light rail network extension requiring a total investment of USD 2.8 billion; a second scenario envisages a 321 km light rail network extension requiring a USD 3.8 billion investment.

Oil and gas industry sub-sector

This sub-sector is responsible for fugitive GHG emissions, which reached 2,496.56 Gg t CO2e in 2015 and decreased to 963.52 Gg t CO2e in 2018 according to the inventory. As we will see below, Angola is already on the path to mitigation.

The NDP 2018-2022 indicates that in recent years there has been a declining trend in crude oil production, coupled with operational problems forcing unplanned production stoppages. The NDP indicates that factors such as the sharp natural decline in the main deepwater and ultradeep producing fields in the order of 8 to 15%; the loss of efficiency of the fields, with increased unscheduled stoppages as production and processing facilities get older; the financial situation leading to delays in the implementation of new field development projects, with first oil postponement, as well as the cancellation of drilling contracts for new development work; and planned operational stoppages may exceed the entry into production of new fields and new approved work. The NDP advocates a 2% decrease in the oil sector by 2022.

As for the gas industry, Angola counts the Angola LNG operation. With a life expectancy of at least 30 years, the facility is supplied with gas from a diverse range of sources. The primary source was initially gas associated with offshore block oil operations. In this way the plant contributes significantly to the elimination of gas flaring in Angola, allowing the development of off-shore oil reserves in a more environmentally sustainable manner.

An extensive pipeline network of over 500 km supplies the Soyo processing and liquefaction plant with gas from offshore oil fields. The pipeline network initially transported the raw material from Blocks 15, 17 and 18. The undersea pipeline was then built to link the Angola LNG factory with Blocks 0 and 14, located north of the Congo River.

Blocks 31 and 32 have also been connected and, in due course, Angola LNG plans to connect the areas of non-associated gas deposits in Blocks 1 and 2.

In addition to the process emissions themselves, this industry is involved:

i) Transport on large carriers to large-scale regasification terminals in distant countries;
ii) Or transport on small LNG carriers to small/medium marine terminals;
iii) Or even transport in small iso-containers or tanks transported by land, sea or rail to small storage and regasification units near the consumer.

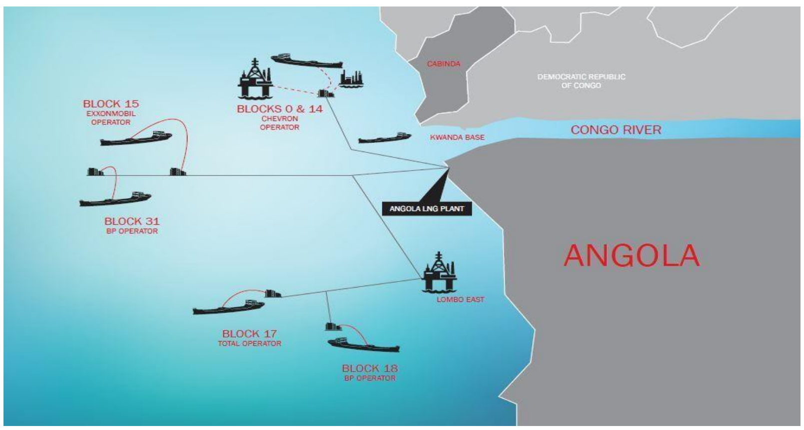


Figure 2: Configuration of Angola LNG

Proved reserves of more than 270,000 million m3 of natural gas have since been discovered and will also be processed in Angola LNG. Other "on-shore" natural gas discoveries have been made in Cabinda that make it possible to convert turbines in local plants to natural gas. Recently, significant new discoveries of natural gas in blocks south of Luanda have been announced. Depending on the amount and cost of extraction, existing subsea pipeline infrastructure could be used and the terminal at Soyo expanded, or a new liquefaction plant could be built in the south of Luanda, or even just be used for domestic consumption associated with large industrial, petrochemical or production projects. It is therefore to be expected that this industry will grow in Angola.

4.2.3 Agriculture and Forestry Sector

According to the country's latest GHG inventory, agriculture, forestry and other land use accounted for 8% of emissions on average from 2005 to 2018.

The country has conditions conducive to agricultural and forestry practice and has great production potential throughout the country. The sector is currently of significant importance in the country, not only in terms of GDP, 5% in 2020[11], but also in terms of the amount of labour it employs, 34%[30].

According to the Report on the 2018-2019 Agricultural Campaign, national agriculture is strongly based on family farming. Of the total cultivated area at national level (5,671,261 hectares, representing 16.2% of the total estimated national arable area), Family Farms (FAR) contributed 92%, with the remaining entrepreneurial holdings. Production remained almost at the same levels as the previous season, EAF was responsible for the agricultural production of more than 17,500,000 tons of agricultural products, corresponding to 81% of cereals, 92% of roots and tubers, 89% of leguminous and oilseeds, 66% of fruit trees, 78% of vegetables produced nationally.

The mechanization of agriculture is scarce. In land preparation, family agriculture contributed with 5,195,533 cultivated hectares, which represents about 92% of the total cultivated land in the whole national territory. Of the total areas worked, 3,740,784 ha (72%) were worked manually, 1,298,883 ha (25%) were prepared using animal traction[31] and about 155,866 ha (3%) were prepared mechanically also in the framework of co-financed projects. The Institute for Agricultural Development (IDA) registers a universe of 2,846,912 peasant families throughout the country; however, only 33% of all peasant families in the country receive some kind of technical assistance and only 4% benefit from technological packages. In the 2018-2019 campaign the funds made available to support family farmers was 8.5M.

According to the "Master Lines for Defining a Strategy for Exiting the Falling Oil Price Crisis on the International Market", agriculture will be a key sector for reducing oil dependence and diversifying the economy. One of the government's objectives is to make the country self-sufficient in basic food products, another is to increase exports and reduce imports. The NDP 2018-2022 proposes an increase of 105% in cereals (maize, millet, sorghum and rice), 49% in root and tuber production (cassava, sweet potatoes and reindeer potatoes), 116% in leguminous and oilseed production (beans), peanuts and soya), 53% fruit production (citrus fruit, pineapple, banana, mango, avocado), 15% vegetable production (onion, tomato, cabbage, garlic, carrot, pepper, aubergine) compared to 2017. In addition, as cash crops, 31% increase in coffee production, 101% increase in sugar production. For the above reasons, these changes will only be possible with strong support for family farming, or a strong campaign to attract private investment. The NDP also sets the targets of increasing the average area of cultivation per family from 1.5

[30] In 201https://ine.gov.ao/images/Populacao_Sociedade/Relatorio_Pop_mundial/RELATORIO_FINAL_IIMS2015_2016 EMPREGO_DG_INE.pdf

[31] De notar que o governo também incentiva esta pratica ao distribuir charruas, na campanha 2018-2019 o governo distribuiu cerca de 50 mil charruas nas províncias do Huambo, Bié, Benguela, Cuanza Sul, Huíla, Cunene, Cuando Cubango e Namibe.

hectares in 2017 to 2.5 hectares in 2022, the availability of work tools/equipment from 10% in 2017 to 80% in 2022 and the availability of fertilizers from 10% in 2017 to 80% in 2022. This would imply fostering the mechanization of agriculture that could cause an increase in emissions and it is known that agrochemicals are net emitters of GHGs.

Livestock production accounts for between 30 and 50% of agricultural GDP. In the 2018-2019 marketing year, total meat production exceeded 137,000 tonnes; this correspond to a decrease in aggregate production of almost 20% compared to the previous year. Livestock production statistics are not segregated between family or business, or intensive versus extensive production. National meat production is dominated by Goat/Ovine, which represents 59% of the total produced in the 2018/2019 campaign and which in this campaign decreased by 30% compared to the previous campaign. Poultry production (21% of the total), Beef (17% of the total) and Pork (4%) follow. Production of these species has risen compared with the previous marketing year. The northern region of the country accounted for more than 50% of the total meat produced in 2018/2019, followed by the Centre which produced almost 30% (29.2%) and the South which contributed 20.6%. Egg production exceeded 1 billion units during the 2018/2019 campaign, 72% of which was in the northern region. There was a 2% decrease in production compared to the previous marketing year. Milk production was almost three million litres in 2018/2019. The Centre region contributed 54% of the total milk produced, while the North contributed 29% and the South 16%; there was also a decrease of 16% compared to last year's production.

The NDP also proposes to increase livestock production, setting targets of 53% increase in meat production by 2022, 164% increase in annual egg production and 201% increase in annual milk production compared to 2017. In parallel, it establishes that the prevalence of the main animal diseases decreases from 15% in 2017 to 5% in 2022 and that animal mortality decreases from 12% in 2017 to 2% in 2022.

The measures provided for in END 2018-2019 do not integrate environmental concerns. The promotion of sustainable practices in agriculture by fostering the water-energy link using new technologies, water and land use efficiency are important to avoid GHGs and allow economic, environmental and energy development. Given that the agricultural sector in Angola is being supported by projects financed by international partners such as the World Bank-financed commercial agriculture development project, which has a sub-component for capacity building on good practices, or the Strengthening Small Producer Resilience project implemented by IFAD.

In turn, forests are of great socio-economic importance due to the use of wood as fuel, building materials and furniture, and the use of other resources for food and medical purposes. Forests are thus a valuable resource for the country, not only because of their importance to the Angolan economy, providing numerous socio-economic and environmental benefits, but also in their fundamental role as a carbon sink and regulator of the balance of ecosystems. Forests have a good capacity to recover from natural climate variations, so the loss of vegetation cover can have consequences in aggravating the impacts of climate change on ecosystems.

4.2.4 Industry Sector and Product Use

Industry contributed 1.2% to GHG emissions on average from 2005 to 2018. From 2012 to 2015 industrial emissions increased but fell again due to the currency crisis.

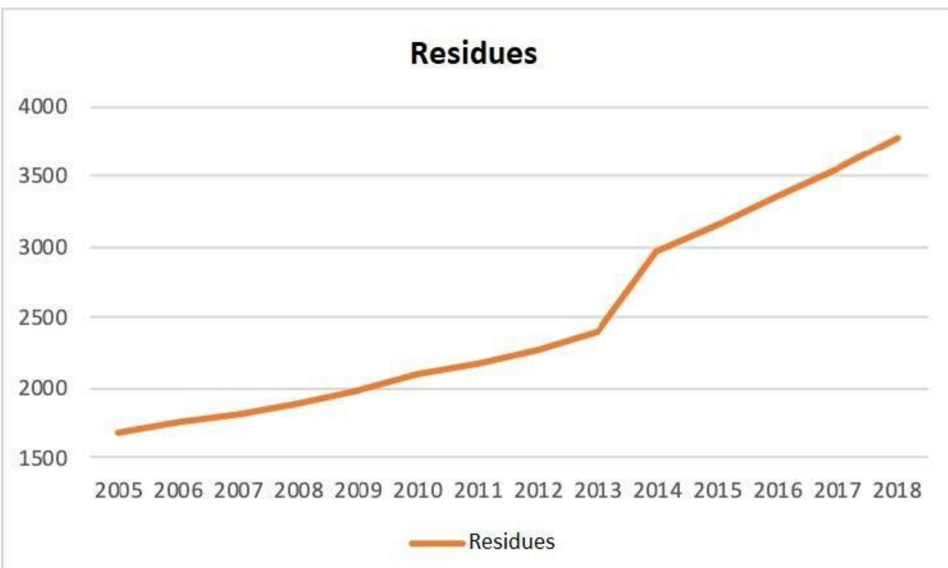
Angola's main industries are oil and natural gas production (which is handled in the energy sector), diamond and other mining industries and manufacturing. The main industries in the territory are oilseeds, cereals, meat, cotton and tobacco processing. The production of sugar, beer, cement and wood, as well as oil refining, are also worth mentioning. The tyre, fertiliser, cellulose, glass and steel industries are also noteworthy.

As for the extraction of Diamonds, Metallic Minerals and Other Minerals, the END 2018-2022 foresees an average real growth rate of 9.4% with the entry into operation of new Diamond mines (Luaxe) and new quarries for the production of ornamental rocks, as well as the continuation of the production of other mines such as Catoca, Cuando and Chitolo (gold, iron ore and concentrated iron). More specifically, the NDP 2018-2022 sets the targets of increasing annual diamond production from 9.0 million carats in 2017 to 13.8 million carats in 2022, annual production of 25.6 thousand fine ounces, annual production of 1.79 million tons of iron ore, annual production of 1.35 million tons of phosphates, an increase in the annual production of ornamental rocks by 62% compared to 2017, an increase of 16% in the annual production of limestone (dolomitic) for the correction of arable soils, the annual production of siliceous sand to support the national manufacturing industry and of abrasives and clay to support the manufacturing industry and art practice. The GHG emissions from this sector are mainly due to the alteration of land use, with the diversion of river courses without subsequent replacement of the initial courses, alteration/destruction of ecosystems, fauna and flora, water contamination and in some cases atmospheric emissions with the treatment of ores and often the abandonment of open-pit mines. Often in practice Law 31/11 (Mining Code) is not implemented.

There is strong political will for the manufacturing industry to develop significantly in the short term. In fact, the Angolan government intends to promote the diversification of the economy in the coming years, both to respond to the oil crisis and to promote economic diversification in the context of its graduation to Middle Income Country. The NDP advocates increasing national production of soap, sugar, corn and wheat flour, pasta, pasteurised milk, meat processing, rods and steel pipes to meet national needs, as well as increasing exports of national beer, juices and soft drinks, cement. There is an opportunity for the country to increase resource efficiency and clean production. One of the measures that can contribute to the reduction of GHG emissions will be the replacement of diesel generators by natural gas cogeneration systems with energy and heat production capacity. The cogeneration systems will guarantee a reliable supply of electricity, avoiding power cuts and the instability of Angola's electricity networks, avoiding possible damage to machinery, as well as the advantage of using an endogenous and abundant fuel that is produced in the country. In addition, cogeneration systems allow heat generated from natural gas combustion to be used in the industrial process itself, increasing the efficiency of energy use.

4.2.5 Waste Sector

According to the country's GHG inventory, the waste sector accounted for 3% to 4% of emissions from 2005 to 2018. In absolute value emissions doubled from 2005 to 2018, from 1685,496 to 3776,480 GgCO2e.



Graph 1: Waste Sector.

The waste sector includes CH4, CO2 and N2O emissions from the final disposal and incineration of solid waste and waste water treatment in the Republic of Angola. For the period 2005 to 2018. The domestic effluent category represents 50.73% of the waste sector's emissions, followed by the disposal of solid waste on unmanaged sites, representing 45.96% of the waste sector. Growth in solid waste disposal emissions represented more than 67% of the total growth of the Waste and Effluent sector between the years 2005 and 2018. Waste Incineration emissions accounted for about 2% and Industrial Effluent emissions contributed 1.34% of total emissions from the Waste sector.

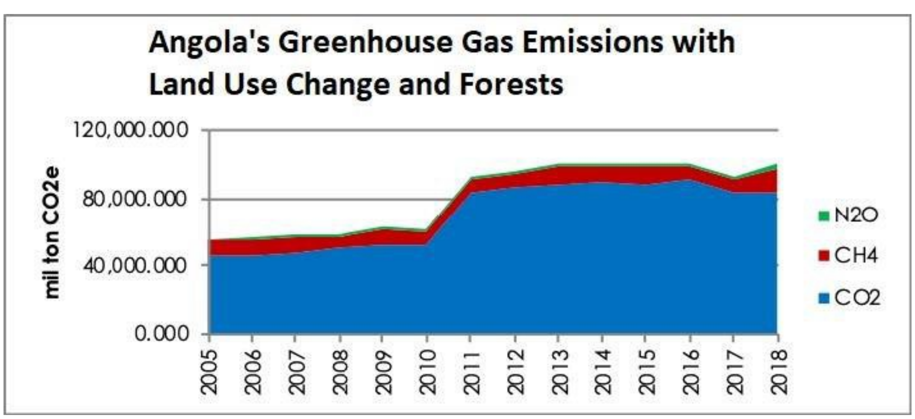
Industrial development, population growth and the large growth rates of cities will lead to increased waste production in Angola. The Strategic Plan for Urban Waste Management (PESGRU), approved in 2012, is the basis for defining a strategy for resolving the problem of urban waste management, and establishes four main lines of action: extending and optimising the rate of urban waste collection; phased implementation, at national level, of the UK treatment, recovery and disposal model; the collection and disposal of existing liabilities; and the launch of selective collection and structuring of specific flows.

The NDP 2018-2022 defines as one of the interventions strengthening actions for waste collection and selection, promoting environmental awareness and education and environmental monitoring. In the programme to improve basic sanitation, the NDP sets as a target for 2022 all provincial capitals are equipped with landfills, at least 10 provinces have solid urban waste management industries, 35 general and central hospitals carry out total waste disposal and the number of villages declared without open defecation (ODA) increases by 35.4% to 425 villages in 2022.

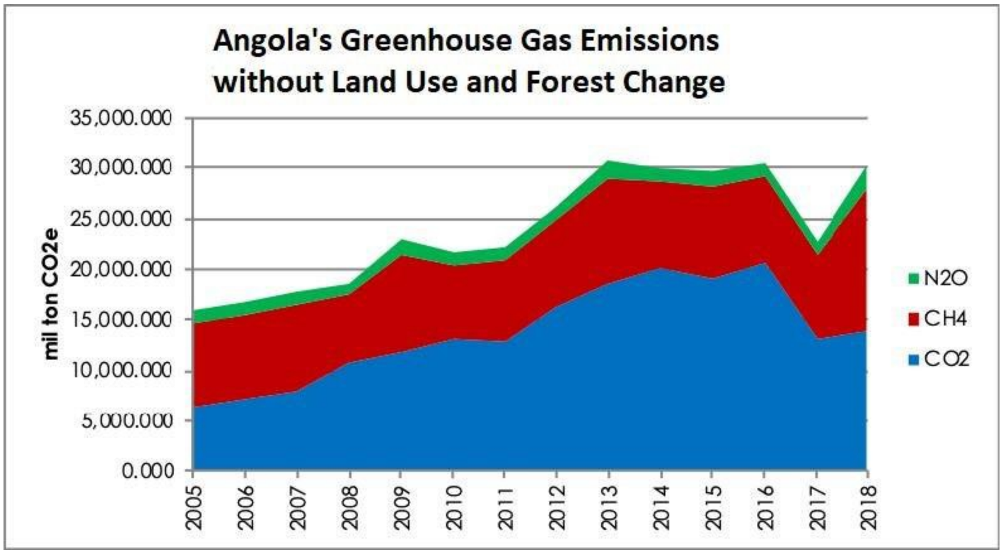
The National Environmental Quality Plan calls for the development of a programme to combat waste liabilities with Provincial Governments.

4.3 Projections of GHG Emissions and National Sinks in a normal scenario

As seen in Chapter 2, most of Angola's greenhouse gas emissions from 2005 to 2018 were CO_2 (carbon dioxide), followed by CH_4 (methane) and N_2O (nitrous oxide). The total value of emissions relative to Land Use, Land Use Change and Forests (LULUCF) represents on average 70% of emissions.

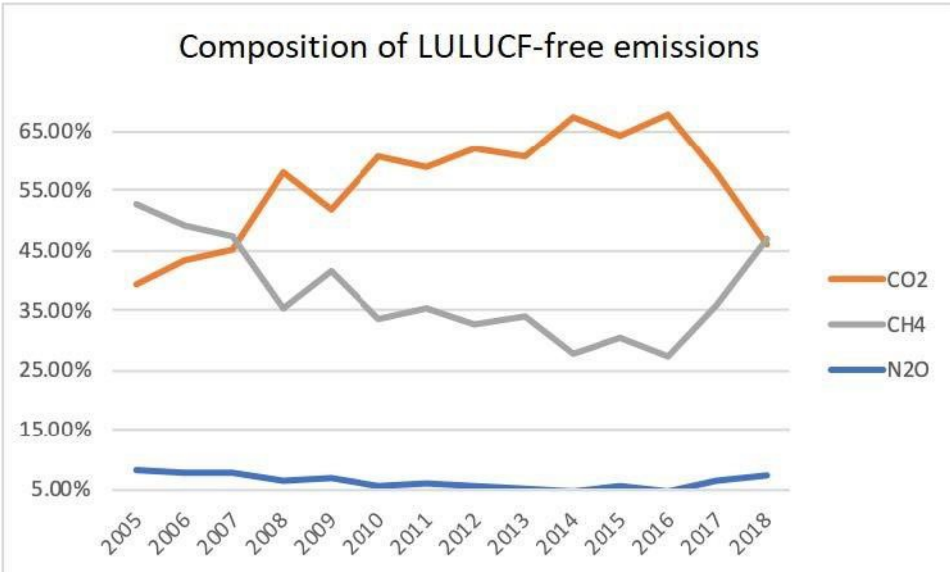


Graph 2: GHG Angola emissions with land use change and forests



Graph 3: Angola GHG without land use and forest change

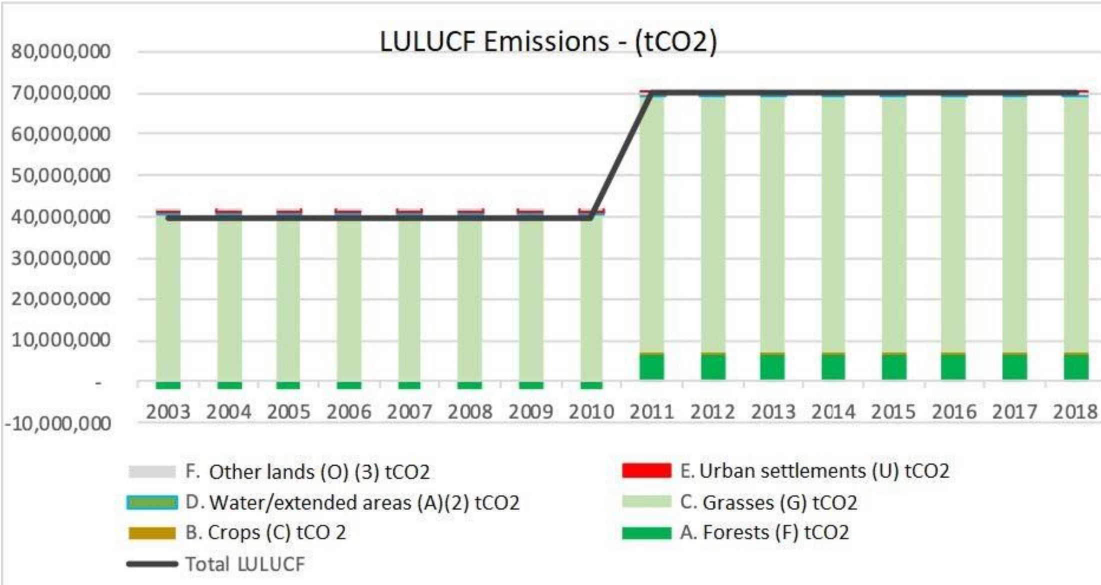
With LULUCF CO_2 represents 80% to 90% of total emissions. In the emissions of the remaining sectors there is a more balanced proportion between CO_2 and CH_4, although on average CO_2 represents 56% and methane 38%.



Graph 4: Composition of LULUCF free emissions.

This inventory of emissions is heavily dominated by LULUCF emissions. The comparison of land cover images used may express some difference in methodology and data quality. There are no data for corrections with field data. If an emission factor is determined for grasses in Angola, the values will certainly vary.

Due to land use change, the inventory indicates that Angola is now an emitter of greenhouse gases. Forests have had a net loss of 200,000 hectares from 2003 to 2018, with grass areas increasing in the same proportion. In the same period 2003 to 2018, urban areas increased by 3.3% and agricultural area by 5%. There is a 7% loss of flooded areas during the period analysed.



Graph 5: LULUCF emissions.

In any case, in a business as usual (BAU) scenario all GHG emissions are projected to increase gradually from the base year (2015) to 2050. According to what has been expressed, the sectors where the largest GHG increases are expected to occur are the Agriculture and Livestock, Industry and Waste sectors.

The intensification of national agricultural and livestock production will lead to a sharp increase in CH4, while the mechanisation of agriculture will lead to higher CO2 emissions. The release of CH4 will mainly result from the decomposition of matter and enteric fermentation of the livestock sub-sector. The increase in population and per capita consumption will also lead to a sharp increase of CH4 in the waste sector.

The industry will mainly contribute to an increase in volatile organic compounds other than methane (VOCNM), in addition to CO2, especially if it does not opt for self-production of renewable energy and cogeneration. On the other hand, the oil production industry will be cleaner with the use of gas like Angola LNG, as well as the expected decrease in production.

The industry will mainly contribute to an increase in volatile organic compounds other than methane (VOCNM), in addition to CO2, especially if it does not opt for self-production of renewable energy and cogeneration. On the other hand, the oil production industry will be cleaner with the use of gas like Angola LNG, as well as the expected decrease in production.

Energy will continue to play a major role in GHG emissions, although there is great potential in Angola for renewable energy.

4.4. Mitigation policies and measures

Angola ratified the UNFCCC in May 2000 and the Kyoto Protocol in March 2007, reaffirming its commitment to implementing measures and programmes to stabilize GHG emissions. In the same year the first strategy for climate change was approved ("National Strategy for Implementation of the United Nations Framework Convention on Climate Change and the Kyoto Protocol", Ministry of Urbanism and Environment, 2007), which sought to "establish the framework for intervention in legal, technical and human terms to contribute to the stabilisation of GHG emissions and technological development of the country. In November 2015, Angola submitted its national contribution to the UNFCCC for reducing GHG emissions ("Intended Nationally Determined Contribution (INDC) of the Republic of Angola"), where it proposed to unconditionally reduce its GHG emissions by 35% by 2030 compared to the baseline scenario (base year 2005), and also, through international funding, to reduce a further 15% of its GHG emissions by 2030.

ENAC 2018-2030 replaced the first strategy from 2007 that no longer responded to the new international climate context arising from the Paris Agreement and the changing Angolan context. ENAC 2018-2030 was structured taking into account five main pillars: 1) mitigation, 2) adaptation, 3) capacity building, 4) financing and 5) research, systematic observation and analysis. In addition to the traditional first three pillars, mitigation, adaptation and capacity building needs, the strategy emphasises the fourth pillar, climate finance, which is essential for action to be taken. The fifth pillar of ENAC responds to the need to strengthen national capacity for climate monitoring and subsequent analysis of its impact on key sectors of the country's economic and social life.

The NDP 2018-2022 establishes as targets until 2022, 5 sectors covered by the National Plan for Greenhouse Gas Emissions, 19 low carbon pilot projects designed, 12 sectoral and/or provincial strategies to implement the National Plan for Adaptation to Climate Change elaborated, 40 sectoral/provincial/municipal climate databases created, Start of construction of 3 river crossings, Start of construction of 6 earth dams for water retention, Planting of a total of 9.000 hectares of trees by 2022 to increase the Forestry Perimeter, Creation of Windbreak Curtain and Soil Protection, and Mapping of Areas with Land Degradation in all provinces.

Objective 4 of the National Environmental Quality Programme (DP 138/20) is to promote the adoption of Clean Energy and Technologies, including those compatible with Greenhouse Gas Emission Mitigation. The measures are: Implementation of educational and awareness-raising actions to encourage the use of alternative energies, clean technologies and cleaner production in the various sectors; Dissemination of the mechanisms for the adoption of energies and clean technologies, including those compatible with the mitigation of greenhouse gas emissions, with priority for the sectors of generation, distribution and energy efficiency and waste treatment; and Promotion of the Science and Innovation Programme of MINAMB and its sub-programmes (in particular sub-programme 4, concerning climate change mitigation measures).

ENAC 2018-2030 presents the main mitigation measures, grouped into initiatives, divided into sectors (energy, agriculture, forestry and other land uses, industry and waste) and outlining their main contributions to achieving the 17 Sustainable Development Goals[15].

Table X - Mitigation initiatives

Sectors	Mitigation initiatives
Energy	M1 - Low carbon electricity generation
	M2 - Access to low-carbon energy in rural areas
	M3 - Regulation of the electricity sector
	M4 - Low carbon transport (air, sea, rail, road)
	M5 - Energy efficiency
	M6 - Low carbon street lighting
	M7 - Reduction of fugitive emissions from oil and natural gas exploration and production
Agriculture, forestry and other land	M8 - Low carbon agriculture
	M9 - Management of forests and other land uses
Industry	M10 - Energy efficiency in industry
Waste	M11 - Waste management

ENAC sets out for each initiative the objectives, targets (not always quantified), measures and their justification, and identified capacity building needs (the table below compiles the information). Aware of the importance that capacity building at school and university level can have[32], ENAC presents two initiatives that compile a set of measures, the implementation of which will be coordinated by the ministries responsible for education and higher education.

The quantification of the effect of mitigation measures remains to be done. Some of the targets do not allow for a projection of the low-carbon scenario.

[32] Refere a ENAC que "os alunos são importantes agentes para a divulgação de boas práticas e conceitos para junto das famílias e comunidades onde se inserem."

The implementation of ENAC 2018-2030 implies the planning of activities during its lifetime, through the elaboration of an action plan (which should have taken place within 6 months). The implementation of ENAC 2018-2030 requires the involvement of the following parties and the Strategy defines the role of each:

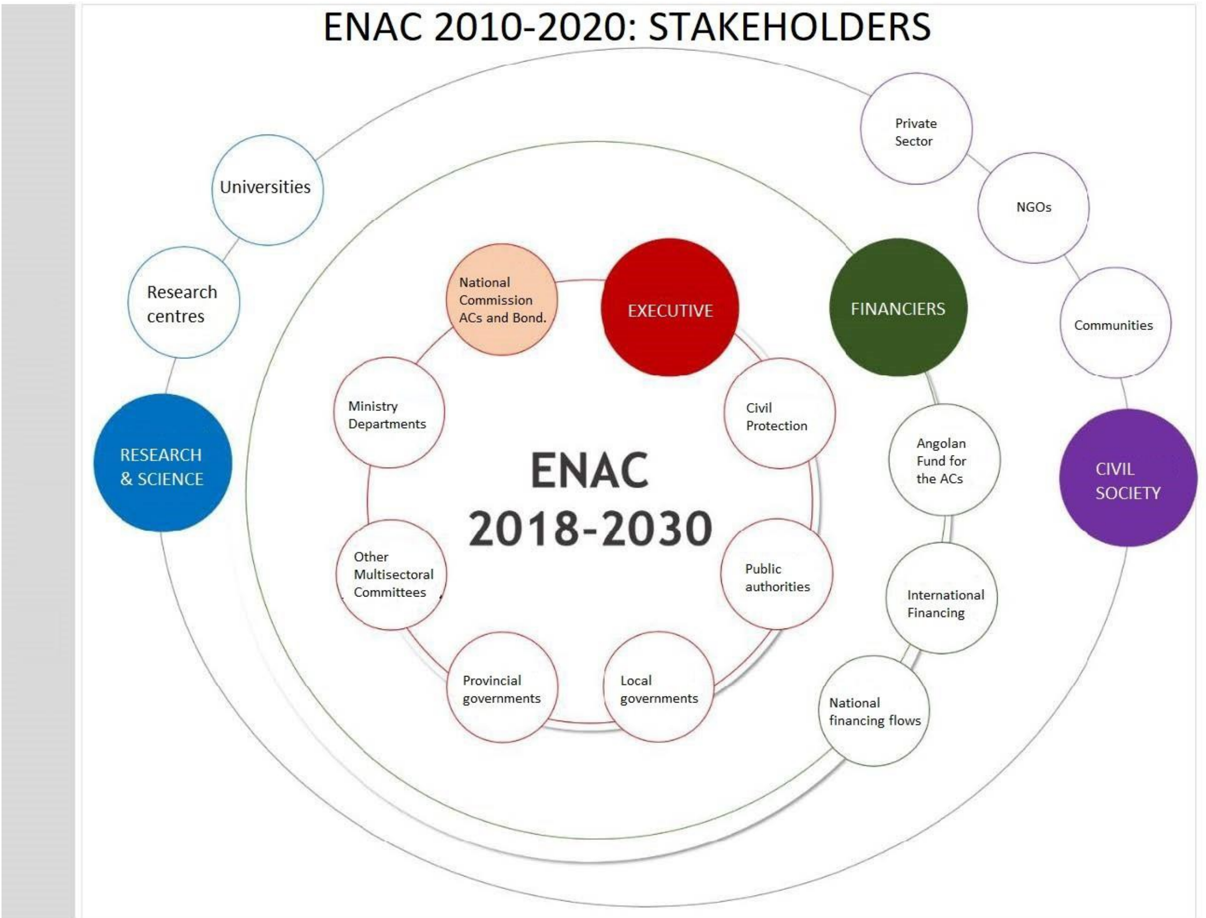


Figure 3: Key actors involved in ENAC implementation, source: ENAC 2018-2030

Sector: Energy				
Initiatives / Objectives	Targets	Responsible	Alignment with ODS	Mitigation measures
M1: Low carbon electricity generation Increased penetration of renewable energy Increase in access to electricity for all Angolans Reduction of GHG emissions	Reach 70% of installed renewable power by 2025	Ministerial Department for Energy and Water	ODS 7 - Renewable and affordable energy ODS 13 - Climate Action ODS 11 - Sustainable Cities and Communities	M 1.1 - Install 800 MW of renewable energy by 2025 M 1.2 - Assess the possibility of implementing geothermal energy projects M 1.3 - Encourage the substitution of more polluting fuels by natural gas in thermal power plantsM 1.4 - Continue to promote the interconnection of Angola's electrical systems and the electrification of rural areas
M2 Initiative: Access to low carbon energy in rural areas Increase in access to electricity for all Angolans Reduction of GHG emissions	Ensure that 60% of the population has access to electricity by 2025	Ministerial Departments for Energy and Water, Agriculture and Rural Development, and Geology and Mines	ODS 7 - Renewable and affordable energy ODS 13 - Climate Action ODS 11 - Sustainable Cities and Communities	M 2.1 - Implement small-scale isolated projects based on solar, wind and hydro energy, providing electricity in rural areas M 2.2 - To extend the "Solar Villages" project so that by 2025 there will be at least 500 villages with access to this programme M 2.3 - Distribute at least 500,000 solar lanterns in rural areas by 2025 M 2.4 - To implement biodigester projects in villages without access to electricity, mainly in areas with higher livestock activity
M3: Regulation of the electricity sector Create regulations that encourage increased investment in renewable energy and energy efficiency	Green tax measures by 2020	Ministerial Departments for Energy and Water, Economy, Finance	ODS 7 - Renewable and affordable energy ODS 13 - Climate Action	M 3.1- Approve specific laws for renewable energies, which stimulate their implementation M 3.2- Creating feed-in tariffs to promote private investment in renewable energy M 3.3 - Creating legal provisions to facilitate contracts (PPA) M 3.4 - Create legislation to ensure that the sale of domestic appliances in Angola is made in accordance with the most modern energy efficiency labelling standards

M4: Low carbon transport Promoting the sustainable growth of the transport system	Expanding the transport network Reducing transport sector emissions	Transport Ministerial Department	ODS 11 - Sustainable Cities and Communities	Road transport M 4.1 - Continue to promote the use of public transport: implementation of an efficient, fast and isolated BRT (bus rapid transit) mass transit system in provinces other than Luanda; continue to extend the taxi network to the whole country; implement intermodal transport M 4.2 - Progressively convert public passenger transport fleets to naturalgas M 4.3 - Create legislation limiting the import of vehicles with high levels of gas emissions per kilometre M 4.4 - Create legislation requiring the incorporation of a percentage of biofuel into the fuel used in road transport; promote the production of ethanol in the country based on sugar cane M 4.5 - To review existing regulations on pollution limits and frequency of inspections of road vehicles in order to control GHG emissions Rail transport

Sector: Energy				
				M 4.6 - Continue the rehabilitation of railway lines to extend the supply of public transport and freight in the country M 4.7 - Replacing diesel locomotives with electric locomotives, a measure which also presupposes the progressive electrification of the railways Air transport M 4.8 - Improve monitoring of fuel consumption and estimation of GHG emissions based on ICAO guidelines M 4.9 - Prepare a GHG compensation programme for national airlines with a view to joining CORSIA Maritime transport M 4.10 - Promote the implementation of fuel consumption monitoring rules based on IMO guidelines M 4.11 - To promote the adoption of technical and operational measures leading to increased energy efficiency and reduction of GHG emissions on the basis of IMO guidelines
M5: Energy efficiency in buildings Promoting energy efficiency	By 2020 - legislation on the inclusion of measures for the rational use of energy in new buildings; Until 2030 - Implementing energy efficiency measures in all buildings of the state	Ministerial Department for Urbanism and Housing Ministerial Department for Energy and Water	ODS 4 - Quality Education ODS 11 - Sustainable Cities and Communities	M 5.1 - Further promotion of efficient lighting notably through the continuity of the lamp exchange programme M 5.2 - Creating legislation to include energy efficiency practices and renewable energy sources in new buildings M 5.3 - Implementing energy efficiency measures in public sector buildings M 5.4 - Implementing energy efficiency measures in schools

M6: Low carbon street lighting Using energy more efficiently	Progressive replacement of conventional luminaires with LED lights	Ministerial Department for Urbanism and Housing	ODS 11 - Sustainable Cities and Communities	M 6.1 - Progressively replace all street lighting for LEDs M 6.2 - Progressively replace inefficient light bulbs with efficient ones and install control devices (light sensors and motion sensors) in state public services (such as hospitals and schools), and in central and provincial administration buildings M 6.3 - Promoting street lighting using solar lamps in isolated rural areas not connected to the electricity grid M 6.4 - Conducting campaigns to supply efficient lamps and control devices (light sensors and motion sensors) at household level M 6.5 - Creating legislation that limits the use of inefficient lamps

Complexo Administrativo Clássicos de Talatona, Rua do MAT,
Building 4, 4th Floor
Talatona Municipality, Luanda
E-mail: dnaac@mcta.gov.ao

Sector: Energy				
M7: Reduction of fugitive emissions from oil and natural gas exploration and production Reducing fugitive emissions in oil and natural gas production	Reduction of fugitive emissions from oil and natural gas exploration and production	Ministerial Department for Petroleum	ODS 9 - Industry, Innovation and Infrastructure ODS 12 - Sustainable production and consumption	M 7.1 - Implementing energy efficiency measures in industrial processes of extraction and production of hydrocarbons M 7.2 - Reduce the *flaring* process by making efforts to stop the routine burning of natural gas in the long term, in line with the World Bank initiative

Sector: Agriculture, forestry and other land uses				
Initiatives / Objectives	Targets	Responsible	Alignment with ODS	Mitigation measures
M8: Low carbon agriculture Increasing the use of sustainable agricultural production systems	Having farming communities with renewable solutions implemented	Ministerial Department for Agriculture and Rural Development	ODS 3 - Quality Health ODS 4 - Quality Education ODS 5 - Gender equality ODS 12 - Sustainable Consumption and Production	M 8.1 - To promote sustainable and low carbon agricultural practices to help combat desertification and unsustainable use of agricultural land, which contribute to the improvement of food security and domestic supply in Angola M 8.2 - Regulating the use of fertilisers M 8.3 - Develop a fire prevention and monitoring programme, a practice widely used in the preparation of agricultural land, which also takes into account public awareness and sensitization M 8.4 - To promote the modernisation of traditional agriculture on the basis of sustainability by applying agricultural practices which ensure the reduction of GHG emissions but which enable producers to increase their incomes M 8.5 - To facilitate the purchase of agricultural machinery using renewable energy or less polluting fuels through special financing programmes for this purpose

M9 Initiative: Management of forests and other land uses Managing the country's forests on the basis of sustainability principles	Reducing deforestation by 2030	Ministerial Department for Agriculture and Rural Development	ODS 15 - Protecting Earth Life ODS 7 - Renewable and affordable energy ODS 12 - Sustainable Production and Consumption	M 9.1 - Ensuring sustainability in forest management M 9.2 - Promoting the reforestation of degraded areas M 9.3 - To implement a tool based on a geographic information system that allows inventorying and monitoring of the forest and land use changes

Sector: Industry				
Initiatives / Objectives	Targets	Responsible	Alignment with ODS	Mitigation measures
Using energy more efficiently in industry	Use of natural gas in all industrial plants by 2030 at the expense of other fossil fuels	Ministerial Department for Energy and Water Ministerial Department for Industry	ODS 7 - Renewable and affordable energy ODS 9 - Industry, Innovation and Infrastructure	M 10.1 - Implement more efficient measures and processes in Angolan industry in order to reduce specific fuel consumption in industrial production M 10.2 - To promote the application of solar and solar photovoltaic technologies for electricity and heat production in industry M 10.3 - Promoting the exchange of diesel generators for natural gas turbines M 10.4 - Promoting cogeneration in industry

Sector: Waste				
Initiatives / Objectives	Targets	Responsible	Alignment with ODS	Mitigation measures
M11: Management of municipal waste Managing and recovering waste	Increase waste collection rates by 100% in peri- urban areas by 2020 and by 80% in rural areas by 2022 Comply with the minimum 10% recycling rate of total recyclable materials by 2022	Ministerial Department for the Environment	ODS 6 - Drinking Water and Sanitation ODS 7 - Renewable and affordable energy ODS 11 - Sustainable Cities and Communities ODS 12 - Sustainable Production and Consumption	M 11.1 - Construction of landfills at all municipal sites by 2022, using biogas generated for electricity generation M 11.2 - To continue to establish separate waste collection programmes covering all municipalities by 2022 M 11.3 - Close down dumps in use by 2022, replacing them with landfills burning biogas and leachate treatment

Once the main feasible mitigation measures are defined, it will be interesting to do a modelling exercise to find out how much GHG emissions can be avoided, not least as a way to prioritise actions.

CHAPTER - 5
TECHNOLOGY TRANSFER IN THE CONTEXT OF CLIMATE CHANGE

Complexo Administrativo Clássicos de Talatona, Rua do MAT,
Building 4, 4th Floor
Talatona Municipality, Luanda
E-mail: dnaac@mcta.gov.ao

The country has been participating since 1992 in the global process aimed at reducing greenhouse gas emissions and creating capacity to adapt to climate change, taking into account the historical accumulation of emissions in the atmosphere since the beginning of the industrial era. Angola participated in the summit in 1992 and in 2000 joined the United Nations Framework Convention on Climate Change (UNFCCC), an instrument that coordinates global actions in this direction.

The vulnerability of ecosystems and communities to climate change can occur at several levels: agriculture, food production and other factors such as water availability. Technologies, seen in the current context of climate change, can contribute to GHG reduction and adaptation to the effects of climate change. Many technologies already exist and need to be widely disseminated by encouraging and removing barriers to their use; others still need to be developed.

Within the UNFCCC the issue of Technology Transfer involves multiple aspects. First, the recognition of the most differentiated common responsibilities, calling on industrialized countries to take possible measures to promote, facilitate and finance, as appropriate, the transfer of environmentally sound technology and know-how, or access to them to developing countries.

Also, part of the discussions in the technology transfer process is the need to identify innovative, efficient and more advanced technologies and know-how and to provide assistance to promote the development and/or transfer of such technologies. Technologies can be light or heavy, both for adaptation and mitigation. In previous chapters on adaptation and mitigation, a set of knowledge and technologies that are needed by Angola has been identified.

Technology needs assessment consists of a set of activities developed in the country to identify and determine the technological priorities for mitigation and adaptation, involving different actors, in a consultative process to identify barriers to technology transfer and measures to address these barriers through sectoral analyses.

Technology information defines the means, including *hardware*, *software* and networks, to facilitate the flow of information between the different actors. It involves information on the technical, economic and environmental parameters of these technologies and on the availability and how they meet the technology needs identified, as well as information.

The creation of an environment conducive to technology transfer focuses on government actions, such as policy options to invest in certain areas, the removal of technical, legal and administrative barriers, the development of financial and fiscal incentives, fair trade policies and the development of national capacity building to promote public and private sector acceptance.

Capacity building is a process that aims to create, develop, strengthen, increase and improve existing scientific and technical skills, capacities and institutions, particularly in developing countries where Angola is located, to assess, adapt, manage and develop these technologies.

One of the key issues in the technology transfer process is the funding needed for its implementation. The UNFCCC recognised technology transfer as an implementation mechanism of the Convention, alongside funding or capacity building, among others. Thus technology transfer can, within the UNFCCC, be seen as a possibility for investment in the public and private sectors.

There are a number of funding opportunities available in the implementation of the UNFCCC through funds such as the Global Environment Facility (GEF), the Clean Development Mechanism (CDM), the World Bank, UN System Agencies and other bilateral and multilateral partnerships.

5.1 Environmental Technologies in Angola

Environmental technologies are defined in Presidential Decree 88/13 and encompass products and services that generate higher added value than conventional alternatives, from an environmental point of view with regard to reducing the impact on the environment through the efficient and sustainable use of energy from water and other resources.

The global market for environmental technologies has grown dramatically in recent years as a result of growing concerns about the environment and the need to find solutions.

Although Angola is among the 10 strongest economies in Africa, this is mainly due to oil, and the country must seek to ensure the interrelationship of economic and social development policies with the principles of environmental conservation and preservation and the rational use of natural resources, in order to achieve the objectives of sustainable development. Environmental technologies emerge as one of the paths that the country must take in order to ensure a harmonious and integrated future from the environmental point of view.

There are many solutions available in the field of environmental technologies applicable in the national context. Among the sectors of strategic importance that can benefit most from environmental technologies are: spatial planning, urban planning, water resources, land use, agriculture and forestry, industry, energy and water, oil, transport, etc.

Angola has started the process of Technological Needs Assessment in a comprehensive manner, with a view to expanding its capacity for mitigation and adaptation. It has conducted a survey of existing technologies for mitigation and adaptation and related the socio-economic context from a needs perspective. The exercise was carried out in a multi-sectoral framework in which participants from various institutions looked at the technologies needed by Angola for climate change mitigation and adaptation.

The next step will be to make a general analysis of the technological options identified, as well as a cost-benefit assessment of them. In addition the potential development of local technologies that can be shared and exported will be assessed.

With the survey already carried out, the process of technological transfer and development in Angola under the UNFCCC may facilitate the strengthening of the use of degraded land in several regions of Angola, including conservation areas; stimulate the planting of forests for energy purposes; increase the efficiency of the use of electricity, as well as its availability; reduce the waste of raw materials such as water and others; improve the use of nitrogen fertilizers, namely organic (manure and others) and avoid the use of synthetics; stimulate the use of agricultural waste. The process can also contribute to accelerating the development of the industry, notably by applying principles of clean production and resource efficiency.

As for adaptation, technologies can help improve the climate prediction system, improve monitoring and early warning systems (using satellite images), develop crops resistant to future weather conditions, control disease vectors, or improve systems for responding to natural disasters, among others.

The country is in the process of rehabilitation and economic reconstruction. The sustainable development option, to which all government policies as set out in the National Development Plan are directed, should be able to maximize efficiency in the use of natural resources and reduce GHG emissions. To this end, it is imperative to review and update sectoral policies and legislation in order to adapt them to this goal and to meet Angola's international commitments under the UNFCCC, the Paris Agreement and the framework for future commitments.

On the other hand, the use of environmental technologies for adaptation and mitigation is essential to meet Angola's reconstruction and development needs. Universities are/will be called upon to place the country alongside other nations in the search for a satisfactory climate balance with the needs of human development.

Environmental education and awareness can play a major role in this sector, combined with strengthening policies, legislation and other incentives for the correct use of environmental technologies.

5.2. National needs in technology transfer

Until very recently, technology transfer to combat climate change has focused almost exclusively on mitigation. Even the most rigorous mitigation efforts today will be futile to prevent climate change in the future, so adaptation is inevitable. The idea of using technology to reduce or lessen an adverse situation is tempting. Many existing technologies that have proven to be effective in reducing the vulnerability of extreme climate events will also be important as technologies for adaptation to climate change.

Any technological choices should be in line with the long-term development priorities of developing countries.

The National Medium-Term Development Plan (2018-2022) highlights the promotion of Sustainable Development and an economy as follows:

- In agriculture, the aim is "to promote the integrated and sustainable development of the agricultural sector, taking as a reference the full exploitation of the potential of the productive natural resources and the competitiveness of the sector, with a view to Guaranteeing food security and domestic supply.
- The objective in the field of fisheries is to "promote the competitiveness and development of industrial and artisanal fisheries in a sustainable manner, contributing to the promotion of employment, with the aim of combating hunger and poverty and ensuring Food and Nutrition Security".
- In the oil sector, the aim is to "ensure Angola's strategic insertion into the group of energy-producing countries and to develop the oil and natural gas *cluster*, helping to finance the development of the economy and its diversification. Among the priorities in this area is the promotion of investments in biofuels from selected agricultural crops, without affecting national food supply and food security.
- The objective in the field of the environment is "to contribute to sustainable development by ensuring the preservation of the environment and the quality of life of citizens.
- In the field of energy, actions are planned to increase the production of electricity, using solar, wind and hydro energy (mini-hydro).

These priorities combined with the National Climate Change Strategy, the National Adaptation Program of Action, and other relevant documents from the UNFCCC and other Rio Conventions (Convention on Biological Diversity and the United Nations Convention to Combat Desertification) provide a framework of priorities for adaptation.

Angola and its population have already begun to record heavy social and economic losses as a result of increased climate variability. In the south of Angola we can see the death of livestock, the loss of agricultural crops as a consequence of the prolonged drought period. In the Dombe region, for example, and in the corridor between Benguela and Namibe, pests that make tomato production impossible and floods that drag agricultural crops have become more frequent. The series of extreme events that the country has been experiencing in recent times support the idea of the need to include the technology.

The extractive industry, which is dominated by the oil and diamond sectors, has been growing with projects for the exploitation of ornamental rocks and building materials, portland cement and limestone. The process of setting up these more recent explorations has been carefully monitored by government authorities with the requirement of scrupulous compliance with environmental legislation passed in recent years. However, energy supply is still a problem as fossil fuels continue to be used to increase GHG emissions, although an effort is being made to place essential services alongside large production areas.

The main incentive for technology transfer concerns innovation which is a factor in strengthening the competitiveness of production. For export products, the level and type of innovation is largely determined by external factors including consumer preference and regulatory standards in importing countries, which need to be responded to with competitively priced goods and services. Firms producing for small consumer markets and those with low purchasing power have less incentive to innovate, especially due to the absence of external pressure to improve product quality. In such cases, government intervention may be justified. This is especially relevant for Angola as once the country is integrated into the SADC Free Trade Agreement and the domestic market opens its doors, local companies have to compete with low-cost imports from other countries in the community. The government has defined policies to stimulate innovative business activities, to make production at lower and more competitive costs and to stimulate exports at competitive prices with SADC and international markets.

At a time when the country is investing in domestic production for development and economic diversification and when financing is often needed, the choice of environmental technologies capable of reducing GHG emissions will be fundamental. For its implementation, the country can join the so-called "Green Bonds" and make the financing process less costly.

In general, the needs in the industrial sector are presented in the following tables:

Industry Sector	Technology transfer
	South-south/North South
Electricity needs from renewable sources for the reduction of GHG emissions in industry	X
New technological processes through the use of clean technologies;	X
Use of physical barriers to protect flooding facilities	X
Alternative materials to avoid and/or reduce the use of scarce resources	X
Industrial zones away from vulnerable areas	X
Reduction of fossil fuel consumption (particularly in the cement industry)	X
Improvement of the clinker drought process	X
Use of High Efficiency Classifiers / separators	X
Advanced oven and grinding concepts	X

In the field of electricity

Angola's hydroelectric potential is estimated at 18 GW. At the end of the Civil War in 2002, Angola had only 205 MW of installed hydroelectric capacity, 412 MW of thermal capacity and almost all of the electricity infrastructure was obsolete and/or damaged giving only 8-20% of the population access to electricity; Luanda, the capital, consumed about two-thirds of the energy produced. Since then, a number of energy projects expanded capacity to 1,160 GW in 2007, of which 77% were hydroelectric and 33% diesel generated. By 2017 the sector had already reached about 4,409 GW and is heading towards the target of 7.5 GW by 2022, with the main target being water.

The International Energy Agency noted that the development of the energy sector was challenge for the government, and despite massive investments in this area, supply still lagged behind consumption, which is estimated to grow by 20% in Luanda alone. A national strategy to increase annual energy production was approved and aims firstly to rebuild or rehabilitate existing dams and secondly to plan the construction of others in the near future. Angola plans to make full use of its hydroelectric potential to increase production and supply of electricity for its development needs and to be able to export another part as part of a regional plan to interconnect the SADC countries' networks.

Despite the expansion of production capacity, the problem of the precarious transmission and distribution network remains, the limited maintenance of which leads to systematic interruptions in energy supply. Most companies maintain their own generators which have an impact on the final cost of goods offered to consumers. Under these circumstances there is much to be done to improve energy efficiency.

In addition to using the capacity of water courses to produce electricity, the strategy also points to the use of other renewable energy sources, photovoltaic, wind and biomass, mainly for rural areas or small settlements, whenever feasible. The signs for the use of new technologies have already begun to emerge with the launch in 2014 of the first solar village in the Catete region, as well as the replacement of higher consumption light bulbs with low consumption light bulbs. Another element that deserves to be highlighted is the construction of mini-hydroelectric plants in small water courses.

In the field of biofuels a considerable leap forward has been made with the Biocom Project and the manufacture of Biogas and Ethanol which should be maximised in the future and contribute significantly to the reduction of GHG emissions. The attraction of new technologies could also come from the use of ethanol in transport.

The use of gas for energy production is also seen as a potential to broaden energy options, although the country already has its stake in hydroelectric exploitation.

Energy	Technology transfer
Energy sector	South-south/North South

Increasing the reliability of the network to reduce losses and thus improve energy efficiency;	X
Reduction of consumption per household through the use of lower consumption light bulbs, more efficient household appliances and the adoption of clean production processes;	X
Dissemination of renewable energy sources through the promotion of the use of solar panels and biodigestors for production and biogas, wind energy and greater efficiency in state-of-the-art thermal power stations	X
Maximising efficiency in coal production	X
Expansion of reused gas to reduce use of biomass	X
Biogas and electricity-based public transport and vehicle use	X

In the field of oil and gas.

The period 1990/2004 can be considered as that of the great oil discoveries, which allowed the country to join the group of the biggest oil producers south of the Sahara. In 2004, average oil production was around 989,000 barrels/day, in 2010 it was around 1,900,000 barrels/day and, due to lack of maintenance and maturation of the fields, production went into decline and in 2019 1,400,000 barrels/day were produced. Oil production involves flaring gas on the platforms. In view of this, Sonangol, aware of the Angolan state's responsibilities to join the UNFCCC, has designed and is developing with partners the LNG Project, which consists of the storage and processing of gas associated with oil from all platforms in blocks 0, 1 and 14 of Cabinda and the Congo basin.

In the framework of the mitigation strategy, the needs in technology transfer are related to the

Oil and Gas Domains	Technology transfer
Oil and gas sector	South-south/North South
Employment of developing technologies that reduce gas flaring or transportation through pipelines and its processing on industrial platforms;	X
Use of new technologies for exploration, drilling, production, transport and storage of crude oil and reduction of fugitive emissions	X
Employment of new processing and refining technologies.	X
Use of Natural Gas	X
Use of gas for transport	X

In the field of Agriculture

Complexo Administrativo Clássicos de Talatona, Rua do MAT,
Building 4, 4th Floor
Talatona Municipality, Luanda
E-mail: dnaac@mcta.gov.ao

This sector covers agriculture, livestock and forestry. The national agricultural potential is high and the potential agricultural area is estimated at about 57,400,000 ha, of which 35 million is fertile and arable land. According to data from the 2018-19 Agricultural Campaign, of the total cultivated area at national level (5,671,261 hectares) Family Farms (FAR) contributed 92%, with the remaining entrepreneurial holdings.

The country has the capacity to be self-sufficient and create surpluses for export for the main agricultural products, maize, cassava, sorghum, rice, peanuts, sugar cane, sunflower, coffee, sisal, vegetables, citrus and other tropical fruits, as well as livestock products such as beef, pork, goat, poultry, milk and eggs.

Commercial agriculture is developing with strong private projects for food crops in government supported agro-industrial clusters. A continuation of public incentives is expected to reverse the current import trend of the main food products once produced in the country. Thus, without the use of environmental technologies, the next few years will see an increase in GHG emissions, not only from the increase in areas cultivated by the transformation of forest land into agricultural land, but also from the increased use of agrochemicals (fertilizers and pesticides) to increase yields per crop and per unit of area.

Agricultural sector	Technology transfer
Agriculture	South-south
Technique of using different crops	X
Terrain topography changes to improve water capture and prevent wind erosion	X
Changes in agricultural practices to conserve soil moisture and nutrients, reduce runoff and control soil erosion.	X
Crop rotation	X
Improve water use and availability and soil erosion control	X
Change in planting and harvesting period	X
Development of new plant varieties	X
Wind curtain	X
Drop irrigation	X
Concentrating irrigation on growing seasons	X
Integration agriculture-livestock-forestry	X
Reforestation in arid and semi-arid areas	X
Conservation Agriculture	X
Production of natural fertilizers through compost;	X
Pest control methods	X
Techniques to increase added value of production	X
Techniques to ensure food safety and quality	X

Aquaculture techniques	X
Combat a diverse number of increasingly resistant pests;	x
Introduction and adaptation of ecologically recommended technologies and inputs;	X
Water saving measures and new irrigation and rational water use schemes;	X
advanced seed varieties on a large scale;	X

In the field of livestock farming

Livestock farming was one of the economic activities that suffered greatly from the war. The number of animals fell sharply. Cattle numbers fell to 1,200,000 in 1989 and small ruminants to 379,000 in the same period. Angola has been catching up and an agricultural census is currently underway. In the 2018-2019 agricultural year Angola produced 137miltonnes of meat, 59% of goats, over 1 billion eggs and around 3 million litres of milk.

The Province of Huila continues to lead national livestock production with more than half of the country's cattle, a quarter of pigs, goats and poultry. Other species that should also be taken into consideration are domestic animals, reared close to homes, namely pigs, rabbits and poultry, which, in terms of the family economy, play a key role in food security.

Agricultural sector	Technology Transfer to Angola
Livestock	South-South/North South
Conversion of manure into energy through the use of biodigestors for biogas production;	X
Choice of fodder species and their large-scale production	X
The use of pharmaceuticals and other veterinary products is becoming increasingly effective in combating diseases and zoonoses and is ecologically sound;	X
Improvement of animal husbandry practices;	X
Collecting, storing and supplying water in ways that reduce the concentration of herds per surface unit	X
Insemination and improvement of breeds more tolerant to pests and diseases and less demanding	X

In the field of Forests

For forest resources, of the 53,000,000 ha of land considered as forest (43.3% of the country's area). Only 2% are dense, humid forests of high productivity, very rich in biodiversity; 65.2% are mosaics of forests and savannahs, as well as open forests of the *miombo* type of medium productivity round wood, more socially and economically very important for the production of woody fuel, wood for construction, medicinal plants, and non-woody products for food. The remaining percentage is occupied by dry savannah with trees and/or shrubs, chana and anharas, sub-desert and desert steppes of low productivity.

The potential of artificial forest was reported in the 1970s to be approximately 148,000 ha, which allowed the exploitation of 850,000 m3/year. Around 86% of the planted area was made up of eucalyptus trees that were distributed across plantations of Companhia de Celulose e Papel de Angola, the Benguela railroad and the Luanda railroad, mainly in the Central Plateau. The remaining area belonged to small private individuals, 10% were pine trees and 4% cypress. The Central Plateau is the main nucleus of these holdings.

Considering that one of the major causes of deforestation is coal production, it is necessary to make both coal production and the use of coal more efficient by introducing improved stoves. This must be coupled with the introduction of gas into the countryside, the extension of the use of biogas and the exploitation of solar technologies for food production.

Forest sector	Technology Transfer to Angola
Forests	South-South/North South
Increase of controlled planted forest, with fast growing species and multiple use.	X
Reforestation in arid and semi-arid areas	X
Improvement of carbonisation techniques	X
Valorisation of other less used species to reduce selective cutting	X
Reduction and control of fires;	X
Introduction of improved stoves to reduce wood consumption;	X

In the field of Urban Waste

Solid waste and sanitation services are not yet coordinated at national level. Provincial governments and communal administrations, according to the available resources and capacities, seek to solve the problem of waste. In order to initiate a process of national control and regulation of this activity, the Government created the National Waste Agency which, among other activities, will define strategies and propose new methodologies for the reduction and treatment of waste in Angola and the possibility of using Clean Technologies.

The Urban Solid Waste Management Plan also provides for the use of technologies in the recycling process and the operation of landfills for energy production.

Common practices used in relation to solid waste have been the burning, open-covered and uncovered dumping and in some cases incineration for hospital waste.

Taking into account the process of administrative deconcentration and decentralisation, in relation to waste and data difficulties, the waste component of the GHG Inventory focuses on information around Luanda, since it is the capital, and since it has more or less the organised structures and extrapolation of data to the other provinces, depending on the population in those locations. The rubbish is dumped in the open.

Waste sector	Technology Transfer to Angola

Waste sector	South-South/North South
Massive construction and operationalization of landfills in all cities,	X
Use of waste for energy generation	X
Plumbing and processing of gas for energy production for rural communities or other uses.	X
Massification of containers and underground tanks	X
Recycling	X
Reuse	X
Re-use	X

With a view to better planning and efficient use of landfills, the President of the Republic set up a commission to carry out studies and surveys throughout the country of the conditions for their application and implementation. Although this is a risky activity and many countries in the world are reducing the use of landfills, there is growing interest in their use by provincial governments and municipal and communal administrations. The introduction of landfills should be accompanied by other measures to maximise the value of waste by reducing the amount of waste going to landfill.

In the field of Transport

Since 2004 a process of rehabilitation of roads, railways and ports in the country has been underway.

In 2004, of the 7,953 Km of paved roads, 88% were in "bad" or "very bad" condition. The rural exodus, aggravated by the difficulties of access to many places, further aggravates the traffic in the cities. According to the Road Fund, the state of roads in Angola in 2018 was illustrated below.

Complexo Administrativo Clássicos de Talatona, Rua do MAT,
Building 4, 4th Floor
Talatona Municipality, Luanda
E-mail: dnaac@mcta.gov.ao

Between 2007 and 2017, the railway lines were rehabilitated over 2612 km in length. Angola's railroad network is defined by three structural lines:

- The Benguela railway line, with a total length of 1340 km, connects the port of Lobito on the Atlantic coast with the border town of Luau in the eastern part of the country, which borders the Democratic Republic of Congo. It also includes a 28 km branch line linking the port of Lobito to Benguela;

_ The Luanda railway line, links the capital of the country to Malanje, capital of the province of the same name, for a total length of 445 km; The Moçâmedes railway line links the coastal city of Namibe to Menongue, in the province of Cuando Cubango, for a total length of 860 km. This line also includes two branches between Entroncamento station (in Dongo) and the mining areas of Tchamutete and Jamba.

Angola's main ports are the Port of Luanda, the Port of Lobito and the Port of Namibe. There is also the port of Cabinda, the port of Soyo and the port of Amboim, which are considered secondary given the international trade flows they carry. According to Muechi (2016) [1], there has been marked investment by the Angolan state in the ports of Luanda and Lobito as a priority. The port of Luanda saw investment of around US$130 million in the 2006-2010 period. An international tender is currently underway for the concession to operate it. The port of Lobito has invested over US$1.2 billion which has resulted in construction of the container terminal at the port of Lobito, the dry port of Lobito, amongst other acquisitions.
These new infrastructures created at the port of Lobito with the rehabilitation of the Benguela railroads could boost trade with neighbouring countries and even access to the sea from neighbouring countries/regions via transit through Angola. The port of Namibe, with the support of the government of Japan, is undergoing refurbishment and is expected to expand into deep waters in order to establish itself as the biggest port infrastructure in the southern region of Angola.

Dry ports are being created as part of the country's logistical development. In the case of the port of Luanda, to alleviate congestion problems, a dry port has been set up in Viana, about 30 km from the port towards the interior of the country, with road and rail links.

Although this infrastructure has been rehabilitated and built, there are still some obstacles to overcome that we believe are congestion of access to the ports, the poor state of the roads that connect to the ports, mainly Lobito and Luanda, the lack of efficiency and performance in handling goods, the acquisition of more equipment and the worsening of handling fees in Angolan ports.

In terms of fleets, aircraft, motor vehicles and railways, the government has been taking steps to make them more energy efficient.

Transport sector	Technology Transfer to Angola
Transport sector	South-South/North South
Creation of residential and commercial areas, reducing the need for displacement	X
Promotion of public transport with increased passenger capacity (train, bus, ferry boats)	X
Use of multimodal transport systems (modes of transport: road, water, rail)	X

In the field of Climate Monitoring

Climate changes throughout the Earth's history have always been due to natural factors (variation of solar radiation, earth's orbit, volcanic activity, etc.) but current climate changes are occurring at a very rapid pace; these changes have generated greater awareness of human vulnerability and its achievements and technical and technological advances.

The frequency of extreme events has increased the vulnerability of populations and the lack of timely information has led to heavy losses, mainly in the center and south. Authorities responsible for safeguarding lives and property have also been lacking more and better information to formulate more effective contingency plans capable of minimizing the impact of extreme events. Therefore, meteorology, hydrology, geophysics and related sciences can play a catalytic role in meeting development challenges in areas such as the mitigation of natural disasters, food security, water management, transport, and tourism and pollution control.

Although technological innovations are taking place at a particularly fast pace, in the country many climate records available to the National Institute of Meteorology - INAMET still remain in non-digital format and many gaps can be noted as a result of the records of climate data from 1961 to 2000 in Angola.

Considering that much of the national weather network was destroyed during the conflict period, this sector has the advantage of benefiting from new technologies in the process of reconstruction, extension and construction of its climate prediction network. The meteorological observation network covers part of the country and is incipient for the needs and territorial dimension of the country.

It is necessary to adapt the meteorological and geophysical services to the category of modern public utility, through the modernization of the National Institute of Meteorology, with priority to the operational aspects of rentabilization of infrastructure and observation networks, as well as the areas of meteorological and geophysical applications.

Since 2019, INAMET has been an investment in modernisation, which includes the training of staff, the creation of a course at the university and the equipping of equipment. The project has the technical assistance of Météo Française Internationale. In a second phase, the rehabilitation of the network of stations is planned.

Climate Monitoring	Technology Transfer to Angola
Climate monitoring sector	South-South/North South
Information on weather and climate, tidal status, seismic and hydrological phenomena, increase and diversification of the coverage network development of scenarios and climate models;	X
Establishment of an early warning system to prevent extreme events capable of jeopardising the security of populations and their goods, production, infrastructure and social equipment essential for economic and social development.	X
Improving climate forecasting and recovery of lost data through satellites	X
Employing the use of the National Satellite to increase the level of certainty in climate prediction	X

In the field of Telecommunications

Communications are a key factor in development and are the basis for the establishment and operation of an information and knowledge society. The Angolan government recognised that need and put telecommunications on the list of priorities for reconstruction.

The White Paper on Telecommunications sets as an overall objective of development policies the expansion of infrastructures to support the provision of diversified information and communication services, of good quality and at affordable prices, in all regions of the country, contributing to the promotion of new modern technological initiatives (education, governance,

Complexo Administrativo Clássicos de Talatona, Rua do MAT,
Building 4, 4th Floor
Talatona Municipality, Luanda
E-mail: dnaac@mcta.gov.ao

medicine, commerce), promoting the development of the information society and following up the various projects in the field of electronic governance.

Angola has made very important investments in infrastructure and in improving telecommunications services for public use. Examples are the installation of the multi-service network, known as DIGINET, which aims to offer an integrated range of services, using techniques and technologies that allow greater bandwidth in local access for companies and institutions. The expansion and modernisation of the domestic transmission network, creating telecommunications corridors (with fibre optics) along the main road and rail routes, and making high capacity and quality links with neighbouring countries possible. The Fiber Optic Submarine Cable Project called SAT 3 /WASC - COLUMBOS - SAFE, with which Angola will be able to provide transmission capacities 25 times greater than current international voice and data communications. The "SAT 3/WASC" cable ties most countries on the west coast of Africa between Cape Town (South Africa), to Dakar (Senegal) and then on to Europe (Sesimbra, Portugal). In addition, a liberalisation process is underway, through Angola Telecom (and on its own initiative).

Complexo Administrativo Clássicos de Talatona, Rua do MAT,
Building 4, 4th Floor
Talatona Municipality, Luanda
E-mail: dnaac@mcta.gov.ao

Telecommunications sector	Technology Transfer to Angola South-South/North South
Expansion of the basic network and its consequent digitization	X
Diversification of the country's communication base with the use of new technologies such as the future Angolan satellite	X

In the field of Health

The health situation in Angola is characterized by high morbidity and mortality rates caused mainly by the development of infectious diseases such as malaria, acute respiratory and diarrhea diseases, tuberculosis, HIV/AIDS, trypanosomiasis. Malaria remains the leading cause of morbidity and mortality, accounting for more than 50% of the demand from health facilities in the country.

The health status is further aggravated by epidemic outbreaks of cholera, which has become an endemic disease. The occurrence of cholera epidemiological outbreaks is justified by the low levels of drinking water supply and sanitation.

The national reconstruction program has made water supply a priority through the "Water for All Program". In several areas the program has given priority to the use of solar panels for water collection. All over the country, including the government, businesses and individuals, the use of solar panels for various purposes has increased.

Despite this and other efforts, the health sector will continue to deserve special care and devote significant amounts of public budget unless there are substantial improvements in the level, education of people, income, environmental sanitation and individual and collective hygiene, decent housing and infrastructure.

It is to be assumed that the epidemiological picture in Angola will change, in the context of climate change, with the frequent occurrence of epidemiological cycles of known infectious diseases, malaria, acute respiratory and acute diarrhea diseases, tuberculosis, HIV/AIDS, trypanosomiasis and immune preventable diseases (measles, polio, tetanus, diphtheria, among others); the likelihood of other pandemics such as the current COVID-19 and genetic mutations in pathogens which, if they occur, will become more violent and further worsen the health status of populations is also not to be ignored. In these cases, health expenditure, both for the State and for families, will increase and, consequently, the quality of life of people will decrease.

Health Sector	Technology Transfer to Angola
Health sector	South-South/North South
Planning new laws and regulating existing ones through knowledge	X
Creation of public policy guidelines	X
Urban planning to reduce the effects of "heat islands and flooding	X
Early Warning Systems	
Emission control	X
Traffic restrictions	X
Improvement of public transport	X
Catalytic converters	X
Use of alternative vehicles (bicycle, etc)	X
Taller, filtered chimneys in the industry	
Diseases caused by vectors	X
Control of vectors	X
Vaccination	X
Education and public awareness	X
Improving water storage	X
Use of technology to prevent water-borne diseases	X
Genetic/molecular studies of pathogens	X
Improving water and wastewater treatment	X
Technology related to sanitation and waste control	X
Early warning systems	X

In the field of Housing

Angola's population is divided between urban and rural.

People in rural areas live in precarious housing made mostly of clay and covered in straw. These offer reasonable comfort and convenience despite the high risk of fire.

In peri-urban areas housing is precarious following various typologies. These poor and irregular constructions are disorderly and there is little chance of providing urban infrastructure (streets, electricity, drinking water and sewage network) and social facilities (schools and hospitals) even if government programmes allow it. The government is making heavy investments in upgrading these neighbourhoods and changing the present framework of irregular construction. Part of the population will be rehoused in principle.

In a context of extreme weather conditions, the Government needs to make available to the population technologies and materials suitable for the construction of their homes according to the characteristics and weather conditions of the places where they live.

Although the private sector plays a leading role in the national housing programme, the state continues and will continue to dictate the rules and influence the use of building technologies that maximise natural resources and contribute to energy efficiency and waste recovery.

Environmental education and awareness can play a major role in this sector, combined with strengthening policies and legislation.

Housing	Technology Transfer to Angola
Human settlements sector	South-South/North South
Urban planning to reduce the effects of "heat islands", as well as of storms, floods and floods	X
Improving water treatment and sanitation	X
Early warning systems	X
Creation of residential and commercial areas, reducing the need for Displacement	X
Promotion of public transport with higher passenger capacity (train, metro)	X
Reduce the area of paved structures in buildings, using vegetation to reduce the effects of heat islands and reduce the energy required by air conditioning	X
Preventing the development of infrastructure in flood areas	X
Establish standard building codes	X
Valorisation of local materials (e.g. adobe) less emitters	X
Improving ventilation and harnessing energy potential	X

CHAPTER - 6
SYSTEMATIC RESEACH AND OBSERVATION

The entry into force of the UNFCCC on 21 March 1994 represented the awakening of public opinion on the scientific evidence of the influence of human activities on global climate change.

Article 4(1)(g) of the Convention calls on Parties to "Promote and cooperate in scientific, technological, technical, socio-economic and other research, systematic observations and the development of databases on the climate system, the purpose of which is to clarify and reduce or eliminate remaining uncertainties regarding the causes, effects, magnitude and evolution over time of climate change and the economic and social consequences of various response strategies.

In Angola, responsibility for research and systematic observation in the field of climate change falls to the National Institute of Meteorology and Geophysics (INAMET), which is a public institution, under the Ministry's supervision of Telecommunications and Information Technology, involving other institutions that by the nature of their duties are framed directly or indirectly in research and systematic observation in the field of climate change.

6,1. State of the Angola Climate Observation Network

Observations of weather and climate parameters are the key starting points for understanding the climate. Such data are collected through land, air, sea and satellite observation networks, supervised in each country by the national meteorological and hydrological services.

Our planet has a worldwide observation network coordinated by the World Meteorological Organization (WMO), composed of more than 11,000 terrestrial meteorological stations and 1,300 superior air and radio stations belonging to member countries (WMO, 2011). In Angola, the climate observation network includes stations from various institutions, is coordinated by INAMET and is connected to the world climate network through WMO.

The surface weather observation network in Angola today presents an improved picture, when compared to the state of the First National Communication network in Angola in 2012. This is both in terms of quantity with the increase in new units, and in terms of quality with the shift from conventional to automatic weather stations. As a result of national investment and international cooperation, the country has expanded its potential for systematic observation.

Table 1: Composition of the Integrated Climate Observation Network

Network INAMET	A network under the responsibility of INAMET, which processes the systematic observation of meteorological and climatic parameters. It is part of the worldwide network of stations coordinated by WMO. Contributes with synoptic and climatic stations.

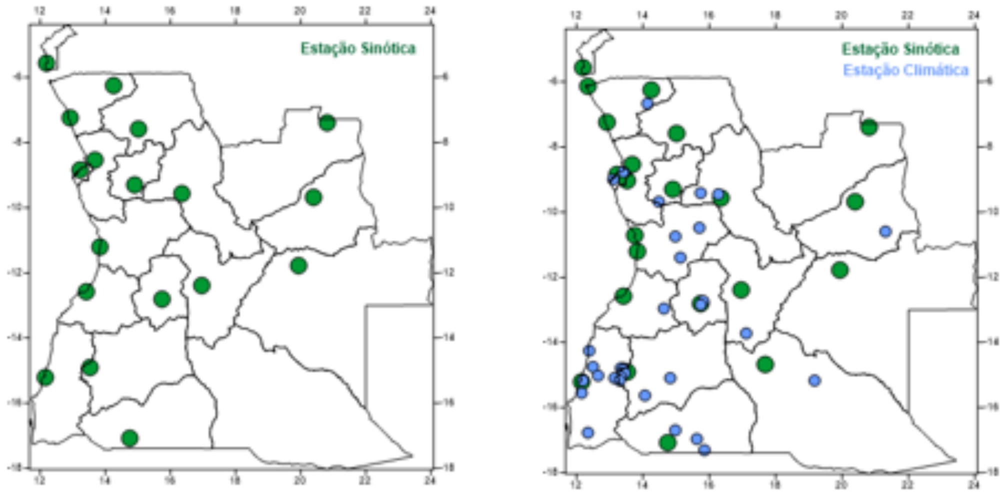
Network SASSC AL	A regional network of joint initiatives from South Africa, Angola, Botswana, Zambia in partnership with Germany as part of the SASSCAL project, whose mission is to conduct targeted research in the area of climate change adaptation and sustainable land management in the SADC region. Contributes to climate seasons
Network MINADER	Network under the responsibility of several bodies under the Ministry of Agriculture, and contributes to an integrated network with monitoring of agro-climatic parameters and precipitation; contributes to climate stations and udometric stations.

Despite the progress made, the number of units in the integrated network is still insufficient to cover the size of Angola's territory satisfactorily in terms of observation. On the other hand, there is a lack of homogeneity in the configuration of the climate observation network in Angola, with 89% of the stations concentrated in the West while the East region has only 11%; this fact does not allow the real behaviour of climate parameters in Angola to be known in depth. Figure 1, illustrates a spatial distribution of the stations.

Table 2: Time evolution of Angola's Integrated Climate Observation Network

Category	1974	2012	2016
Synoptic Station	32	18	22
Climate Station	225	0	32
Udometric Post	281	1	156

Source: INAMET, 2017.



(a) 2012 (b) 2016

Figure 1 - Spatial distribution of Angola's climate observation network. Source: INAMET, 2017

On the other hand, besides the systematic observation of atmospheric parameters, the country had a network of tide gauge stations (sea level measurement) strategically distributed along the coast; however, it has been completely paralysed since 1999. Variations in mean sea level may occur as a result of climate change and Angola's territory, with a coastline of around 1600 km, may be greatly affected, with the replacement of the network of tide gauge stations being of great importance.

This analysis identified several constraints that, if overcome, could increase the efficiency of the climate observation network in Angola, and suggested the respective recommendations (Table 3).

Constraints	Recommendations
Low density of the climate observation network and special distribution of stations at national level not homogeneous	Increasing the number of stations in order to expand the observational coverage of the country and adapt the spatial distribution of the network
Weak capacity for maintenance of the stations by the institutions, with outsourced services being very costly for them.	Training of technical staff in instrumentation within the institutions to reduce costs with the maintenance of the stations.
Difficulties in entering data directly from automatic weather stations into the central database.	Training of technical staff for this area .

Complexo Administrativo Clássicos de Talatona, Rua do MAT,
Building 4, 4th Floor
Talatona Municipality, Luanda
E-mail: dnaac@mcta.gov.ao

Difficulty in collecting data from udometric posts.	Make use of new technologies, use of sms.
Maregraphic network totally inoperative.	Replacement of the national maregraphic network in order to restart the monitoring of oceanographic variables.

Table 3: Constraints and recommendations on the climate observation network

6.2 State of Angola´s Historical Climate Data

Historical data are essential for the development and validation of regional climate models and are crucial in determining possible future patterns of climate change.

When preparing the first national communication, INAMET practically had a physical database (paper) and monthly data of the main climate parameters of some stations in Excel format. At the time, there were also problems related to the historical archive, which was largely lost and with numerous gaps in observations.

The consultancy noted progress related to the management of historical climate data with the transition of the database from physical to digital format (Figure 2), with the use of CLIMSOFT software, a tool recommended by the WMO, and adopted for the SADC region, as part of the SASSCAL project.

Figure 2 - Evolution of the INAMET Climate Database from physical to digital format.

In a first stage, the transition from historical data in written to digital format was made, with the data for the period 1950 to 1974, 25 synopic stations, 132 climate stations and 144 udometric posts. The data input for the period 1975-2016 is now critical due to the numerous data gaps resulting from the inoperativeness of several stations during and after the period of armed conflict. To fill in the gaps, a process is underway to collect historical data from Angola existing in international centres, namely NOAA, CLIMAT, GPCC and SASSCAL, where 648 files with national data have been accessed and are being analysed and subsequently validated. The automatic stations currently report the results of observations directly to the database.

In order to establish a uniform basis for comparing the calculations of climate change anomalies, the IPCC takes the 1931-1990 climatological normals as a reference. According to WMO, the normals are averages of climatological data calculated for consecutive 30-year periods, and have served two main purposes. First, they are a reference for which current or recent conditions can be assessed, and second, they are used for predictive purposes as an indicator of conditions likely to occur in a given region. Only Cabinda, Luanda, Benguela and Namibe stations have complete series for 30 consecutive years referring to the 1961-1990 (standard climatological normal). The other stations have numerous gaps that are linked to the period of inoperativeness of the stations due to the military conflict, which makes the data series statistically inconsistent for the assessment of climate change.

The table identifies the constraints and related recommendations concerning historical climate data.

Table 4: Constraints and recommendations concerning historical climate data

Constraints	Recommendations
Inconsistencies in the treatment of historical data series currently in use by INAMET have been identified.	The revalidation of the historical data series according to the WMO Instruction No. 100, including the 1961-1990 climatological normal and the provisional normal. Filling in faults, where observations do not exist, according to the WMO Guide to Climatological Practices (WMO-N° 100), by interpolation of data obtained from stations, by combining data from stations with remote sensing or even by the reanalysis technique.

6.3 Satellite Technology for Monitoring the Impact of Droughts and Supporting Agricultural Activities in Angola

Due to the increased frequency and magnitude of droughts in various regions of the world, as a possible result of climate change, WMO recommends to member countries the importance of monitoring the phenomenon and setting up early warning systems. In this Angola is part of the international cooperation project AMESD - Environmental Monitoring for Sustainable Development in Africa, financed by the European Union and benefiting 48 African countries.

The objective of the AMESD initiative is to provide African beneficiary countries with satellite receiving stations, support in the maintenance and continuous supply of their satellite data and products free of charge, so that they can manage their environment more effectively and ensure long-term sustainable development in the region. Launched in 2007, the AMESD project is scheduled to run until mid-2013. From 2014 to 2018, the AMESD project has taken another name, MESA (Monitoring for Environment and Security in Africa). In Angola, the project did not produce the results expected in the first phase. The second phase is ongoing and the process of receiving new equipment and training activities is underway.

Figure 3 -AMESD satellite receiving station of INAMET in Luanda. Source: INAMET, 2016.

Table 5: Constraints and recommendations concerning satellite technology

Constraints	Recommendations
The first phase of the project did not produce the expected results in Angola, due to human resources issues.	The training of human resources with the higher level (post-graduation) in the area of remote detection and photointerpretation, in order to improve the country's performance in the second phase called MESA.

6.4 State of Early Warning Systems in Angola

The risks of natural disasters can be reduced by observing hazards (floods, droughts and others) in good time. Natural disasters cause great suffering to the population and substantial economic losses throughout the world. Climate change and rapid urbanisation further increase the problem. In order to create efficient plans against natural disasters for prone areas, the use of early warning systems is necessary.

The Benguela Basin Flood Early Warning Sys1t6em (SAP), under the responsibility of the National Civil Protection Service (SNPC) and the Cuvelai Basin Flood Early Warning and

Forecasting System under the responsibility of the IRH, has been identified.

The SAP system is designed to monitor and predict water behaviour to generate flood alerts for communities, providing sufficient time for action. The main elements of this system are observations from a network of automatic hydrometeorological stations in the Coporolo, Cavaco and Catumbela basins and a data processing and analysis system centralised in Benguela.

The SAP system does not meet the objectives which led to its creation, due to a lack of human resources in the processing of the data generated by the system.

Figure 4: Example of SAP hydro-meteorological station.
Source: SAP, 2015.

Table 6: Constraints and recommendations concerning the Early Warning System

Constraints	Recommendations
Hydrometeorological stations operational, but lack of processing of the information generated by the system due to lack of specilised human resources	Training of human resources with a higher level in the area of hydrological modelling.

6.5 State of Climate Change Research in Angola

The 5th IPCC Report (AR5) demonstrated that appropriate responses to climate change mitigation and adaptation are quite complex and will never be completed due to the dynamics of updating knowledge from ongoing research and improving climate models.

AR5 provides global and regional indicators on observed and future climate change patterns, as well as likely impacts for different sectors. However, it is assumed that national and local details will be improved by countries, with hard research work, so that they can produce detailed knowledge on their local indicators.

From the report on research and systematic observation in Angola, it appears that the level of research on climate change in Angola is weak. The main difficulties stem from the lack of specialised human resources and sufficient climate data for research. However, some local projects have been identified as part of SASSCAL's activities, developed by some researchers from various higher education units in the country.

As part of the development of the Report on Research and Systematic Observation, studies on the evolution of the climate observed in Angola were initiated, the preliminary results of which are an integral part of it.

Table 7: Constraints and recommendations regarding climate change research

Constraints	Recommendations
Lack of researchers in the institutions contacted, particularly human resources trained in geosciences with doctorate and master's degrees, who can develop the activity of scientific production in the area of climate change. The few senior staff are usually allocated to operational and management activities. Lack of a climate database at the time of providing reliable data for research.	Implementation of the national strategy on research and systematic observation for Angola. See recommendations on climate data in previous sections of this chapter.

CHAPTER - 7

EDUCATION, TRAINING AND PUBLIC AWARENESS ON CLIMATE CHANGE

Complexo Administrativo Clássicos de Talatona, Rua do MAT,
Building 4, 4th Floor
Talatona Municipality, Luanda
E-mail: dnaac@mcta.gov.ao

Most of Angola's population is young (under 15). The average age of the population is 20.6 years[33]. This situation means high pressure on the National Education System.

It should be noted that after Angola's independence the main objective of the government was the creation of a new society, which would only be possible with the formation of the "new man". Everything that reminded us of colonisation should be changed. The new country should have a political, economic and social structure different from the colonial structure that excluded the majority of the population from exercising their citizenship. The new education system had to be different from the colonial system.

Education thus becomes compulsory and accessible to the entire Angolan population. The state alone was responsible for the process of formation, putting the churches out of this responsibility, as was happening[34] under the colonial regime. The compulsory and free teaching, together with the fact that education was defined as a priority in the tasks of the state, led to an explosion in schooling (a large number of students faced with a blatant shortage of infrastructure, teachers and school materials).

Free of charge in the education and teaching system means no payment for registration, class attendance and school material. The obligation of education translates into the duty of the state, society, families and companies to ensure and promote access and attendance to the education and teaching system for all individuals of school age.

The 2010 Constitution of the Republic of Angola recognises in its article 79 that the State promotes the access of all citizens to education and literacy, within the framework of their economic and social rights. Accordingly, the Basic Law of the National Education System presents two principles - compulsory and free of charge.

The education and teaching system is unified and consists of six education subsystems and four levels of education. The general education subsystem is structured in primary and secondary education. Primary education is the foundation of general education and its completion is a prerequisite for attendance at secondary education.

7.1 Literacy and school lag in Angola

According to the latest census[35], the country has a national literacy rate of 66% for people aged 15 and over, 80% for men and 53% for women. About 4,676,900 people over the age of 15 (34% of the population) could not read or write at the time of the census in 2014. The

[33] INE (2016). Inquérito dos Indicadores Múltiplos da Saúde (IIMS) 2015-2016.
[34] PAXE, I (2017). Políticas Educativas em Angola: Um Desafio do Direito à Educação. 1ª Edição, Editora Casa das Ideias.
[35] INE (2016). Resultados Definitivos do Recenseamento Geral da População e da Habitação de Angola 2014.

2019[36]Human Development Index uses the same data and points to a literacy rate[5] of the Angolan population of 15 years or more of 66%. This figure is likely to have increased since then given the cuts in service provision and due to the reduction in life.

literacy as a result of the economic crisis that has dragged on since 2014. The need to catch up is extremely high, given that only 20% of the population aged 18 and over have completed primary school - the average schooling level for the population aged 25 and over is 6.4 years for men and 4 years for women, which . The NDP 2018-2019 aims at increasing literacy with a focus on women and the rural area. The Sustainable Development Goals up to 2030 include an objective to ensure that all young people and a substantial proportion of adults are literate and have acquired the basic knowledge of mathematics. Angola is still far from this target.

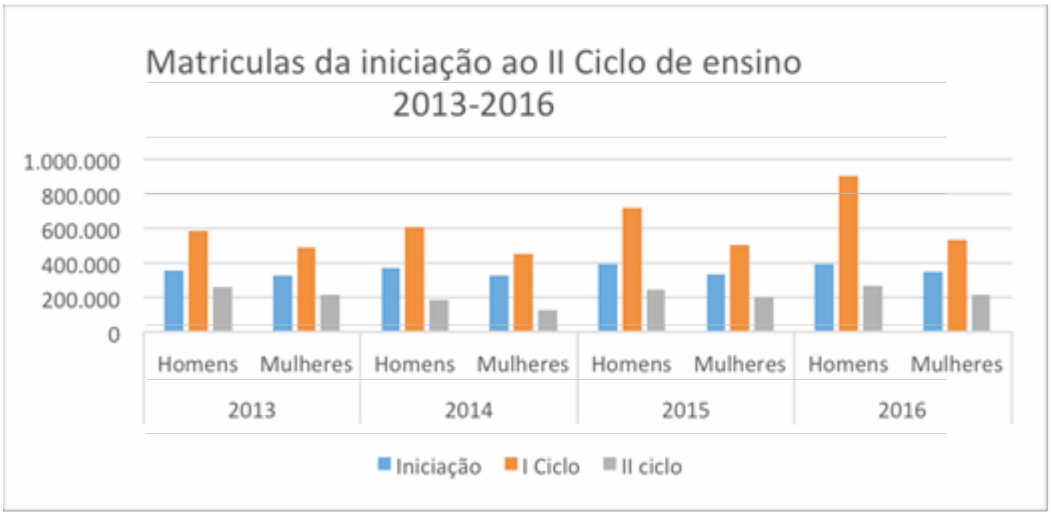
Primary and secondary education

According to the IIMS 2015-2016, 71% of children aged 6-11 years, both male and female, were in primary education in the reference year of the survey.

With regard to school attendance in secondary education, there is a notable gender inequality, among 12-18 year olds in secondary education, only 37% are women. The Gender Parity Index (GPI) is 1.02 in primary education and 0.85 in secondary education. This means that for every boy there is one girl in primary education and for every ten boys there are eight girls in secondary education.

Children in urban areas are more likely to attend primary (78% compared to 59%) and secondary (50% compared to 14%) education than children in rural areas. The graph below shows the difference between the number of pupils enrolled in the different levels of education (initiation, I and II Education cycle), which highlights the high levels of dropout between cycle I and II. According to the Human Development Index, the drop- out rate at the end of the first cycle is 68%.

[36] http://hdr.undp.org/en/countries/profiles/AGO



Source. Ministry of Education Report (2017)

Complexo Administrativo Clássicos de Talatona, Rua do MAT,
Building 4, 4th Floor
Talatona Municipality, Luanda
E-mail: dnaac@mcta.gov.ao

As the education statistics show, Angola still faces a major challenge in achieving its national (NDP) and international goals. The goals set by the Government demonstrate the will to improve the education and learn situation. The importance of education is demonstrated in the NDP 2018-2022, as it foresees that the allocation to the education sector will gradually increase from 12.4% to 20% of total expenditure. The 2020 GBS proposal indicates a clear intention to improve education through increased investment in the sector.

Higher Education in Angola

The development of higher education in recent years has accompanied the different phases of sociopolitical and economic developments in society. Higher education was only established in Angola in 1963, with the creation of the General University Studies of Angola (then a Portuguese colony). The Catholic Church had, however, created its seminary in 1958, with higher studies in Luanda and Huambo[37] . The creation of General University Studies of Angola was followed by the creation of courses in the cities of Luanda (medicine, sciences and engineering), Huambo (agronomy and veterinary) and Lubango (letters, geography and pedagogy).

With the proclamation of independence, the University of Angola was created (in 1976), maintaining a single institution of higher education of national scope, and in 1985 it was renamed the Agostinho Neto University, a situation that continued until 2009. That year, the Agostinho Neto University (UAN) was split into 7 regional universities, with UAN operating in Luanda and Bengo province, while the colleges, institutes and higher schools located in the other provinces began to be allocated to the other six new state universities:

- Benguela - Katyavala Bwila University (operates in the provinces of Benguela and Kwanza-Sul),
- Cabinda - 11th November University (Cabinda and Zaire),
- Dundo - Lueji-a-Nkonde University (Luanda-Norte, Lunda-Sul and Malanje),
- Huambo - José Eduardo dos Santos University (Huambo, Bié and Moxico),
- Lubango - Mandume ya Ndemofayo University (Huila, Cunene, Kuando Kubango and Namibe),
- Uige - Kimpa Vita University (Uige and Kuanza-Norte).

Records for 2011 indicate that Angola had 17 universities (7 state and 10 private), 19 higher institutes (7 state and 12 private) and 2 autonomous higher schools (both state) [38]. By 2017 these figures had risen to 24 public and 41 private universities.[39]

[37] OAK, P (2012). "Evolution and Growth of Higher Education in Angola". **Revista Angolana de Sociologia** [Online]. Available at http://journals.openedition.org/ras/422;DOI:10.4000/ras.422. Consulted on 6/Jan/2020.

[38] OAK, P (2012). "Evolution and Growth of Higher Education in Angola". Revista Angolana de Sociologia [Online]. Available at http://journals.openedition.org/ras/422;DOI:10.400/ras.422. Consulted on 6/Jan/2020.

[39] According to figures released by Manuel Vicente, at the time Vice-President of Angola, at the official opening ceremony of

As for access to higher education, the literature indicates that from 2002 to 2011, the number of students attending undergraduate courses at higher education institutions in Angola increased to 140,016, as shown in table 3. In that period, the average growth rate of the number of students per year was 30.7 percent. It should be noted that the big *boom* in access to higher education in Angola occurred with the end of the civil war (in 2002) and the increase in the budget for it. Its expansion across the provinces has contributed to access to this level of education for an increasing number of young people.

Recent data show that 2.5% of the population aged 24 and over have higher[40] education. The Human Development Index indicates that the percentage enrolled in tertiary education is 9%.

Recent years have seen a renewed commitment to higher education on the part of the Government expressed in the NDPs. The current NDP (2018-2022) assumes as measures aimed at the expansion of higher education, greater investment in order to overcome some problems, such as the lack of infrastructure, the difficulties in responding to demand, the small size of the teaching staff and their low educational qualifications, the low flexibility of curricula, low pay, the few financial resources allocated to the higher education subsystem and the absence of adequate public policies for its development.

"One of the main roles reserved for education is, first and foremost, to give humanity the capacity to master its own development. It must, in fact, make everyone take their destiny into their own hands and contribute to the progress of the society in which they live, basing development on the responsible participation of individuals and communities" Education, a treasure to be discovered, Report to UNESCO of the International Commission on Education for the 21st Century. This recognises the role that education plays in the implementation of any development programme in a country like Angola.

Despite the efforts undertaken in this area, during the 45 years of National Independence, the education sector continues to face some constraints, such as a severe shortage of teachers with adequate basic education, the destruction and destructuring of the existing school network, especially in rural areas, many generations of pupils without access to education, a lack of bases for learning occupations and trades, low income and efficiency, with high failure and dropout rates.

This set of factors limits the capacity of professionals to take responsibility, as most workers do not have the skills to meet the requirements of the employment market, which forces the use of expatriate labour force, for a large part of foreign companies and even some domestic ones.

The Angola 2025 Development Strategy highlights the following issues for the education sector:

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the 2017 academic year.

[40] INE (2016). Multiple Indicators of Health Survey (IIMS) 2015-2016.

- Low educational level of the population, low schooling and high illiteracy;
- Disarticulation between education and training systems and between these and the development needs of the country;
- The need to link the demand for access to education with the demand for knowledge, skills and qualifications;
- Articulation between the different education subsystems.

The Ministry of Education's ultimate goal is to *promote human and educational development, based on education and lifelong learning for each and every Angolan.* To achieve this objective, the following priorities, among others, are established:

- To increase the quality of teaching, paying attention to the training of teachers and the system of learning evaluation;
- Continue the process of expanding the country's school infrastructure, as well as improving the conditions of existing schools;
- Ensure pre-school education;
- Guaranteeing compulsory and free education up to the 1st cycle of secondary education (9th grade);
- Increase the rate of schooling in Primary and Secondary Education with the construction, expansion and equipping of schools;
- Strengthening the Adult Literacy Program;
- Expanding technical education and preparation for work, through training centres managed in cooperation with business entities, in line with national development needs and priorities;
- Increase the network of primary and secondary schools in the 1st cycle;
- Ensure the training and capacity building of teachers and school managers;
- Improve the organisation and administrative and pedagogical management of public and public schools.

7.2 Education, Training and Public Awareness on Climate Change

7.2.1 Education and Training

Addressing environmental issues in the Republic of Angola is mandatory and essential for the life of societies and in all spheres of political, economic and social development. The Constitutional Law (*Article 39, Right to the Environment*) states that "*Everyone has the right to live in a healthy and unpolluted environment, as well as the duty to defend and preserve it".* The same article obliges the State and the population in the following way: The *State shall adopt the measures necessary to protect the environment and species of flora and fauna throughout the national territory, to maintain the ecological balance, to locate economic activities correctly and to exploit and use all natural resources rationally, within the framework of sustainable development and respect for the rights of future generations and the preservation of the*

various species".
The law punishes acts that endanger or harm the preservation of the environment.

Thus, all the actions that contribute to raising the awareness of society and the population that promote knowledge and disseminate information on the various environmental aspects, have the necessary support in the country's Magna Law.

There are several legal instruments that the State, as recommended by the Constitution, has established to regulate human activities among which it has enacted the Basic Law of the Environment (LBA), which in its Article 20 refers to Environmental Education.

Based on the LBA, the Ministry of Education, an important partner of the Ministry of Environment, has developed environmental education actions through the formal education system, introducing into thematic school programmes and textbooks related to the environment and its preservation, with emphasis on *climate change, in order to* contribute to the development and elevation of an environmental awareness of society, through the knowledge of ecology and other environmental factors, in the new generations.

National Week of Nature Conservation, January 1976

Consideration of the environment in development policies started early. The new Republic, just proclaimed on 11 November 1975, held from 26 to 31 January 1976 the National Week for the Conservancy of Nature, a scientific-technical day with a strong educational and awareness-raising focus.

As a result of Angola's first multi-party elections, in 1992, the Government of Unity and National Reconciliation emerged, with an innovation in its outfit, the creation of the Secretariat of State for the Environment, which in 1997 became the Environment Ministry.

It is exactly in 1992 that the formal establishment of contacts between the entity responsible for the environment policy (the Secretary of State) and the Ministry of Education begins, for the first training actions on Environmental Education. Following this process, the Ministry of Education, through the National Institute for Research and Development in Education (INIDE) appointed two technicians to monitor environmental activities in order to complement them with aspects of education.

Of the various educational activities, under the Secretary of State for the Environment, the *National Symposium on the Environment* should be highlighted, an event that mobilized practically all national entities and individuals in some way interested in addressing environmental issues, with emphasis on education and awareness.

The *Training Course for Journalists on Environmental and Development Issues,* held from September to December 1993 under the auspices of ADRA (Action for Rural Development and Environment) with funding from Sida (Swedish International Development Agency), is a major contribution to addressing environmental issues in the national journalistic class and with it the emergence of editorial spaces for dealing with environmental issues. Undoubtedly an important step towards environmental awareness. 24 journalists from Radio, Television, Press and Agency participated in this course.

After the Rio Summit in 1992, the countries began to attach greater importance to environmental aspects. The curricular reformulation carried out before the implementation of the Second Educational Reform took into account the recommendations of international and national events. The relevance of including environmental themes in their different dimensions (given their inter and multi- disciplinary character) aimed at the *knowledge and understanding* of global environmental problems and subsequent *actions of intervention* in relation to local environmental problems, guided the actions in the Education sector.

The issue of *climate change,* although not a new problem, as far as formal education is concerned, takes on unique characteristics given the cross-cutting nature of its treatment. That is to say, particular approaches are required, depending on the age level and education cycles. Taking into account didactic issues and taking care of the progression of the contents directed towards *climate change*, they are part of the curriculum of Primary and Secondary Education:

- Human activities and natural resources;
- Environmental factors that influence living beings;
- Air pollution: sources of pollution. Consequences of air pollution;
- Drought and desertification: causes and consequences;
- Importance of forests for life on the planet;
- The fight against air contamination: air pollutants;
- Consequences of air pollution: the greenhouse effect, destruction of the ozone layer;
- Measures to reduce air pollution;
- Environmental safety;
- The burns: consequences of the burns;
- The degradation of marine habitats and coastal areas: causes of the degradation of coastal areas;
- International cooperation in solving environmental problems;
- The influence of human activities on air quality;
- Greenhouse effect: consequences of the greenhouse effect;
- Importance of the ozone layer;
- The acid rain: consequences of acid rain;
- Measures to reduce air pollution;
- The Convention on Biological Diversity;
- Agenda 21;
- Living conditions in urban areas;
- Strategies and solutions to improve cities.

Other environmental themes included in the curricula are

- Components of the natural environment;
- Natural environment and the human being;
- The protection of plant and animal species: measures to protect them;
- The areas of environmental protection in Angola;
- The preservation of the environment;
- Importance of the World Ocean and its resources;
- The management and protection of water on the planet;
- Combating deforestation;
- Terrestrial ecosystems;
- The movements for environmental protection in the world and in Angola;
- Biodiversity: in Angola;
- Water resources in Angola: protection and management;
- Ecological consequences of poor management of natural resources;
- Ecological planning in land use planning;
- The main African protected areas;
- The wetlands. The Ramsar Convention;
- Global Programme of Action for the Protection of the Marine Environment from Land-based Activities.

It should be noted that education plans include addressing environmental aspects from the point of view of the bilateral, regional and multilateral cooperation in which the country is involved.

Higher education institutions, considering the country's development programmes, have included in their training curricula degree courses related to the environment:

- The Independent University of Angola, included a *degree in Natural Resources and Environmental Engineering.* Its main objective is the correct use and management of natural resources and the preservation of the environment, with 5 years of duration, participating in the preparation of studies to characterise the reference situation and planning plans.
- The Technical University of Angola presents as a novelty the *degree* course *in Environmental Engineering*, whose main objective is to use vital resources such as water, soil, air and ecosystems in a sustainable way. It is expected that the future engineer will acquire skills to carry out technical, management and management functions in planning, licensing and supervision services for industrial companies, environmental project companies, supervision services in civil construction and public works and in tourism.
- The Methodist University of Angola included a degree in *Environment and Territory Management.*
- The Faculty of Sciences of the Universidade Agostinho has instituted a Master's degree course in Environmental Management.

In the framework of the UNESCO Chair in Chemical Engineering and Environment at the

Agostinho Neto University, its Faculty of Engineering held between 2007 and 2009 the 1st edition of the Master's and Specialization Course in Environmental Engineering.

Since 2011 Agostinho Neto University is a full member of the Network of Environmental Studies of Portuguese Speaking Countries (REAPLP). The Network was created in 1997 with the aim of promoting scientific cooperation in the area of the environment and sustainable development. The Network is composed of twelve universities from Portuguese-speaking countries, including Agostinho Neto University.

7.2.2 Public Awareness and Information

The participation of the media in the treatment of environmental issues, in the most diverse media and themes, should be a pleasant note.

However, with a few exceptions, there is a general lack of knowledge among media professionals in the proper handling of environmental issues

Radio Diffusion of Angola

There is already a continuing concern of radios throughout the country to address specific environmental issues:

Rádio Nacional de Angola has spaces that privilege the environmental approach.

LAC (Luanda Antena Comercial), a private commercial radio station, has on its programme schedule a weekly space of two hours, exclusively dedicated to addressing environmental issues, in which climate change has been adequately addressed.

Written press

Private newspapers favour the challenging approach that contributes to questioning the actions of the various actors in the social, economic and political life of the country.

Jornal de Angola has a team of reporters dedicated to dealing with environmental issues, as does ANGOP, the Angolan news agency.

Environmental Protection Associations

The environmental associative movement in Angola, which experienced moments of effervescence and great prominence in the 1990s, is experiencing a certain slowing down of its actions, which in some way inhibits the massive pro-environmental activities. This, despite being part of a kind of federation, the Mayombe Network, theoretically the interlocutor of all environmental NGOs in the country.

CHAPTER – 8
EXISTING CAPACITIES AND CAPACITY BUILDING NEEDS

Coordinated integration at all levels of different policy areas will be the most appropriate way to achieve the objectives and targets set by the UNFCCC. Angola is a signatory party and, as in different countries at the same stage of development, has sought to build/create an institutional capacity (technical, human and financial) to deal with the issue of climate change, which is roughly interfering with countries' economic models and consequently their development.

Institutional capacity building/creation and consolidation has been done gradually and within projects that have been implemented across the board. Technical capacity building/creation is differentiated, namely at the level of the legislator, political decision-making centre, technical, as well as at the level of civil society, private sector and local communities, as a result of their involvement in projects and different initiatives related to climate change.

In Angola, in particular, the urgent need for institutional capacity building in the public sector, civil society and the private sector is highlighted in order to change citizens' attitudes and behaviour.

At central level institutional capacity is still limited. Efforts have been made to improve the situation, but they lack an integrating mechanism, and greater involvement of academic institutions and research centres. At the provincial and local level this capacity is still weak, requiring innovative and integrative actions in other areas such as vocational training, local administrations, field schools and the active involvement of civil society organisations.

NGOs that should be very active in forming environmental awareness at the local level, although they are starting from a low base to focus on climate change, also lack the knowledge to address the issue in a comprehensive and in-depth way. Therefore, it is necessary to inform, raise awareness, educate, the population about climate change by establishing an effective and reliable information system, which implies providing institutions with adequate human, technical and financial capacity.

8.1 Specific capacities of the various institutions

The preparation of the First National Communication, the National Climate Change Adaptation Program of Action, as well as the five-year implementation of the National Strategy for the Implementation of the United Nations Framework Convention on Climate Change and the Kyoto Protocol (2007/2012) and the elaboration and development of projects in the field of mitigation and adaptation to climate change have been highlighting a number of difficulties:

- Limited understanding and/or familiarity with the subject of climate change;
- Limited data availability;

- Limited project preparation and development capacity;
- Limited budgeting and management capacity;
- Limited inter-institutional technical cooperation;
- Difficulty in preparing the data for processing in the IPPC inventory software;
- Low availability of senior staff of institutions with expertise in climate modelling;
- Limited amount of training and capacity building actions at national level;
- Limitations on the English and French languages in which much of the training takes place;
- Limited availability of frames;
- Technological limitation and knowledge of the problem of climate change and its consequences.

To take stock of the current state of play, the SNA coordination conducted a survey in 2014 in the various institutions to assess the progress made in capacity building since the preparation of the NCI. This survey has been regularly updated through findings and informal interviews with key partners in the implementation of climate change related actions; the survey and interviews led to the conclusion that, although information and sensitivity on climate change issues have increased, only a few sectors have a real perception of the impact these may have on their activities.

In general, technicians have limited knowledge of the likely extreme weather events that may occur in the country and the area's most prone to such phenomena. They also lack in-depth knowledge about the most vulnerable sectors and the main adaptation measures to be taken at sectoral level.

There are a number of projects and initiatives in the country that could contribute to reducing emissions or even attract carbon credits, for example as part of the country's commitment to energy growth for economic development and meeting the basic needs of the population. Seen from a cross-sectoral perspective within the implementation of the National Climate Change Strategy, such initiatives can leverage the UNFCCC implementation process in Angola and attract greater capacity for technicians from various institutions.

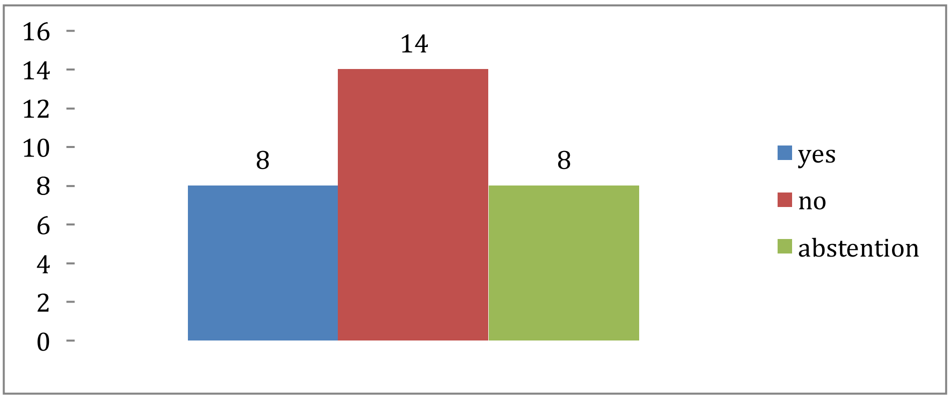
The need for capacity building in institutions should be balanced for the different types of actions. About one third of the institutions seem to be more geared to adaptation activities, another third to awareness raising and/or education and another third to research.

According to the results of the capacity survey, 46% of respondents said that there was insufficient capacity in their institution to respond to climate change, 28% of the sample abstained, while 26% said that there was this capacity in their institution.

Table 1: Existing capacities related to climate change

OPINION	FREQUENCY	%
Yes	8	27
No	14	46
Abstention	8	27
Total	30	100

Graph 1: Technical capacity of institutions to intervene in climate change issues



These results lead us to an in-depth analysis of the need for awareness-raising work to be present at all levels of the institutions such as directorate, plan, area of implementation, etc.

Some respondents responded that their institutions lack the capacity to respond to climate change and that there is a need for institutional capacity building to address the challenges that climate change poses to the economic and social progress of nations. In particular, representatives of the institutions are aware of the need to prepare the country to take part in the global challenge of climate change.

The survey also highlighted the continued lack of (i) experts in vulnerability assessment and adaptation, (ii) human resources for the identification and removal of barriers to environmental technologies, (iii) human resources for the collection and monitoring of climate data, and (iv) scarcity of information and lack of an organized and systematized information database.

Therefore, the sectors and technicians questioned pointed out the following as measures for the creation and strengthening of institutional capacity:

- ➢ Need for training in GHG inventory methodologies;
- ➢ Need for capacity building in relevant methodologies, models and software applications related to mitigation analysis and vulnerability and adaptation;
- ➢ Need for systematic interpretation of meteorological data and climate modelling;
- ➢ Preparation and management of mitigation and adaptation projects;
- ➢ Inform and/or report on a range of climate change actions taking place in the country;
- ➢ Scientific research linked to national context and concerns.

8.2 Other necessary capacities

The survey indicated that the main capacity shortfalls are in the area of adaptation and mitigation activity design. In fact, the limited number of initiatives is due to:

- ➢ Insufficient knowledge about vulnerability to climate change and its spatial distribution, as there is no concrete knowledge about which region of the country is most likely to occur, which population strata will be most affected and what economic impact they will have on the national economy;
- ➢ Limited dissemination and dissemination of key operational documents such as the National Adaptation Action Plan, the First National Communication, National Contributions to the Paris Agreement, the National Strategy on Climate Change and other relevant documents in the context of the implementation of the Convention;
- ➢ Limited availability of funds for the work of presenting and disseminating the results;
- ➢ Limited number of staff trained for the vast extension of the national territory;
- ➢ Limited national and local studies on climate change issues;
- ➢ Little interest of the institutions in integrating climate change into their sectoral plans and programs.

Despite strenuous efforts to design it, the NAPA and First National Communication, the National Strategy on Climate Change, the proposed Intent of National Contributions supporting the accession to the Paris Agreement, as strategic documents to guide the process of integrating climate change and phenomena related to the development of the neuralgic sectors have little dissemination and use. The documents developed in the framework of the implementation of the UNFCCC should be treated carefully and appropriately and presented to the public in ways that facilitate the implementation process.

The design and implementation of national and sectoral programs for economic and social development, as well as the design and development of important infrastructure (bridges, roads, railways, airports and ports) and social facilities, housing and other constructions continue to be carried out with the parameters of the last century, without taking advantage of the opportunities offered by the Clean Development Mechanism (CDM).

Some infrastructure projects that have been undertaken in Angola could have benefited from their technical and financial support from the CDM, provided they were negotiated at the outset. Project design, technical design, construction and monitoring may be eligible for CDM negotiated credits. However, the country has dispensed with this mechanism due to the complexity, lack of negotiating capacity and urgency of implementation to enable other important development projects.

Research institutions could together contribute to the generation of basic knowledge by helping the relevant government bodies to define/delimit areas that are susceptible and have the greatest impact on the phenomenon of climate change. However, there is a continuing lack of national capacity to map vulnerability across the country in ways to build the adaptation strategy for each sector of activity and each geographic area in particular.

The greatest difficulty highlighted and which seems to condition all the others is related to modelling. The development of climate models adapted to the national reality is fundamental to inform and raise awareness, but also to demonstrate future climate trends and provoke the consequent political decision-making, which would be reflected in national and sectoral plans for economic and social development.

Mitigation is also a branch of knowledge where there is limited technical capacity necessary to implement the measures announced in the UNFCCC implementation strategy:

- Revitalisation of the country's forest management and intensification of forest management plans by establishing measures to reduce uncontrolled logging of forests, establishment of community forests for multiple purposes (energy, wood, firewood and coal, tannins, sap, fruit, mushrooms, etc.) in order to provide a real alternative to the current energy deficit;

  Promotion and modernisation of traditional agriculture, stimulating and facilitating investments in rural areas that promote the introduction of new techniques and technologies (agroforestry, agroforestry, organic agriculture, micro-port, hydroponics, etc.) and other methods that combine agricultural production, soil conservation and soil fertility fund maintenance;
- Increased investment in the production of clean energy (hydro, solar and wind, biogas) which is less damaging to the environment and measures to promote energy efficiency;
- Encouraging the use of technologies that allow re-injection of gas into wells or other underground formations for possible future use or conversion to multiple purposes; and
- Assessment of impacts of landfills in Angola, with particular emphasis on Luanda promoting their expansion throughout the country, not forgetting their use in power generation and also in the complementarity of carbon credit generation.

8.3 Information, Education and Communication

Awareness of climate change is closely linked to access to information and knowledge. There is a certain level of environmental awareness in the country as a result of the interventions of different projects and programs over time. However, the population's perception of issues such as climate change, land degradation, drought and desertification, genetically modified organisms and persistent organic pollutants is still very limited.

There are several lines of action that need strengthening, such as the introduction of climate change in school curricula for different levels of education (formal education), the continuity of awareness raising projects through more active involvement of the media mainly radio and television (non-formal education) and street activities, lectures, conferences, campaigns and competitions (informal education). The latter could be under the responsibility of NGOs providing high levels of popular participation and with immediate results in the continuing need to generate a well-informed population aware of its role and social duty.

In terms of formal education, the Government has made a great effort to include more and more students in the education system (reduction of the school drop-out rate) and an exponential growth in higher education with university coverage throughout the country. However, there are more theoretical courses, such as psychology, pedagogy, law, economics, international relations, among others, than practical courses such as engineering (environmental, chemical, geographical, oil), natural sciences (geosciences, biology), cartography, etc.; the latter are beginning to emerge and are being able to give some concrete answers to some of the problems that are occurring. The response of the education system today is more focused on the expansion of the school network than on issues related to quality and its articulation with the problems and real needs of the populations.

Vocational technical education is a fundamental instrument that aims to assist all educational and informative work and help in the process of creating specific capacities and intervention.

There should be a comprehensive and holistic view of climate change in environmental education, from the point of view of interpretation and dissemination of results and their verification. This vision should be built with a view to addressing social, scientific and technological problems.

8.4 Training needs for the technology transfer process

As seen previously, technology transfer in Angola is necessary for the energy, water, industry, infrastructure and transport, agriculture, forestry and land use, health and solid waste management sectors. The Ministry of the Environment's Strategic Plan for Environmental Technologies has the mission of including environmental technologies in the implementation of the Executive's policies, with a view to protecting, preserving and conserving environmental quality, controlling pollution, areas of conservation and enhancement of the natural heritage, as well as the preservation and rational use of renewable natural resources.

The Ministry's vision for environmental issues on environmental technologies is as follows:

- Develop programs and initiatives that promote the dissemination of environmental technologies and their application in the public and private sectors;
- To contribute to the sustainable development of the country, in sectors of strategic importance, such as urbanism and construction, agriculture, transport and geology, and mining;
- Disseminate and promote environmental technologies relevant to the priority sectors;
- To encourage and support the application of environmental technologies relevant to each sector in the Angolan context and ensure the sustainability of the sector in question.

CHAPTER – 9
INFORMATION AND NETWORKS

In recent years, innovation has become an important factor in ensuring the growth, competitiveness and differentiated profitability of a group of companies, essentially for their survival in the context of the globalised and very dynamic world.

Around the world several governments have made use of information technologies to increase the effectiveness and efficiency of actions in the implementation of various environmental commitments. Some countries already use information technology to warn about dangers in certain areas, others use it as a way to control losses in the energy and water sector, prevent oil spills, among others.

Information technologies can be defined as the set of all activities and solutions provided by computerized resources that aim to allow obtaining, storing, protecting, processing, accessing, managing and using information, a system that usually consists of hardware and software. They can also be defined as a set of technological resources, used in an integrated way, with a common goal.

Although information technologies have ensured their role in the process of globalization and development, they present challenges such as the need for electricity, the internet or good quality GRM coverage, as well as providing an increasing volume of information that needs to be sorted out.

Through the Internet, new communication and information systems have been created, forming a true network. Creations such as email, webcam, internet communications, forums, online group agenda, virtual communities, among others, have been revolutionizing human relationships. Geographically distant professionals now work in teams. The exchange of information and collaborative work generates new knowledge and skills among professionals.

Information and Communication Technologies (ICTs) represent a step forward in the process of distance education. With the creation of virtual learning environments, students have the possibility to relate by exchanging information and experiences. Teachers and/or tutors have the possibility to work in groups, debates, forums, among other ways to make learning more meaningful. In this sense, the management of one's own knowledge depends on the infrastructure and will of each individual.

The situation of the COVID 19 related disaster that the country has been facing since March 2020 has elevated the importance and role of information technologies in the teaching learning process, capacity building process and training of national frameworks as well as in networking.

9.1 The use of Information Technologies in Angola

Angola's future and its insertion into the globalised world depends on how quickly the country absorbs the new information and communication technologies that are advancing ever faster.

We are in the era of Information and Communication Technologies and H.E. the President of the Republic of Angola encouraged in 2018 the whole society to use Information Technologies as a way to accelerate sustainable development: "Let us all have the boldness and determination, to create the conditions that allow the emergence and solidification of the new era of the digital society, in order to guarantee a modern society with electronic services that are closer to the citizen".

In Angola it is believed that ICTs play a decisive role in the fight against poverty and in solving basic problems of society in access to information. Therefore, the investment in ICTs should be seen not only as an option, at the economic level, but also as a real strategy to enhance and develop all sectors of the country's working life.

Angola has made significant progress in establishing infrastructures that ensure the effective management of information technologies, as well as efforts in the process of installing and managing services at various levels. Even so, some challenges arise mainly related to the management and operation and maintenance of the systems.

Progress is being made in improving the availability of electricity in all major urban centres, in the installation of fibre-optic cables, in the construction of the satellite and all its infrastructure and in building national capacities

Several institutions have improved the level of services such as internet, fibre-optics and the installation of the future satellite to interconnect the country. In this way, the use of ICTs is becoming accessible to the entire population.

Among the various initiatives, the following stand out in the process of transforming the country into a true technological information society:

- The creation of the Government Portal, where various contents and information are made available, extremely useful for the population;
- The creation of Action Plans, namely the Information Society Action Plan (ASAP) and the Electronic Governance Action Plan (EGAAP), where the strategies approved by the Government for the development of Information Technologies in the country are materialised;
- The elaboration of the Information and Communication Technologies Massification Project, which aims to give the Angolan population the opportunity to enter the information society in a constructive way, providing them access to

Information and Communication Technologies and encouraging their use throughout the national territory;

- The creation of the Electronic Governance Project, which will enable the future interconnection of the whole apparatus of the State, thus allowing a better organisation and analysis of data, by creating conditions for the sharing of information and making available access to government information and services through the Internet, and which will involve the computerisation of all public institutions in the country;
- The creation of the National Data Centre of Angola, whose project was approved at the end of 2007, with the aim of creating, maintaining and integrating a physical structure of technology that can cope with the strategic and operational demands of the State and with the levels of organisation of the Information System already achieved, where all the critical information of the State can be kept in a secure and confidential manner;
- The creation of the Technology Park, to house several companies in the area of information and communication technologies, and in which important research and research activities will be carried out in the sector;
- The annual International Forum on Information Technologies in Angola, which is a space for discussion and interaction, between the state, civil society and private companies, on the policies and projects adopted by the government in the area of information and communication technologies.

The White Paper, which includes all government policies on Telecommunications in Angola, considers the need to develop and structure national research capacity, through cooperation and exchange in the field of technological research.

The national ICT market has grown considerably and has allowed for more openness in the country. The different telecommunications operators have been expanding services in various areas of the national territory and beyond, and continue with the expansion programme of services. There has been growth in internet users, an increase in the use of technological equipment, from personal computers, tablets and smartphones, which has been helping to consolidate Angola's development and growth.

The Government created the National Information Commission (CNTI) with the aim of making science and technology a decisive instrument for the implementation of the programme to combat poverty, illiteracy and, consequently, the improvement of the quality of life of the population, in addition to increasing the efficiency and effectiveness of public and private institutions. Among other recommendations the Government's programme provides for:

- The creation of a digital solidarity fund;
- Capacity building of human resources;
- Development of a hardware and software industry;
- Creation of public-private partnerships and encouragement of mechanisms that guarantee technology transfer and "Know How".

9.2 Information technologies in the environment sector

According to the White Paper on the State's Information Technology policy for the period 2018/22, environmental issues are a cross-cutting concern in the Country's long-term strategy defined by até 2025, and are present in various strategic policies, but also constitute a fundamental option of the strategy, translated into the following overall objective: "Ensure the existence and maintain the quality of nature's resources (natural capital), guaranteeing their healthy use for current and future generations, through an appropriate legal and institutional framework and adequate management, involving strong participation by society".

In this chapter, ICTs play a fundamental role in the process of implementing the National Strategy on Climate Change, which arises from the need to articulate objectives, instruments and institutions in the pursuit of the most recent challenges the country is facing, both at the level of the economy and the improvement of the living conditions of the population, and at the level of the most recent commitments arising from the Paris Agreement on Climate Change.

Responding to the established challenges, the Executive establishes the national policy vision for the mitigation of the causes and adaptation to the effects of Climate Change, one of the key resources.

The focus of actions for the implementation of ICTs in the environment sector can be on monitoring or alerting on climate change, mitigating and adapting its effects on society or through the use of technologies and on social behaviours themselves that contribute to a greener and more ecologically responsible community.

Some of these innovations gain physical shape in technological devices such as

- *Smart grids* and infrastructure;
- The analysis of Big Data;
- Sensor networks combined with Internet access terminals, enabling rapid action on disaster prevention and mitigation
- natural;
- Services and processes in education and the construction of community programmes;
- Implementation of Satellite Wildlife Monitoring Systems and Services with Internet access.

It is important to stress here that the processes related to environmental reporting and climate change have been developed with little resources to Information Technologies this has made the processes more expensive in terms of financial resources because it is always necessary to collect information that is often not easily accessible, overspends time because often the information is more not accessible and in many cases the same information is held by different institutions in different ways, and the various changes that have been made in the institutional political landscape cause many data to be lost along the way.

The process of developing national communications has been characterised as difficult because of the management of information and the use of environmental technologies if applied could help this process in ways that make it rapid, fast, dynamic and integrative:

- Difficulty in collecting data, there is still no clear and transparent process in the country to make the information available for the preparation of the different components of the national communication and other reports on climate change;
- The storage of information received from the various consultancies carried out continues on computers and files without the necessary classification and valorisation, much information from previous years no longer exists because it has been lost over time and the change of people in the institutions;
- The processing of information does not yet follow strict criteria because it is not filtered, in the institutions that produce this data they are scattered and the integration of experienced people is necessary to obtain the information, the process of collecting environmental indicators is not yet effective;
- The selection of information to be used in the preparation of the reports begins with institutional information and then follows the collection from other sources, it has often been easier to obtain information from outside Angola than from the sites where the same information is produced;
- There is no work of comparing the data in such a way that new observations can be defined, so often it is an estimated figure which often does not represent reality;
- Difficulty in the distribution of existing data to facilitate the decision-making process, hampering the process of environmental governance;
- The process of evaluating existing information is often not possible because few institutions produce information, with the result that decisions are dependent on a single source of information;
- Much data and information is lost in the institutions due to the lack of a data processing and storage system.

To mention that the awareness for the operationalization of Information Technologies for the environment in Angola is already old in 2006, with the beginning of the elaboration of environmental indicators and consequently the creation of the first environmental database in Angola in the sector of environmental issues, where technicians from different institutions were trained and the material to support the database was acquired.

Notes that the main difficulty with the environmental database has been its operationalization, although there are a number of institutional focal points indicated, the limited technical and institutional capacity has led to delays and difficulties in its effective operation, therefore difficulty in its management, since the technological means available are not enough and it is necessary to be effective and efficient in the management processes.

Despite the various difficulties listed, the reporting process related to climate change has in many cases already relied on processes linked to information and communication technologies, through which experts in various parts of the world have been called upon to remove doubts on specific issues, review documents through the quality control process, remote work of the teams installed in the different institutions, with all the limitations that are imposed.

The application of Information Technology in the reporting process related to the environment, climate change, greenhouse gas inventories and others should apply a series of models, methodologies, processes, techniques and tools to help achieve strategic objectives, involving people, processes and technology.

The creation of technical groups already working on the elaboration of reports such as the national communication and the biennial update reports, may help to structure the improvement of the needs in the use of Information Technologies because in these technical groups the subjects are classified by themes and host people with the same area of knowledge.

Information Technology Needs Assessment to facilitate the reporting process under the United Nations Framework Convention on Climate Change.

The conclusion of the National Communication involving national consultants located in different institutions and localities, reviewers and trainers in Pandemic times was made possible by the use of information technologies

9.3 ICT Needs Assessment to facilitate the reporting process under the UNFCCC

In a process aimed at identifying institutional conditions for networking, as well as the use of information and communication technologies to facilitate and speed up the reporting process, especially the Second National Communication, questionnaires were addressed to technicians from different institutions who have been in contact in various ways with the elaboration of the national communication, this includes consultants, reviewers and other technicians who have been part of various consultation and validation processes of components. This questionnaire sought answers to the following type of questions:

- Does your institution use information technology? Easier information sharing mechanism?

- How can the institution best participate in environmental reporting? Do IT-related operating conditions exist?
- Existing conditions related to information technology? Existing conditions that facilitate networking?
- The answer was mostly yes, the institution uses information technologies among them the use of outlook.
- On the issue of existing conditions. The existence of a responsible area for environmental issues.
- What needs to be created within your institution to respond to networking and facilitate reporting on environmental issues, national communication and the greenhouse gas inventory?
- In relation to information technology and the questions necessary for remote operation?

In relation to environmental issues most of the answers point to the existence of environmental staff as the easiest way to respond to environment-related work.

As to how best to participate in the process of environmental reporting, the responses focused on the need to integrate more staff directly concerned with environmental issues into the institutions as in most institutions people directly concerned with the environment also engage in other types of activity, which causes time constraints.

With regard to what could be the easiest mechanism for sharing information, the responses focused more on integrating in this process people who are part of the more specific area linked to Information Technologies because in the institutions there is a clear distinction between these technicians and those assigned to other areas.

As regards information technology and the questions necessary for remote operation, most of the answers point to the use of available technologies being very focused and dependent on the institution's directorates for the provision of authorisation on the use of factual data outside the institution

In relation to the need for improvements in certain areas so that work with ICTs can be better developed on environmental issues, the following comments were made:

Policy - most of them refer to the existence of general policies oriented to the use of ICTs, pointing out the need for practical implementation.

Legislation - most responses point to the existence of general ICT legislation and point to the need for specific legislation to answer questions related to the environment and climate change

Material conditions - most respondents were in favour of material conditions for the use of ICTs, but referred to the fact that it was very focused on specific people working in this area

Human Conditions - Most of the responses refer to the existence of sufficient human resources in the institution and point to the need for capacity building in order to make it easier to make exhaustive use of ICTs.

9.4. Recommendations

The need to reactivate the database and website established at the time of the First National Communication, in order to facilitate the preparation of other documents in the field of climate change;

Make formal agreements with institutions to provide annually the environmental indicators related to climate change so that they can be used in the process of different reports;

Use of Information Technologies in the process of training and capacity building of national staff in ways to reduce costs and maximize results.

CHAPTER – 10
RESTRICTIONS AND GAPS, TECHNICAL, FINANCIAL AND TRAINING NEEDS

Complexo Administrativo Clássicos de Talatona, Rua do MAT,
Building 4, 4th Floor
Talatona Municipality, Luanda
E-mail: dnaac@mcta.gov.ao

10.1 Institutional Arrangements for the Preparation of National Communications on a Permanent Basis

The National Strategy for Climate Change was developed taking into account the need to articulate objectives, instruments and institutions in the pursuit of the challenges facing the country, both in terms of its economy and of improving the living conditions of the population, interconnecting with national and international climate events. By ratifying the UNFCCC, the country made commitments not only to the international community, but also to the people at the national level, since the problem is global but its action is local, and the effects of climate change are already being felt in several parts. Given that science is dynamic and so are events, a number of agreements and commitments have been put in place in order to place the Objectives of the Convention in the current context.

Recently the Paris Agreement[41][42]and the Agenda 2030 Sustainable Development Goals have sought to adjust what are the latest challenges posed by environmental issues in general and climate change in particular. The idea that climate change is not only an environmental issue, but also a development issue is becoming more and more visible as its causes and consequences are linked to the sectors of social and economic development and its consequences cut across all sectors of working life in the country. The Climate Change Strategy seeks to establish a vision of Angolan national policy taking into account the need to articulate policies in terms of mitigation and adaptation to the effects of climate change.

The commitment of national institutions to environmental issues goes back even to the period before independence, but it is important to note that with only 2 months of independence in January 1976 the first national nature conservation week was held. The summit held at this time recognises the role and importance of man in causing and solving problems. This summit is important because it recognises a number of international events and developments in relation to the environment and makes a number of initiatives happen at national level in relation to the environment where climate change is also a part of it.

The period of internal conflict interfered with the process of integrating the environment into Angola's social and economic life, but it also interfered with the limitation of

[41] UNO (2015). Resolution adopted by the General Assembly on 25 September 2015.

[42] UNFCCC (2015). Decision 1/CP.21.

knowledge at the time, since the existing one was very much focused on nature conservation.

The establishment of the State Secretariat for the Environment in 1992 and the consequent approval of the Basic Law on the Environment in 1998 has institutionalized environmental issues at the governance level. This process was consolidated with the regulation of the Basic Environmental Law and the subsequent creation of a department responsible for environmental issues in some institutions such as oil, industry, mining, etc.

All these events contributed to the country's parliament's approval of the ratification of the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol. These milestones reaffirm Angola's interest in and commitment to the implementation of the convention, and all related processes. Subsequent steps include the elaboration and approval of the National Strategy for the Implementation of the United Nations Framework Convention on Climate Change and the Kyoto Protocol" for a 5-year period. In 2009 the country established the Designated National Authority (DNA) for the Kyoto Protocol mechanisms and started the development of its National Adaptation Program of Action (PANA), submitted to the UNFCCC Secretariat in 2011, Angola's 1st National Communication to the United Nations Framework Convention on Climate Change. In 2015 the country elaborated its intention of national contribution as a target to the challenges established with the Paris Agreement.

Work to integrate environmental issues into sectoral policies, programs and projects gained new momentum with the institutionalization of the Multisectoral Technical Commission for the Environment, which generally addressed environmental issues, taking into account the specificity of climate change issues and the need to integrate commitments to the so-called Rio Conventions, the Governor established the Interministerial Commission on Climate Change and Biodiversity, which also addresses desertification issues.

As can be seen, there has been governmental sensitivity to environmental issues over the years, which has allowed climate change issues to develop at some level. On the other hand, it is also possible to notice some limitation of capacity that vision to transform all political decisions into practical implementation.

A survey of capacities to deal with climate change concluded that there were shortcomings in (i) technical vulnerability and adaptation assessment, (ii) limited human resources for environmental technologies, (iii) insufficient human resources for the collection and monitoring of climate data, and (iv) persistent information shortages and lack of an organized and systematized information database for climate change.

Therefore, the sectors and technicians questioned pointed out the following as a measure for the beginning of institutional capacity building:

- ➢ Need for training in GHG inventory methodologies; and
- ➢ Need for capacity building in relevant methodologies, models and software, related mitigation analysis as well as vulnerability and adaptation

The study also concluded that the limited existing capacity was engaged in positions of responsibility in different institutions and that there were constraints related to the time available for dedication to other issues such as climate change.

Within the strategic framework for climate change governance there has been a clear need to train and empower more national frameworks that can be dedicated to the various commitments and needs surrounding climate change. Some constraints have made greater results not more evident as in most of the existing opportunities are in the English national language and there is a limitation in this sense as the majority of the population speaks Portuguese, the most evident opportunities are workshops of 3 to 5 days quite insufficient to meet a set of needs that the technicians bring.

The proposed National Strategy for Climate Change identified the Ministerial Department responsible for the Environment as being responsible for the issue of climate change because, in addition to being a development issue, climate change was initially an environmental problem and has always been part of the sector dealing with environmental issues. Through the environment sector, environmental actions have been implemented at the national level, as well as the monitoring and participation of Angola in international climate change policy. Angola's reporting to the UNFCCC is its responsibility, as well as the coordination of Angola's participation in the conferences of the parties (COP) organized by the UNFCCC.

Following its first climate change strategy, Angola created the National Commission on Climate Change and Biodiversity (CNACB), with a more specific mandate for climate change and a more executive and political harmonization mandate, made up of various entities such as the Ministry of Petroleum, Transport, Higher Education, Science and Technology, Health, and Agriculture and Rural Development and Fisheries, under the coordination of the Ministerial Department responsible for the Environment.

In the light of this Commission's past experience, it was felt that coordination and cooperation between ministerial departments and public institutions in the relevant sectors should be further explored. In addition, it was noted that it is essential that this

Commission redefines its responsibilities, functions and objectives and that it draws up an annual program of activities setting out the timetable for its meetings. In addition, it is recognized that the extension to the participation of provincial governments in this commission is important for the decentralization process currently underway in the country, which allows these government structures to participate in decisions taken at the national level. The new strategy proposal on climate change proposes to extend the composition of the Commission with other ministerial departments and public institutions, as well as the establishment of two committees, the Executive Committee and the Technical Committee, in order to ensure a more operational character and greater efficiency in the results of the Commission, particularly with regard to the articulation between the different sectors. The proposal to redefine the National Commission on Climate Change and Biodiversity is presented below:

Complexo Administrativo Clássicos de Talatona, Rua do MAT,
Building 4, 4th Floor
Talatona Municipality, Luanda
E-mail: dnaac@mcta.gov.ao

Table 1: National Commission on Climate Change and Biodiversity

National Commission on Climate Change and Biodiversity - Proposal for redefinition	
Tasks (proposed new tasks)	• Concert Initiatives and harmonize policies to implement the national climate change strategy and the biodiversity strategy; • Create the necessary conditions for implementation and enforcement of ENAC; • Coordinate and articulate the different sectors in the implementation of the Initiatives defined in ENAC; • Create a national investment plan that integrates the mitigation and adaptation initiatives foreseen in ENAC, articulated with the future Angolan Climate Change Fund (PAAC); • Create centres of excellence to carry out disaster studies and systematic observations and observation of the climate; • Formulate proposals on national climate change mitigation and adaptation policies; • Identify legislative needs in this area; • Coordinate the integration of climate change policies in various sectors of the economy and at provincial level; • Prepare an opinion on climate policy documents developed by the Ministerial Department responsible for the Environment for submission to the UNFCCC; • Prepare a recommendation opinion on climate policy documents developed by the Ministerial Department responsible for the Environment for submission to the UNFCCC; • Develop guidelines for the planning and preparation of ENAC progress reports; • Promoting public discussion on climate change; • Establish an ENAC follow-up secretariat.

Composition	• Executive Committee, composed of the Minister of the relevant ministerial departments, to meet at least quarterly • Technical Committee, composed of focal points technical offices of the relevant ministerial departments, to meet at least once a month (responding to a specific programme
	drawn up in advance and approved)
Indicators	• Preparation of annual business plans • Creation of working groups to discuss climate change in the various sectors • Meetings held • Periodic publication of documents in the context of Angola's obligations under the UNFCCC (Comunicação Nacional, INDC, BUR)

In addition, it is important to establish within the Ministerial Department responsible for the Environment a follow-up secretariat for the implementation of the Strategy, which will make it possible to assess the performance of the implementation of the measures listed here, and which will be an open route for interaction between the various actors.

The institutional framework facilitating the implementation of environmental issues is thus composed as follows:

President of the Republic	• To approve projects over USD 1 billion; • Targeting the sectors certain socio-economic interests contained in the projects

Council of Ministers	• Approving technically sound projects for a department dealing with environmental issues; • Create legislative conditions to provide the best possible environment for developing projects that mitigate climate change; • Implement mitigation and adaptation projects; • Leverage investment, taking advantage of international financing lines; • Angolan climate change funds budget allocation; • Raise awareness among the population and the private sector of the need for a joint response to the problem of climate change.
Social and Economic Commission of the Council of Ministers	• Assess the social and economic benefits derived from the implementation of the projects and prepare opinion for the Council of Ministers; • Addressing the complementarity of projects to the Government's programme and preparing an • Opinion
Interministerial Committee on Climate Change	• Technical appraisal of existing proposals; • Promoting the active participation of other sectors; • Propose the inclusion in the Agenda of relevant issues of other institutions, in addition to those of the environmental sector;

Ministerial Department responsible for the Environment	• Mobilise other sectors and promote the mainstreaming of climate change; • Coordinate and monitor the implementation of the Strategy; • Coordinate Angola's representation in the UNFCCC negotiations; • Responsible for reporting under the UNFCCC; • Coordinate and develop mitigation and adaptation measures; • Coordinate and develop capacity building and awareness raising actions; • Coordinate and boost climate finance.
Local Authorities	• Promoting Local Content; • Fitting projects into local development and local adaptation plans
Private Sector Universities a nd Research Institutions	• Take advantage of investment lines to develop mitigation and adaptation projects; • Participate in the provision of data for the national GHG inventory; • Mobilise international investment funds to improve process efficiency and make more rational use of energy; • Cooperate with the Government in establishing projects that mitigate climate change; • Participate actively in the development of sectoral policies on climate change. • Develop scientific knowledge in the area of climate change; • Include climate change content in university programs; • Train citizens to be aware of the urgency of action on the effects of climate change.

Civil Society	• Promote more conscious daily behaviour, leading to a lower carbon footprint; • Promoting Community mitigation and adaptation projects; • Participate in the global effort to fight the effects of climate change in Angola through the mobilization of society and local communities

The process of preparing the national communication and biennial report has been designed to ensure sustainability in the preparation of this type of report through the process of institutionalisation and accountability of institutions for greater engagement and ongoing participation of institutions in this process.

The process has consisted essentially of requesting and engaging the institutions that are directly involved in matters that are of interest to the report being drawn up, where technicians are requested to participate in training and other processes with a view to achieving harmony in terms of content and knowledge, and generally have been asked to keep the appointed representatives. For this purpose, an email list has been created with the various representatives in which the subsequent events are addressed to the same participants, who will then interact with the respective directorates in order to participate.

This procedure has proved efficient in some approaches and inefficient in other approaches because there are technicians who remain throughout the process but often do not bring added value and with a high degree of absenteeism. At other times, even when the invitation to participate is addressed, the areas replace their representatives according to other engagements of the same technician, change in the management structure of the area in which the technician is part, etc.

This has not always been possible because many institutions, after appointing a technician to represent them, do not provide the necessary technical support for a better involvement of the technician.

On the other hand, the beginning of the implementation of the Technical Working Groups in some way helps the process of institutionalisation, but it will be necessary to see under what conditions partnerships can be formalised in order to facilitate the whole process related to the implementation of the United Nations Framework Convention on Climate

Change.
As in many countries with a particular focus on the southern African region, specific legislation is produced in many cases between institutions to provide data and human resources capable of participating in the process on a more permanent basis. This framework can be achieved by reviewing the Strategy and including the accountability of institutions and recommending a set of loose legislation that encourages and promotes the participation of all actors in this process. The development of a set of climate change indicators will certainly be one of the steps in the institutional framework and will work to facilitate not only reporting but also specific projects on climate change mitigation and adaptation.

10.2 Financial needs for the Convention implementation process

Angola is a developing country and is still part of the group of Least Developed Countries, with a population of around 30 million and an economy focused and dependent on oil exploration. It also notes the 27 years of internal conflict that have had a significant impact on the country's social and economicstructure.

The challenges are still enormous, from the recovery of infrastructure, housing, energy, water, development of industry and agro-industry, continuous process of national reconciliation, among others that make the sensitivity to environmental issues and climate change not enough for the country to be able to respond to the various challenges related to the issue in Angola. The financial contribution from various sources to help reduce emissions and build adaptive capacity will add value to the whole process.

The effects of climate change are real. The country has experienced, among other effects, recurrent cycles of drought and flooding which have affected the different regions of the country differently, most notably the southernregions.

Angola's National Adaptation Action Program identifies agriculture and food security, forestry and biodiversity, fishing, water resources, human health, infrastructure, coastal areas and energy as the main sectors affected by climate change. These are currently key sectors in promoting Angola's internal and sustainable development. The same paper identifies that the main threats and expected impacts of climate change are floods, droughts, soil erosion and rising sea levels.

In rural areas, people choose areas close to the riverbeds, rich in natural resources, taking advantage of fishing activity and soil fertility for agricultural practice. However, these areas are particularly sensitive during flood seasons, causing crop devastation, loss of material goods and proliferation of diseases. High temperatures are likely to prolong the seasonality of diseases such as malaria, and in a future scenario in which Angola's climate will be warmer and wetter, even in areas above 1500m where the risk of contracting the disease is lower, the incidence of malaria will be more frequent[43]several populations have reported an increase in the frequency of severe flooding in recent years. The Cuanhama basins and the city of Ondjiva have been severely affected by severe flooding in the last 10 years[44]. The El Niño phenomenon affected at least 1.4 million people in 7 provinces in 2015, 78% of whom live in the regions of Cunene, Huila and Namibe in southern Angola. In the cities of Luanda, Benguela and Namibe, flooding is responsible for the destruction of houses and commercial buildings and the interruption of transport for long periods, which is also a consequence of the development of cities in flood risk areas. Floods are also responsible for large crop failures as well as worsening public health security due to the proliferation of mosquitoes and other disease vectors. Changes in the cold Benguela current foreseen in the PANA could have implications for coastal fisheries as well as for communities and the fishing industry. Changes in river hydrology or changes in water temperature could have implications for river and lake fisheries.

Soil erosion has implications for sedimentation in river basins and the increased frequency of drought episodes has aggravated the entire livestock sector. According to UNDP figures[45], agricultural and livestock losses were estimated at US$242.5 million in 2016, with rural communities being most affected by the progressive loss of their seed and food supplies, causing cycles of poverty. The dependence of rain on agricultural production, combined with unsustainable land use practices, soil erosion and reduced rainfall, are responsible for the loss of pasture and meadow quality, reduced access to drinking water for human and animal consumption, and the degradation of soil and water fertility[46]. According to the National Committee for Civil Protection (CNPC), food insecurity could affect about 43% of the population.

Several financial resources have been diverted from Angola's development program to address climate change emergencies, further limiting the government's capacity and making aid for better implementation of the convention and other commitments derived from it even greater.

On the other hand, the main economic activity and the steps towards the development of a general trend lead to some upward trend in emissions in sectors such as energy, land use change and agriculture, forestry, industry and waste, which draws attention to the form and steps for development should consider the assumptions contained in the United Nations Framework Convention on Climate Change. In presenting its INDC in 2015, the country presented financial needs of around USD 15 billion for a period of 15 years. These needs are related to a foresight identification to make the development process more sustainable in order to respond to national and international challenges. On the other hand, challenges were also presented on a preliminary basis with a view to increasing adaptive capacity through a set of initiatives to meet immediate adaptation needs.

[43] UNFCCC (2011). National Adaptation Programme of Angola (PANA).

[44] UNFCCC (2011). National Adaptation Programme of Angola (PANA).

[45] ONU (2016). Angola: Drought. Office of the Resident Coordinator Situation Report No. 1.

[46] UNFCCC (2011). National Adaptation Programme of Angola (PANA).

Financial needs are not limited to mitigation and adaptation, capacity building that can contribute to an adequate response to the effects of climate change and the consequent awareness of the population throughout the national territory is essential and should be mobilized in ways that integrate climate change into the autarchic process. The mobilization of resources for this whole process should be essential to provide the country with sufficient capacity.

Through the funds available the country has been receiving some contributions in the framework of the National Communication and biennial update report as well as implementation of some projects identified as a priority but which these contributions are still limited to put into practice all the political engagement the country has been able to mobilize.

A better structure for participation in the Green Climate Fund and other funds is mirrored in the national climate change strategy. Bilateral contributions and private sector engagement could be complementary in order to boost the implementation of the Convention.

The Second National Communication to the United Nations Framework Convention on Climate Change is an activity coordinated by the institution that oversees environmental issues in Angola, which within the framework of the Convention is considered as an Executing Agency, and which has the responsibility to coordinate technical implementation, in relation to political responsibility, it is divided between different hierarchies established in the country with particular emphasis on the President of the Republic, the Council of Ministers, the National Assembly, etc. The first communication was developed in the same way that the participation and engagement of national technicians is promoted in order to guarantee the sustainability of the issues in Angola. As it is a project financed by resources of the *Global Environment Facility* (GEF), the supervision of activities necessary to achieve the objectives of the Second National Communication is carried out by the United Nations Environment Program.

The preparation of the Second National Communication has a Supervisor, a coordinator, an assistant and a group of consultants from different public and private institutions. These duties also include the following: (i) project management and implementation; (ii) coordination of the management of financial resources; (iii) preparation of reports on the application of resources and the results achieved; (iv) preparation of management reports; (v) interinstitutional articulation; and (vi) monitoring, evaluation and dissemination of project results. The Interministerial Commission on Climate Change and Biodiversity is responsible for the supervision and monitoring of the project.

The Second National Communication presents the results of unprecedented surveys in the area of training needs and the use of information technologies. In the context of the elaboration of adaptation measures, the assessment of vulnerability for some localities relied on field trips in order to reinforce the set of established measures.

The Second National Communication seeks to present in summary form, the national circumstances of Angola where the issues related to climate change fit, the Greenhouse Gas Inventory, information on appropriate mitigation and adaptation measures, training and capacity building initiatives, environmental awareness on the topic, research and systematic observation, technological needs for mitigation and adaptation and a set of conclusions and recommendations.

Preliminary list of some projects in the field of climate change mitigation and adaptation:

LIST OF PROJECTS	Technological Reference
Technology adapted to local climate conditions and helping to reduce greenhouse gas emissions	
Extension of the Soyo Combined Cycle Project	Yes
Banes Dam and other Hydroelectric Power Plants to be identified	Yes
Tombwa Wind Farm	Yes
Solar Power Plants (Hybridization)	Yes
Installation of Mini-hydro	Yes
Expansion of biogas use	Yes
Stabilising emissions in agricultural production (Sustainable Agriculture, and REDD+ initiatives)	Yes
Transformation of industrial processes to the use of clean technologies	Yes
Use of Biomass to generate electricity	Yes
Technology related to Land Use, Land Use Change and Deforestation	Yes
Monitoring and control of the land conversion process	Yes

Complexo Administrativo Clássicos de Talatona, Rua do MAT,
Building 4, 4th Floor
Talatona Municipality, Luanda
E-mail: dnaac@mcta.gov.ao

Ecosystem Recovery in Degraded Areas	Yes
Promotion of alternative sources of energy to reduce deforestation	Yes
Promotion of SLM (Sustainable Land Management) for modernisation and diversification of agricultural production to improve food security	Yes
Ensuring access to primary health care	Yes
Study of the vulnerability of the fisheries sector to current changes and climate change	Yes
Extension of electricity in rural areas	Yes
Review of sectoral legislation to promote proactive adaptation	Yes
Creating an early warning system for flood control and Monitoring	Yes
National institutional mechanism for adaptation planning and integration	Yes
Erosion control through forest plantation	Yes
Diversity of agricultural production for less climate-sensitive crops	Yes

Assessment of technological needs	Yes
Seed varieties adapted to local conditions	Yes
Climate monitoring and data management system	Yes
Study of the implications of climate change on the pattern of human and animal diseases	Yes
Increasing water availability at community level through boreholes and wells	Yes
Integrated water resources management	Yes
Mapping of areas at risk of erosion	Yes
Implementation of water collection systems in drought areas	Yes
Improving knowledge of the country's hydrology	Yes
Extension of the water and sanitation network in rural Areas	Yes
Exploiting industrial opportunities in the face of climate change	Yes

Aquifer monitoring	Yes
Construction of flood protection barriers on major rivers	Yes
Study of the impact of sedimentation and salinisation processes on the coastal zone	Yes
Improving the architecture and construction of buildings	Yes
Study of the impact of changes on the hydropower sector	Yes
Review of construction parameters to discourage the emergence of buildings in flood areas and coastal zones	Yes
Construction of sea level protection structures	Yes
Study of the impact of climate change on the mining sector	Yes

Provision of information on financial and technical resources from various sources or other contributions in kind made possible by the Government in preparing the SNC;

The preparation of the Second National Communication was supported by Fundo Global para o Ambiente (Global Environmental Fund), through the United Nations Climate Change Programme as an implementing agency and was co-finalised by the Angolan government to complement the items with the staff directly involved in the project. It also had the support of all the institutions that provided the technicians and information that made it possible to draft the document.

To note the contribution of the Lusophone Core Group on Climate Change, the Secretariat of the United Nations Framework Convention on Climate Change, National Communication Support Program in terms of guidance and structuring of the process.

The process of drafting the National Communication, the Biennial Update Report and others concerning the implementation of the Convention has been marked by an institutional framework in terms of response that can be characterised as good. In general, they all contribute to the response to the institutional framework outlined by the Multisectoral Commission for the Environment and the Interministerial Commission for Climate Change and Biodiversity. This is because many institutions have already appointed their representatives for environmental issues, which has somewhat facilitated the whole process.

It is a very dynamic and increasingly demanding process and it is necessary to review some of the procedures adopted in order to respond to the above dynamics.

CHAPTER – 11 CONCLUSIONS AND RECOMMENDATIONS

Complexo Administrativo Clássicos de Talatona, Rua do MAT,
Building 4, 4th Floor
Talatona Municipality, Luanda
E-mail: dnaac@mcta.gov.ao

In order to strengthen adaptation/mitigation capacity and to manage climate risks, Angola's main challenges can be said to be in terms of knowledge, governance, research, data production and limited financial resources.

Greater efforts are needed to ensure complementarity between ongoing climate change and economic development, as well as different metamorphoses. The country therefore needs to commit to improving the link between climate change and economic development planning and mitigation and maximising the synergies between poverty reduction and adaptation to climate change.

In order to integrate climate change into national sustainable development plans, into the socio-economic sectors and to strengthen cooperation between the public and private sectors, work needs to be done on four key areas: i) generating and disseminating knowledge; ii) improving planning; iii) improving legislation and implementation mechanisms; iv) improving financial management and planning.

In the field of knowledge

Improve national climate prediction systems and increase the capacity to work with climate models in order to adequately represent the different regions and climate areas of the country;

Promote action-research projects with the aim of knowing the actual vulnerability of productive sectors in the country. This requires the objective identification, quantification and analysis of the risks of climate change at the national level, on a significant scale, both in spatial and temporal terms;

In the context of Governance

Promote awareness and dissemination actions among policy-makers, parliamentarians, the private sector and civil society. These actions should be implemented, according to a multi-annual action plan, with different activities for different target audiences;

To base the activities undertaken in response to climate change on the needs, visions and priorities of the country, so that development is sustainable in the long term;

Continue implementation of the National Adaptation Program of Action (NAPA) to Climate Change and the Nationally Appropriate Mitigation Action (NAMA), as well as other national and provincial instruments enabling its implementation. The articulation of these instruments with the policies, plans and programs of all relevant sectors (e.g. agriculture and rural development, water resources management, oil and diamond exploration, etc.) should be ensured;

Reinforce materialisation in the technical component of the Interministerial Commission on Climate Change and Biodiversity;
Create a technical secretariat, with the capacity to prepare proposals, monitor projects, prepare studies and opinions, among others;

Increase inter-ministerial coordination so that national sustainable development strategies, poverty reduction strategies and public policies take into account existing or developing climate change instruments;

Train national experts to ensure that the country has sufficient capacity to integrate climate change adaptation actions into national planning.

In the context of strengthening legislation and enforcement

Legislative reform leading to an obligatory strategic and social environmental assessment, as well as the "climate proofing" of strategies, programs and plans in key sectors of the national economy (including spatial planning instruments) and public infrastructure (roads, railways, ports, hydro-electric power stations and other dams and dams, buildings, social housing, among others);

Continue the regulation of land use planning, in particular the coastal zone, establishment of agricultural reserves and conservation areas, implementation of protection zones along rivers, designation of inert extraction areas;

Air quality and emission control - including monitoring requirements;
Water resources management - regulations to the water law, with incentives for effective management and waste reduction; development of plans established in legislation;

Waste - appropriate waste management (avoiding burning and uncovered waste), taking into account emissions in landfills;

Regulation of the Agrarian Development Law, namely with the creation of incentives for permaculture and diversification of crops and agro-sylvo-pastoralism;

Continue to regulate the areas of oil, geological and mining activities (and diamonds) and industry to integrate mitigation but also climate change adaptation obligations;

Energy sector reform (legislation on energy efficiency and the use of renewable energy, creating incentives for its implementation);

Establishment of financial incentive mechanisms (tax incentives, subsidised interest to national companies, etc.) for investments in environmentally friendly and highly energy efficient technology in the development of industry;

Establishment of financial mechanisms to encourage the cultivation of species for food, in order to prevent farmers from massively embracing the production of biofuels at the expense of food.

Reinforcement of monitoring and enforcement capacities in areas such as forestry, fisheries, inert removal, environmental performance of works and related activities.

Strengthening emission monitoring and enforcement capabilities in areas such as oil exploration and industry.

Within the framework of Financial Management:

It is well known that the mobilisation of "adequate, predictable and sustainable" financing is a priority to minimise the effects of climate change in developing countries. There are a number of estimates of the amount of funding required and the evidence shows that existing commitments and disbursements are far removed from these estimates. Climate change financing presents major challenges not only for the international community, as funds must be additional to those of cooperation, but also for developing countries. Mobilising sufficient resources for climate change adaptation and mitigation will require expressed political will to generate international community confidence and creativity given the current economic climate. In raising new funds there will be full advantage in using innovative sources such as voluntary carbon markets. On the other hand, it is crucial that climate change funding contributes to poverty reduction and other sustainable development goals;

One of the major challenges is the integrated control of the Funds. With Angola's oil exploration and its developing industry as the base of the economy, it is a country with possibilities of generating Certified Emission Reductions (CERs) that is exposed to investors, some more scrupulous than others. There is a need for a strong capacity to select only the most relevant and effective projects and to do so within a strategic framework for implementing CDM and other markets initiatives.

Another major challenge, particularly in the field of adaptation, is to ensure that Angola has sufficient capacity to absorb and use effectively the financial resources additional to cooperation for its purposes. Angola's public bodies, at central and provincial level, which are actors in the implementation of adaptation measures, have shown difficulties in executing the General State Budget and in particular investments.

It is therefore recommended:

Assess, within the framework of existing climate change adaptation/mitigation instruments, which activities can be covered with national funds on an autonomous basis, without the need for donors and which activities the GoA gives priority to through stronger co-financing;

Development of a strategy to mobilise financial resources for the implementation of various climate change and climate risk management programmes/plans/projects;

Promote donor coordination to avoid complex and fragmented sources of climate change financing and to achieve increased funding (co-funding) for integrated, longer-term programmes with a well-designed monitoring and evaluation system;

Simplify information sharing procedures and encourage donor coordination to avoid proliferation and duplication of isolated actions;

Integrating climate change financing into the planning and delivery mechanisms of the General State Budget and Investment Programmes, which will allow the country to plan, manage and control these financial resources in a simpler and more transparent way - by integrating these resources into the state budget their use is subject to control and oversight by the parliament, other national institutions and civil society - which increases investor and donor confidence;

Develop a portfolio of possible investment projects under the Clean Development Mechanism, aligned with development policies and strategies, and capable of generating Certified Emission Reductions and Voluntary Emission Reductions. Project fiches should contain minimum objectives to be achieved, targets and deadlines for implementation, potential threats and investment estimates;

Train national experts to ensure that the country has sufficient capacity to absorb and control climate change financing;

Complete the preparation of the Emissions Plan; Create conditions for access to REDD+

mechanisms;

Continue the process of training and capacity building of staff for the challenge of climate change;

Accelerate the NAMAs process to diversify sectors in the reduction of greenhouse gases, and engage them in the effort to achieve the objectives of the Convection;

Strengthen the supervisory committees in the implementation of projects with a view to encouraging and facilitating the participation of other sectors.

Synergies relating to the three Rio Conventions

The three Rio Conventions, Climate Change (UNFCCC, Biodiversity (CBD) and Combating Desertification (UNCCD) provide an appropriate platform for promoting sustainable development. In the framework of their implementation there are several actions carried out by different actors in common areas such as soil and water conservation, forests, agriculture, coastal areas, etc.

Looking at the commitments made by the ratification of the three Conventions, it is clear that there is a need and opportunity for synergies to ensure that the commitments are respected and that the country develops in a sustainable manner. An integrated approach in terms of joint implementation of activities in specific areas, namely information, education and communication; research; observation and systematic monitoring; disaster prevention and management; and technology transfer, can be adopted in a resource- efficient way.

The strengthening of the functioning of the Interministerial Commission on Climate Change and Biodiversity should ensure the process of integrating climate change, the strengthening of individual and institutional capacity, and the implementation of all instruments to achieve the objectives of the Convention, in the spirit of meeting the needs of both future and future generations.

The drafting of the national communication has created some capacity in relation to climate change. However, limited resources and short-term capacity building actions make it necessary to continue the capacity building process.

A key aspect is the strengthening of synergies between ministries, institutes and between the central level and the provinces. Inter-institutional coordination and cooperation is crucial for information sharing, capacity building and the implementation of joint activities necessary to respond to the challenges of climate change.

In each institution human, technical and methodological capacity building will be required.

Other priority trainings include:

Capacity building of the institutions involved for the effective implementation of the Convention, including the development of national communications;

Capacity building of the Institute of Meteorology for climate modelling;

Creation of a systematic documentary database of scientific support in relation to climate change at the Ministry of the Environment;

Improve the means and techniques of dissemination of information and capacity building necessary for its evaluation.

Annex

CLIMATE EVOLUTION OBSERVED IN ANGOLA

The variability of air temperature in Angola's territory has been evaluated for seven seasons with a series of homogeneous data on average temperature, maximum temperature and minimum temperature for the period from 1961 to 2016 (56 years).

From the temporal distribution of the mean (Figure 1), maximum (Figure 2) and minimum (Figure 3) temperature, one can see the history of alternating behaviour of these variables with increases and decreases, but with the (positive) tendency to increase.

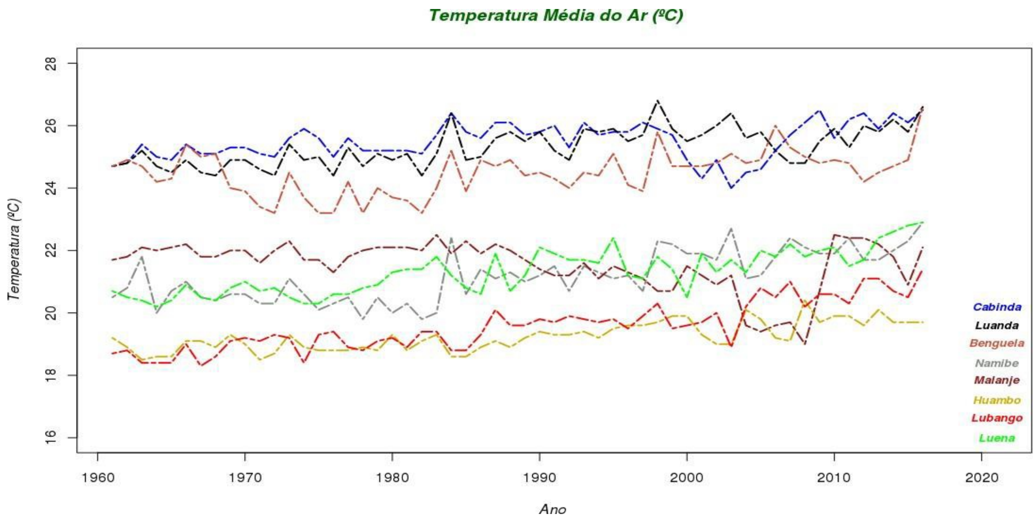


Figure 1: Time distribution of the average air temperature for the period 1961-2016.

Complexo Administrativo Clássicos de Talatona, Rua do MAT,
Building 4, 4th Floor
Talatona Municipality, Luanda
E-mail: dnaac@mcta.gov.ao

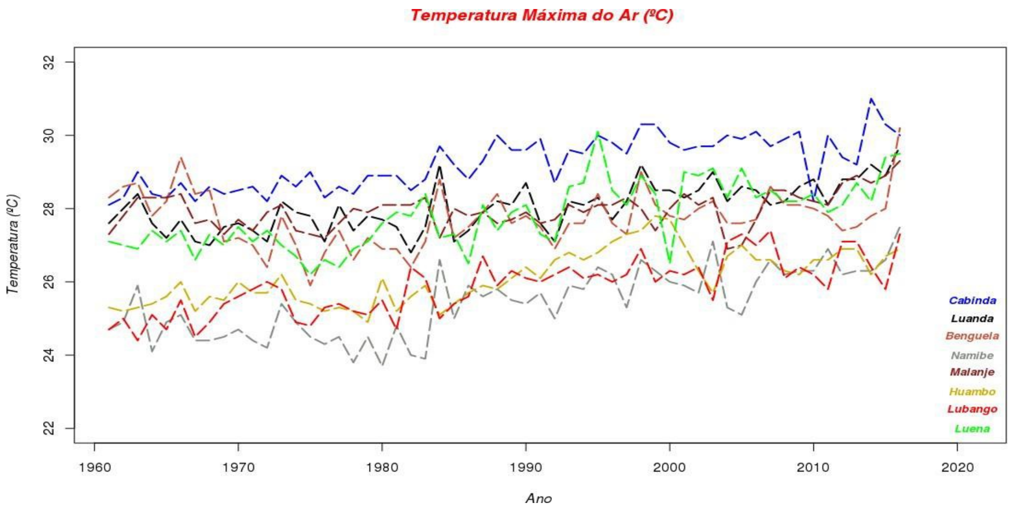


Figure 2: Time distribution of the maximum air temperature for the period 1961-2016.

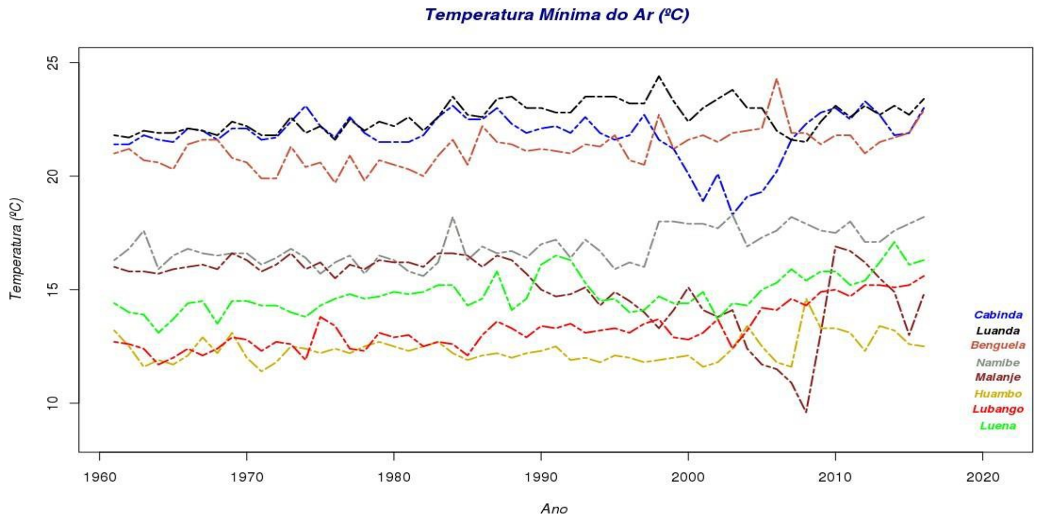


Figure 3: Time distribution of the minimum air temperature for the period 1961-2016.

The analysis of the variability of the average air temperature per season for the period 1961-2016 illustrates that from the 1980s onwards, there is a general tendency for temperature values to remain above those considered normal (climatological normal 1961-1990) for each season studied, which confirms the warming trend.

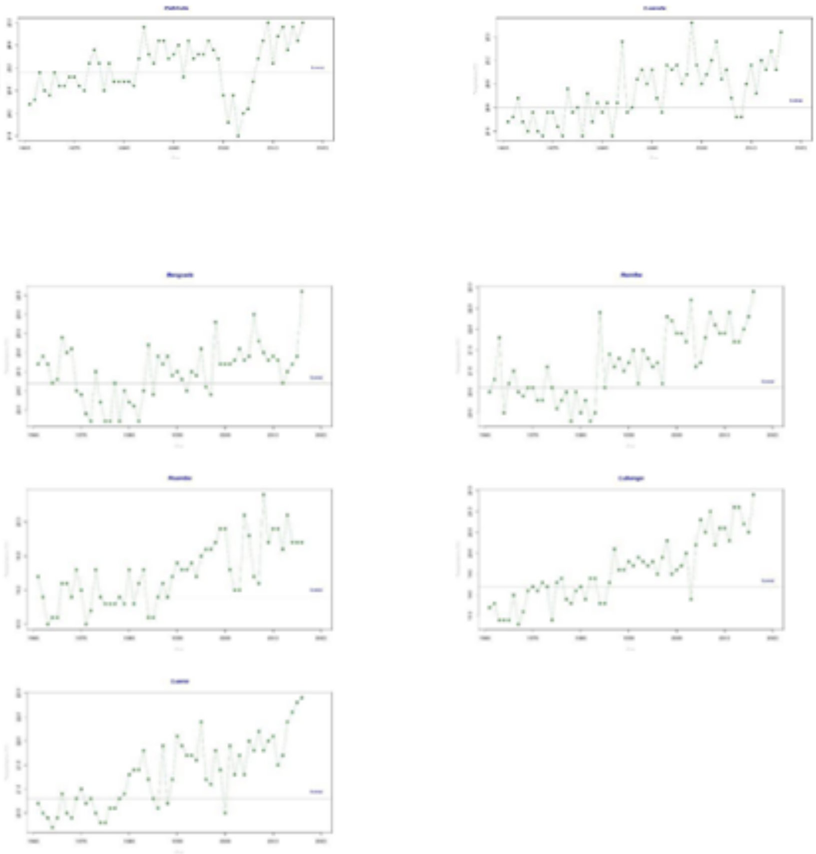


Figure 4: Variability of average air temperature for the period 1961-2016 in relation to the climatological normal 1961-1990.

From the analysis of the spatial distribution of mean air temperature variability at the selected stations, it is notable the generalised increase in mean air temperature in the order of 0.1 ºC to 0.5 ºC relative to the respective climatological normals, a result concordant with the data on observed air temperature variation for the southern African region published in IPCC AR5. It should be noted that warming is greater in the southern region, which corresponds to Angola's colder climates.

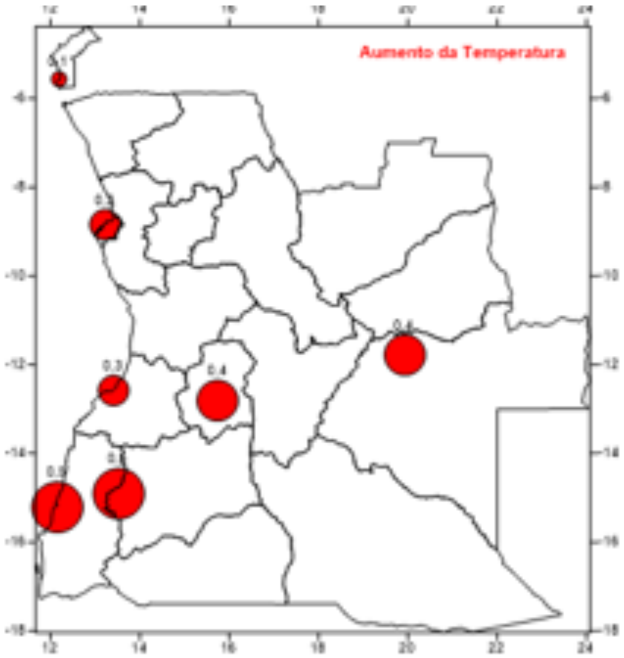


Figure 5: Spatial distribution of the variability of average air temperature in Angola for the period 1961-2016 in relation to the climatological normal 1961-1990.

Statistical analysis of the observational data confirms that 2016 was the hottest year in Angola, followed by the years 2014, 2013, 2015 and 1998 respectively.

The variability of rainfall for the territory of Angola was evaluated for fifteen synoptic stations referenced by the WMO, with a series of homogeneous data for the period from 1961 to 2016 (56 years). The reference period adopted was from 1961 to 1990, recommended by WMO, for studies on climate change, which are the climatological normals computed by INAMET.

The analysis of the annual variability over the period 1961-2016 of the amount of rainfall based on the 1961-1990 weather standards for each season indicates that there is no single pattern of rainfall trend, with nine of the fifteen localities showing a predominance of below-normal values (less rainfall than normal).

Complexo Administrativo Clássicos de Talatona, Rua do MAT,
Building 4, 4th Floor
Talatona Municipality, Luanda
E-mail: dnaac@mcta.gov.ao

Complexo Administrativo Clássicos de Talatona, Rua do MAT,
Building 4, 4th Floor
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E-mail: dnaac@mcta.gov.ao

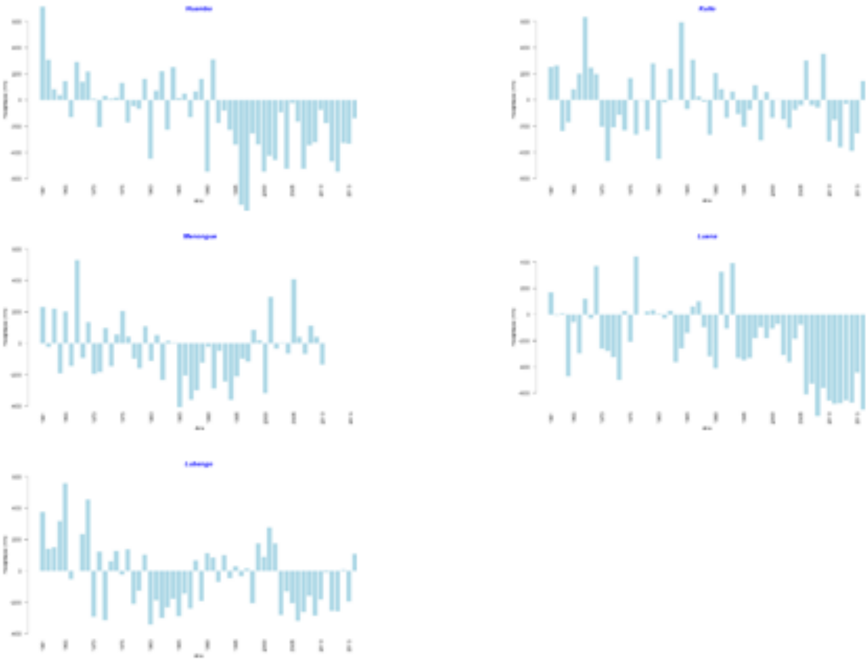

Figure 6: Variability of annual precipitation over the period 1961-2016 compared to climatological normal 1961-1990

The spatial distribution of rainfall variability mirrors low increases in rainfall from 1 to 26 mm with incidence in the coastal region and the Northeast, and increases up to 170 mm above normal. However, it can be observed that the tendency to increase the amount of rainfall is overcome by the tendency to decrease rainfall in most of the locations studied, reaching values between 21 and 201 mm below normal values. In general terms, there was a decrease in rainfall in Angola during the period under review, a result consistent with the IPCC's AR5 studies for southern Africa, where there was a reduction in rainfall due to the displacement of rainfall systems to the eastern side of the continent due to greater warming of the Indian Ocean (IPCC, 2014).

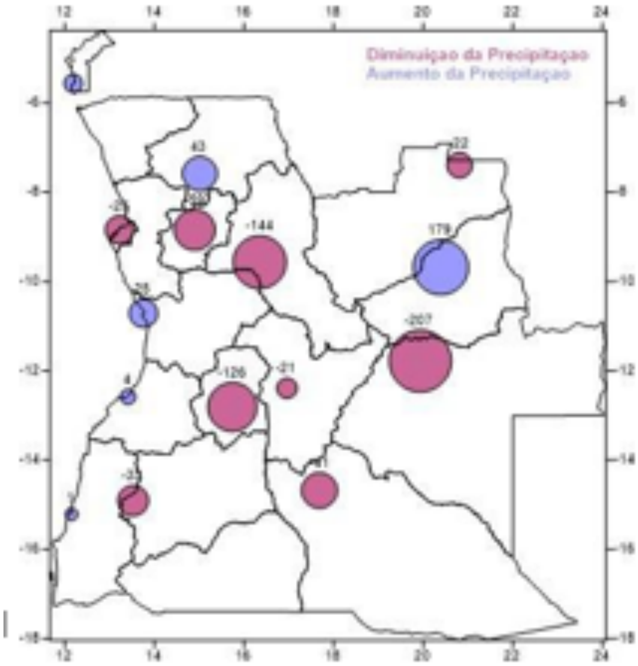

Figure 7: Spatial distribution of rainfall variability in Angola over the 1961-2016 period relative to the 1961-1990 climatological normal.

Statistical analysis of the observational data leads to the conclusion that 2012 was the year with the lowest average total rainfall in Angola (675 mm), followed by 2013 (678 mm), 1978 (771 mm), 2004 (789 mm) and 2014 (801 mm), when compared to the average total rainfall of 954 mm.

Characterization of drought events in Angola

Drought is a natural calamity, which translates into water scarcity associated with periods of reduced or no rainfall and has negative repercussions on both ecosystems and socio-economic activities.

Droughts result from anomalies in the general circulation of the atmosphere that cause climate fluctuations on a regional or local scale generating unfavourable weather conditions, with prolonged periods of low or no rainfall. Due to its geographical situation, Angola is sensitive to drought events, usually associated with blocking weather situations in which the South Atlantic anticyclone is positioned so as to prevent the ITCZ (low pressure belt that favours rainfall in the inter-tropical region) from entering the territory.

Drought is a phenomenon difficult to predict because it has its own characteristics and only becomes perceptible when its effects are already visible, that is, it is already installed, and there is no universal definition for the dry concept. It can be analysed from different perspectives, whether it is meteorological (decrease in humidity conditions in the air), agricultural (reduction in soil moisture content), hydrological (reduction in water levels in riverbeds and the consequent decrease in the volumes stored in reservoirs and the infiltration for recharging aquifers), or even economic (if the precipitation deficit remains, reducing existing availability so that different human uses and activities begin to be affected).

These types of drought differ from each other in intensity, duration and spatial coverage. In order to improve drought management and forecasting, indices are usually used. Drought indices serve as the basis for assessing the duration, severity and spatial distribution of a given event. The indices also allow for greater standardization for comparing different drought events between different regions. Over the years, many drought indices have been developed and used by meteorologists and climatologists around the world.

The statistical analysis of the drought indices leads to the conclusion that 2013 was the driest year with an average SPI of -1.6, followed by 2012 (-1.2), 2014 (-0.9), 1978 (-0.7).

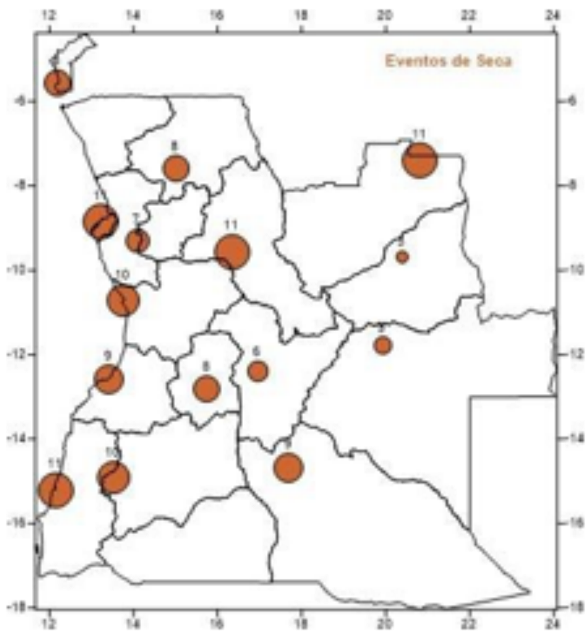

Figure 8: Spatial distribution of drought events for the period 1961-2016

Complexo Administrativo Clássicos de Talatona, Rua do MAT,
Building 4, 4th Floor
Talatona Municipality, Luanda
E-mail: dnaac@mcta.gov.ao

Period	Drought Moderate	Drought	Extreme Drought	Total
1961 - 1970	4	0	0	4
1971 - 1980	12	3	3	18
1981- 1990	13	7	3	27
1991- 2000	14	4	5	23
2001 - 2010	16	5	1	21
2011 - 2016	14	13	13	40

Figure 9: Distribution of drought events by decade.

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Complexo Administrativo Clássicos de Talatona, Rua do MAT,
Building 4, 4th Floor
Talatona Municipality, Luanda
E-mail: dnaac@mcta.gov.ao