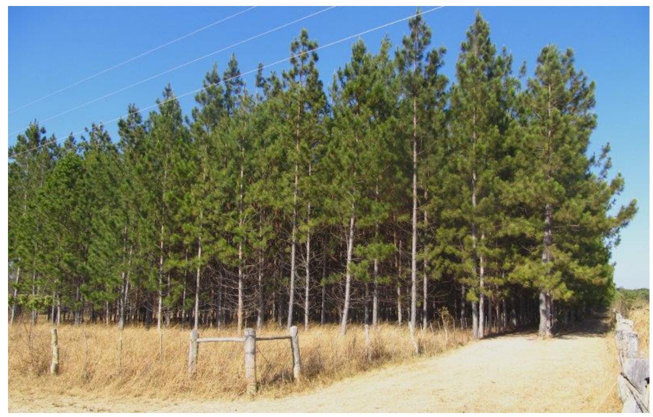
ONE ZAMBIA ONE NATION

MINISTRY OF LANDS NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION



SECOND NATIONAL COMMUNICATION TO THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE (UNFCCC)

2000 - 2004

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FOREWORD

Climate variability and change has become a major threat to sustainable development in Zambia. The country is already experiencing climate induced hazards which include drought and dry spells, seasonal and flash floods and extreme temperatures. Some of these hazards, especially the droughts and floods have increased in frequency and intensity over the past few decades and have adversely impacted on the food and water security, water quality, energy and livelihoods of the people especially rural communities. What is worrying the Government is the unpredictable nature of some of the drought and floods occurrence which could be an indication of human induced interference with the climate system through build-up of the greenhouse gases in the atmosphere.

As a country which is vulnerable to the adverse impacts of climate change and a Party to the United Nations Framework Convention on Climate Change (UNFCCC), Zambia takes its responsibility to develop, periodically update and publish national inventories of anthropogenic emissions by sources and removals by sinks of all its greenhouse gases seriously. Government takes its obligations under the UNFCCC seriously and shall continue to do so in order to contribute to the global efforts of addressing climate change. The Government believes that further delays in taking action to address the problem of climate change will significantly lead to greater damage and consequently increase our adaptation needs.

The Second National Communication (SNC) to the UNFCCC highlights Zambia's greenhouse gas inventories for the period 1994 to 2000. It was developed through a broad based consultative process and proposes measures that need to be implemented in order for the country to mitigate and adapt to the adverse impact of climate change in a more sustainable manner. Such measures include establishment of a long term institutional framework that will promote coordinated response to climate change and a robust and permanent greenhouse gases inventory system.

It is worth noting that the total greenhouse gases emissions increased by 6.2% from 51.52 million tonnes of Carbon Dioxide equivalent in 1994 to 54.72 million tonnes of Carbon Dioxide equivalent in 2000. The bulk of this increase in our emissions was from our land use sector. In this regard, Government has taken measures to address this challenge through combating deforestation, promoting sustainable agriculture and sustainable land management. I would, therefore, urge all Zambian citizens to take precaution, minimize and prevent the emission of the greenhouse gases that contribute to global warming and climate change.

The Second National Communication does not belong to Government alone but to all Zambian. It will be used as a planning tool in the country's development process. The mitigation and adaptation projects ideas that have been proposed will serve as an input into development of concrete, detailed and bankable project proposals for funding by Government, UNFCCC and other bilateral and multilateral organisations. Government will count on its bilateral and multilateral partners to support our efforts.

Finally, I wish to implore all stakeholders to work together and implement the proposed mitigation and adaptations project contained in the SNC in order for the country to contribute to the attainment of the objective of the Convention and meet the aspirations of our people and the global community.

Hon. Mwansa Kapeya, MP

MINISTER OF LANDS, NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION

ACKNOWLEDGMENT

The Government of the Republic of Zambia received support in various forms and from different institutions and individuals in the process of preparing this Second National Communication and I now wish to extend our gratitude to them.

In the first place, I wish to thank the Global Environmental Facility (GEF) which provided financial resources which made this whole exercise possible. In the same vein, I further wish to extend my gratitude to the United Nations Development (UNDP) Zambia Country Office which played a vital role of our implementing agency for the efficiency, commitment and technical backstopping which ensured that the country produces a report that reflects our national circumstances and efforts.

The Zambia Environmental Management Agency which coordinated the whole exercise on behalf of Government demonstrated leadership and passion in ensuring all relevant stakeholders played their respective roles effectively in the process. However, the actual input and technical expertise came from different Government line ministries, civil society, the academia, local communities and individuals who volunteered information, relevant reports and various data that went into the report. Government is highly indebted to them. This gratitude similarly applies to the different technical working groups who ensured quality control by meticulously reviewing reports from consultants and providing technical backstopping.

Another team that deserves commendation for its efforts on this exercise is the editorial team which proof read and tidied up the document and ensured it was in a suitable format for submission.

Lastly, but not the least, I extend Government's gratitude to all individuals, institutions and organizations I may not have mentioned here that played a role during the process of formulating this document.

Inūtu Etambuyu Suba
Permanent Secretary
MINISTRY OF LANDS, NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION

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Acronyms

ACP	African, Caribbean and Pacific Group of States
CBU	Copperbelt University
CCCMA	Canadian Centre for Climate Modelling and Analysis
CDM	Clean Development Mechanism
CDM SUSSAC	Clean Development Mechanism – Start-up CDM in ACP Countries
CDM-CAPSSA	Clean Development Mechanism - Capacity Building among the Private Sectors in Southern Africa
CF-SEA	Carbon Finance to Promote Sustainable Energy Services in Africa Project
COMAP	Comprehensive Mitigation Analysis Process
CSIRO	Commonwealth Scientific Industrial Research Organization
CSO	Central Statistical Office
DMMU	Disaster Management and Mitigation Unit
DNA	Designated National Authority
DoE	Department of Energy
ECZ	Environmental Council Zambia
FD	Forestry Department
FNDP	Fifth National Development Plan
GACMO	Greenhouse Gas Abatement Costing Model
GCM	General Circulation Model
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GMAs	Game Management Areas

HAC	Human–Animal Conflict
HADCM3	Hadley Centre Coupled Model-Version 3
HFO	Heavy Fuel Oil
HIV/ AIDS	Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome
ILUA	Integrated Land Use Assessment
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial Processes and Product Use
IRR	Internal Rate of Return
KCM	Konkola Copper Mines
LEAP	Long Range Energy Alternatives Planning
LPG	Liquefied Petroleum Gas
LULUCF	Land Use, Land Use Change and Forestry
MACO	Ministry of Agriculture and Cooperatives
MMMD	Ministry of Mines and Mineral Development
MTENR	Ministry of Tourism, Environment, and Natural Resources
NAPA	National Adaptation Programme of Action
NMVOC	Non-Methane Volatile Organic Compounds
NPV	Net Present Value
NWASCO	National Water Supply and Sanitation Council
PDDs	Project Design Documents
PINs	Project Idea Notes
QA/QC	Quality Assurance/Quality control
REDD+	Reducing Emissions from Deforestation and Forest Degradation
SNC	Second National Communication

SNDP	Sixth National Development Plan
UNFCCC	United Nations Framework Convention on Climate Change
UNZA	University of Zambia
WWF	World Wide Fund for Nature
ZAFFICO	Zambia Forest and Forestry Industry Corporation
ZEP	Zambia Education Programme
ZESCO	Zambia Electricity Supply Corporation
ZMD	Zambia Meteorological Department

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EXECUTIVE SUMMARY

National Circumstances

Zambia is a land locked country covering an area of 752,614 km^2 and lies between latitudes 8^o and 18^o south and longitude 22^o and 34^o east of the Greenwich Meridian. Forests and woodlands cover about 535,000 km^2, or about 66% of the total national land area.

Zambia's climate is tropical but varies according to elevation and latitude. Mean annual temperatures vary from 18-20^{o}C. Annual rainfall ranges from 600mm in the south to 1200mm in the north. The population of Zambia in 2000 was estimated at 9.90 million of which 4.95 million were males and 4.94 million were females.

The country is endowed with natural resources that include copper, cobalt, coal, emeralds, gold, silver, uranium, forest, water and fertile land. The main industries are mining, transport, construction, manufacturing and agriculture. Zambia's economy grew at an average annual rate of 1.7% during the pre-market reform period (1964-1991) and 1.6% in the post-market (1994-2000) reform period. The main sectors of the economy generally performed well and were key contributors to GHG generation during the reporting period.

Zambia's main sources of energy include petroleum, hydro-power and biomass. The country has a potential for expansion into other sources of energy such as solar energy and geothermal. Indigenous energy sources include woodlands and forest for fuel wood, and coal. The energy consumption pattern in Zambia is dominated by households and mining. Households accounted for 73% of total energy consumption in 2000. The largest share of energy consumption by households is attributed to woodfuel, which indicates the overall importance of woodfuel in the provision of energy in Zambia.

Agriculture is one of the key sectors of the economy contributing between 18 -20% to Gross Domestic Product (GDP). Climate change is expected to pose a significant challenge to the sector thereby undermining food security, poverty reduction and other development objectives. The sources of GHG from agriculture arise from application of fertilizers, rearing of livestock; manure management, burning of agricultural residues, and related land clearing influences. However, there is insufficient data to describe the contribution of the agriculture sector to GHGs.

While climate change affects agricultural production, the sector presents opportunities for emissions reductions, especially in interventions such as bioenergy, agro-forestry and conservation farming.

Zambia's woody vegetation can be divided into five forest types, namely the Dry evergreen, Dry deciduous, Montane, Swamp and Riparian Forests, and five woodland types – the Miombo, Kalahari, Mopane, Munga and Termitaria, and Grasslands. Under the Integrated Land Use Assessment (ILUA-I), these national vegetation classes were re-classified into global classes namely: semi evergreen forests; deciduous forests; evergreen forests shrub thickets; and grasslands and/or wooded grasslands.

Deforestation rate which ranges between 250,000 to 300,000 hectares per annum poses the main threat to the forestry sector. The main drivers of deforestation and forest degradation are charcoal production (4.5%), commercial firewood (1.4%), timber (16.8%), semi-permanent agriculture (23.7%) and shifting agriculture (53.6%).

The sustainability of wildlife resources and by implication the tourism sector, are currently facing additional threats of extinction due to changes in climatic patterns as well as the Human –Animal Conflict (HAC). Wildlife populations are sensitive to their habitats and tend to be adversely affected by extreme weather conditions such as floods and droughts.

The ad-hoc institutional arrangements used so far for the preparation of National Communications have not been effective and efficient. In view of this, a new institutional framework is being planned for future preparation of National Communications in the country. It will involve all key actors in climate change among them: Government departments, Civil Society Organisations and private sector.

Greenhouse Gas Inventory

GHGs inventory for the year 1994 and 2000 were estimated and compared. However, GHG inventory of 1994 has been recalculated to take into account changes in methodologies, activity data and emission factors. Total GHG emissions increased by 6.2% from 51.52 million tonnes CO_{2e} in 1994 to 54.72 million CO_{2e} in 2000. In 2000, the largest contribution to GHG emissions came from Land Use, Land Use Change and Forestry (LULUCF) at 73.7% followed by agriculture at 18.9%. Energy registered 4.8% followed by industrial processes and waste at 1.8% and 0.8% respectively. By gas, the largest contribution came from CO_2 at 65.5%, followed by CH_4 and N_2O at 23.1% and 9.9% respectively. HCFs and SF_6 registered the lowest at 1.5% and 0.01% respectively.

Greenhouse Gas Projections and Mitigation Options and Policies

Total GHG emissions from all sectors are expected to increase from 54.7 million from all the sectors in 2000 to 216.8 million tonnes CO_{2e} in 2030. If all the mitigation and policy options recommended under this National Communication are implemented, a reduction potential of 10.3 million and 20.0 million tonnes CO_{2e} can be realised for the years 2020 and 2030 respectively. Mitigation options include energy management, promotion of renewable energy including biofuels, conservation farming, and electricity generation from biomass.

Vulnerability Assessment, Climate Change Impacts and Adaptation Measures

Studies and research undertaken in Zambia have been used as input in the preparation of the Second National Communication (SNC) on vulnerability assessment, climate change impacts and adaptation measures. These studies have also been used to assess evidence of climate change and its effects on major sectors. Adaptation measures have been indentified based on the assessments done.

Under agriculture, some of the risks hazards identified were decreasing crop yield due to change in rainfall and increasing temperatures, livestock population to increase in areas to experience increased rainfall, and rangeland carrying capacity will be low owing to variation in rainfall, temperature and evaporation. Some of the adaptation measures recommended include: Strengthening of early warning systems, increase in irrigation to boost maize production and water management systems, development/growing of drought resistant crops, increased use of manure to avoid build up and release of methane, and improvement of grazing management practices.

Under energy and water, risks/hazards identified were: reduced run-off and hydro power generation due to projected droughts, and reduced stream flow and ground water due to reduced rainfall affecting agriculture and other sectors. Corresponding adaptation measures included: inter-basin water transfers, alternative energy sources, early warning systems, integrated water management system with climate scenarios considerations, and conservation of water in agriculture sector and water harvesting.

In the natural resources sector, risks/hazards identified were for wildlife and forests. For wildlife risks/hazards are biodiversity loss and habitat degradation due to projected high temperatures, droughts and floods. While for forests, drought, high prolonged temperatures, shorter rainy seasons, floods and excessive rainfall are likely to affect vegetation type. Adaptation measures recommended are: identification of possible wildlife refugia and corridors under conditions of climate change, development of response plans for water supply and flood management in National Parks, improvement of fire management, and promotion of soil conservation.

Under health, risks/hazards identified were: more cases of diseases such as malaria due to higher temperatures and floods. Corresponding adaptation measures included: early warning systems for malaria and other diseases and capacity building for improved environmental health.

Under infrastructure, risks/hazards identified were: damage to infrastructure such as bridges, railways and roads due to extreme events. Adaptation measures recommended are: development of design standards and codes of practice for infrastructure

Other Information Relevant to the Convention

There has not been much progress made on transfer of technology, research and systematic observation, and education training and public awareness. It should, however be noted that good progress is being made in implementing environmental friendly technologies in the agriculture sector, in particular conservation farming. There is, however, great need to synergize these activities with carbon trading.

Some efforts were being initiated to undertake systematic observation aimed at addressing the issue of limited climate monitoring stations in the country. For example, Zambia at the time had 36 meteorological stations country wide. There were, however, voluntary climate monitoring stations available which were providing additional information to the Zambia Meteorological Department (ZMD).

Public awareness in Zambia is taking place through print and electronic media by Government, Civil Society Organisations, Faith Based Organisations and international organizations. Systematic environment programmes need to be instituted in the regular curriculum of learning institutions. Programmes on adverse effects of global warming in the electronic and print media will need to be undertaken.

The Ministry responsible for Environment is the UNFCCC focal point and is responsible for formulation of policies and legislations, strategies and plans on environment and natural resources. It also serves as the Designated National Authority (DNA) for CDM under the Kyoto Protocol. The DNA still needs more resources for infrastructure and capacity development to expand its mandate to include provision of CDM promotional services. The ministry delegated the responsibility to undertake GHG inventories and preparation of the SNC to ECZ.

Government is considering establishing a long term institutional framework that will promote coordinated response to climate change. This will include establishment of a robust and permanent GHG inventory system.

1 NATIONAL CIRCUMSTANCES

1.1 Geographical setting

Zambia is a land locked country covering an area of 752,614 km^2 and lies between latitudes 8^0 and 18^0 south and longitude 22^0 and 34^0 east of Greenwich Meridian. It is centrally located in the southern region of Africa. The country shares borders with eight countries namely; Angola, Botswana, Democratic Republic of Congo, Malawi, Mozambique, Namibia, Tanzania and Zimbabwe.

Zambia is composed of three main topological areas: mountainous regions, high plateau and lowlands. The Zambezi River drains much of the west and south of the country. The Kafue River drains west-central Zambia, while much of the northern and eastern parts of the country are drained by Luapula and Luangwa rivers respectively. Over half of the country is covered by forest, with open or savannah woodland comprising 66%. The most extensive type of woodland is the Miombo (predominantly *Brachystegia species*), a semi-evergreen vegetation, covering 42% of the country.

1.2 Climate

Zambia's climate is tropical but varies according to elevation and latitude. Mean annual temperatures vary from 18-20^{o}C. According to the Koppen-Geiger climate classification system, the major part of the country is classified as humid subtropical or tropical wet and dry, with small stretches of semi-arid climate in the south-west, along the Zambezi valley. The country experiences a rainy season (November to April) and a dry season (May – October), which can further be divided into cool dry (May – August) and hot dry (September – October). Annual rainfall reaches 1200mm in the north, decreasing to 600mm in the south.

Zambia's climate and the relative abundance of potential arable land render much of the country suitable for agricultural production. While the potential arable land covers 47% of country's land mass, only 15% is currently under cultivation. There is a considerable variation in soil quality from the uplands to the lowlands and much of the plateau and hilly areas have been degraded by geomorphologic processes. Upland soil has low inherent fertility, being moderately leached sandveldts, loams and clays. The lowlands or dambo areas have soils characterized by high organic matter content and are important areas for cultivation as they can sustain production without the need for external fertilizers.

1.3 Population

The population of Zambia in 2000 was estimated at 9.90 million of which 4.95 million were males and 4.94 million were females. The country is divided into nine provinces of which Copperbelt had the largest population size of 1.6 million followed by Lusaka (1.4 million) and Eastern (1.3 million). North Western Province with 583,350 was the least populated. The annual average growth rate between 1990 and 2000 was estimated at 2.4% at national level, and 3.0% and 1.5% for rural and urban areas, respectively. About 65% of Zambia's population was in rural areas and the proportion of rural population has steadily increased during the last three decades from 60% in 1980 to 62% and 65% in 1990 and 2000, respectively.

Zambia's population density in 2000 was 13.1 persons per square kilometre, and age-sex population distribution for children (0 -14 years) constituted 43.6% of Zambia's total population. For reproductive age group (15 -49 years), the age-sex population distribution was 52% and above 65 years was 1.2%. Nationally, one in five households is female headed. The prevalence of HIV and AIDS has had a significant impact on the population of Zambia and estimated that 21.6% of adults between the ages of 15 to 49 were living with HIV/ AIDS in 2001. The AIDS epidemic contributes to high death and infant mortality rates, and lowers life expectancy currently estimated at 39.7 years.

1.4 Government Structure

Zambia attained its independence from Great Britain in 1964. The country is a unitary State headed by a Republican President who is elected through universal suffrage for a term of five years. Administratively, it has 9 provinces, namely, Central, Copperbelt, Eastern, Luapula, Lusaka, Northern, North-Western, Southern and Western. Further, Zambia is divided into 72 districts. The legal system is based on English Common Law and Customary Law. The President appoints Cabinet from Members of Parliament. The Parliament comprises 150 members elected by universal suffrage for five-year terms and an additional eight members nominated by the President. Zambia has an independent Judiciary headed by the Chief Justice. The political system is based on multiparty democracy, and the country has enjoyed political stability since independence.

1.5 Economy

The country is endowed with natural resources that include minerals (copper, cobalt, coal, emeralds, gold, silver and uranium among others), forests, water, wildlife, fish and fertile land. The main sectors contributing to Zambia's economy include mining, transport, construction, manufacturing, tourism and agriculture. Energy is a cross-cutting sector that serves all industries.

Zambia's economy grew at an average annual rate of 1.6% during the period 1994-2000. In terms of sectoral growth performance, during the period 1995-2000, the fastest growing sector was agriculture at 3.1% per year. Manufacturing industry, including mining, recorded a negative growth of 3.2% per year during the 1994-2000 period.

Sectors mostly vulnerable to climate change include agriculture, energy and water, and natural resources (forest and wildlife). On the other hand, sectors mostly likely to contribute to Green House Gas (GHG) emissions and/or sequestration include agriculture, manufacturing, energy, infrastructure and natural resources.

1.6 Agriculture

Out of the country's land area of 752, 614 square kilometers, 47 percent is potential arable land. However, only 15 percent of the arable land is presently cultivated. Zambia has a total labour force of 5 million, out of which 85% are engaged in the agriculture sector. Climate change is expected to pose a significant challenge to poverty reduction and other development objectives.

Globally, there is concern about the contribution that the agriculture sector makes to GHG and climate change. GHG emissions by sector for the year 2000 attributed 13% to agriculture, and 18% to Land Use Change and Forestry. However, in the case of Zambia, the share of GHG contribution from agriculture is 18.93% and that of land use change and forestry is 73.67%. It should also be noted that under land use change and forestry, the major contributing factor in Zambia is deforestation caused by agriculture.

The sources of GHG from agriculture arise from application of fertilizers, rearing of livestock, manure management, burning of agricultural residues, and related land clearing activities. Whilst ongoing climatic changes affect agriculture production, the sector itself also presents opportunities for emissions reductions, especially in interventions such as bioenergy, agro-forestry and conservation farming.

1.7 Natural Resources

1.7.1 Forest

Forests and woodlands cover about 535,000 km^2, or about 70% of the total national land area. Zambian woody vegetation can be divided into five forest types, namely the Dry evergreen, Dry deciduous, Montane, Swamp and Riparian Forests, and five woodland types – the Miombo, Kalahari, Mopane, Munga and Termitaria, and the

Grasslands. Under the Integrated Land Use Assessment (ILUA-1), the national vegetation classes were re-classified into global classes as follows:

i. Miombo woodlands (plateau and hills) to semi evergreen forests;
ii. Baikiaea forests, Munga, Mopane and Kalahari woodlands to Deciduous forests;
iii. Riparian, Swamp, Parinari, Itigi and the lake basin chipya forests to evergreen forests;
iv. Termitary associated bushes to shrub thickets; and
v. Tree less areas comprising riverines, plains, dambos to either grasslands or wooded grasslands.

The deforestation rate in Zambia ranges from 250,000 to 300,000 hectares per annum and is attributed to agriculture expansion (77.3%), timber (16.8%), charcoal production (4.5%), and commercial firewood (1.4%). Biomass stock cleared for agriculture, settlements and others such as charcoal production and timber logging was estimated at 176,000, 88,048, and 44,028 hectares, respectively.

Although Forest and Forest Industry contribute at least 3.7% to GDP, deforestation releases significant volumes of GHGs from activities such as charcoal production processes. Reducing deforestation through sustainable forest management, afforestation and reforestation will make a significant contribution towards reducing GHG emissions from the sector. This report indicates that the largest contributions of GHG emissions are from deforestation and forest degradation. For this reason, potential exists for mitigation to GHG emissions' in the forestry sector.

Another source of GHG emissions is large amounts of waste left to decay or burnt annually from timber harvesting in the forests and during sawmilling. This waste can be transformed into value-addition through biomass electricity generating facilities. Total forest biomass resource and bioenergy potential are estimated at 688,000 tonnes and 267,000 GJ, respectively. The largest potential comes from Kaoma and Sesheke, with estimated economic electricity output of 20 MW and 18 MW.

Similarly, Zambia's forests can play an important role in reducing and mitigating the effects of climate change through sequestration. A recent study estimates that Zambia's forests, excluding plantations, store as much as 2.3 billion metric tonnes of carbon.

1.7.2 Wildlife

Wildlife resources play a critical role in the socio-economic development of Zambia, through its contribution to the tourism sector, job and wealth creation and as an important source of protein. This is in addition to its aesthetic and cultural values.

The sustainability of wildlife resources and by implication the tourism sector, are currently facing additional threats of extinction due to changes in climatic patterns as well as poaching and wildlife-human conflict. Wildlife populations are sensitive to their habitats and tend to be adversely affected by extreme weather conditions such as floods and droughts.

Most wildlife species' reproduction patterns are sensitive to temperature, solar radiation, pollution as well as the overall condition and size of their habitat. Ecosystems degradation and changes in environmental conditions cause wildlife population dispersion and migration outside their protected areas and subsequently cause land use change and increased conflicts with humans. Zambia has a wide range of plant and animal species and has an impressive network of protected areas to protect this wide diversity of nature.

1.8 Energy

Energy is one of the important driving forces behind the development of an economy as it cuts across most economic and social activities. Zambia's sources of energy include petroleum, hydro power electricity, solar energy, coal and wood fuel. The overall energy consumption by sector for Zambia is illustrated in Table 1 for the year 2000.

Table 1: Energy consumption by sector

Sector	Peta Joules	Percent
Agriculture & Forestry	5.75	2.8
Commerce & Industry	17.06	8.3
Government/Services	2.29	1.1
Households	150.56	73
Mining	20.99	10.1
Transport	9.67	4.7
TOTAL	206.32	100

Source: Department of Energy 2000

The energy consumption pattern in Zambia is dominated by households and mining. As shown in Table 1, households accounted for 73% of total final energy consumption in 2000. The largest share of energy consumption by households is attributed to firewood, which indicates the overall importance of firewood in the provision of energy in Zambia. The mining sector, second in importance in terms of energy consumption, accounted for 10% of total final consumption, followed by industry at 8% and transport at 5%.

Zambia's electric installed power capacity is slightly over 1,700 MW. This consists of large hydros, mini-hydro and diesel powered electricity generating systems. Deposits of coal in Zambia are estimated at 30 million tonnes with the largest deposits occurring at Maamba along the Zambezi valley. Other areas where coal deposits have been located are Luangwa North, Luano, Lukusashi, Chunga and Lubaba .

1.9 Mining

The mining sector is one of the main drivers of economic development in Zambia. The export of mineral products contributes about 70% of total foreign exchange earnings, generating between 6 to 9% of GDP. The sector creates about 40,000 jobs to total formal sector employment. It is projected that, by 2010, annual production would reach 1970 levels of over 700,000 tonnes. However, due to the fluctuation in demand, copper output may be adversely affected.

The mining operations use huge quantities of electricity and fossil fuels such as diesel and coal. In view of the heavy processes involved, substantial quantities of flue gases are generated that currently go to waste. This waste can be turned into value-addition through on-site electricity generation by application of steam generators and corresponding steam turbines to produce electricity on-site. Additionally, a substantial number of electric motors are used and most of them have low-efficiency and experience idling situations, which can be avoided through use of efficient electric motors and automatic load control devices.

1.10 Manufacturing

The manufacturing sector comprises a number of industries which include: food, beverages and tobacco, textiles and leather products, wood and wood products, paper and paper products, chemical, rubber and plastics, non-metallic mineral products, base metal products, and fabricated metal products. For the year 2000, manufacturing contributed 11.6% to total GDP. Some of the industries which are likely to be affected by climate change are wood and wood products, food, beverages and tobacco.

The production processes of the various types of the food industry are similar, and involve preparatory stages including crushing, refining, drying and packaging. Some of these production processes results in residuals, which typically go to waste. Food production requires electricity, process steam and thermal energy, which in most cases are produced from fossil fuels. The major GHG emissions from the food industry are CO_2, from the combustion of fossil fuels (diesel, heavy fuel oil, and coal) in boilers and furnaces, and CH_4 from wastewater systems due to anaerobic reactions occurring in the lagoons. These processes offer great opportunities for mitigation since the methodologies for combustion of fossil fuels and CH_4 emissions from wastewater are easily identifiable.

The chemical, rubber and plastics sub-sector has identical supporting systems in the form of boilers and furnaces, and is, therefore, another candidate for mitigation opportunities. Another manufacturing sub-sector of relevance to CO_2 emissions generation and mitigation is cement / lime. The production of clinker, the principal material in cement, emits CO_2 from the calcination of limestone. The major energy uses are fuel for the production of clinker and electricity for grinding raw materials and the finished cement. Various processes are used in clinker and cement-making with varying energy intensities. Carbon-intensive fuels, for example coal, dominate in clinker-making, and hence the cement industry is a major source of CO_2 emissions.

1.11 Institutional arrangements

The five pillars which informed the formulation of institutional framework for the implementation of Zambia's national communication to the UNFCCC included; overall institutional set-up for the national communication and specific institutional frameworks for GHG Inventory, Vulnerability and Adaptation, Mitigation Working Groups, and awareness raising working groups.

It has been observed that the current institutional framework for the preparation of the National Communication falls short of some key elements necessary to provide for their effective and efficient implementation. The submission of the National Communication to the UNFCCC has been faced with a number of challenges. The main challenge was the lack of an agreed institutional arrangement. The ad-hoc institutional arrangements used so far have not been effective and efficient.

The Environmental Council of Zambia (ECZ) was the lead institution for preparation of the SNC. Other key institutions involved were the Central Statistical Office (CSO), Disaster Management and Mitigation Unit (DMMU) and Zambia Meteorological Department (ZMD). Others were data providers among them National Water Supply and Sanitation Council (NWASCO), Department of Energy (DoE), Forestry Department (FD), Department of Agriculture and Department of Mines and Mineral Resources. The processes of GHG inventory data generation, storage and retrieval as well as the institutions providing this data had limitations. In view of this, a new institutional framework is being planned for future preparation of National Communications in the country. It will involve all key actors in climate change among them: Government departments, Civil Society Organisations and private sector.

2.0 GREENHOUSE GAS INVENTORY

2.1 Background

As a Party to the UNFCCC, Zambia is required to produce and regularly update National GHG Inventories. National GHG Inventories were produced for the years 1994 and 2000.

This section of the report provides detailed information on GHGs inventory for the year 2000 in comparison to the 1994 GHG inventory for the sectors: Energy, Industrial Processes, Agriculture, Land Use Change and Forestry, and Waste. However, GHG inventory of 1994 had been recalculated to take account of changes in methodologies, activity data and emission factors. The section also contains background information, methodology, national emissions and removals, source and sinks category emission estimates.

2.2 Methods of estimation

The revised 1996 Guidelines provided worksheets to assist with the transparent application of the most basic (or Tier 1) estimation methodologies. The following greenhouse gases were covered as per the revised 1996 Guidelines; carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6). Detailed description of the methodology of greenhouse gas inventories for Zambia under the sectors energy, industrial processes, agriculture, land use change and forestry and waste is provided as follows:

2.2.1 Methodology for Energy Sector

The source categories for energy included; fuel combustion, fugitive emissions, and CO_2 capture and storage. GHG emissions from fuel combustion were estimated using tier 1 method. Similarly, Tier 1 method was used for selection of the method for estimation of CO_2 from stationary combustion which requires data on the amount of fuel combusted and default emission factor for each source category and fuel. The source category included fuel combustion from energy industries, manufacturing including mining, transport and other sectors including household, commercial and agriculture sectors. Further, Tier 1 method was selected for surface coal mining and handling, for determining fugitive emissions (CH_4) from mining and post mining activities.

The activity data, in terms of fuel consumption for the different sectors namely, energy industries, manufacturing and construction, agriculture, transport, commerce and institutional and, residential were collected from different sources. Among these sources were DoE and Ministry of Mines and Mineral Development (MMMD). Default emission factors for different fuel sources to include gasoline, diesel, JetA1, kerosene, fuel oil, LPG, coal, firewood and charcoal were obtained from 2006 IPCC guidelines. The data was analysed using the spreadsheet developed by the UNFCCC.

2.2.2 Methodology for Industrial Processes

Industrial Processes and Product Use (IPPU) covers GHG emissions occurring from industrial processes, from the use of GHGs in products, and from non-energy uses of fossil fuel carbon. GHG emissions are produced from a wide variety of industrial activities. The main emission sources are released from industrial processes that chemically or physically transform materials. During these processes, many different GHGs, including CO_2, CH_4, N_2O, HFCs and PFCs, can be produced. Non CO_2 emissions CO and NMVOC are also generated during asphalt roofing and road paving with asphalt.

The general computation approach that was employed to estimate the emissions associated with each industrial process was based on the revised 1996 IPCC methodologies. The computations involved the product of the amount of material produced or consumed and an associated emission factor per unit of consumption or production. These were employed for categories including; (i) mineral products including asphalt roofing and road paving with asphalt, (ii) chemical industry including food and pulp industry and (iii) metal production.

GHG emissions from consumption of HFCs and SF6 were computed from:

(i) refrigeration and air conditioning equipment;
(ii) fire extinguishers;
(iii) aerosols;
(iv) solvent;
(v) electrical equipment (transformers, switch gears).

Under this sector, emission factors for various activity data including clinker/cement, lime production, food and beverage, HFCs consumed under refrigeration, foam blowing, fire extinguishers, aerosols and solvents and SF_6 consumed were obtained from the revised 1996 IPCC guidelines. Activity data were obtained from different sources namely CSO, ZESCO Limited, ECZ and MMMD.

2.2.3 Methodology for Agriculture Sector

Determination of greenhouse gas emissions was undertaken following the procedures outlined in the revised 1996 IPCC guidelines. The GHG and polluntants emissions computations considered under this sector included; (i) CH_4 and N_2O emissions from domesticated livestock (enteric fermentation and manure management); (iii) N_2O emissions from agricultural soils, (iv) CH_4 emissions from rice cultivation, (v) CH_4, CO, N_2O and NO_x, emissions from burning of agricultural crop waste; and (vii) CH_4, CO, N_2O and NO_x emissions from prescribed savannah burning.

Activity data under agriculture were obtained from Ministry of Agriculture and Cooperatives. The data included crop production (maize, wheat, rice, beans, soya beans, potatoes, sugar cane and groundnuts) and livestock production (dairy cattle, non dairy cattle, sheep, goats, pig, and poultry). The other data included, harvested area for irrigated rice, nitrogen input from application of synthetic fertilizers and from manure applied to soils, area of cultivated organic soils(hectare/year), area of savanna burnt and average above- ground biomass density.

2.2.4 Methodology for Land Use, Land Use Change and Forestry

The methodology that was used to calculate emissions and removals was based on the 1996 IPCC revised guidelines. In making the calculations default IPCC values were used. The priority calculations of emissions from land use change and forestry in Zambia focus upon, forest clearing and on-site burning, off-site burning (firewood and charcoal combustion), on-site biomass decay, carbon emissions from managed organic soils and carbon emissions from application of lime. CO_2 and non CO_2 emissions (CH_4, CO, N_2O and NO_X) from land use change and forestry namely forest clearing and on-site burning, were calculated in accordance with IPCC methodology.

The calculation for the annual CO_2 uptake from biomass increment by biomass stock was accomplished according to the revised 1996 IPCC Guidelines. The basis of the calculation was on carbon uptake, annual biomass increment, carbon fraction of dry matter, forest/biomass area abandoned over 20 years and annual growth rate.

The activity data used under this sector was obtained from various sources including, Ministry of Tourism, Environment, and Natural Resources (MTENR) and Ministry of Agriculture and Cooperatives (MACO). Biomass burnt in form of firewood and charcoal was obtained from the energy balance from DoE.

2.2.5 Methodology for Waste Sector

The main sources of emissions are from the following categories: CH_4 from waste disposal on land (managed and unmanaged) and waste water handling (industrial, domestic and commercial), N_2O from human sewage, and CO_2 and N_2O waste incineration. The revised 1996 IPCC guidelines provided methodologies used in estimation of emissions from these categories.

2.3 Summary of Greenhouse Gas Inventory in 2000

2.3.1 Summary of National Emissions and Removals

This section of the report provides a summary of GHGs inventory for the year 2000 in comparison to 1994. However, the GHG inventory of 1994 was recalculated to take account changes in methodologies, activity data and emission factors. Provided in Table 2 and Figure 1 are GHG emissions by sector for the year 2000 and 1994.

Table 2: GHG emissions by sector (Gg CO_2 Equiv)

Year	Total with LULUCF	Total without LULUCF	Energy	Industrial processes	Agriculture	LULUCF	Waste
1994	51,520	13,354	2,778	2,008	8,198	38,165	371
2000	54,716	14,406	2,629	1,006	10,359	40,310	412

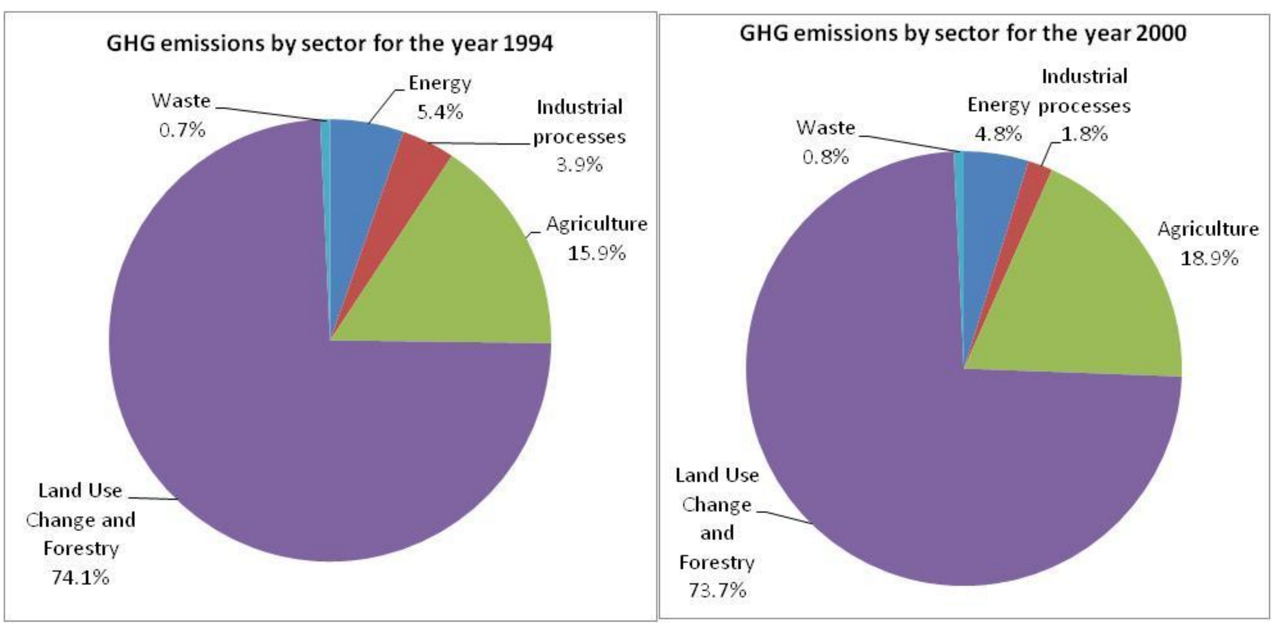


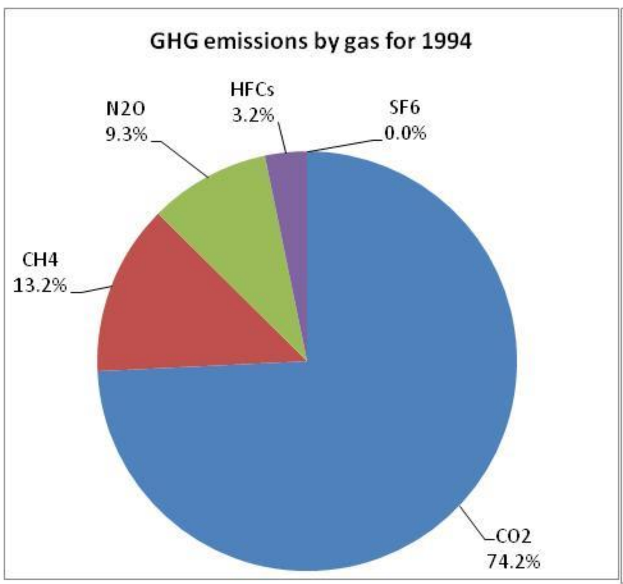
Figure 1: GHG emissions by sector (Gg CO_{2e}) for 2000 and 1994

Total GHG emissions increased by 6.2% from 51.52 million tonnes CO_{2e} in 1994 to 54.72 million CO_{2e} in 2000. In the year 2000, the largest contribution to GHG emissions came from land use change and forestry at 73.7% followed by agriculture at 18.9%. Energy registered 4.8% followed by industrial processes and waste at 1.8% and 0.8%, respectively. By gas, the largest contribution came from CO_2 at 65.5%, followed by CH_4 and N_2O at 23.1% and 9.9%, respectively. HCFs and SF_6 registered the lowest at 1.5% and 0.01%, respectively (Table 3).

Table 3: GHG emissions by gas (Gg CO_{2e})

Base Year	TOTAL	CO_2	CH_4	N_2O	HFCs	SF_6
1994	51,520	38,248	6,793	4,811	1,664	4
2000	54,716	35,810	12,648	5,434	819	4

Figure 2 provides percentage contribution of emissions by gas for the year 1994 and 2000.



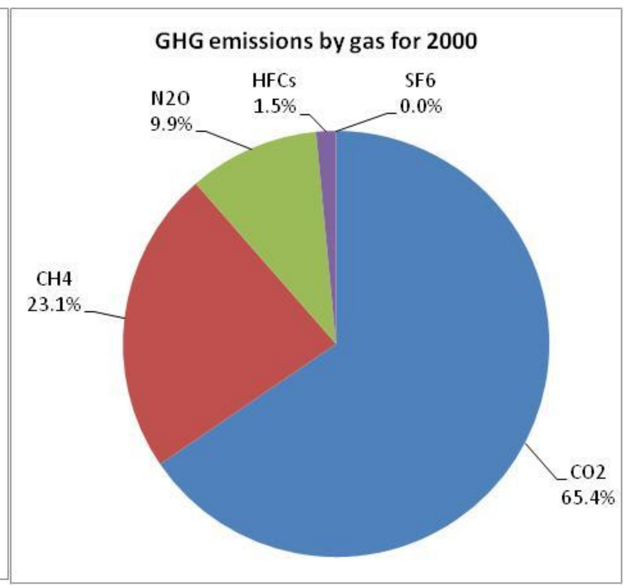


Figure 2: GHG Emissions by Gas (Gg CO2e) for the years 1994 and 2000

In 2000, the largest contribution for indirect GHG emissions for CO came from agriculture followed by land use change and forestry, and energy. The largest contribution for NO_X came from energy, agriculture, land use change and forestry (Table 4).

Table 4: Indirect GHG Emissions in 2000

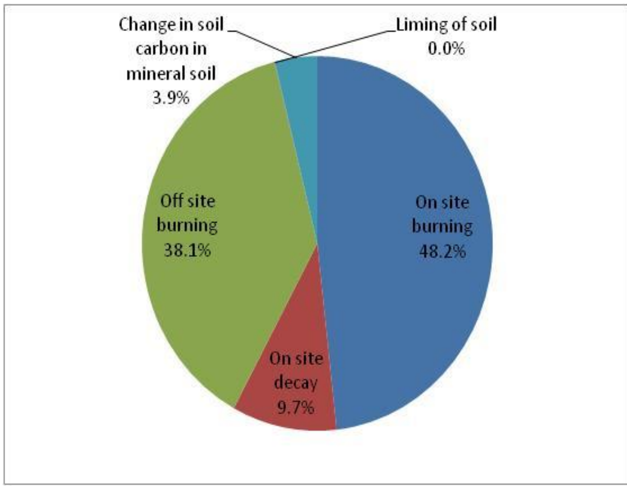
	NO_x (Gg)		CO (Gg)		NMVOC(Gg)		SO_2(Gg)	
	2000	1994	2000	1994	2000	1994	2000	1994
Energy	1,201.47	1,199.12	1,081.15	1,079.28	90.57	84.51	6.16	5.94
Industrial Processes					2.97			
Agriculture	60.76	40.33	3,400	2,201				
Land Use Change	14.44	4.74	2,534	840.00				
Waste								

The total CO_2 emissions decreased from 36.11 million tonnes in 1994 to 34.1 million tonnes in 2000 representing a decline of 5.6 % (Table 5 and Figure 3). However, in both years, Zambia was still a net source of CO_2 emissions. The net source was as a result of deforestation caused by on site burning (18.14 million tonnes of CO_2), followed by offsite burning (14.34 million tonnes) and on site decay (3.63 million tonnes), representing 48.0%, 38.0% and 3.6% of total annual emissions from the sector, respectively.

Table 5: GHG emissions and removals summaries for the year 2000

	Annual Emissions CO_2 Gg		Annual Uptake (Removal) CO_2 Gg		Balance Gg	
SOURCES	**2000**	**1994**	**2000**	**1994**	**2000**	**1994**
On site burning	18,135.8	22,053.7				
On site decay	3,630.5	3,631.3				
Off site burning	14,337.8	11,958.8				
Liming of soil	18.1	303.1				
Change in soil carbon in mineral soil	1,468.0	1,468.0				
Total Sources	37,590.2	39,414.98				
SINKS						
Carbon uptake by plantations			959.52	978.51		
Carbon uptake in abandoned areas			2,504.1	2,326.3		
Total Sinks			3,463.6	3,304.8		
Balance					-34,126.6	-36,110.2

On site burning and decay are due to deforestation mainly caused by land clearing for agriculture (176,000 hectares per annum), infrastructure (68,000 hectares), charcoal production (19,000 hectares) and timber harvesting (7,000 hectares). Off site burning is due to use of charcoal and firewood mainly for cooking in households and to some less extent in industry and mining. The carbon sink is limited to carbon uptake through regeneration of forest in abandoned land (72.0%) in the last 20 years, and from carbon uptake in Zambia Forest and Forestry Industry Corporation (ZAFFICO's) 50,000 hectares plantations (28.0%) at a total of 3.46 million CO_2 sequestrations per annum.



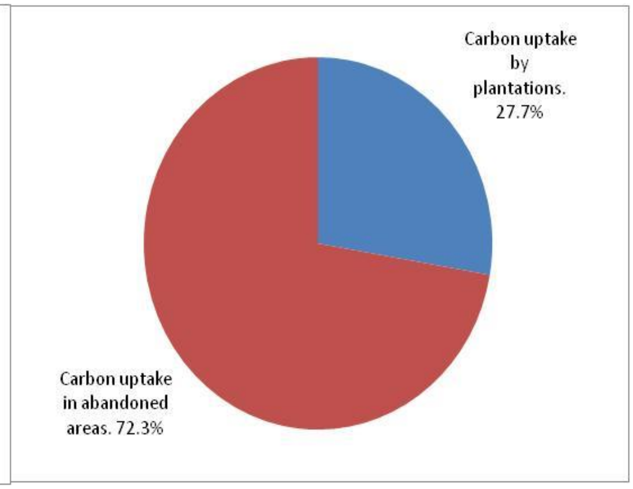


Figure 3: GHG emissions and removals distribution for the year 2000

2.3.2 Summary of Inventory

The largest contribution of CO_2 came from land use, land use change and forestry at 95.3%, of total CO_2 emitted in 2000, followed by energy and industrial processes at 4.2% and 0.5%, respectively. As regards CH_4, the largest contribution came from land use, land use change and forestry at 48.1%, followed by agriculture at 42.1% and energy at 7.5%. Waste registered 2.3%. In case of N_2O, the largest contribution came from agriculture at 92.7%, mainly due to use of fertilizers and burning of savannah and crop residues. Energy contributed 3.2%, waste and LULUCF 2.2% and 1.9%, respectively. Provided in Table 6 are *CO2e*emissions in 2000.

Table 6: Summary of CO_{2e} Emissions in 2000

Greenhouse Gas Source and Sink	CO_2	CH_4	N_2O	HFCs	SF_6	Total
Categories	CO2e(Gg)					
Total (Net Emissions)	**35,812.42**	**12,648.43**	**5,434.33**	**819**	**4.06**	**54,718.24**
1. Energy	1,503.42	952.15	175.8			2,631.37
2. Industrial Processes	182.47			819	4.06	1,005.53
3. Solvent and Other Product Use						
4. Agriculture		5,324.04	5,035.33			10,359.37
5. Land-Use Change and Forestry	34,126.53	6,078.45	105.4			40,310.38
6. Waste		293.79	117.8			411.59
7. Other *(please specify)*						
Memo Items:						
International Bunkers						
Aviation	86.85	1.68	7.44			95.97
Marine						

Given in Table 7 are detailed summary reports for CO_{2e} emissions for the year 2000.

Table 7: Summary report for CO2e Emissions in 2000

Greenhouse Gas Source and Sink	CO_2 (1)	CH_4	N_2O	HFCs	SF_6	Total
Categories	CO2e(Gg)					
Total (Net Emissions)	35,812.42	12,648.43	5,434.33	819.0	4.06	54,718.24
1. Energy	1,503.42	952.15	175.80			2,631.37
Fuel Combustion (Sectoral Approach)	1,503.42	952.15	175.80			
1. Energy Industries	18.95	0.14	0.04			
2. Manufacturing Industries and Construction	806.50	72.28	16.43			
3. Transport	583.60	0.25	0.78			
4. Other to include household , commercial and agriculture	94.37	873.60	158.10			
B. Fugitive Emissions from Fuels		2.94	0.23			
1. Solid Fuels		2.94	0.23			
2. Oil and Natural Gas						
2. Industrial Processes	182.47			819.0	4.06	1,005.53
A. Mineral Products	182.47					182.47
B. Chemical Industry						
C. Metal Production						
D. Other Production						
E. Production of Halocarbons and SF_6						
F. Consumption of Halocarbons and SF_6				819.0	4.06	823.06
G. Other						
3. Solvent and Other Product Use						
4. Agriculture		5,324.04	5,035.33			10,359.37
A. Enteric Fermentation		2,496.56				2,496.56
B. Manure Management		89.61	1,550.00			1,639.61
C. Rice Cultivation		3.30				3.30
D. Agricultural Soils		0.00	2,965.15			2,965.15
E. Prescribed Burning of Savannas		2,649.62	484.84			3,134.46
F. Field Burning of Agricultural Residues		84.95	35.34			120.29
G. Other						
5. Land-Use Change and Forestry	34,126.53	6,078.45	105.40			40,310.38
6. Waste		293.79	117.80			411.59

Solid Waste Disposal on Land					
B. Wastewater Handling					
C. Waste Incineration					
D. Indirect emissions					
7. Other *(please specify)*					
Memo Items:					
International Bunkers					
Aviation	86.85	1.68	7.44		95.97

2.4 Gaps, further work and improvements

Under energy, there is no Quality Assurance/Quality control (QA/QC) system in place to ensure routine and consistent checks required for data integrity, correctness and completeness from different data sources. Other gaps include lack of harmonization between Zambia's energy balance reporting classification with that of the UNFCCC, reliable biomass activity data, and appropriate emission factors for biomass combustion and charcoal production. In Therefore, a QA/QC system will be introduced in the data collection and archiving across all the systems currently involved in energy data analysis. There are plans to re-align the Energy Balance to conform to the UNFCCC sector wise classification.

Gaps under industrial processes are lack of reliable activity data for determination of GHG emissions for HFCs and SF_6 for the following activities: road paving with asphalt, pulp and paper production, food and beverages, refrigeration and air conditioning, and consumption of SF_6 in electrical equipment (transformers).

In case of agriculture, gaps identified included lack of assessment of uncertainties and QA/QC, and use of default emission factors and unreliable activity data for animal waste management, agricultural soils, and burning of agriculture crops. For LULUCF, gaps identified included lack of assessment of uncertainties, absence of the QA/QC system, use of default emission factors and unreliable activity data. Gaps identified under Waste included lack of complete activity data on solid waste management and wastewater flow from all utilities and industries, pit latrines and incineration.

As such, studies need to be undertaken to improve on the activity data and /or emission factors for the following sectors: Agriculture, LULUCF, Industrial Processes and Waste. Further, QA/QC systems for the various sectors will be established.

3.0 GREENHOUSE GAS PROJECTIONS AND MITIGATION OPTIONS AND POLICIES

3.1 Background

This chapter provides information on activities carried out to address anthropogenic emissions by sources and removals by sinks of all GHGs not controlled by the Montreal Protocol, including, as appropriate, relevant information by key sectors on methodologies, scenarios, results, measures and institutional arrangements. It also provides information on mitigation efforts planned in Zambia under the Convention which include CDM, Voluntary Emissions Reductions and REDD+.

Zambia participated in various capacity building and awareness programmes on CDM which include:

- Start-Up CDM in ACP countries (CDM SUSSAC);
- Capacity Building to Develop an Enabling Environment for Industrial CDM Projects in Africa;
- CDM Capacity Building among the Private Sectors in Southern Africa (CDM-CAPSSA);
- CDM for Sustainable African-Capacity Building for Clean Development Mechanism in Southern Africa;
- Using Carbon Finance to Promote Sustainable Energy Services in Africa Project (CF-SEA) -Zambia, and Green Facility.

These programmes have resulted in a number of CDM project ideas which have been identified under various sectors. Some project ideas have been elaborated on further and have been developed into Project Idea Notes (PINs) and Project Design Documents (PDDs).

The following issues were considered under GHG projections and mitigation analysis; (i) policy direction/environment and implementation strategy, (ii) sector and aggregate GHG baseline and projected emissions, (iii) mitigation scenarios modeling for the period 2000 to 2030, (iv) marginal costing of mitigation measures identified, (v) and Financial/sensitivity analysis of identified mitigation measures.

As part of preparation of the SNC, an in-depth study was undertaken involving development of baseline scenario, and analysis of various mitigation options including policy considerations. The main focus of the study was to develop baseline scenarios in energy, industrial processes, agriculture, LULUCF and waste. It should be noted that in a country like Zambia, energy and LULUCF are interlinked through household energy demand mainly charcoal and firewood. The interdependence is therefore influenced by the increasing demand for household energy which is associated with increasing deforestation. This scenario creates the need to undertake mitigation analysis in the two sectors.

3.2 Methods and Assumptions

The general methodologies used for GHG projections and mitigation included, reviewing of policy environment, direction and implementation strategy for overall and all sectors to include Energy, Industrial processes, Agriculture, LULUCF and Waste in relation to mitigation integration. Other documents reviewed included Vision 2030 and Fifth National Development Plan (FNDP) for overall and relevant sectors in relation to climate change mitigation policy integration. In terms of sector and aggregate GHG baseline emissions/removals, projections were done for Energy, Industrial processes, Agriculture, LULUCF and Waste. The tools used in accomplishing the above tasks included, Long Range Energy Alternatives Planning (LEAP) model which was used in forecasting energy demand and GHG emissions, spreadsheet and Comprehensive Mitigation Analysis Process (COMAP) model and GACMO. Projections for current and future energy demand and GHG emissions are given under Table 8.

Table 8: Growth Rate Assumptions up to 2030

Sector	Growth rate (%)
Energy Industries	4
Manufacturing	4
Transport	3.5
Commercial	3.5
Residential	2.9
Agriculture	8

GHG baseline emission projections for Industrial processes were determined based on a projected growth rate of 4% as outlined in the Vision 2030. Under this sector, no mitigation options are suggested in view of the relatively low GHG emissions emanating from this sector. GHG emissions projections from Agriculture was determined by growth rates, based on historical trends, representing animal and crop production, at 1% and 2.5% respectively. Emission projections under LULUCF were determined based on a growth rate of 3.1% per annum from the baseline. The growth rate was based on the average rates of forest and land clearing for commercial firewood, charcoal, and agriculture between 1995 and 2030. GHG emissions projections from Waste was determined based on a growth rate representing projected population growth rate of 2.9% as outlined in the Vision 2030.

3.3 Results

If all the mitigation options and policy considerations recommended under energy, agriculture, LULUCF and waste under this National Communication are implemented, a reduction potential of 10.3 and 20.0 million tonnes CO2ecan be realised for the years 2020 and 2030 respectively. The policies include: energy management, promotion of renewable energy including biofuels, conservation farming through use of manure crops, and electricity generation from agriculture biomass and municipal solid and liquid organic waste.

3.3.1 Energy

Under both baseline and mitigation analysis, the following issues were considered; (i) assessment of present energy demand and GHG emissions related to physical sources and economic sectors, and projections of these according to a baseline linked to the Vision 2030, (ii) identification of options for the mitigation of GHG emissions and their corresponding reduction potential, concentrating on major emitting sectors to include energy industries, manufacturing including mining, transport, agriculture, and commercial and households, (iii) determination of marginal costing aimed at ascertaining the minimum cost of abatement and financial viability of selected projects through Internal Rate of Return (IRR) and Net Present Value (NPV) analysis.

Baseline Energy Demand and GHG Projections

Figure 4 depicts baseline energy demand under the energy sector focusing on energy industries, manufacturing, transport, commercial, residential, and agriculture for the period 2000 to 2030 based on computation from the LEAP.

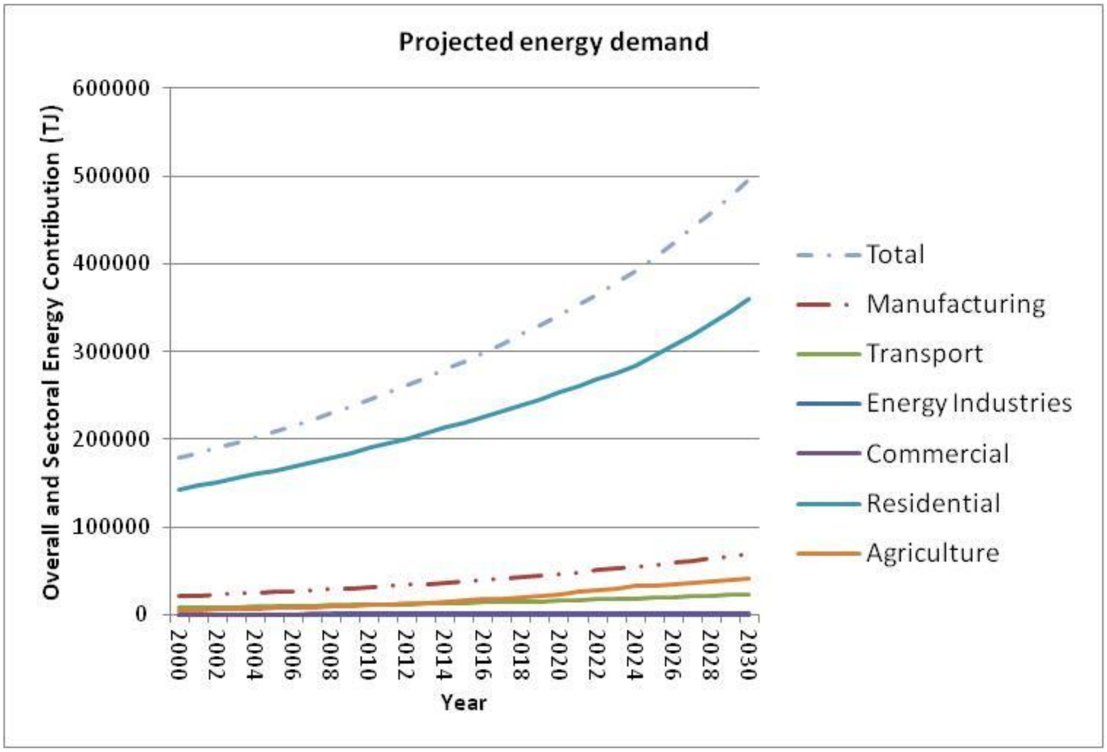
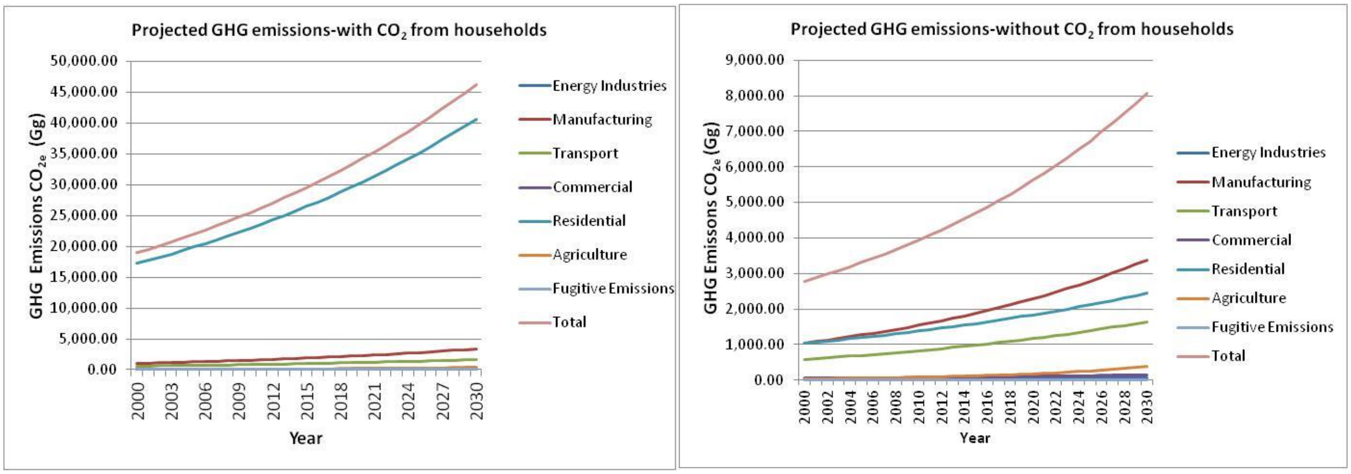


Figure 4: Projected Energy Demand 2000 to 2030

The total energy demand is expected to grow from 178,399 TJ in 2000 to 495,574 TJ in the year 2030 under the assumption of business as usual scenario where no efforts are undertaken to introduce energy efficiency from the energy end use. The largest contribution to projected energy demand is residential followed by manufacturing, agriculture, transport, and commercial. Residential contribution is largely due to use of charcoal and firewood for household in both rural and urban areas, respectively. The projection of GHG emissions for Zambia by sector in GHG equiv is given in Figures 6 (a) depicting inclusion of CO_2 emissions from households and Figures 6 (b) depicting exclusion of CO_2 emissions from households.



(a) (b)

Figure 5: Projected GHG Emissions with and without CO_2 from households

Figure 5 reveals that projected GHG emissions from energy are expected to increase from 19 million tonnes of CO_{2e} in 2000 to 46.22 million tonnes by 2030. Following the energy demand trend, the largest contribution is being influenced by household energy. However, under IPCC Inventory Guidelines, CO_2 emissions are counted under LULUCF. Under this consideration, overall GHG emissions are expected to increase from 2.8 million tonne CO2ein the 2000 to 8.1 million tonnes CO2ein 2030 with the largest contribution expected to come from household sector followed by manufacturing and transport. The dominance by households is due to CH_4 and N_2O emissions emanating from combustion of firewood and charcoal in the sector. Households are the biggest consumer of energy in the country. CH_4 and N_2O emissions are calculated under energy based on the IPCC Inventory Guidelines.

Mitigation Analysis

Mitigation under the energy sector considered various mitigation options to include fuel switch from diesel/HFO to biodiesel, and fuel switch from coal to biomass(in the form of either pellets or biomass loose) in diesel and coal operated boilers in industry and commercial sectors. Other options include a switch from existing isolated diesel stations in isolated grids to mini hydro, and production of ethanol and biodiesel to partially substitute gasoline and diesel, respectively. Switch from petrol to ethanol requires initially constructing a 20 million litres capacity per annum ethanol plant based on molasses from sugar industries, and with sweet sorghum as a complementary feedstock. An approximate similar amount of biodiesel will be required to blend with fossil fuel.

Grid extension in isolated areas where there is no national grid to replace diesel plants and where appropriate, will entail construction of mini hydro power stations with a capacity of around 1 to 2 MW. Corresponding reduction potential of selected options under energy is elaborated in Figure 6.

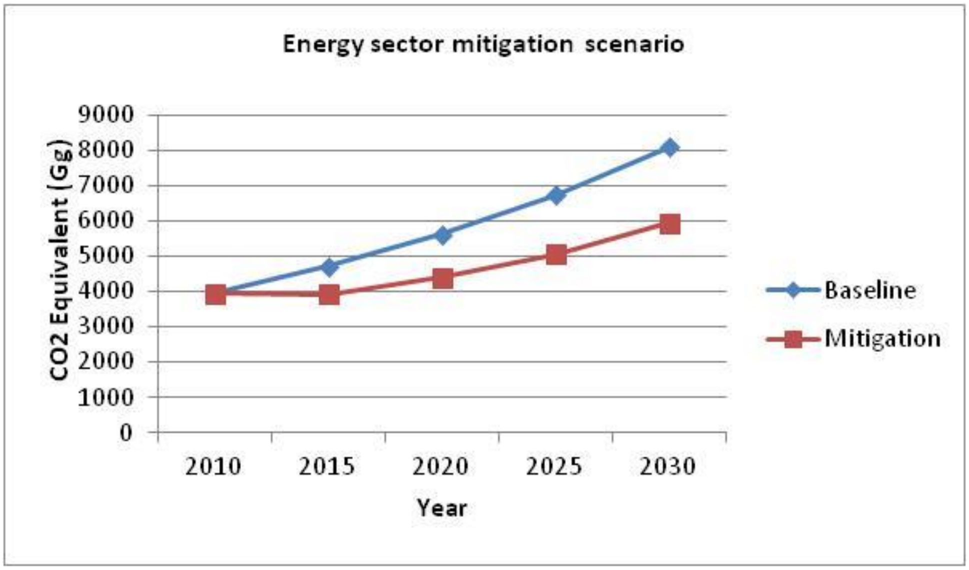


Figure 6: Energy sector mitigation scenario

Under energy sector, by 2020 and 2030 , partial substitution of diesel with biodiesel yields the greatest reduction potential at 476 and 793 thousand tonnes, respectively. This is followed by grid extension from hydro based grid to rural areas depending on isolated diesel small plants for electricity supply and using firewood and charcoal for cooking at 280 and 561 thousand tonnes CO2e, respectively. Fuel switch from diesel/HFO, and coal to biomass loose in boilers in the industry and commercial sectors, and partial substitution stand third, fourth and fifth in CO_{2e} reduction potential, respectively as shown in Figure 7. On the overall, energy sector has reasonable reduction potential of up 1.2 and 2.1 million tonnes of CO_{2e} for the years 2020 and 2030, respectively.

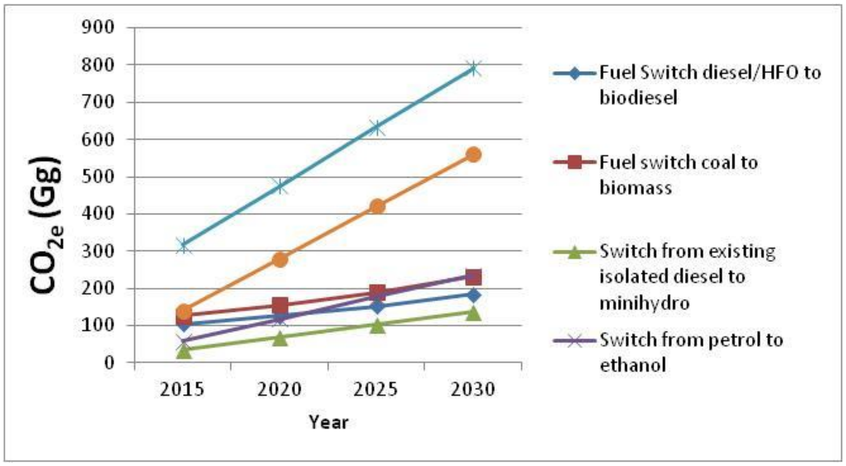


Figure 7: Energy Mitigation Options Potential

In terms of marginal costing, fuel switch from diesel/HFO in boilers in the industry and commercial sectors, switch from existing diesel to mini hydro, and grid extension to isolated diesel are no regret options with negative abatement costs. However, from financial perspectives, fuel switch from diesel/HFO and from coal to biomass in boilers in the industry and commercial sectors have higher IRRs at 348% and 63%, respectively. This is followed by partial substitution of gasoline with ethanol at IRR of 47%.

3.3.2 Industrial Processes

GHG emissions projections under Industrial Processes are expected to increase from 1.01 million to 3.26 million tonnes in the years 2000 and 2030, respectively (Table 9).

Table 9: Baseline GHG Emissions projections from Industrial Processes

Year	2000	2005	2010	2015	2020	2025	2030
Emissions(million tonnes)	1.01	1.22	1.49	1.81	2.20	2.68	3.26

3.3.3 Agriculture

3.3.3.1GHG Projections

The sources of GHG from agriculture are enteric fermentation, rice cultivation, agriculture soils, burning of savanna and agriculture residues. Baseline GHG emissions projections from agriculture are shown in Figure 8. In this sector, Gross GHG emissions are expected to grow from 10.3 million tonnes CO_{2e} in 2000 to 15.2 million tonnes CO_{2e} by 2030. The largest contribution to GHG in agriculture between years 2000 and 2023 will be enteric fermentation. After 2023, GHG emissions from agriculture soils are projected to surpass emissions from enteric fermentation and will become the major source of emissions from this source because of a higher growth rate for crop production against animal production. Emissions from burning of savanna were the third largest contributor although remaining constant.

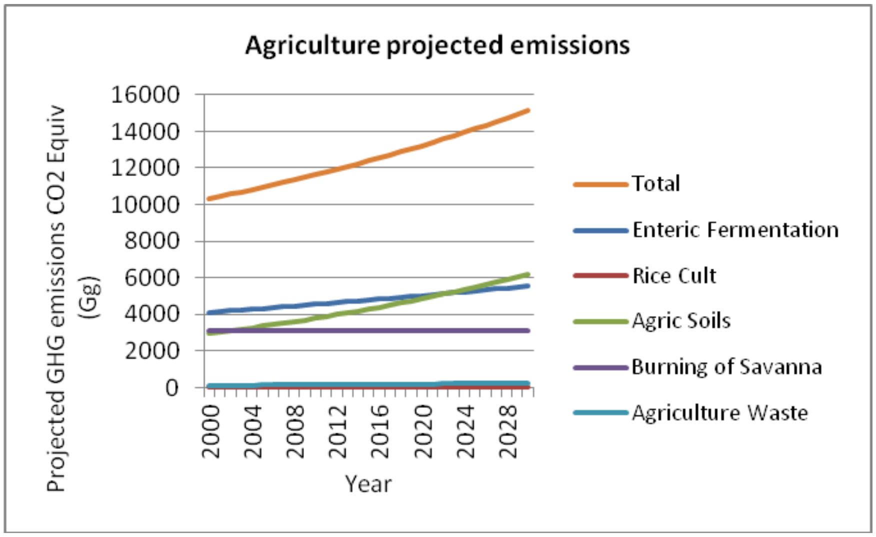


Figure 8: Trends of agriculture baseline GHG emissions projections

3.3.3.2 Mitigation Analysis

Various mitigation options were considered under agriculture sector involving rural biogas and biomass electricity generation, and reduction of use of inorganic fertilisers through application of green manure crops and conservation farming. The projects under consideration in this sector require use of organic waste from animals and biomass waste in particular from agriculture residues to produce electricity in rural Zambia with sizes of around 60 KW and 1MW, respectively. The other option involves reduction of use of inorganic fertilisers through use of organic fertilizer produced from green crops manure.

Under this sector, the reduction potential at 2020 and 2030 stand at 296 thousand and 539 thousand tonnes CO_{2e} respectively. The largest contribution is emanating from rural biogas and biomass electricity generation, and improved agriculture management through growing of green manure crops to replace fertilizer (conservation farming) at 320 and 107 thousand tonnes CO_{2e} for the year 2030 as shown on Figure 9 for the year 2030.

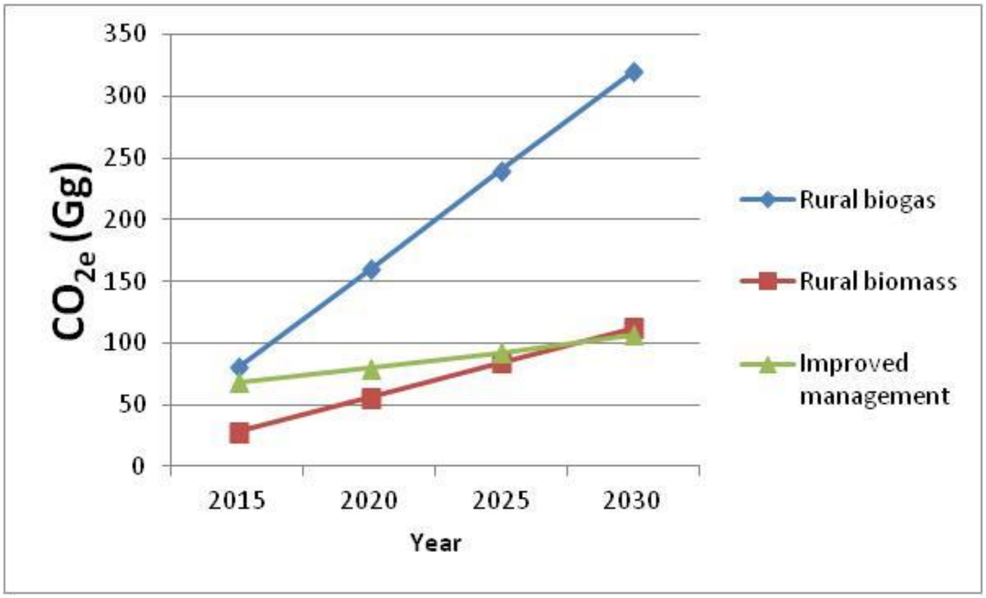


Figure 9: Agriculture sector mitigation scenario

Marginal costing and financial analysis revealed that both rural biogas and biomass electricity generation have negative abatement cost and positive IRR

3.3.4 Land use, land use change and forestry

3.3.4.1 Baseline forest cover and GHG emissions projections

Forest cover is expected to decrease from 48.2 million hectares to 38.9 million hectares in 2035 based on an average deforestation rate of 365,000 hectares per annum representing 20% reduction over a period of 25 years. Further, the COMAP was used to estimate the product and supply demand during the target period as shown in Table 10.

Table 10: Product supply and demand (‘000’ tonnes)

	2005	2025	2045
Supply	22,366	22,525	24,582
Demand	10,634	19,483	28,521

In view of Zambia’s abundant forest cover, the demand is still within supply levels although this supply cannot be infinite. Given on Table 11 are land use change and forestry emissions projections.

Table 11: Land use, Land use change and Forestry emission projections (Gg)

Year	2000	2005	2010	2015	2020	2025	2030
Emissions	40,310	46,958	54,702	63,723	74,232	86,474	100,734

Emissions from land use change and forestry are expected to rise from 40 million tonnes in the year 2000 to 100 million tonnes CO_{2e} as a result of related deforestation activities from land clearing for agriculture, settlements and infrastructure, timber harvesting and charcoal production.

3.3.4.2 Mitigation analysis

The intention of mitigation under this sector is to increase the area under forest cover and reduce deforestation through enhanced regeneration and reforestation. Using the projected changes in the area under land use activities, the biomass density and pool were generated for the baseline and mitigation scenarios. Under mitigation scenario, biomass pool is expected to increase from 30 thousand tonnes in the year 2005 to 52 thousand tonnes in the year 2030. This is a modest contribution to restoration of forest cover since it will modestly reduce deforestation rate.

Under this sector, proposed mitigation options projections include improved and traditional wood stoves. The penetration levels for improved cookstoves estimated to range from 220 thousand to 685 thousand and for improved wood traditional stoves from 249 thousand to 955 thousand for the year 2015 and 2030. The second option involves introduction of improved traditional charcoal kilns and charcoal retort with the former rising from 250 to 955, and the latter from 60 to 380. Forest recovery through enhanced regeneration and reforestation is another option under this sector with additional forest plantation/recovery of 10,000 hectares per year.

Biomass electricity generation from forest waste and sawmills will involve installation of 4 MW units per year under this sector. The most promising option involves sustainable agriculture through switching by small scale farmers to conservation farming involving 600 hectares in 2015 and 1.5 million hectares in 2030.

Significant reduction is estimated to be realised from sustainable agriculture with 7.4 and 13.3 million tonnes CO_{2e} for the year 2020 and 2030, respectively (Figure 10). The second largest reduction will be realised with improved charcoal production at 526 thousand and 1.2 million tonnes CO_{2e} for the years 2020 and 2030, respectively. Overall mitigation under this sector stands at 8.5 million tonnes in 2020 and 16.1 million tonnes CO_{2e} in 2030. Mitigation under land use change and forestry offers great promise for GHG reduction in Zambia in view of the so many small scale farmers and entrepreneurs involved in this sector who will benefit from carbon trading.

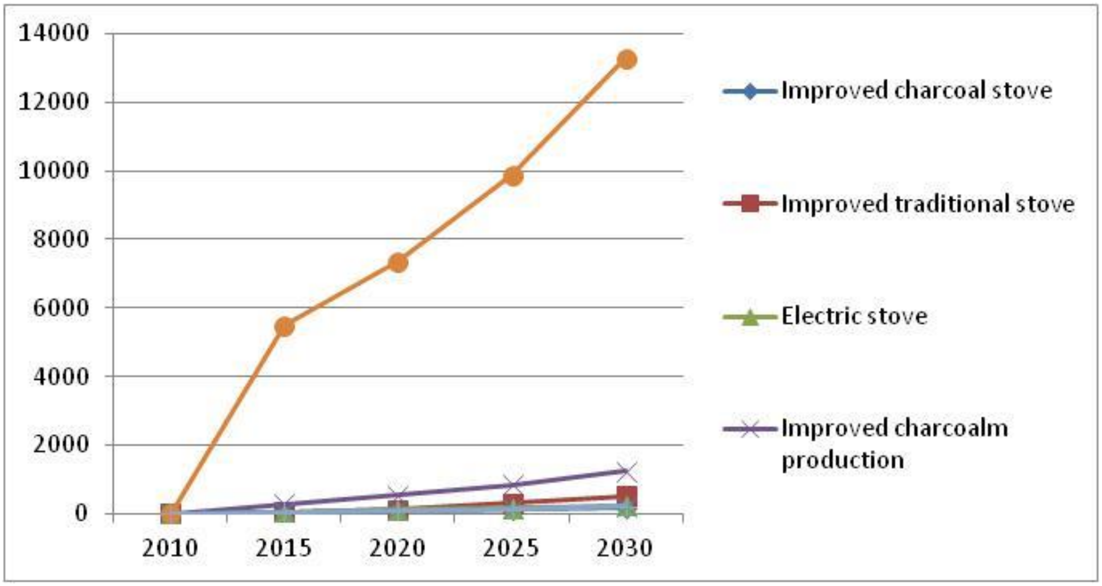


Figure 10: LULUCF sector mitigation scenario

Marginal costing and financial analysis of selected mitigation options are provided in Table 12.

Table 12: Marginal costing and financial analysis of selected mitigation options

Mitigation Options	Marginal Costing (US$)/tonne CO2 reduction
Improved cookstoves 2015	-6255.26
Improved traditional stoves 2015	19.53
Electric stove 2015	-15419.15
Improved charcoal production	0.05
Biomass electricity generation	-16
Charcoal retort	46

3.3.5 Waste

3.3.5.1 Baseline GHG Emissions Projections for the Waste Sector

Under this sector, two projects namely biomethanation and landfill are recommended for implementation. The two projects can be used to generate electricity from organic matter in sewerage and solid waste, respectively. Given in Figure 11 are baseline GHG emissions projections for the waste sector. GHG emissions from the Waste sector are projected to increase from 400 thousand to about 1.0 million tonnes of CO_{2e} in the year 2000 and 2030, respectively.

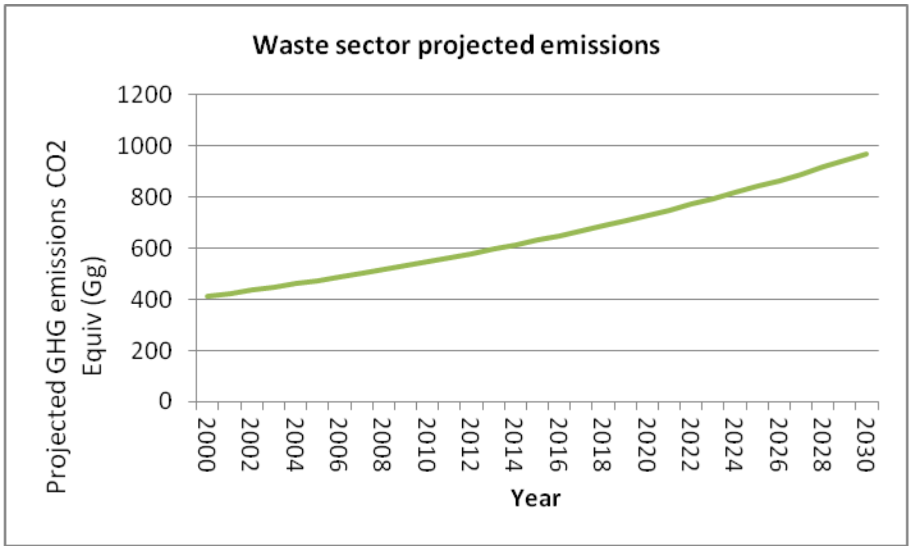
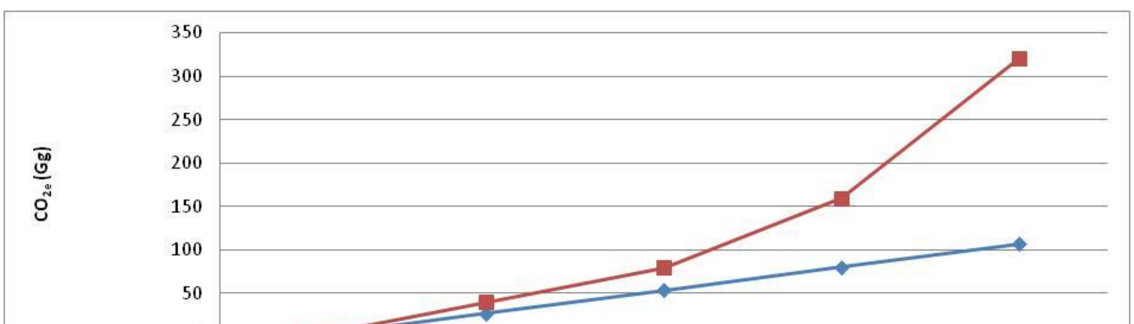


Figure 11: Waste sector projected emissions

3.3.5.2 Mitigation Analysis

Given in Figure 12 are reduction potentials for mitigation options on biomethanation and landfill for electricity generation. Of the two mitigation options landfill offers a higher reduction potential estimated at 80 thousand and 320 thousand tonnes CO_{2e} for the years 2020 and 2030 respectively as compared to 54 and 107 thousand tonnes for biomethanation.



	2010	2015	2020	2025	2030
Biomethanation	0	27	54	80	107
Landfill	0	40	80	160	320

Figure 12: Waste sector Mitigation Scenario

A landfill mitigation project has a higher marginal costing as compared to biomethanation project at US$ 15 and US$ 6.2 per tonne of CO_2 reduction, respectively. However, the landfill project has a better IRR of 52% compare to biomethanation at 35%.

3.3.6 Aggregate GHG baseline emissions and mitigation potential

The total baseline emissions and reduction potential for all mitigation options under energy, agriculture, LULUCF and waste are shown in Table 13 and Figure 12.

Table 13: Total baseline emissions and reduction potential for all mitigation options under energy, agriculture, LULUCF and waste

	2000	2010	2015	2020	2025	2030
Baseline	54,715.0	82,971.3	103,599.5	130,860.8	167,359.2	216,836.1
			Reduction			
Energy		0.0	781.9	1,224.4	1,676.4	2,142.0
Agric		0.0	176.6	295.7	416.3	539.0
LUCF		0.0	6,072.7	8,531.6	11,792.2	16,089.6
Waste		0.0	106.8	213.6	400.4	747.2
Total		0.0	7,138.1	10,265.3	14,285.3	19,517.8
Mitigation	54,715.0	82,971.3	96,461.4	120,595.5	153,073.9	197,318.2

Total GHG emissions from all sectors are expected to increase from 54.7 million to 216.8 million tonnes CO_{2e} between 2000 and 2030. If all the mitigation options recommended and policy considerations are equally implemented under this National Communication, a reduction potential of 10.3 and 20.0 million tonnes CO_{2e} can be realised for the years 2020 and 2030 respectively (Figure 13).

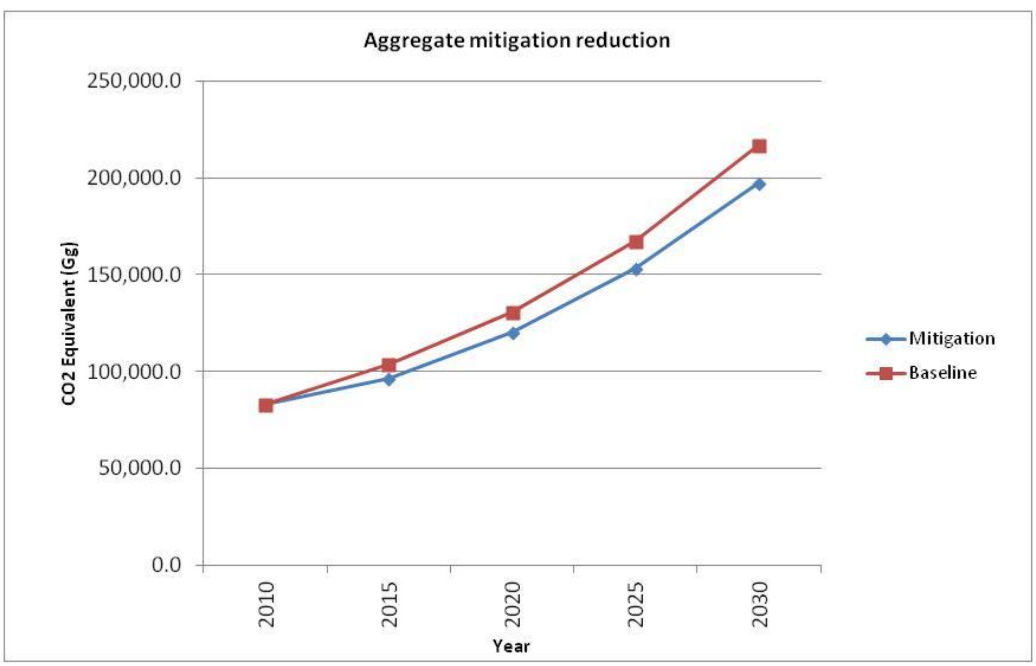


Figure 13: Aggregate Mitigation Reduction

3.4 Policies

The Fifth National Development Plan (FNDP) contains several projects on grid extension, energy efficiency and conservation, promotion of biofuels industry and use of renewable energy to included mini hydro and biomass for electricity generation. Further consideration are being made to mainstream climate change adaptation and mitigation in national development plans. The 2005 energy policy contains measures on energy management, promotion of renewable energy to include mini hydro, electricity generation from biomass, promotion of biofuels to partially replace fossil fuels.

In agriculture sector, various activities in conservation agriculture integrating use of green manure crops are being promoted. These activities need to be encouraged and supported further to ensure that expansion of hectarage for growing of green manure crops is sustained and increased. Under the energy policy, are elements encouraging use of biomass in this case in the form of animal manure and agriculture crop waste for electricity generation. Economic biomass potential for electricity generation from agriculture waste is estimated at 450 MW which can be exploited as part of this strategy. Further, the Government is supporting farmers to adapt to climate change through conservation agriculture. A number of yield enhancing conservation/farming technologies have been identified as a means to raise agriculture crop production and productivity in a sustainable way while at the same time promoting a more sustainable use of land and water resources.

For waste sector, municipalities would be encouraged to use liquid and solid waste to generate electricity under biomethanation and landfill electricity generation opportunities. Implementation of such projects will provide municipalities and communities and various industries access to a wide range of renewable energy sources. Further, these projects will contribute to sustainable development through the promotion of clean environment.

4 EVIDENCE OF CLIMATE CHANGE, AND VULNERABILITY ASSESSMENT, CLIMATE CHANGE IMPACTS AND ADAPTATION MEASURES

4.1 Background

This section provides information on the scope of vulnerability, impacts and adaptation assessments, including identification of vulnerable areas that are most critical. The information includes key findings, direct and indirect effects arising from climate change as well as an integrated analysis of the country's vulnerability to climate change.

Studies and research undertaken in Zambia have been used as input in the preparation of the SNC on vulnerability assessment, climate change impacts and adaptation measures. These studies have also been used to assess evidence of climate change and its effects on major sectors which include agriculture, energy and water, natural resources (forestry and wildlife), health and infrastructure. Adaptation measures have been indentified based on the assessments done.

4.2 Methodology

The method used for assessing evidence of climate change involved data collection of historical climatological data on rainfall and temperature, followed by derivation and assessment of climate change indicators for baseline determination. GCM models namely, Canadian Centre for Climate Modelling and Analysis (CCCMA), run by the Commonwealth Scientific Industrial Research Organization (CSIRO) based in Australia and the Hadley Climate Model run by the Hadley Center (HADCM3) in UK were used to obtain projected rainfall and temperatures for the years 2010 to 2070 for the three agro-ecological regions in Zambia and the identified vulnerable sites.

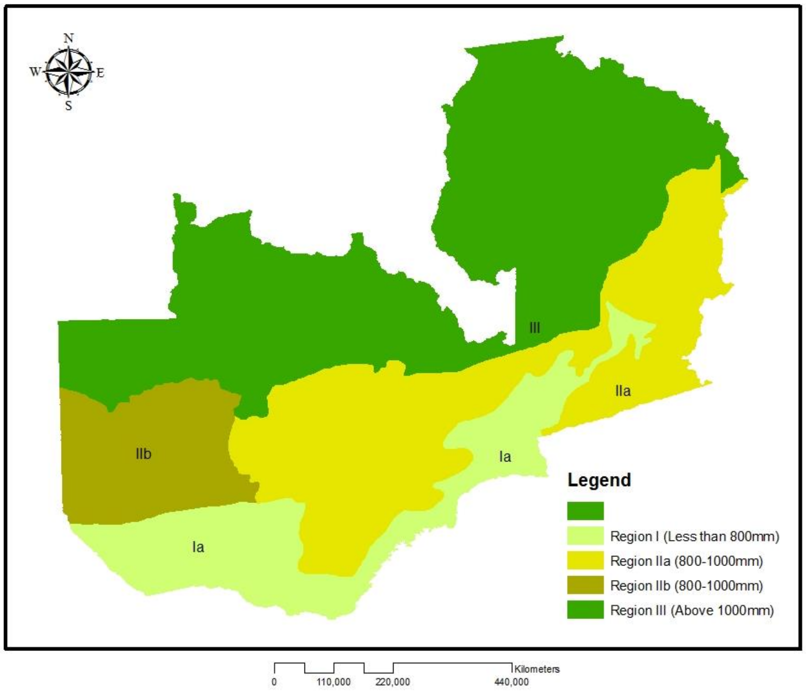


Figure 14: Zambia Agro-ecological zones

Various studies used different models/ methodologies for assessing vulnerability risks /hazards, and development of adaptation measures. One of the methods used was the GCM models, as indicated above, for climate forecasting feeding projected generated data (temperature and precipitation) into energy and water sector impact models. Expert judgment was also used based on correlation between historical/observed temperature and precipitation over the baseline period (1970-2000), indicators observation and sector performance for agriculture, natural resources and human health.

4.3 Evidence of climate change, vulnerability risks/hazards assessments and development of adaptation measures

4.3.1 Evidence of climate change

The studies have revealed that Zambia has experienced a significant decline in seasonal rainfall between 1940 and 2000. An average country-wide decline in rainfall of about 58 mm (6 percent) occurred in the period 1971-2000 compared to the period 1940-1970. Southern, Western, Central and North-Western Provinces had experienced significant declines in seasonal rainfall during this period.

Further, agro-ecological region I of Zambia was found to have a trend towards dryness from 1970 up to 2000. The annual rainfall has been declining over the years in this region. Of the three agro-ecological regions, region I was found to be more vulnerable to climate change/variability. No apparent indications of declining trend in annual rainfall were identified in Region II, but it must be mentioned that it displayed a higher degree of annual rainfall variability over the baseline period. Conversely, Region III showed less annual rainfall variability as opposed to region II. Region III is a higher rainfall region with a fairly stable annual trend which was observed in the baseline period. This region is less vulnerable to climate change/variability and provides suitable adaptation in the area of agriculture if all other conditions are right (Figure 15).

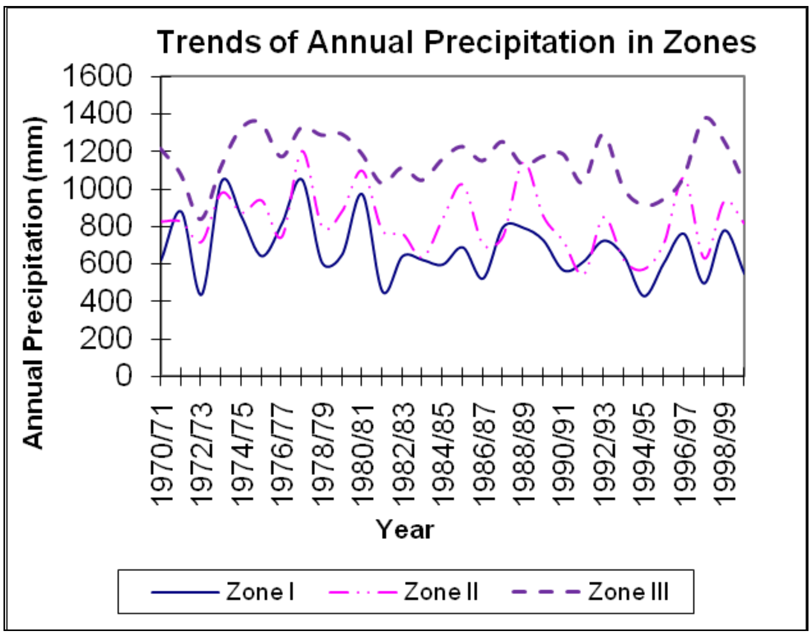


Figure 15: Comparison of Annual Rainfall Trends in the three ecological Regions
Source: GRZ, 2007 (NAPA)

In general, surface air temperatures over all the regions displayed some degree of consistency seasonally. A tendency of slight increase of temperature was observed generally on all regions for the whole baseline period.

Future climate projections for Zambia up to the year 2070 indicated the following trends:

i. Region I is expected to increasingly become highly vulnerable to climate change/variability expressed through droughts and extreme temperatures;
ii. Region II is also expected to be subjected to increasing climate variability expressed in decreasing rainfall and higher temperatures;
iii. Region III is expected to experience less vulnerable to climate change/variability as expressed in small variation in rainfall.

Additionally, Hadley Centre Coupled Model-Version 3 (HadCM3) has projected increases in temperature and changes in rainfall amounts and patterns for the region of sub-Saharan Africa and Zambia is expected to experience a 5–20% decrease in length of growing (rainy) season by the year 2050.

Studies were carried out in three sites representing the three agro-ecological regions of the country to ascertain the variations in major climate change parameters. The study revealed that in the baseline period (1994-2000), temperature trends for Sesheke, Kapiri Mposhi, and Mansa which respectively represents regions I, II and III were characterized by a tendency to increasing temperatures with corresponding warming rates of 0.34^{o}C, 0.48^{o}C and 0.26^{o}C.

On the other hand, rainfall for Mansa in the baseline period was characterised by a tendency towards decreasing rainfall and shortening of the rainy season. For Kapiri Mposhi, baseline rainfall period was characterised by general decrease with a slight recovery in 2000 and reduction in intensity of rainfall. Rainfall for Sesheke in the baseline period was characterised by a decline trend with peaks of rainfall in the recent decade and shortening of the rainy season.

Projected rainfall trends (2010-2070) exhibited for Sesheke is likely to be that of oscillation in nature around 1000mm (Figure 16).

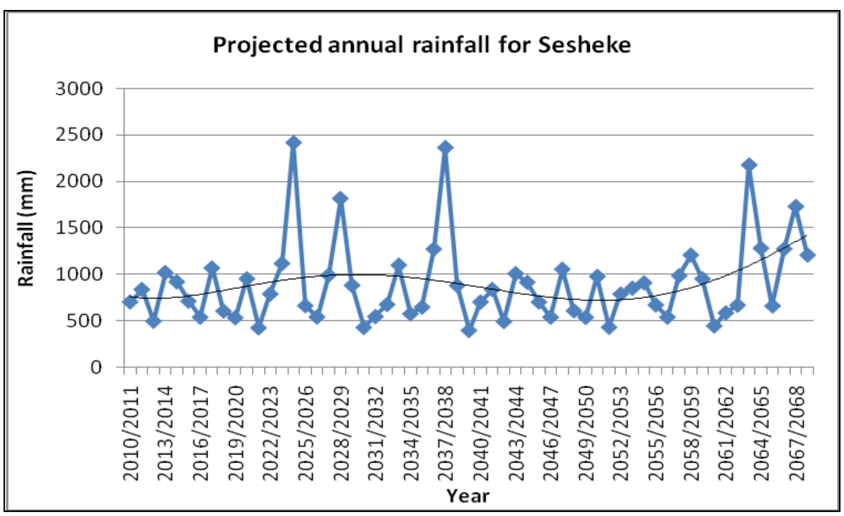


Figure 16: Future rainfall trends for Sesheke

(Source: IUCN report, 2009)

As for Kapiri Mposhi, future rainfall trend may probably be oscillatory (figure 17) with major peaks likely to occur in the seasons 2028/29, 2031/32 and 2058/59. A significant dip in precipitation may happen between the year 2033 and 2053.

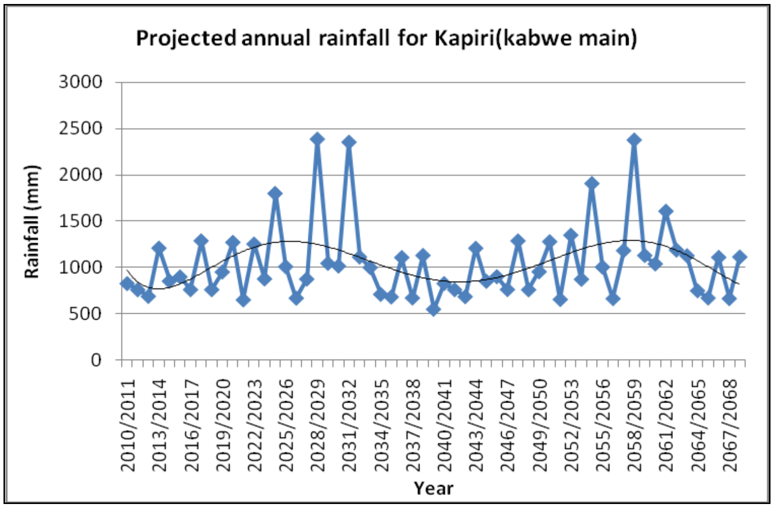


Figure 17: Future rainfall trends for Kapiri Mposhi: (Source: IUCN Report 2009)

Out of the projected 60 years, 52 seasons are likely to be near normal rainfall, 3 very wet season, and 5 extremely wet.

As for Mansa, the projected period of 2010 to 2070 extreme wet events are likely to occur in the seasons 2025/26, 2038/39, 2055/56 and 2058/59. Most of the seasons are likely to be near normal (figure 18).

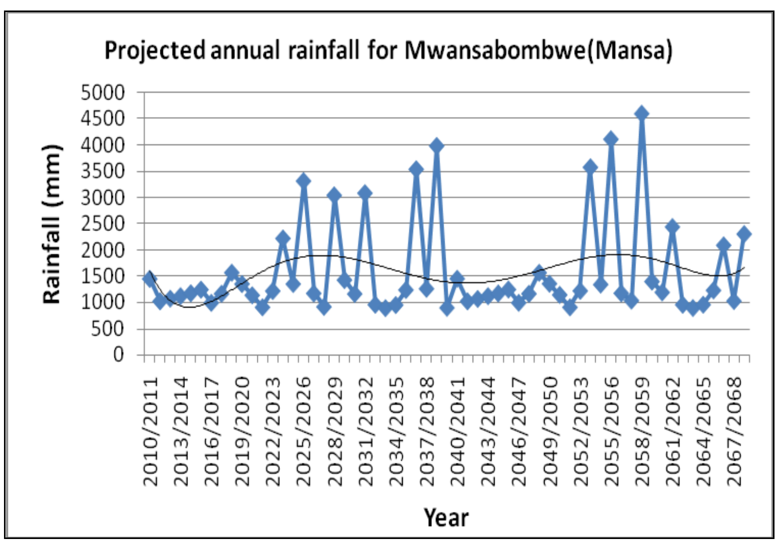


Figure 18: Projected annual rainfall for Mansa: (Source: IUCN Report 2009)

4.3.2 Vulnerability risks, hazards, assessments and development of adaptation measures

4.3.2.1 Agriculture

As part of the NAPA studies, sector vulnerability assessments were undertaken to correlate precipitation changes with agriculture production (i.e. livestock, crop production and fisheries) to help in understanding the sensitivity of these subsectors to climate change/variability for the baseline period (1994-2000). The correlations also helped in understanding the intensity of impact of climate change variabiliy on agriculture production.

Under agriculture, a correlation between precipitation and crop production was done for the following crops: maize, sorghum and sunflower for the baseline period. A similar correlation was undertaken for livestock to include cattle, sheep, goats and pigs. Under this correlation, the effect of drought on national livestock production focused on the years when the country experienced dry years between 1994 and 2000, and what effects these droughts had on the trends of livestock production. The trends of livestock production as measured in numbers generally showed an increase during wet years and a decline during dry years.

Correlation between fish catch and rainfall was undertaken for different fishing areas namely; Kafue flood plain fishery, Lukanga, Kariba, Upper Zambezi, Mweru-wa-ntipa, Itezhi Tezhi, Tanganyika, Bangweulu, Mweru-Luapula, and Lake Lushiwashi. The results showed a strong relationship between fish catches and droughts on one hand and wet years on the other. During drought period, fish catches reduced tremendously as compared to wet years.

Some of the risks/hazards identified under agriculture can be summarized as decreasing maize yield due to change in rainfall and increasing temperatures, livestock population to increase in areas to experience increased rainfall, and rangeland carrying capacity will be low owing to variation in rainfall, temperature and evaporation. Based on the risks and vulnerabilities identified above, the following adaptation measures were prioritized:

i. Adaptation of the effects of drought in the context of climate change in agro-ecological region I of Zambia
ii. Strengthening of early warning systems to improve services to preparedness and adaptation to climate change

iii. Improvement of grazing management practices such as optimizing stock numbers
iv. Improvement of management of manure to avoid build-up and release of methane
v. Research on climate change impacts on fisheries in relation to droughts and floods and promote community participation in fisheries management

4.3.2.2 Energy and water

4.3.2.2.1 Energy

One of the studies analysed the effects of various factors on hydroelectric generation potential to include precipitation, water demand and installation of proposed hydroelectric power schemes for both baseline and projected scenarios. GCM models were used to generate projected precipitation, whereas a water balance model was used to determine projected run-offs of sub basins of the Zambezi River Basin.

The results of baseline analysis (1970-2000) revealed that hydro-electric power generation was generally negatively affected by the droughts and floods. Droughts had devastating effect on the hydropower generation in Zambia with significant economic reduction in the power potential. The study further revealed the influence of rainfall fluctuations on run-off, reservoir storage capacity and hydropower potential on the Zambezi River basin. The run-offs of Kariba sub-catchment were observed to have been responsive to rainfall fluctuations (Figure 19).

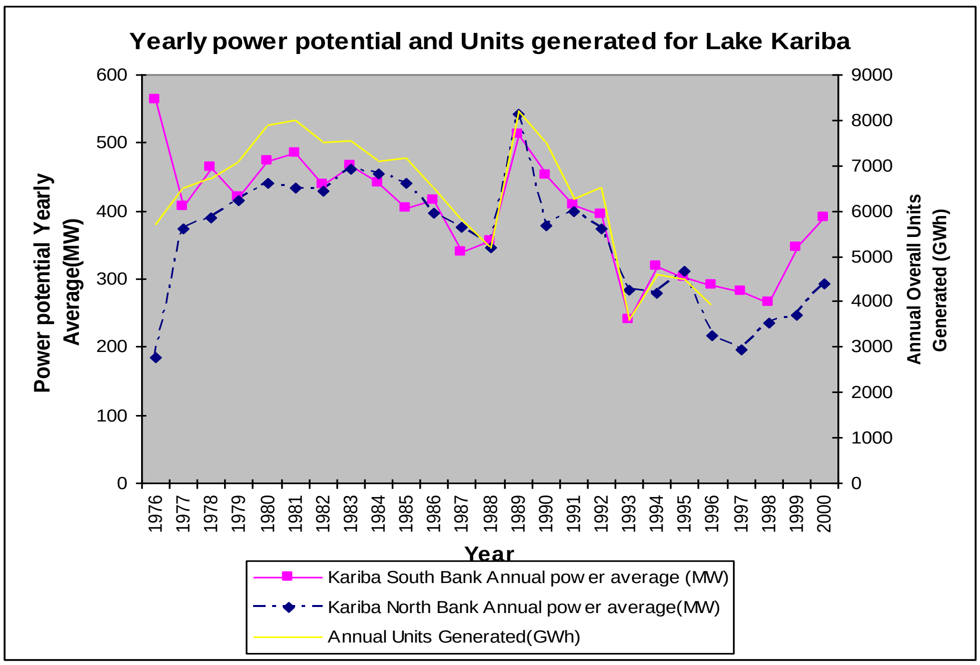


Figure 19: Yearly power potential and units generated for Lake Kariba
source: Eskom Study,2006

The study has further revealed that the main climate and other risks associated with future hydro electric power generation include projected dry years which will likely result in reduced run-off and reservoir storage. This may reduce the power generation capacity.

In case of projected wet years, flooding is likely to result in floods-threat of damage to infrastructure resulting in reduced power generation potential and projected increase in water demand (likely to reduce run-off). The projected effects of reduced rainfall will result in reduced stream flow and ground water, whereas projected increased flooding will result in risks to life, property and water quality. To mitigate against such risks, the following adaptation projects are being recommended (Table 14).

Table 144: Recommended adaptation measures under energy and water

	Adaptation measure	Sector
1	Inter-Basin Water Transfer	Energy/Water
2	Alternative Energy Resources	Energy
3	Water Management	Energy/Water
4	Early warning system	Energy/Water
5	Demand Side Management	Energy
6	Development of efficient irrigation technology	Water
7	Development of conservation agriculture and waste water recycling	Water

4.3.2.3 Natural Resources

4.3.2.3.1 Wildlife

The projected higher temperatures and variations in precipitations are likely to induce biodiversity loss and habitat degradation. In this regard, management of wildlife populations in the face of expected hazards need to be based on the management of protected area networks as opposed to managing individual protected areas in isolation. The networks will allow animal movements and flourish across the protected areas. In this regard, human settlements and development in between the protected areas need to be well managed in such a way that corridors are created between networks for free movement of wildlife. Since the protected area networks are in different geographical locations, there is also need to maintain interconnectivity between the different networks so that wildlife in one vulnerable network can find refuge in other networks.

Community participation in wildlife management and private ownership of wildlife will be critical in the future because animals will migrate to areas where there will be more vegetation especially during the period of drought. If the shift is into areas that are under protection then wildlife would be secure. However, if the shift is into land that is under private ownership and used for other purposes other than biodiversity conservation, then the potential for Human-Animal Conflicts (HAC) will increase. Therefore, there is need in future to prepare communities living in areas where animals might move into in relation to projected hazards.

In view of these concerns the following adaptation measures are recommended:

i. Identification and Creation of possible wildlife refugia and corridors under conditions of climate change
ii. Develop response plans; for water supply and flood management
iii. Promotion of alternatives sources of livelihoods to reduce vulnerability to climate change/variability to communities living around Game Management Areas (GMAs)
iv. Maintenance and provision of water infrastructure to communities to reduce human-wildlife conflict

4.3.2.3.2 Forest

The projected climate change hazards such as drought, high prolonged temperatures, shorter rainy seasons, floods and excessive rainfall are likely to affect vegetation types to include: *baikiaea* forests, munga woodlands and grasslands (across all agro-ecological regions). Under drought conditions, *baikiaea* forests are highly susceptible to fires due to thickets and huge biomass levels from the undergrowth which characterize the forest type. Damages to bigger trees can be very common as compared to other forests which survive wild fires.

Under flood conditions, munga woodlands are susceptible to nutrient loss in the soils due to increased soil erosion. Equally, high temperatures will contribute to intensive fires in the grasslands, which subsequently cross over into some forest land and scorch the regenerating trees. Additionally, droughts and high temperatures will likely decrease the amount of water transpired by plants. In view of these possible future threats the following adaptation measures are recommended:

i. Promotion of natural regeneration of indigenous forests
ii. Implementation of silviculture and cultural practices (i.e. selective cutting, thinning and observing fire management regimes)
iii. Improvement of fire management systems
iv. Promotion of soil conservation methods

4.3.2.4 Health

All regions in Zambia will be affected by a changing climate but the resulting health risks to human populations will vary from region to region depending on geographical location. For example Luapula, Northern and North-Western provinces which normally experience heavy rains and high temperatures that favour breeding of mosquitoes are more likely to be affected by severe epidemics of malaria and diarrhoea. The sensitivity of malaria cases to rainfall increased with increased rainfall in the area. Particularly notable are the reductions in malaria cases during the drought year of 2000.

Southern and parts of Lusaka province which have become more prone to drought, agricultural activities will greatly be disturbed resulting in food shortages leading to malnutrition. These areas produce a significant amount of food for Zambia. In view of these hazards on health, the following recommendations are being suggested:

i. Development of early warning systems for malaria and other diseases
ii. Capacity building for improved environmental health in rural areas
iii. Improvement and diversification of nutrition and fortified food supplementation for the under fives and other vulnerable groups
iv. Improvement of access to water for better environmental health
v. Provision of water treatment for quality control to prevent water bone diseases

4.3.2.5 Infrastructure

Infrastructure like roads, bridges, railways, drainages, water ways, schools and hospitals are likely to be vulnerable to extreme climatic events such as floods, storms and landslides. The above extreme climatic events may lead to damage to infrastructure resulting in reduced economic activities and delivery of social services.

In view of these threats to infrastructure, the following recommendations are been suggested:

i. Development of design standards and codes of practice for infrastructure (roads, bridges, dams, buildings) for use by consulting engineering houses adapted to climate change resilience aimed at reducing risks due to floods.
ii. Construction of climate resilient infrastructure using appropriate design standards and codes
iii. Rehabilitation of canals

5 OTHER INFORMATION RELEVANT TO THE CONVENTION

This chapter provides information that has been undertaken to integrate climate change considerations into relevant social, economic and environmental policies and actions in accordance with Article 4, paragraph 1 (f), of the Convention. In order to collect climate change related information on technology transfer, research and systematic observation, education, training and public awareness, capacity-building, information and networking, constraints and gaps, and related financial, technical and capacity needs, a number of institutions/organizations were consulted. The purpose of such information was to establish baseline conditions for Zambia.

The methodology employed under other information relevant to the Convention included, literature review and stakeholder consultations (interviews with relevant government ministries, multi lateral institutions, cooperating partners, private sector, among others).

5.1 Technology Transfer

This category provided assessment of status of the extent of transfer of environmentally sound technologies under mitigation and vulnerability and adaptation arrangements from developed countries to Zambia in accordance with the convention and the Kyoto Protocol.

5.1.1 Technology Transfer –Mitigation

From the African perspective, CDM was meant to allow companies in developing countries to become fully engaged in climate change initiatives and benefit from new investments and transfer of cleaner technologies. Under CDM modalities, the private sector from developed countries is expected to invest in developing countries.

However, it is noted, as part of SNC that some companies in Zambia are implicitly introducing environmentally friendly technologies in their operations, aimed at addressing carbon emissions. For example, Konkola Copper Mines (KCM) Plc has significantly reduced the consumption of coal and hence SO_2 emissions through the replacement of the Nkana IBU Reverbatory and Converter type Smelter with the new Flash Smelter at Nchanga IBU. This has increased the SO_2 capture from 65% to 98%. Secondly, KCM has replaced the Old Coal Fired Concentrate Dryers with Press Filters (Larox Filter) thereby saving 600 MT of coal consumed monthly. Thirdly, KCM has replaced the HFO Fired Boilers with electric ones resulting into coal savings amounting to 4000MT/month. Finally, KCM has embarked on a tree planting exercise within the mine area in order to increase the number of carbon sinks. For instance, 100,000 trees have been planted over the last two years which is expected to reduce the GHG emission.

At Kansanshi Mine, the major GHG produced are CO_2 from burning of diesel by extractors and haulage vehicles and sulphur (SO_2) from the acid plants. However, the SO_2 emissions into the atmosphere have significantly been reduced by the pre-heating circuit in the acid plant and the use of stack emission columns with double contact. The High Pressure Oxidation Plant comprising a pre-heating circuit additionally improves copper recovery as well as generating some of the acid required for oxide leaching.

5.1.2 Technology Transfer –Vulnerability and Adaptation

Under vulnerability and adaptation, technology transfer/cooperation is being facilitated through various activities including donor funded capacity building programmes in conservation agriculture. In addition, the Government received support and developed the NAPA to address its urgent and immediate adaptation needs. Capacity building programmes were undertaken and plans were underway to develop proposals on framework for the development of aquaculture in Zambia.

5.2 Research and Systematic Observation

This category provides assessment of status of the following:

(i) research efforts to analyze direct and indirect impacts of climate change;
(ii) socio-economic and environmental impacts;
(iii) observation relevant to climate change with focus on the atmosphere, forestry and biodiversity; and
(iv) weather forecasting research programme focusing on the consolidation of methods to evaluate whether forecasting accuracy need for development of databases that store and process climatic data and other environmental parameters.

There is limited research being undertaken at higher learning institution such as University of Zambia (UNZA) and Copperbelt University (CBU) on climate change focusing on impacts of climate change on health, climate modeling downscaling and climate vulnerability and risks assessment.

Some efforts were being initiated to undertake systematic observation aimed at addressing the issue of limited climate monitoring stations in the country. For example, Zambia at the time had 36 meteorological stations country wide. There were, however, voluntary climate monitoring stations available which were providing additional information to the Zambia Meteorological Department (ZMD) such as Samfya Farmers Training Centre.

The Systematic observation of the climate system can be carried out by the ZMD in conjunction with specialized centres. Observations can be taken at standard pre set times and places, and monitor atmosphere and terrestrial systems. The major climate variables that can be measured include temperatures, rainfall, wind speeds and tropical cyclones.

5.3 Education, Training and Public Awareness

This section provides information on activities relating to climate change education, training and public awareness. As regards education and training, a number of initiatives are taking place which includes the following:

i. school environmental policies (teaching and learning about the holistic nature of the environment but does not cover climate change);
ii. civic education at secondary school level (conservation of wetlands and the convention on combating desertification are covered);
iii. teachers' training in environmental education (in collaboration with the World Wide Fund (WWF) Zambia Education Programme (ZEP);
iv. school environmental policies (afforestation, propagating and planting trees);
v. environment clubs (opportunity for disseminating extra climate change information);
vi. Copperbelt University programme (intending to develop specific climate change related courses in the curriculum in collaboration with other institutions); and
vii. Enhanced stakeholder and community participation in climate change activities which has resulted in improved awareness.

Public awareness in Zambia is taking place through print and electronic media by Government, Civil Society Organisations, Faith Based Organisations and international organizations. Systematic environment programmes need to be instituted in the regular curriculum of learning institutions. Programmes on adverse effects of global warming in the electronic and print media will need to be undertaken.

5.4 Mainstreaming

As part of the preparation of the Sixth National Development Plan (SNDP), Government intends to mainstream climate change in relevant sectors of the economy such as energy, agriculture, tourism, water and sanitation, health and natural resources.

To achieve the set goals of economic growth, poverty reduction, human development and middle income status, the key strategies of the SNDP will be interfaced with key climate change related strategies under infrastructure, growth sectors (energy, agriculture, mining, manufacturing and tourism), and rural development. The key strategies include identifying threats related to climate change inhibiting achievement of the set goals and targets, and development of corresponding action plans. Consideration has also been made to develop strategies to take advantage of opportunities arising from mitigation of climate change through linking to carbon trading, and co-benefits to include competitiveness, poverty reduction and contribution to abatement of pollutant.

5.5 Constraints, Gaps, and Related Financial, Technical and Capacity Needs

This section provides information on national, sub-regional and/or regional capacity-building activities for integrating adaptation and mitigation to climate change into medium and long-term planning. This can be achieved through learning-by-doing programmes, participation in climate change related research, and involvement of local institution in project development and formulation.

Lack of awareness compounded by limited financial resources negatively affected the implementation of climate change initiatives in the country. Zambia should therefore take advantage of the climate related financing mechanisms to build its capacity and implement adaptation and mitigation projects.

5.6 Institutional Arrangement for Climate Change

The Ministry responsible for Environment is the UNFCCC focal point and is responsible for formulation of policies and legislations, strategies and plans on environment and natural resources. It also serves as the Designated National Authority (DNA) for CDM under the Kyoto Protocol. The DNA still needs more resources for infrastructure and capacity development to expand its mandate to include provision of CDM promotional services.

The ministry delegated the responsibility to undertake GHG inventories and preparation of the SNC to ECZ.

Government is considering establishing a long term institutional framework that will promote coordinated response to climate change. This will include establishment of a robust and permanent GHG inventory system.

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