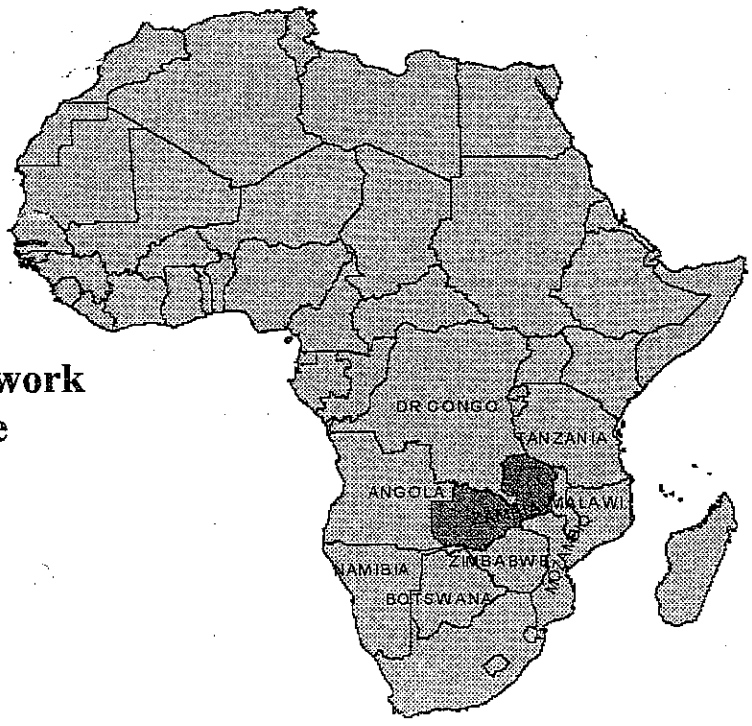
Republic of Zambia

Ministry of Tourism Environment and Natural Resources



Initial National Communication Under United Nations Framework Convention on Climate

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Environmental Council of Zambia
Corner Suez and Church Road
P.O.Box 35131
Lusaka.
ZAMBIA

Tel: 260 - 1 - 254130 / 1
Fax: 260 - 1 - 254164
E-mail: necz@zamnet.zm

FOREWORD

Zambia like many countries made a commitment at the Rio Summit of June, 1992 aimed at contributing to the global reduction of greenhouse gas (GHGs) emissions as a way of promoting sustainable development. The United Nations Framework Convention on Climate Change (UNFCCC) came into force in 1994. Zambia became a signatory to the Convention on 11 June, 1992 and ratified it in March, 1993. Since then a number of studies on climate change have been undertaken to enable Zambia meet her obligations to the Convention.

In pursuit of her commitments under the Convention, Zambia has been developing her National Programme of Action on Climate Change since February, 2000. This communication represents a summary of achievements so far taken in climate change activities. The National Programme of Action is spearheaded by the National Climate Change Steering Committee, which is chaired by the Permanent Secretary in the Ministry of Environment and Natural Resources. The National Climate Change Steering Committee is represented by government ministries and departments, the private sector, parastatal organisations, academia, research institutions and non-governmental organisations.

Although some of the analyses are still preliminary and a lot of proposed actions are still on the drawing board, this communication represents a major benchmark in Zambia's endeavour to join the international community in preventing and minimizing the impact and causes of climate change. By submitting this communication, Zambia wishes to demonstrate her unreserved will and commitment to meeting her obligations under the UNFCCC. The communication will serve as useful reference in the planning, execution and evaluation of future development programmes.

It is my honour and great pleasure to present, on behalf of the Government of the Republic of Zambia, the Initial National Communication of Zambia to the Conference of Parties to the UNFCCC. This document is a product of collective effort of development practitioners in the country.

Mr. Patrick Kalifungwa (MP)

Minister of Tourism Environment and Natural Resources.

EXECUTIVE SUMMARY

The United Nations Conference on Environment and Development (UNCED) adopted the Framework Convention on Climate Change (UNFCCC) in Rio de Janeiro in June, 1992 in recognition of the rise in global temperature attributable to concentration of greenhouse gases in the atmosphere. Zambia signed and ratified the Convention in June, 1992 and March, 1993 respectively. As party to the Convention, Zambia is obliged to comply with the Convention's provisions by conducting climate change studies designed among other things to implement mitigation and vulnerability adaptation measures for dealing with effects due to climate change in sensitive economic sectors. Henceforth, the Zambian Enabling Activities for the Preparation of the Initial National Communication have culminated into producing this consolidated and authoritative report funded by the Global Environmental Facility (GEF).

National Circumstances

Zambia achieved independence on 24th October, 1964 after 72 years of British colonial rule. The country is entirely landlocked between latitudes 8° and 18° south and longitudes 22° and 34° east with a land area of approximately 752,614 km^2. Its neighbours include Tanzania in the northeast, the Democratic Republic of Congo in the north, Malawi in the east, Mozambique in the southeast, Zimbabwe in the south, Botswana in the southwest, Namibia and Angola in the west. Besides being within the tropics, Zambia enjoys a warm-cool climate that is ideal for agriculture. It has three distinct seasons, the dry season that starts in April and ends in mid-August, the hot and dry season that falls between mid-August and early November and the wet season for the remaining months up to March the following year. Its mean annual temperature and rainfall are quoted at 21°C and 1,000 mm respectively.

Zambia is drained by five major river systems namely the mighty Zambezi, Kafue, Luapula and Chambeshi and they are the basis for Zambia's relatively high hydroelectric potential within the Southern African region. Major lakes include Tanganyika, Bangweulu, Mweru and Kariba that is man made. Vegetation wise, Zambia is well covered by open and closed forests and grasslands. The forest resources include miombo, mopane and other woodlands, evergreen and deciduous forests, some of which provide habitat to wildlife. Zambia is also home to the world famous black lechwe, which is endemic to the Bangweulu flood plain. Water mammals like hippo and crocodile including a variety of bird species also inhabit the rivers, lakes and other wetland ecosystems.

In 1994 the Zambian population was estimated at 8 million of which about 55 percent lived in rural areas. The population is projected to reach 22 million by the year 2030 that would, put pressure on the economy given that at independence the population was only 4.4 million. A mixed type economy was employed at independence but was soon replaced by a socialist oriented economy in which the State had absolute control under one-party participatory democracy. The return to plural politics in 1991 brought with it a free market economy buttressed by privatisation which in turn freed the Government to concentrate on governance matters. By early 2000, most parastatal companies had been sold including the Zambia Consolidated Copper Mines.

National Inventories of Greenhouse Gases

Zambia has so far conducted 2 inventories of GHG emissions. CEEEZ participated in the GTZ sponsored study while various consultants were involved in the US Country Studies Program (USCSP) under the guidance of the Environmental Council of Zambia. In all five source categories were considered and these are Energy, Industry, Agriculture, Land use and Forestry and Waste Management. The amount of GHG emissions were computed according to the revised Inter-governmental Panel on Climate Change (IPCC) guidelines of 1996 and where appropriate IPCC recommended emission factors for fuels were adopted. The GHGs considered in this study include carbon dioxide (CO_2), methane (CH_4),

nitrous oxide (N_2O) and precursors like oxides of nitrogen (NO_X), carbon monoxide (CO) and non-methane volatile organic compounds (NMVC). The inventory study also considered sulphur dioxide (SO_2). As for input data the Central Statistical Office (CSO) and the Department of Energy (DOE) statistical bulletins were used as source documents.

The total CO_2 emissions for the year 1994 were 72,710.05 Gg with Land-use change and Forestry being the largest emitter. Methane (CH_4) emissions were exclusively the result of savannah and on-site burning which amounted to 40 percent and 30 percent of the total respectively. Managed (plantation) forest and natural forest regeneration on the other hand provided sink for CO_2 emissions to the tune of 71,504.00 Gg. In other words as far as the figures go, Zambia (1994) was a net CO_2 emitter amounting to 1,206.05 Gg.

Mitigation Options

A study of mitigation options was designed to identify policies and programmes for reducing GHG emissions in strategic sectors of the Zambian economy. In the energy sector the supply mitigation options included the improvement of the charcoal production process, switching from use of diesel power generators to minihydros, streamlining operations of the petroleum industry and minimising spontaneous GHG emissions from coal mining. On the other hand recommendations for energy demand mitigation options included use of energy efficient cook-stoves in the household sector, increasing electrification of households in low-income groups and use of renewable energy source (e.g. solar, biogas and wind).

Mitigation measures for reducing CO_2 emissions in the manufacturing industries have focused on improving boiler operating efficiency as well as converting coal/diesel fired boilers to electric. In the mines reduction of CO_2 emissions, besides fuel switching from diesel to electricity, would be achieved through adoption of new technologies in the smelter operations (e.g. use of flash smelting furnace, ceramic concentrate filters, oxyfuel smelters etc).

In the transport sector, GHG emissions are related to consumption of gasoline and diesel. Pooling transport, running vehicles that are technically efficient and blending fuel with ethanol are examples of recommended measures for reducing GHG emissions.

In agriculture, mitigatory measures focused on reducing CO_2 emissions from chitemene cultivation etc by promoting usage of organic fertilisers, CH_4 emissions from paddy rice fields through intermittent flooding and N_2O emissions from livestock through feed supplementation.

Protection of CO_2 sinks is currently being achieved through implementation of the Environmental Support Programme (ESP) under the Ministry of Environment and Natural Resources. Under the ESP community based management of forest resources is being promoted in Luapula, Central and Copperbelt provinces. Other provinces in the country will similarly be addressed under the Zambia Forest Action Plan of 1995.

Vulnerability and Adaptation Assessment

The impact of climate change on anthropogenic activities and natural systems in Zambia was investigated in five economic sectors using IPCC guidelines. In the agriculture sector two GCMs, (CCCM and GFDL) were employed to simulate climate change scenarios at three locations representing Zambia's three agro-ecological zones. Thereafter, the DSSAT3 model was used to simulate the production of three maize varieties (MM752, MM603 and MM605), Sorghum (SIMA) and three groundnut varieties (Natal common, Makulu red and Chalimbana) under normal and irrigated conditions. The results for the 1977/78 season showed that the production of maize varieties would reduce under $2xCO_2$ climate especially in agro-ecological zones II and I. Unlike maize, sorghum production increased while for groundnuts there was no significant change. Adaptation measures consonant with the existing agriculture policy framework are already being implemented. They include development of drought-tolerant and early maturing crop varieties,

crop diversification, improvement of crop management techniques and construction of supporting infrastructure among others. The effect of climate change on livestock was assessed using a selected sample in agro-ecological Zone II. Among climatic variables considered were temperature, solar radiation, relative humidity, rainfall and day-length. However, owing to the smallness in size of the sample studied no conclusive correlation between livestock population and climatic variables was established. Adaptation measures were thus based on impacts resulting from drought and excessive rainfall situations. Some of these include restocking in badly affected areas and promoting the rearing of drought-tolerant goats. The fisheries sub-sector addressed climatic impacts on commercial fish in relation to fish production, abundance and distribution. Three fisheries namely Lake Kariba, Lake Itezhi-tezhi and Lake Mweru were considered in this study and results have shown that a decline in rainfall would affect nutrient levels thereby affecting fish's breeding activities. Conversely, excessive rainfall would result in increased fish population. Adaptation measures included strict licensing to regulate influx of fishermen to fisheries and promotion of fish farming and encouraging fish conservation.

Regarding wildlife, a study of effects of temperature, rainfall and soil moisture content was conducted in protected and ecologically sensitive areas. Under drought conditions reduced soil moisture would give rise to poor quality fodder, stress and uncontrollable migration. Under excessive rainfall wetland animals like puku and lechwe would be impacted adversely. Adaptation measures thus called for sinking of boreholes to provide water to game during drought, encouraging game ranching for conservation purposes and even resorting to curling animals if doing so would reduce competition for food.

Use of the SPSS/PC statistical program to establish correlation between climatic variables and vegetation distribution showed vegetal migration to the extent where valuable species of miombo and Baikiea would be reduced considerably. Therefore adaptation measures in the forestry sector recommended the use of alternative sources of energy to reduce pressure on miombo woodlands that are predominantly consumed as charcoal, establishing a forest resource data bank, capacity building and research. Some of these measures are being addressed under the ESP and ZFAP programmes.

In the water sector computation of balances between water demand and the water resources for the drought year with a ten-year return period indicated that some parts of Southern Province (especially agro-ecological Zone I) were extremely vulnerable. The three socio-economic scenarios used in the water sector were agriculture expansion, industrialisation and conservation growth case. Improvement of water resources management, vesting groundwater ownership in the State and strengthening of institutional framework are among the recommended adaptation measures for the water sector. The Ministry of Energy and Water Development has formulated the Water Resources Action Plan designed to reinforce the National Water Policy.

The health sector addressed impacts of climate change on malaria the top killer disease in Zambia. Correlation between rainfall, humidity and temperature and malaria incidence rates was determined to be positive in all the three agro-ecological Zones. The ongoing Health Reform Programme has a number of sub-programmes that are themselves adaptation measures for reducing malaria incidence rates. Most important is the Roll Back Malaria under the WHO sponsorship which, is based on consensus among stakeholders.

Systematic Observation and Research

The Climatology and Advisory Services Division of the Zambia Meteorological Department (ZMD) is responsible for collecting and recording climatic observations in the country. Its work is collaborated by the two Universities and private companies.

The ZMD has conducted a few climatic research studies that include "occurrences of dry spells" and "long-term study on trends of rainfall and

temperature variations in Zambia". However, a lot could be achieved if only the ZMD had the equipment and manpower it needs. More specifically there is urgent need to re-organize the Climate Data Bank and Services in order to meet user requirements.

Currently, the National Climate Change Steering Committee (NCCSC) is planning to review past climate change studies so as to identify priority areas that require detailed evaluation. A preliminary evaluation has identified the following study areas namely modelling of vegetation - climate interactions, measurement of spontaneous CO_2 emissions at Maamba Collieries Ltd., indirect effects of climate change on socio-economic sectors etc.

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Education, Training and Public Awareness

There has been improvement in the dissemination of environmental information in Zambia. Formally, pupils at primary school level are given basic instructions in environmental education while under the ESP the curriculum for Grade 8-9 pupils is being revised to cater for their needs. Moreover, the Copperbelt and University of Zambia do offer environmental science courses that include Environmental Management, Cleaner Production and Environmental Physics respectively. The electronic media continues to play its part in propagating informal environmental information through the radio and newspapers while NGOs and private companies are involved in disseminating non-formal environmental information.

Of late the Environmental Council of Zambia has conducted training workshops for Print and Electronic Media personnel and Government Planning Officers. The workshops for journalists were meant to sensitise them on climate change issues as well as giving them necessary skills to develop cost-effective public awareness programmes. As for the Government Planning Officers, their training was designed to assist them integrate findings of studies on climate change in national development plans. Notwithstanding, there is need to equip members of the National Study Teams (NST) with proper skills in order to make them more effective.

Implementation Mechanisms in Climate Change

The National Climate Change Steering Committee (NCCSC) that is chaired by the Permanent Secretary in the Ministry of Environment and Natural Resources is responsible, for among other things dealing with matters pertaining to the fulfilment of Zambia's obligation to the United Nations Framework Convention on Climate Change. The (NCCSC) is served by a Secretariat based at the Environmental Council of Zambia (ECZ) whose Director is additionally national climate change co-ordinator. Since 1994 the ECZ has spearheaded a number of climate change studies through a team of experts drawn from key institutions in Lusaka.
Although Zambia has not benefited from the existing financing mechanisms under the UNFCCC (e.g. JI, AIJ), there is scope for improvement following recent enquires by donors (e.g. the Dutch). Possible co-operation with the Dutch would be in the replacement of diesel power generators with mini-hydros in Mwinilunga in Northwestern Province of Zambia.

Zambia is also involved in the SADC Climate Technology Initiative (CTI) Needs Assessment which aims at implementing article 4.5 of the (UNFCCC). A SADC Regional Workshop on Climate Technology Investment Needs Assessment that was held in Gaborone, Botswana in September 1999
agreed on the criterion for technology selection.

ACKNOWLEDGEMENT

The National Climate Change Steering Committee (NCCSC) is highly indebted to various institutions and individuals whose participation in Climate Change have contributed to the preparation of this report as shown in pages x and xi below.

Timely advice provided by Mr. J.S. Phiri, Director of the Environmental Council of Zambia and Mr A. Mbewe, project Co-ordinator during the course of their work is gratefully acknowledged.

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CO-ORDINATORS:

National Climate Change Co-ordinator:

J S Phiri
Executive Director
Environmental Council of Zambia
Lusaka

Projector Co-ordinator:

A Mbewe
Environmental Council of Zambia
Lusaka

CONTRIBUTORS:

Initial National Communication:

Njuwe Consultants Limited
Lusaka

Inventories:

Center for Energy, Environment and Engineering of Zambia
Lusaka

Mitigation Analysis:

LHL Chandi
Transport

GB Kasali
Agriculture
Government Services
Industry
Mining

CL Mulenga
Households

Vulnerability and Adaptation Assessments:

NC Chipepo and K Mwansa
Zambian Forestry Ecosystem

B Chirwa, M Phiri and P Mulenga
Agriculture

K Mazingaliwa and JP Daka
Fisheries

B Mukanda and Kambole M
Livestock

D Nkolonganya and D Mwanza
Zambian Water Resources

CM Phiri
Wildlife

JS Phiri and D B Msiska
Health

Vulnerability and Policy Framework Assessments:

M Macwani and P Chipungu

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ABBREVIATIONS AND ACRONYMS

AIJ	Activities Implemented Jointly
CBO	Community Business Organisation
CDM	Clean Development Mechanism
CEEEZ	Centre for Energy, Environment and Engineering (Z)
CH_4	Methane
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CSO	Central Statistical Office
CTI	Climate Technology Initiative
DSSAT	Decision Support System for Agro-technology Transfer
DGIS	Directorate General of International Co-operation
DOE	Department of Energy
ECZ	Environmental Council of Zambia
ELMS	Environmental Land Management Services
ESP	Environmental Support Programme
FAO	Food and Agriculture Organisation
FINNIDA	Finish International Development Aid
GCM	General Circulation Model
GDP	Gross Domestic Product
Gg	Giga gramme
GHG	Greenhouse Gas
GMA	Game Management Area
GRZ	Government of Republic of Zambia
GTZ	German Agency for Technical Co-operation
GWP	Global Warming Potential
IPCC	Inter-Governmental Panel on Climate Change
JI	Joint Implementation
Kwh/m^2	Kilowatt-hour per square meter
NGO	Non governmental organisation
MAFF	Ministry of Agriculture, Food and Fisheries
MMD	Movement for Multi-Party Democracy
N_2O	Nitrous Oxide
NCCSC	National Climate Change Steering Committee
NCL	Njuwe Consultants Limited
NEAP	National Environmental Action Plan
NISIR	National Institute for Science and Industrial Research
NMVOC	Non-Methane Volatiles
NP	National Park
NST	National Study Team
NO_x	Oxides of Nitrogen
ROADSIP	Road Sector Investment Programme
SADC	Southern African Development Community
SEI	Swedish Environmental Institute
SO_2	Sulphur Dioxide
USCSP	United States Country Support Programme
UDI	Unilateral Declaration of Independence
UN	United Nations

UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNZA	University of Zambia
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
USCSP	United States Country Study Programme
WMO	World Meteorology Office
WRAP	Water Resources Action Plan
WRM	Water Resources Management
WWF	World Wild Fund
ZMD	Zambia Meteorological Department
ZAWA	Zambia Wildlife Authority
ZCCM	Zambia Consolidated Copper Mines
ZFAP	Zambia Forest Action Plan
ZNBC	Zambia National Broadcasting Corporation

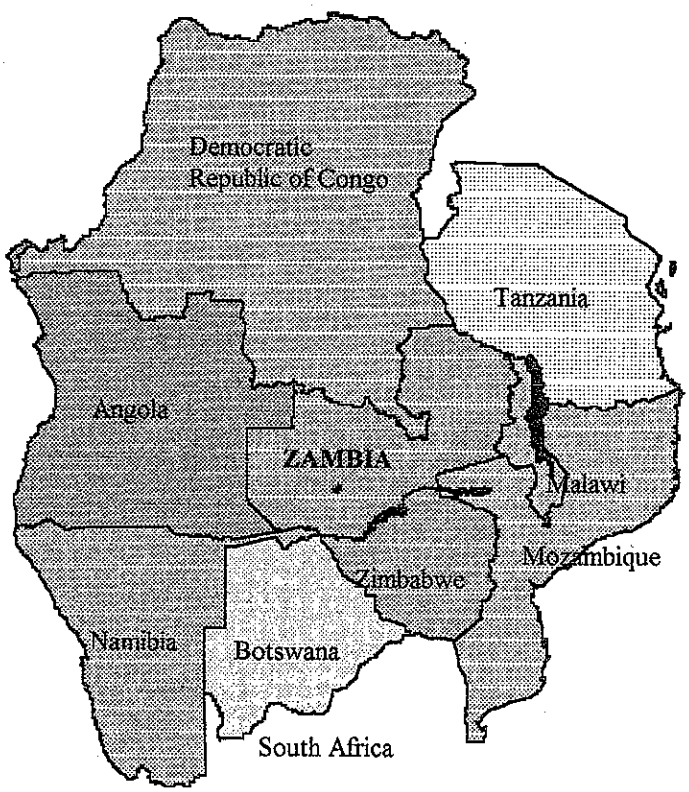
CHAPTER 1

NATIONAL CIRCUMSTANCES

Zambia became independent at midnight on 24th October, 1964 after 72 years of British colonial rule. The country covers an estimated land area amounting to 752,614 km^2 and it is surrounded by eight neighbouring states. It is multi-racial and had a population of approximately 8 Million in 1994.

Besides being located within the tropics, Zambia enjoys a warm and cool climate that is ideal for agriculture. However, copper mining remains the major economic activity in the country.

Since1991, Zambia has embraced an open market oriented economy leading to the sale of Zambia Consolidated Copper Mines (ZCCM) on 30th March 2000 under the privatisation programme.



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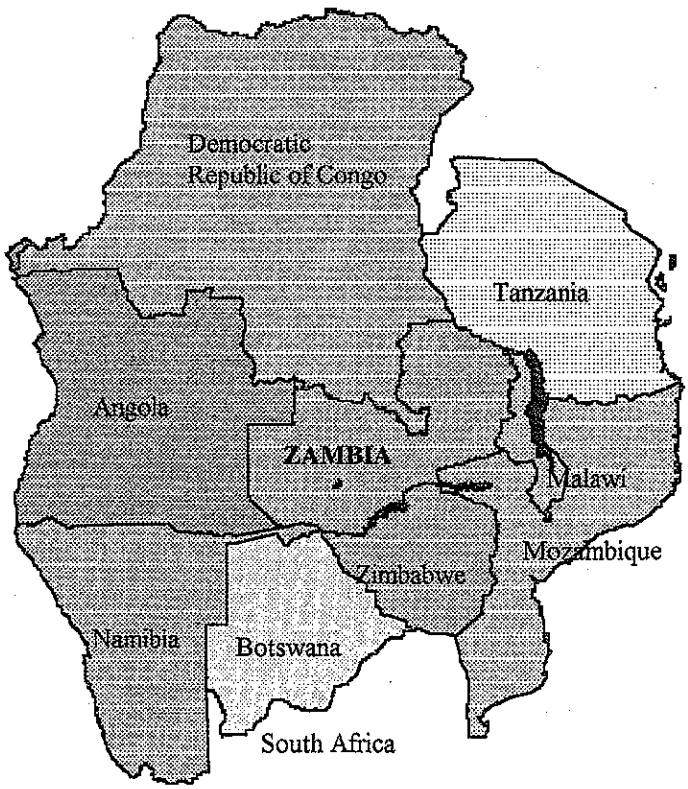


1.1 INTRODUCTION

This Chapter provides a comprehensive overview of the geography, climate, demographic parameters and socio-economic statistics for Zambia. The Chapter also focuses on institutional framework under which climate change activities are implemented thereby enabling Zambia to fulfil its obligation to the United Nations Framework Convention on Climate Change (UNFCCC).

1.2 Geography

Zambia is a landlocked 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 actually centrally located in the southern region of Africa. The country shares border with eight countries namely Angola, Botswana, Democratic Republic of Congo, Malawi, Mozambique, Namibia, Tanzania and Zimbabwe. Zambia lies on a plateau with an altitude of between 300 and 1800 metres.

The vegetation of Zambia comprises open forests, closed forests and grasslands. Forests cover an area of 446,000 km^2 or 59 percent of the country`s total land area. The open forests (savannah woodlands) account for 65.4 percent of total forest area. The closed forests and grasslands account for 5.3 percent and 29.3 percent of the forest area respectively. The forest resources of Zambia include miombo, mopane and other woodlands, evergreen and deciduous forests. In addition to natural forest, the Zambian government through the Department of Forest has established forest plantations that cover about 500 km^2 the majority of which are found in the Copperbelt Province. Predominant species among the plantation forest are *Pinus kesiya, Pinus oocarpa* and *Eucalyptus*.

The forest ecosystems also provide habitat for the country`s wildlife and their habitats outside protected areas.

Negative effects of climate change due to over - exploitative anthropogenic activities on forest resources are associated with soil erosion, loss of biodiversity, dwindling water and agricultural productivity and environmental degradation in general.

1.3 Climate

The climate in Zambia is subtropical and ranges between 9.1 - 30.1°C with an annual mean of 21°C. Zambia has three distinct seasons; the cool dry season, which starts in April and ends in mid-August, the hot and dry season, which falls between mid-August and about early November, and the wet season for the remaining months up to March the following year.

There are approximately 2,500-3,000 hours of sunshine a year providing a steady daily solar radiation amounting to about 4 kWh/m^2. The wind speeds vary across the country between 1.1-3.05 m/s (SADC, 1990).

The annual rainfall ranges from 800 mm to 1,400 mm with an average of 1,000 mm. However, there has been a reduction in rainfall and increase in temperature between 1980 and 1995 as shown in Figures 1 and 2 below.

Fig 1. Average Annual Temperature by Agro-ecological Zone

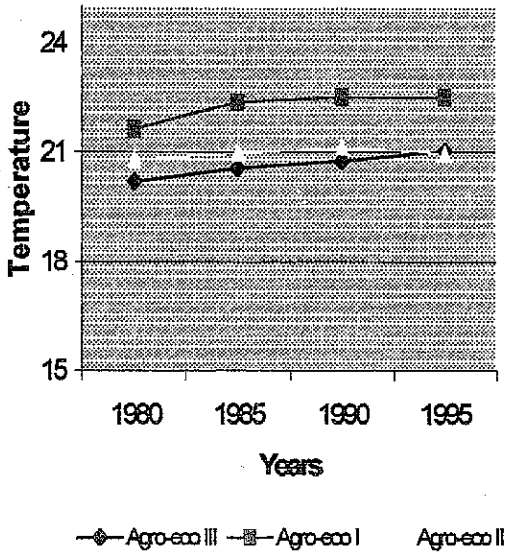
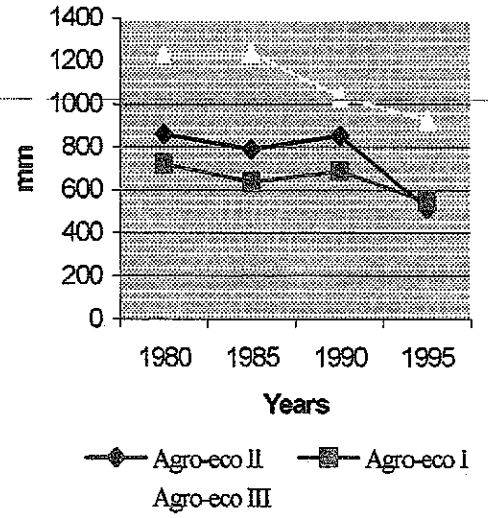


Fig 2. Average Annual Rainfall by Agro-ecological Zone



The rainfall and temperature readings plotted in Figures 1 and 2 are for Livingstone, Lusaka and Mansa which represent agro-ecological Zone I, II and III respectively.

It is evident that generally while, the average annual temperature increased by 0.85^0C the average annual rainfall decreased by as much as 250 mm from 1980 to 1995.

1.4 Population and Social Welfare

Zambia is one of the highly urbanised countries in Africa. In 1990, about 37.7 percent of the population lived in urban areas constituting 535,028 households.

The national census for Zambia was last conducted in 1990 and recorded a total population of 7,759,162. With a total land area of 752,614 km^2, Zambia's population density in 1990 was 10.3 persons per square kilometre. The population growth rate for the period 1980-1990 was 2.7 percent. In 1990 the total number of households in Zambia was 1,527,643 with an average family size of 4.8 persons per household. The family size ranged from 3.3 to 6.4 persons per household. In rural areas the average family size was 4.6 persons while in urban areas it was 5.2 persons per household. According to the Central Statistical Office of Zambia the population, urbanisation and household formation were all expected to proceed at growth rates of between 3 percent and 4 percent. These growth rates have led to increased pressure on provision of basic social services such as electricity, water, education, medical, transport, housing and so on.

The Zambian population is projected to reach 22 million by the year 2030 of which 60 percent would live in rural areas. The rural-urban migration has gone down in absolute figures (from 9,000 or 7 percent of total migration in 1996 to 8,970 or 11 percent in 1998), but has gone up as a proportion of total migration[1]. The transfer of head of household in search for employment and business opportunities has been the main causes. Mining activities on the Copperbelt have attracted people to migrate from rural to urban areas.

Zambia needs to decentralise its political authority and economic activity from the line of rail if the rural-urban migration is to be slowed down.

1.4.1 Political and Decision Making Structure

Zambia is a multi cultural, multi racial and multi religious country.

Zambia was colonised and ruled by Britain at the turn of the century but was later administered by the British South African Company. At first the territory which later evolved as Zambia was administered as two entities: Northwestern Rhodesia and Northeastern Rhodesia. However, in 1911 the two entities were amalgamated to form Northern Rhodesia with the capital located in Livingstone.

In 1923, the administration of the British South African Company was terminated and the British Colonial Office directly ruled Northern Rhodesia. In 1935, the capital of Northern Rhodesia was moved to Lusaka. Between 1953 and 1962, Northern Rhodesia was incorporated in the British Central African Federation of Rhodesia and Nyasaland comprising three countries which later became known as Malawi, Zimbambwe and Zambia.

Zambia attained self-government in 1963 and in October, 1964 became an independent sovereign country.

Zambia's post-independence political and economic developments have evolved through three transformations. These have generally been characterised as the First Republic (1964-1972); the Second Republic (1972-1990) and the Third Republic (1990-present). Each phase has its distinctive political ideology and preferred approach to managing national economy.

The Constitution of the First Republic was formulated by the British colonialists complete with the Bill of Rights and enshrined the principles of separation of powers. Political organisation was based on a multi-party system and the dominant economic philosophy was in general agreement with commitment to a mixed economy where both the private and the public sectors were to play a complimentary role.

The advent of the Second Republic saw the end of a multi-party political system. Essentially, the Second Republic was modelled along socialistic lines and the United National Independence Party (UNIP) became the supreme and only political organisation in the country. In the economy, the state assumed the leading role through establishment of parastatal companies and centralised planning became the main method of managing the country's economic affairs. Owing to the predominant role of the state in the economic and political life of the nation, the President became the only person who could make all major appointments as well as all the major economic decisions in the country.

The Third Republic heralded the return to a multiparty system of government and a market oriented economy. During this period, privatisation and liberal economic policies replaced notions and practices of centralized planning and state participation.

Zambia's multi-party democratic system of governance is based on the doctrine of separation of powers. In this system, there are three organs of the state, which are autonomous but act as a check on each other.

[1] CSO 1996 & 1998 Living Conditions Survey

These are the Executive, the Legislature and the Judiciary.

The head of government and the Executive is the President. The President is elected for a term of five years. The present Constitution does not allow a President to serve more that two terms of five years each. Ministers and senior government officials assist the President in running the government. The President from among Members of Parliament appoints the ministers. The Legislature is composed of the National Assembly with a total membership of 150 Members of Parliament. Out of this number 140 are elected by their constituencies while the President has powers to nominate 10 members. The major functions of the National Assembly are:

- to enact laws
- approve and supervise public expenditure
- scruitinize government policy and activities through various Parliamentary Committees

The Judiciary is responsible for interpretation of the law and administration of justice through the courts of law.

The Zambian legal system is modelled on the English legal system.

Zambia is administratively divided into nine provinces. Each province has its own administrative headquarters, which is headed by a Deputy Minister.

All provincial headquarters are linked to Lusaka, the seat of government by roads. The provinces are further sub-divided into districts.

1.4.2 **Education**

The education system in Zambia comprises pre-primary, primary, secondary and tertiary levels. Tertiary education includes teacher training, technical and vocational training and university education. In 1994, Government formulated a National Education Policy whose overall objective was to restructure and reorganise the entire education system in the next six years.

The budgetary allocation to the education sector in 1994 was increased to 15 percent from 13 percent in 1993 in order to improve access as well as providing quality education. In an effort to provide Universal Primary Education by the year 2005, more resources were allocated to the provision of basic education through the establishment of an Integrated Basic Education Sub-sector Investment Programme. This programme is financed through a combination of resources from GRZ, IDA, ADB, OPEC, EU and bilateral agencies.

1.4.3 **Health**

Zambia's national health strategy is aimed at providing equity of access to cost-effective quality health care as close to the family as possible. Government's 1994 expenditure to improve primary health care increased to 13 percent of total budgetary allocation from 8 percent in 1993. However, in 1994, the country experienced outbreaks of epidemics such as Malaria, Meningitis, HIV/AIDS and Tuberculosis. The rise in malaria cases by 60 percent between 1989 and 1994 was attributed to a growing chloroquine resistance, resource constraints and ineffective malaria control programmes. The collapse of the residual insecticide spraying programmes in urban areas in the late 1970s has also raised malaria cases to above 60 percent.

In 1999, the Government continued to implement the Health Sector Reform Programme in order to realise the twin objectives of equity and efficiency in health care delivery.

1.4.4 Employment

Employment in Zambia is desegregated into two major categories namely formal and informal sector employment. Formal employment agencies include central government, local authorities, and parastatal companies while informal sector employment comprises the bulk of private enterprises and other services (MOF, 1999).

Total employment increased by 3.0 percent from 4,033,417 in 1998 to 4,156,169 in 1999. Much of this increase was accounted for by informal sector employment activities, which registered an increase of 3.2 percent over 1998. Informal agricultural employment registered an increase of 5.2 percent for the year 1999 while informal non-agricultural employment registered a decline of 4.2 percent.

Formal sector employment increased by 2.2 percent from 467,193 in 1998 to 477,508 in 1999. Much of this increase is attributed to expansion in the trade and distribution services and agriculture sectors.

In 1999, private sector employment increased at a growth rate of 6.7 percent over 1998. Private sector companies accounted for 60.0 percent of total formal employment (Table 1.1).

1.5 Overview of the Zambian Economy

Zambia's macro economic policy objectives for the period 2000 - 2030 are an extension of the existing ones that stress the need for economic stability and poverty reduction. Broadly, the above referred to objectives will be realised through the following anticipated actions:

- Shifting from copper mining to agriculture
- Processing of finished products instead of producing basic goods for export and
- Increased investment into tourism.

Table 1.1 Employment Trends, June 1996-1999

	1996	1997	1998	1999	% Change 1999/1998
Employment Type	**3,468,000**	**3,739,823**	**4,033,417**	**4,156,169**	**3.0**
Formal Sector Employment	479,400	475,161	467,193	477,508	2.2
Informal Sector Employment	2,988,600	3,264,662	3,566,224	3,678,661	3.2
Informal Agricultural Employment	2,318,600	2,579,407	2,807,174	2,951,671	5.2
Informal non-agric. Employment	670,000	685,256	759,050	726,990	(4.2)
Formal Employment by Industry	**479,400**	**475,161**	**467,193**	**477,508**	**2.2**
Agriculture, Food and Fisheries	68,300	58,898	58,898	60,000	1.9
Mining and Quarrying	47,700	44,498	39,160	38,521	(1.6)
Manufacturing	47,400	47,118	46,685	46,000	(1.5)
Electricity, Gas and Water	4,400	5,009	5,237	5,300	1.2
Construction	13,100	17,106	13,459	12,895	(4.2)
Trade and Distribution	46,800	48,893	48,964	51,097	4.4
Transport and Communication	38,300	45,963	45,840	45,000	(1.8)
Fin. Real Estate and Bus. Services	37,600	37,862	35,276	34,682	(1.7)
Comm. Social and Personal Services	175,800	169,814	173,674	184,013	6.0
Formal Employment by Agency	**479,300**	**475,100**	**467,193**	**477,508**	**2.2**
Central Government	132,000	129,200	117,250	112,345	(4.2)
Local Authorities	17,300	15,000	13,048	12,900	(1.1)
Parastatal Companies	115,200	73,900	68,046	65,300	(4.0)
Private Sector Companies	214,800	256,900	268,849	286,963	6.7
Size of Labour Force	**3,982,000**	**4,411,263**	**4,579,000**	**4,635,000**	**1.22**
Total unemployment rate	**12.9**	**15.2**	**11.9**	**10.3**	

Source: Quarterly Employment and Earnings Inquiry, Central Statistical Office

However, the above economic transformation will experience the following hurdles:

- Financial constraints that are mainly due to limited access to financial credit facilities, weak and low levels of foreign direct investment (FDI) emanating partly from lack of effective marketing strategy for Zambia to the outside world in comparison to other neighbouring countries, high interest rates on local finance at almost 50 percent which apparently have been going down slowly following the fall in Treasury Bills yield rates on the short-term tender of 28-days.

- Trade constraints as a result of instability in neighbouring countries (e.g. DR of Congo, Angola, Burundi, etc), has constrained growth of Zambia's export market in these countries. Further, unfair competition in form of dumping of goods or export subsidisation by neighbouring countries has had adverse effects on the Zambian economy. When COMESA and SADC trade protocols come aboard, the Zambia Bureau of Standards (ZABS) will not be able to protect local industry because it does not have the capacity to monitor the standards and origins of imported goods as per requirements of these protocols especially that ZABS' standards are voluntary which puts the Zambian manufacturing at a disadvantage in their own market.

- Although the road infrastructure has significantly been improved it is however limited to the line of rail, residential areas and highways. Lack of a consistent plan for maintenance of

road infrastructure has constrained the communication network in terms of bad condition of roads and road network causing excess maintenance cost on vehicles. Roads and communications infrastructures in commercial and industrial areas need to be improved.

- Enterprise constraints in terms of low capacity utilisation due to limited markets and reduced earnings and purchasing power by local populace: inability to compete with imported items and limited access to technical information of modern products, processes, and machinery appropriate to the existing scale of production.

- There has been very little preparation of local community and industry in understanding how environmental issues are going to affect their way of living in the near future. In the case of business, these issues are going to be used as non-tariff barriers to hinder entry into the export market.

Zambia belongs to the group of African developing countries, which depend on a narrow range of primary commodities for export and have weak financial and infrastructure base. A high population growth rate of 3.7 percent weakens prospects further.

Zambia's economy has benefited primarily from the government's open market macro economic policies of 1992 and the creation of financial support mechanisms. In this regard, the Zambian economy is being transformed from one, which is highly regulated to one, which is diversified and essentially driven by market forces. However there is no coherent long-term economic plan. Zambia under its continued commitment to reform the economy has moved from the three-year programmes under the Bretton Woods Institutions of the World Bank and IMF such as the Structural Adjustment Programme (SAP), Enhanced Structural Adjustment Facility (ESAF), and now the Poverty Reduction and Growth Facility (PRGF). Under the latter the Poverty Reduction Strategy Paper (PRSP) will replace the Policy Framework Paper (PFP) under ESAF as precondition to accessing the debt relief under the Highly Indebted Poor Countries (HIPC) initiative.

Notwithstanding, there are a number of policy changes that have been effected to ensure that privatisation and liberalisation are beneficial to the business community and consumers at large. Thus the Zambia Privatisation Agency (ZPA) has been privatising the State owned enterprises while the Zambia Investment Centre (ZIC) has been promoting investment in Zambia. Amendments to the Bank of Zambia Act (1994) are made to ensure that financial services market is stable. The Securities and Exchange Commission (SEC) has been established to ensure that the capital and securities market are developed and function properly. The Energy Regulation Board (ERB) has been established to regulate activities in the energy sector whose pricing, environmental and safety standards could be improved. The Zambia Competition Commission (ZCC) ensures that the Zambian market is indeed competitive and no one enterprise can yield monopoly power to the disadvantage of consumers and other business players.

Furthermore, Zambia will continue to enter into bilateral or multilateral trade and development agreements such as COMESA, SADC trade protocol or ACP-EU successor agreement to Lome IV, etc.

Table 1.2 Some Macro-economic Statistics on Zambia

	1995	1996	1997	1998	1999	2000*
Total Dom. Revenue (K' Mn)	595,860	824,596	1,028,435	1,127,920	1,460,000	1,828,000
Total Dom. Expenditure (K' Mn)	579,4711	729,661	893,354	1,019,472	1,353,000	1,945,000
Overall Dom. Balance (K' Mn)	**3,885**	**53,399.0**	**80,285.0**	**(14,536.0)**	**107,000**	**(117,000)**
Exports (US$ Mn)		1,001.72	1,275.13	858.0	753.0	
Imports (US$ Mn)		(1,056.3)	(1,218.0)	(1,022)	(939.0)	
Trade Balance (US$ Mn)		(54.58)	57.13	(164)	(186)	
Exchange Rate (ZK: 1 US$)		1,213.6	1,321.3	1,862.15	2,385.84	3,022.00
Inflation rate		35.2	18.6	30.6	20.6	23.8
Real GDP Growth Rates (percent)	-2.49	6.59	3.3	-1.88	2.44	4
Real GDP at Market Prices (K 'Bn)	2,184.8	2,328.8	2,405.6	2,360.4	2,418.0	
O/W Total Gross Value Added	*1,923.2*	*2,052.5*	*2,119.2*	*2,089.6*	*2,166.4*	
Taxes on Products	*261.6*	*276.3*	*286.4*	*270.8*	*251.7*	

Source: Ministry of Finance & economic development
* Exchange and inflation rates are those as of end of June 2000, the rest being period averages.

For the most part of the second half of the 1990s, the Zambian Government has been attaining a budget surplus, except in 1998 when a deficit of K14.536 billion was declared. For the 2000 budget the Government has planned for a deficit of K117 billion from planned domestic revenue of K1,828 billion and K1,945 billion as expenditure. Zambian Government expenditure is undertaken on cash budget, that is, if there is no money raised by Government then it will not spend any (Table 1.2 above).

1.5.1 Gross Domestic Product (GDP)

The Gross Domestic Product has only grown at an average of 3.3 percent per annum during the 1990s. The performance of the Zambian economy has been fluctuating from a low of -2.49 percent (1995) to 6.59 percent the next year. In 1999 the economy grew by 2.44 percent, and during 2000 the economy is forecast to grow by 4 percent. While the Gross Value Added ranged from K1,923.2 billion in 1995 and K2,166.4 billion in 1999 the taxes on the products were between K261.6 billion and K252 billion over the same period. A summary of GDP by sector is shown in Table 1.3 below.

The composition of the Zambian Gross Domestic Product is grouped into three major categories as follows:

❒ **Primary Sector**
- Agriculture, forestry and fishing
- Mining and quarrying

❒ **Secondary Sector**
- Manufacturing
- Electricity and Water

❒ **Tertiary Sector**
- Trade, hotels and restaurants
- Transport and communication
- Financial institutions, real estates and business services
- Community and Social Services

The major contributor to the GDP is the mining sector; wholesale and retail trade; agriculture, and manufacturing. The financial sector and community, social and personal services also contribute significantly to the GDP of Zambia.

The sectional GDP contributions in 1994 were subject to economic estimates that indicated a decline of 6.6 percent in real Gross Domestic Product. This was mainly due to the weak performance of the three major sectors of the economy namely agriculture, mining and manufacturing which resulted from partial drought spells

Table 1.3 Gross Domestic Production by Sector of Origin, K'Billion

Kind of Economic Activity	1994	1995	1996	1997	1998	1999*
Agriculture, Forestry and Fishing	302.2	403.0	400.4	379.9	386.7	439.6
Agriculture	109.0	204.9	203.2	189.7	191.4	239.0
Forestry	106.5	110.7	115.1	119.8	124.5	129.5
Fishing	86.7	87.3	82.1	70.4	70.7	71.0
Mining and quarrying	373.9	270.9	278.5	284.5	213.0	160.2
Metal Mining	369.0	266.3	274.0	279.8	208.5	155.7
Other mining and quarrying	4.9	4.6	4.5	4.7	4.6	4.5
Manufacturing	219.8	219.0	231.1	242.8	247.2	254.2
Food, Beverages and Tobacco	134.6	140.8	144.3	138.6	146.0	154.8
Textile and leather industries	24.9	22.0	27.1	39.1	42.4	44.8
Wood and wood products	20.4	18.6	18.1	19.6	19.2	19.3
Paper and paper products	5.7	4.5	4.8	7.2	7.3	7.6
Chemicals, Rubber and Plastic products	18.1	16.2	20.6	22.5	18.7	15.5
Non-metallic mineral products	4.1	4.4	4.7	4.1	4.5	4.4
Basic metal products	1.8	1.8	3.1	3.3	1.3	1.3
Fabricated metal products	9.7	10.1	7.9	8.0	7.3	5.9
Other Manufacturing n.e.c	0.6	0.6	0.5	0.5	0.5	0.6
Electricity, Gas and Water	72.2	71.1	67.1	69.9	67.9	70.0
Construction	111.5	107.8	95.9	123.7	111.2	123.7
Wholesale and Retail trade	332.1	297.0	395.2	412.9	428.5	470.3
Restaurants, Bars and Hotels	36.1	38.0	41.2	44.1	45.8	45.0
Transport, Storage and Communications	133.8	125.0	134.5	134.2	145.7	149.7
Rail Transport	13.7	13.2	13.1	10.0	11.4	10.0
Road Transport	52.1	49.3	57.6	59.5	67.7	71.1
Other Transport and Allied Services	20.2	19.2	21.8	23.1	24.6	26.2
Communications	47.8	43.3	42.0	41.6	42.0	42.5
Financial Intermediaries and Insurance	182.8	218.1	200.1	200.7	201.6	221.7
Real Estate and Business Services	113.0	122.2	141.2	158.9	179.1	183.6
Community, Social and Personal Services	178.7	176.6	182.4	183.1	178.8	175.8
Public Admin. & Defence; Public & Sanitary Services	103.0	102.3	104.2	104.3	101.4	99.2
Education	47.3	46.9	47.8	47.9	46.5	45.2
Health	11.9	11.8	12.0	12.0	11.7	11.3
Recreation, Religious, Culture	7.5	7.4	7.6	7.6	7.4	7.1
Personal Services	9.1	8.2	10.9	11.4	11.8	12.9
Less:FISIM	(105.0)	(125.3)	(115.0)	(115.4)	(115.8)	(127.4)
TOTAL GROSS VALUE ADDED	1,951.1	1,923.2	2,052.5	2,119.2	2,089.6	2,166.4
Taxes on Products	289.6	261.6	276.3	286.4	270.8	251.7
TOTAL G.D.P AT MARKET PRICES	2,240.7	2,184.8	2,328.8	2,405.6	2,360.4	2,418.0
Real growth rates		-2.49	6.59	3.30	-1.88	2.44
Real GDP per capita (1994 prices)	255,785	239,824	246,431	245,974	233,702	231,825

Source: Central Statistical Office
***Preliminary; based on partially available data, likely to undergo revision.**

during the 1994/3 season on the one hand, reduced production levels and obsolete infrastructure on the other.

As the economy grows it is expected that there will be a shift from mining to agriculture and other sectors in the services industry. This means the mining sector's contribution to GDP is bound to decline. Manufacturing will also take on a significant share of the GDP with industry concentrating on processing of finished products instead of producing basic goods for export. Tourism is a sector that is expected to receive a lot of focus from now onwards. This is because the growth potential in this sector is enormous. The other sectors are bound to grow and increase their contribution to the GDP.

1.5.1.1 Agriculture

The Agriculture Sector is important for maintenance of household and national food security as well as providing raw materials for the manufacturing industry. About 50 percent of the Zambian population depend directly on agriculture for their livelihood. This is highlighted by the fact that the agriculture sector employs 67 percent of the formal labour force. The major crops grown in Zambia are maize, millet, sorghum, cassava, groundnuts, soya beans, mixed beans, sunflower, paddy rice, wheat, tea, coffee, seed cotton, burley tobacco, virginia tobacco and sugar cane. Maize is the staple food crop.

Currently, crop producing barely meets national demand and the country therefore imports maize, wheat and others. This is because the agricultural sector only utilises about 20 percent of the country's potential arable land and most of the producers are small-scale farmers. Climate change therefore renders the sector vulnerable and further threatens the country's food security. In 1996, the livestock sub-sector's contribution to GDP was estimated at 6.4 percent while in 1997 it rose slightly to 6.5 percent which accounts for about 35 percent of the total agricultural production (Daka, 1999). Given that about 23 percent of the per capita supply of protein in Zambia come from animal products the livestock sector has potential and capacity in contributing towards poverty alleviation and the overall economic growth of the country.

The fishery sub-sector on the other hand contributed an average of 21 percent to the agriculture sector, which translates into 0.03 percent average contribution to GDP between 1994-1999. Commercial fish production in 1999 increased by 9 percent from the previous year's records. (MOF, 1999). The fishery sub-sector contributes about 55 percent of the country's total protein requirement (ASIP, 1994). About 300,000 people are directly or indirectly employed by the sector.

Fish production in Zambia is mainly from natural freshwaters that include small streams, lagoons, swamps, dams lakes and rivers. Production also takes place through aquacultural systems from both private fish farms and government fish culture centres. Zambia's natural water bodies cover about 45,000 km^2 making up 6 percent of the total land area.

The agriculture sector is poised to grow once ASIP II is implemented for the policy will enable small–scale farmers to access finance through the revolving fund and Rural Investment Fund (RIF). There is also good sign in favour of agricultural expansion both in traditional and non-traditional crops. The Zambian Export growers Association (ZEGA) is destined to increase its export of flowers to the European Union in particular. These existing economic policies have also had the effect of luring South African farmers and others to buy farms and settle in the Mkushi farming block. However, growth of the non-traditional export from agricultural sector will depend on how the export markets, especially the EU, are going to behave under the World Trade Organisation (WTO) since there is pressure to conform to its principles of

reciprocity and non-discrimination of countries.

1.5.1.2 **Tourism**

Zambia has some of the finest tourist attractions in Africa that include wildlife and the world famous Victoria Falls.

The country has 19 National Parks and 34 GMAs covering about 6 percent and 22 percent of the country respectively. In addition, there are 31 game ranches stocked with 26 species of wildlife and 7 crocodile farms scattered across the country.

However, poaching, land-use pressure, bush fires and destruction of natural habitats continue to pose danger to the wildlife and natural habitats in the country.

In order to strengthen wildlife conservation and management, the Government transformed the National Parks and Wildlife Service Department into an autonomous entity, the Zambia Wildlife Authority (ZAWA). The ZAWA is expected to bring prudent business by way of managing Zambia's wildlife in an environment friendly manner. ZAWA therefore will complement efforts of the Zambia National Tourist Board (ZNTB) in ensuring that the tourism sector realises its potential.

Moreover, the tourism industry is poised for a great transformation following the construction of the Sun International Hotel at Victoria falls at an investment outlay of US$55.8 million up to the year 2002. Indeed, the industry has witnessed a 30 percent annual increment in the number of tourists visiting the country since privatisation in 1991. This translated into revenue receipts amounted to US$85.2 million during the 1999 season.

1.5.1.3 **Mining**

Mining constitutes the greatest part of the Zambian economy and will continue to play a vital role in the economic development of the country.

It accounts for almost 90 percent of export earnings and has had significant contribution to the country's gross domestic product over the years. Copper and cobalt mining are the major activities in this sector while coal and gemstone-mining activities have great potential but have yet to be fully realised through national development programmes.
The Zambia Consolidated Copper Mining (ZCCM) has been the sole copper mining company in the country since 1982. Before then, the Anglo American Corporation and Rhodesian Selection Trust were major investors in the Zambian mining industry.

The highest copper production peak of 700,000 tonnes was reached in 1977. Since then production has steadily declined to 380,000 tonnes in 1991, 360,500 tonnes in 1994 and 260,296 tonnes in 1999. The decline in production is attributed to low retention of earnings, inadequate reinvestment in equipment and growing expenditure in non-mining activities.

Through the market-oriented economic policy adopted by Government the final phase in the return of the mining industry to the private sector was completed on 31st March 2000 when the remaining assets of the Zambia Consolidated Copper Mines were sold to the Zambia Copper Investments. The new owners of the mining conglomerate are poised to recapitalise the ageing copper mines with prospects for improved production and hence foreign exchange earnings. Zambia is currently witnessing heightened exploration activities both in small and big mining in Northwestern Province and Konkola North near Chingola. Development of small-scale mining will be of priority since this is the area where indigenous capital can participate effectively.

There is potential for growth in the mineral processing industry (jewellery, cutting and polishing of stones) since small-scale mining sub-sector is dominated by mining of gemstones and semi-precious metals.

1.5.1.4 **Manufacturing**

The structure of the manufacturing sector has been influenced by past policies of import substitution, protection and heavy public sector involvement. The composition of the manufacturing sector includes food, beverages and tobacco, fabricated metal products and equipment, textiles and leather, chemicals and petroleum products, rubber and plastics, paper and paper products, wood and wood products, non metallic mineral products and basic metal products. The sector's contribution to the total GDP over the last five years has been in the range of 9-11 percent annualy.

Inhibiting factors such as high production costs has slowed the performance and growth of the manufacturing sector. These factors are due to high utility costs of electricity, petroleum products, water and transport; declining demand to and from ZCCM, insufficient long-term development finance and the continuing civil conflicts in the DR Congo and Great Lakes Region.

The provision of long-term finance to the manufacturing sector is expected to improve when the Enterprise Development Fund to be administered by the Central Bank is fully operational. Furthermore, government will facilitate the setting up of industrial estates and export processing zones to enhance export performance and create job opportunities.

The investment pledges for the manufacturing sector from 1993 to the end of February 2000 have amounted to US$602 million with potential employment propects as shown in Table 1.4.

Expressed as a percentage of the total investment pledges, the manufacturing industry attracted more than 35 percent and this explains why it is regarded as a growth sector.

Table 1.4: Investment Statistics in the Manufacturing Industries (1994-2000)

	Pledged Investment US$ (Million)	Employment Prospects	Estimated actual Investment US$ (Million)
Agro-Processing	12.0	146	7.4
Food, Beverage and Tobacco	178.9	1,770	110.9
Textiles, Leather and Clothing	76.8	1,516	47.6
Chemicals, Pharmaceuticals	44.1	561	27.4
Pulp and Paper products	4.5	125	2.8
Wood and wood Products	51.7	1,325	32.0
Non-Metallic Mineral Products	4.0	-	2.5
Base Metals	29.8	70	18.5
Fabricated Metal Products	9.1	370	5.7
Other Products	60.8	571	37.7

Source: Ministry of Commerce (2000)

1.5.1.5. **Transport and Communications**

The Zambian transport network comprises five distinct modes of transport, which are rail, road, inland water transport and also pipeline transport for crude petroleum oil.

The annual contribution of the transport sector to the overall GDP over the second half of the 1990s is quoted at 6 percent.

Rail

Historically, the railways have played a dominant role in the nation's economic development being the major transporter of copper, which is the country's main foreign exchange earner. The railways are also used for transporting passengers and haulage of other goods.

Zambia has two rail networks; Zambia Railways and the Tanzania Zambia Railways (TAZARA). The Zambia Railways network runs from Southern to the northern part of the country. It is a state owned company and is currently under a management contract in collaboration with the Swedish Government. The Zambian and Tanzanian Governments jointly own the TAZARA Railway line which runs from Kapiri Mposhi in the Central province of Zambia through Northern province to Dar-es-Salaam in Tanzania. This sub-sector has not performed well for many years due to poor infrastructure and equipment. However, the on-going track rehabilitation project should improve operations which Government hopes will attract private investment.

Road Transport

Road transport in Zambia is undertaken primarily by private operators with limited government participation. Most of the traffic is public transport, which in the local context means passenger and freight transportation on a commercial basis. The road network, therefore, is a major player in both passenger and cargo transportation

A significant increase in output was registered by the road sub-sector in 1999 owing to the continued implementation of the Road Sector Investment Programme (ROADSIP).

Air transport

Air transport is used for external traffic, linking Zambia with other countries regionally and internationally and for speedy travel to connect to remote areas especially tourist resorts within the country where road access is difficult and time consuming. There is also the business dimension of exporting non-traditional exports as mentioned in section 1.5.1.1 above.

Inland Water Transport

The inland water system provides the only form of transport to those areas such as islands, which are not accessible by road. The sub-sector is currently experiencing operational problems due to old age of vessels etc.

Pipeline Transport

This is used to transport petroleum products from Dar-es-Salaam in Tanzania to Ndola in Zambia a distance of 1704 km. The pipeline currently experiences technical losses but this is being addressed through the Petroleum Rehabilitation Project.

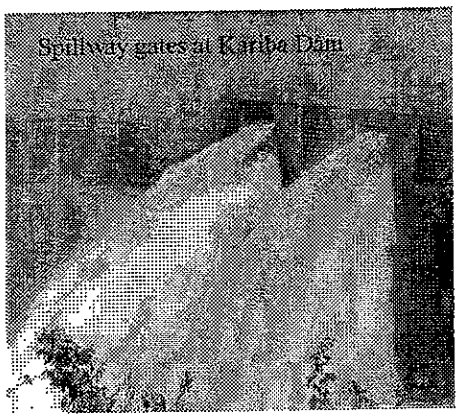
The government's policy is to improve operating efficiency and performance of the sub-sector to satisfy consumers' needs.

1.5.1.6 **Energy and Water**

Zambia is drained by five major river basins. The main rivers are the Zambezi, Kafue, Luangwa, Luapula and Chambeshi. Major lakes include Tanganyika, Bangweulu, Mweru and Kariba, which is a man-made lake. Zambia's water supply potential comprises therefore surface

water resources in form of rivers and other wetland ecosystems and groundwater resources in form of aquifers distributed across the country.

These river basins are the basis for Zambia's relatively high hydroelectric potential within the Southern African region. According to the National Water Resources Master Plan Report prepared by JICA in 1995, surface and groundwater potentials calculated for an average year are estimated at 237 million m^3/day and 157 million m^3/day respectively.


Spillway gates at Kariba Dam

However, areas within agro-ecological Zone I do experience water shortages during drought conditions. Similarly, a high water Table in areas like Lusaka for instance makes them extremely vulnerable to excessive rainfall as was the case in 1978.

Zambia is largely self sufficient in her energy needs except for petroleum which is imported. The total primary energy supply of the country consists of woodfuel accounting for about 72 percent, petroleum 12 percent, electricity 12 percent and coal 4 percent. The Energy and Water sector's annual GDP contribution over the last five years is quoted at about 3 percent.

Woodfuel in the form of firewood and charcoal is the principal source of energy in Zambia. The household sector is the largest consumer of woodfuel accounting for about 88 percent.

Electricity is the second most important indigenous energy source after woodfuel and it is consumed largely by ZCCM mines.

Despite being self sufficient in hydropower generation, only 20 percent of the population have access to electricity for reasons ranging from high installation costs and the fact that most areas are located far from the national grid system.

Petroleum accounts for about 12 percent on average of national energy requirements. Its consumption is dominated by the transport sector, which accounts for more than 50 percent. The second largest consumer is the mining industry accounting for 25 percent while other sectors consume the rest.

Coal accounts for about 5 percent on average of the total energy consumption. The mining industry is the largest consumer of coal accounting for about 50 percent. Manufacturing and industry are some of the bulk consumers of coal. Some of the coal is exported to the Democratic Republic of Congo and Tanzania.

Renewable energy resources remain largely untapped. However, Government has introduced an energy policy that is aimed among other things to promote the use of renewable energy resources through private sector participation. The dissolution of the National Energy Council in 1996 gave rise to the establishment of the Energy Regulatory Board under the Electricity Act in 1995. This Act has done away with the monopoly of the Zambia Electricity Supply Corporation and opened the electricity industry to other participants.

1.5.2 Overall Domestic and Foreign Trade

Zambia's Current Account has always been in deficit. When debt service obligations

are excluded, that deficit becomes smaller as reflected for example in the trade balance figures (difference between export revenue and import payments) as shown in Table 1.2 above. However, even though both imports and exports have declined lately, the exports have fallen faster than imports resulting into the trade balance deficit becoming larger. In other words the demand for imports and therefore foreign exchange has been out-stripping the export revenue, and therefore Zambia can not pay for all the imports without straining the exchange rate of the Zambian Kwacha.

The poor performance of the ZCCM mines, major foreign exchange earner, in the 1990s, exerted pressure on the Zambian Kwacha to devalue against convertible currencies.

Devaluation of the Zambian Kwacha was moderate between 1996 and 1997 compared to the level of depreciation the Zambian Kwacha underwent between 1999 and June 2000. Note that the foreign exchange of the Zambian Kwacha is freely determined by market forces of supply and demand. Because the exchange is not artificial the level of imports has gone down.

The inflation rate has been unstable, but at lower levels in the second half of the 1990s compared to first half of the decade. The macro-economic fundamentals that have characterised the Zambian economy in the last decade were such that most of the economic variables were unstable and were changing by large margins in relatively short space of time. Thus from 35.2 percent in 1996 the inflation rate went down to 18.6 percent the next year but rose back to 30.6 percent in 1998. Before economic liberalisation in the early 1990s inflation was in excess of 100 percent.

1.5.3 GDP Projections

The GDP projections are based on the general economic performance in the last five years and the policy framework that Zambia is pursuing. In the economic reform programme, sectors for growth have been identified as agriculture, industry and tourism. It is expected that mining will still be predominant in the economic activities.

The indicative growth rates that the Government would like to see in the next five years are 4 percent per annum. It has been assumed, therefore, that the long-term growth rate will be 4 percent between the years 1999 and 2010 with agriculture and industry exhibiting higher rates than tourism and mining. It is forecasted that industry and agriculture will grow at 4 percent per annum and tourism at 2 percent. The transport sector is assumed to grow at 2 percent per annum as well. Beyond the year 2010 to 2030 the growth rates will be scaled down to 2 percent for all sectors (Table 1.5).

Table 1.5 Projected Average Sectoral Annual Growth Rates percent (Baseline Scenario)

Sector	Period of Projection		
	1990-2000	2000-2020	2020-2030
Agriculture	3.5	4.1	3.4
Commerce & Industry	3.3	4.4	4.3
Govt & Se	4.0	4.3	3.6
Mining	2.8	3.9	2.9
Non-Energy Use (Bitumen)	4.9	5.0	4.9
Residential Urban	4.0	3.7	3.1
Residential Rural	2.8	3.1	3.7
Transport	4.4	3.4	2.7

Source: Kasali (1977)

The growth sectors namely agriculture, manufacturing, tourism and mining (especially small-scale mining) have potential for increasing economic growth because of their multiplier effects in terms of generating employment and business opportunities for themselves and related industries. These will determine Zambia's future prosperity. Zambia needs to be consistent in implementation of laws (enforcement of regulations) and economic policies that will continuously build business confidence of local and foreign investors alike. The Government should be seen to be upholding and promoting good governance principles too.

Politically, Zambia is one of the most stable countries in Africa. The democratisation process is getting entrenched each year since the return to multi-party politics in 1991. The political stability and economic opportunities obtaining in Zambia are behind foreign confidence for investment. The projected growth in GDP is based on the following assumptions which are:

- Agriculture, industry and services will be the leading economic sectors over the projection;
- Though not regarded as the growth industry, the mining sector is expected to be the driving force for the entire Zambian economy;
- The use of bituminous products in road rehabilitation or construction will depend on continued donor support to provide concession loan facilities. To this end, contractors have been importing bitumen for use on the ROADSIP (Road Sector Investment Programme) assignments because the Indeni bitumen was considered of low quality. However, there is potential for business projects to increase use of the LPG from Indeni as a source of energy.
- The use of state of the art technology will be on the increase given that technological innovations have led to cutting down on unit cost of production in some cases. Therefore use of solar is likely to go up, as conventional sources (Diesel and Hydro) become very expensive. The developed countries have already started to reap benefits from newer technologies in wireless and solar power technologies.
- Urban residential energy use will continue to be dominated by charcoal.
- The demand for energy in rural areas will grow proportionately to the household growth rate of 2.8 percent per annum.

The projected GDP growth is shown in Table 1.6 below.

1.5.3.1 Projected Energy Consumption and CO_2 Emissions

The LEAP Model was used by Kasali et al 2000, to make baseline energy demand projections in economic sectors of interest and hence CO_2 emissions. The results are as shown in Tables 1.7 and 1.8 below:

Table 1.6 Projected GDP Growth to 2030 (K Billion).

Sector	1994	2010	2030
Agriculture	302.2	620	770
Mining	373.6	456	567
Industry	219.9	397	494
Services	1026.6	1518	1887
Transport	133.8	176	219
Total	**2056.1**	**3167**	**3937**

Source: T Mwale (1999); NB: The total GDP figures do not include import duties and imputed bank charges.

Table 1.7 Baseline Energy Demand Projections by Sector (Petajoules)

Sector	YEAR			
	2000	2010	2020	2030
Agriculture	7.74	15.41	30.75	61.44
Manufacturing	-	46.40	-	142.03
Mining	-	47.56	-	71.49
Households	-	209.85	-	282.76
Transport	15.95	24.07	36.45	55.44

Adapted from Kasali et al, 2000.

Table 1.8 Baseline CO_2 Emissions by Sector ('000' tonnes)

Sector	YEAR			
	2000	2010	2020	2030
Agriculture	714.89	1,399.20	2,740.59	5,371.40
Manufacturing	-	6,678.44	-	13,366.8
Mining	-	1,237.18	-	2,669.83
Households	-	27,790	-	48,280
Transport	-	-	-	-

Adapted from Kasali et al, 2000.
Key: - Not available

1.5.3.2 **Future Mitigation Options**

Given the results in Tables 1.7 and 1.8 above coupled with financial constraints facing the country, the way forward for Zambia demands that it transforms its economic sectors in a manner that would make them more efficient. This is achievable so long as current policies are maintained.

Government should encourage adoption of environment friendly technologies through giving incentives (lower tariffs or prices for equipment) to business houses and the community. Similarly, the Government should impose penalties to deter people from using unfriendly technologies and practices that are harmful to the environment. Such regulations or disincentives can be legislated. The advantage of doing likewise is that not only will business companies produce goods at competitive costs but that energy conservation and efficiency measures would result in reduced GHG emissions as well (Table 1.9).

Table 1.9 Comparison of CO_2 Emissions under Baseline Demand Projection and Mitigation Scenarios ('000' tonnes)

	Scenario	2010	2030
Agriculture	Baseline	1,399.20	5,371.40
	Mitigation	1,077.82	3,373.33
	CO_2 Reduction (percent)	**22.97**	**37.20**
Mining	Baseline	1,237.18	2,669.83
	Mitigation	730.41	1,514.60
	CO_2 Reduction (percent)	**40.96**	**43.27**
Manufacturing	Baseline	6,678.84	13,366.8
	Mitigation	3,450.80	9,09.98
	CO_2 Reduction (percent)	**51.7**	**32.5**

Adapted from Kasali et al, 2000.

1.5.4 Climate Change Institutional Framework

The Ministry of Environment and Natural Resources is the focal point for climate change activities in Zambia. The ministry discharges this responsibility through the Environmental Council of Zambia (ECZ) which was created in 1992 following enactment of the Environmental Protection Pollution Control Act (EPPCA) of 1990.

The functions of the Environmental Council of Zambia are to:

- advise the Government on the formulation of policies relating to good management of natural resources and the environment;
- recommend measures aimed at controlling pollution resulting from industrial processes or otherwise;
- advise on any aspect of conservation;
- advise on the need to conduct and promote research analysis, surveys, studies, investigations and training, of personnel, in the field of environmental conservation protection and pollution control;
- receive and review reports and make recommendations to the Government on environmental matters;
- conduct studies and make recommendations on standards relating to the improvement of the environment and the maintenance of a sound ecological system;
- co-ordinate the activities of all Ministries and other bodies concerned with the protection of the environment and control of pollution;
- advise on co-operation between national and international organisations on environmental matters;
- advise on the need for, and embark upon general educational programmes for the purpose of creating an enlightened public

opinion regarding the environment and an awareness of an individual and the public on their role in the protection and improvement of the environment;

- identify projects or types of projects, plans and policies for which environmental impact assessment are necessary and undertake or request others to undertake such assessments for consideration by the Council;

- consider and advise, on all major development projects at an initial stage and for that purpose the Council may request information on the major development projects;

- monitor trends in the use of natural resources and their impact on the environment;

- identify, promote and advise on projects which further or are likely to further conservation for sustainable development and the protection and improvement of the environment;

- hold seminars, symposia and prepare studies on matters relating to environmental and natural resources use and protection;

- request for information on projects proposed, planned or in progress by any person anywhere in Zambia;

- request for information on the quantity, quality and management methods of natural resources and environmental conditions from any individual or organisation anywhere in Zambia;

- provide support for environmental conservation protection and improvement by way of grants or loans the provision of accommodation, equipment and the common use thereof;

- advise on the effects of any sociological or economic development on the environment;

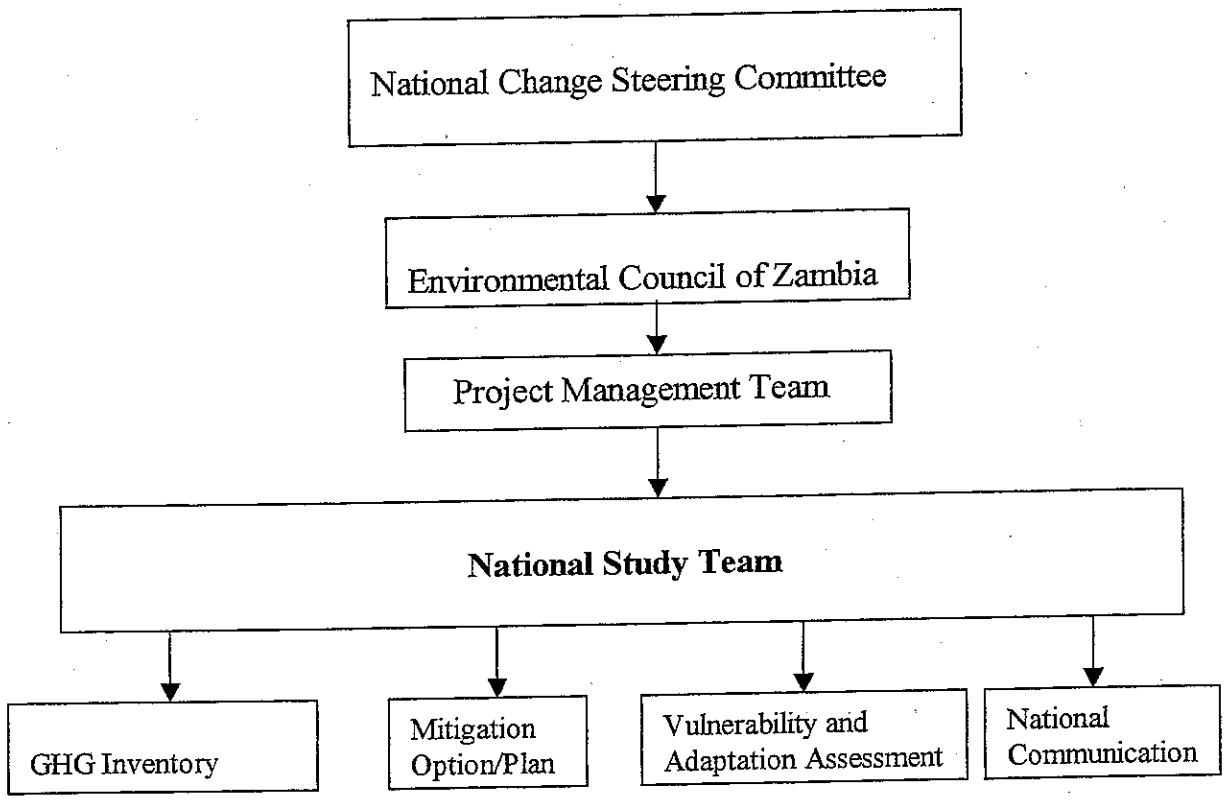
- publicise all relevant information on any aspect of the environment;

- carry out any other activities relating to the protection of the environment and the control of pollution which are necessary or conducive to the better performance of its functions under this Act.

The ECZ houses the secretariat of the National Climate Change Steering Committee (NCCSC) that was formed to give guidance for the implementation of the Enabling Activities for the Preparation of Initial National Communication as well as providing policy guidelines in general. More importantly, the NCCSC reviews climate change reports for quality, technical, scientific and policy. Its membership comprises senior policy planners drawn from key economic sectors and has the added responsibility of ensuring the successful integration of study results into national development plans. The Permanent Secretary of the Ministry of Environment and Natural Resources chairs the NCCSC.

The Executive Director of ECZ is the National Co-ordinator of Climate Change activities and is assisted by a Climate Change Co-ordinator to carry out co-ordination of various climate change programmes. The programmes on climate change activities are conducted through studies by a national team of experts as shown in the climate change organisation structure below.

ORGANISATION STRUCTURE FOR CLIMATE CHANGE ACTIVITIES IN ZAMBIA



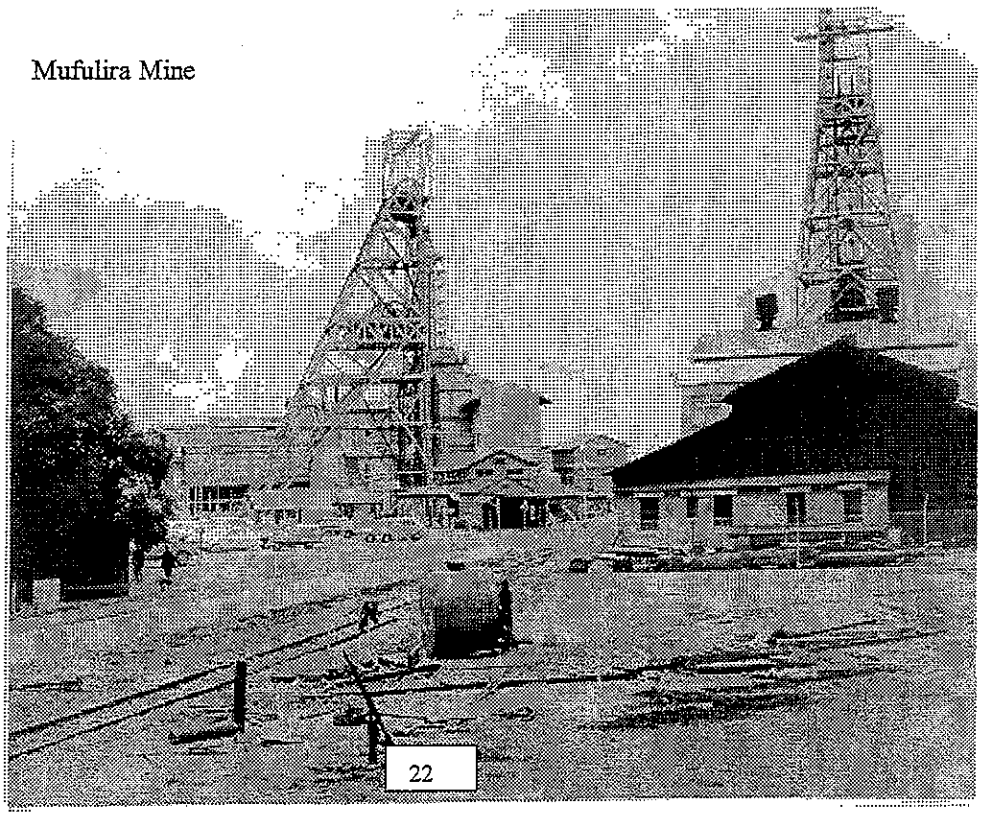
CHAPTER 2

NATIONAL INVENTORIES OF GREENHOUSE GASES

The Zambia Consolidated Copper Mines (ZCCM) are the backbone of Zambia's economy and had consumed approximately 70 percent of commercial energy fuels in 1994. GHG emissions from mining operations are mainly due to consumption of gasoline, diesel and coal. Residents of Kitwe and Mufulira on the Copperbelt need no reminder of pollution caused to their environment by toxic fumes of sulphur dioxide (SO_2) that emanate from copper smelting processes etc. Yet in Zambia, the Land-use Change and Forestry contribute the most GHGs mainly due to Chitemene cultivation and woodfuel consumption.

Thus, the National Inventories of GHG emissions will assist in mapping out strategies for reducing GHGs and their impact on Zambia's environment.

Mufulira Mine



2.1 Introduction

This Chapter provides methodologies for computing the amount of GHG emissions from various economic activities in Zambia. The greenhouse gas emission and sink figures reported in the Initial National Communication are for the year 1994 representing source categories namely energy, industry, agriculture, land-use change and forestry and waste management. Greenhouse gases that have been considered in Zambia are:

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O)

Other non CO_2 emission gases which have been considered and have an indirect effect on the climate through their influence on other greenhouse gases are precursors such as:

- Oxides of nitrogen (NO_X)
- Carbon monoxide (CO)
- Non methane volatile organic compounds (NMVC)

The inventory study also considered sulphur dioxide (SO_2). An attempt was made to consider the existence of PCFs, tetra flouromethane (CF_4) and hexaflouro-ethane (C_2F_6), sulphur hexaflourine (SF_6) and HFCs (HFC – 134a, HFC- 125, HFC – 143a and HFC – 152a)

2.2 Methodology

The greenhouse gas inventories presented in this Initial National Communication were calculated according to revised Inter-governmental Panel on Climate Change (IPCC) guidelines for 1996. Where appropriate, conversion and emission factors for certain fuels used were based on Zambia's local conditions.

The general methodology used involves knowledge of the product of activity level for example amount of material produced or consumed and an associated emission factor per unit consumption or production. Carbon dioxide and non carbon dioxide from energy through fuel combustion have been calculated by the "main source categories approach" which considers emissions by sector. Emission factors used were IPCC default values.

Carbon dioxide and no carbon dioxide from industrial process were determined from various activities which are not related to energy and include cement production, road paving, glass manufacture, ammonia production, nitric acid production and alcohol and soft drink beverage production. IPCC default figures were used as emission factors.

Emission from agriculture namely: methane, nitrous oxide, carbon monoxide and nitrogen oxides were determined from five sources namely domestic livestock (enteric fermentation and manure management), rice cultivation (flooded rice fields) prescribed savanna burning, field burning of agricultural residues and agricultural soils. Emission factors used in the calculations were IPCC default figures.

Emission from land-use change and forestry in Zambia, originate mainly from on site forest biomass burning, from forest biomass decay and off-site burning of firewood and charcoal. The amount of biomass burning in Zambia depends on the type and purpose of forest clearing which include shifting cultivation, permanent cultivation, selective logging in natural forests and clear cut logging in managed (plantation) forests. Of these activities, logging involves little biomass burning and therefore its contribution to emissions from on-site forest biomass is negligible. The methodology for determining carbon dioxide and non carbon dioxide emissions from land-use change and forestry and carbon sinks is in accordance with IPCC methodology. Emission factors and other related parameters used for determining emissions were derived locally.

Table 2.1 Global Warming Potential (GWP) calculated for A Time Horizon of 100 years (Direct GWP) for Gases and indirect GWP for Methane

Gas	CO_2	CF_4	C_2F_6	SF_6	HFC-125	HFC-134a	HFC-143a	HFC-152a	CH_4	N_2O
GWP	1	6500	9200	23900	2800	1300	3800	140	21	310

Source: CEEEZ, 1999.

Data contained in Table 2.1 above for CO_2, CH_4 and N_2O emissions have been used in Table 2.2 below to show the relative contribution of GHGs in the total emission by sector.

Table 2.2 Contribution of GHG by Sector (1994)

Sector	Emissions in CO_2 equivalent Gg	Percent of Total Emissions
Energy	17,409.5	16.2
Industry	326.5	0.3
Agriculture	13,624.2	12.6
Land-use Change and Forestry	74,961.9	69.6
Wastes	1,415.2	1.31
TOTAL	**107,737.3**	**100**

Methane is the predominant greenhouse gas from land waste. Methane emissions were determined using IPCC methodology from solid waste disposal sites, domestic/commercial wastewater and sludge, industrial wastewater and sludge. Emission factors used were IPCC default figures. The reader is referred to the report by CEEEZ on Inventories of Anthropogenic Greenhouse Gas Emissions and Removals in Zambia for more details on methodologies employed in computing GHG emissions.

Comparison of climatic effects due to various gases is made possible by utilising IPCC Global Warming Potentials (GWPs) for emissions of interest as shown in Table 2.1 above.

2.2.1 Sources of Data

Data used in compiling the inventory of greenhouse gas emissions was obtained from the following sources:

- Energy Balance for 1994
- Energy Statistics Bulletin 1974-1996
- Agriculture Statistics Bulletin 1980-1996
- Central Statistics Office

In addition, input data on the activity such as carbon uptake were obtained from extensive research undertaken at the University of Zambia in 1994.

2.2.2 Organisation

The National Inventory has been organised into five major source categories:

i) Energy Activities

a) Fuel Combustion Activities
- Oil refinery
- Households
- Agriculture and Fisheries
- Mining
- Industry and Commerce
- Government Service
- Transport

b) Fugitive Emissions

ii) Industrial Process
- Cement production
- Lime production
- Ammonia production
- Nitric acid production
- Road paving

iii) Agriculture

- Enteric fermentation
- Animal wastes
- Rice cultivation
- Savannah burning
- Agriculture waste burning
- Agricultural soils

iv) Land-Use Change and Forestry

- On site burning
- Off site burning
- On site decay

v) Waste

- Solid waste disposal sites
- Domestic/commercial waste water and sludge
- Industrial wastewater and sludge

2.3 GHG Emissions by Sector

2.3.1 Energy

Greenhouse gas emissions for this sector were mainly from two fossil fuel types namely liquid fossil fuels (e.g. gasoline, diesel, kerosene, heavy fuel oil and aviation fuel) and solid fuels that included firewood, charcoal and coal.

The consumption of electricity from a few diesel generating power plants that serve isolated areas in the country gives rise to GHG emissions. However, the bulk of electricity generation in Zambia is hydro that emits low GHGs.

The total amount of CO_2 emissions for the energy sector in 1994 was 2,294.885 Gg. with transport being the largest contributor at 53 percent followed by mining (29 percent) and industry (14 percent). The government services and households on the other hand accounted for about 2 percent each as shown in Table 2.3 and Figures 3 and 4 below.

Figure 3. CO_2 Emissions by Sector (1994)

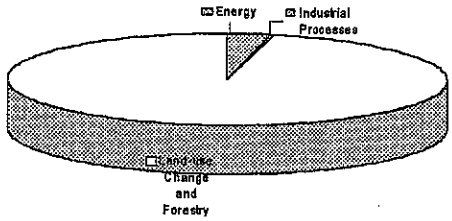
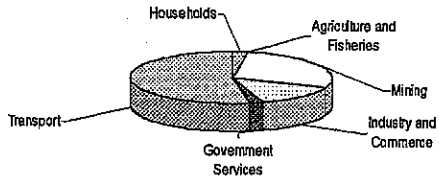


Figure 4. CO_2 Emissions by Energy Sub-sectors 1994.



2.3.2 Industry

Electricity is the main source of energy in industry for driving motors, lighting and air conditioning. Some of the industries use fossil fuels in the boilers for production of steam.

The major industries considered in this sector are:

- Copper mining and processing
- Cement production
- Lime production
- Fertiliser production
- Food, beverage and tobacco
- Textile and leather industries
- Wood and wood products

CO_2 emissions from the industrial sector amounted to 300.465 Gg. which is less than 1 percent of the total CO_2 emissions.

2.3.3 Agriculture

Zambia's agricultural activities include production of food crops and livestock. Besides maize the staple food other food crops are rice, sorghum, millet, sunflower, soya beans, cassava and groundnuts.

The main types of livestock in Zambia are cattle (beef and dairy), sheep, goats and poultry. Cattle account for approximately 57 percent of the total livestock population. Cattle in Zambia is classified into two categories; traditional and commercial representing 82 percent and 18 percent respectively.

GHG emissions from agricultural activities are produced from rice cultivation, prescribed burning of savannahs, field burning of agricultural residues, agricultural soils and enteric fermentation and animal waste. An estimate of 0.72 Gg of CH_4 was due to rice cultivation while prescribed burning of savannahs contributed 297.29 Gg of CH_4, 3.68 Gg of N_2O, 132.98 Gg of NOx and 7,803.84 Gg of CO.

Field burning of agricultural residues amounted to 0.51 Gg of CH_4, 0.02 Gg of N_2O, 0.73 Gg of NOx and 10.64 Gg of CO while agricultural soils contributed 14.62 Gg of N_2O.

Enteric fermentation and animal waste in livestock production gave rise to 76.48 Gg of methane, 3.04 Gg of methane and 0.0003 Gg of N_2O respectively.

2.3.4 Land–Use Change and Forestry

In this sector, the calculation of emissions focused on three main activities:

- On site burning
- Off site burning
- On site decay

Biomass in Zambia is cleared through shifting cultivation, permanent cultivation, charcoal production, logging in plantations, selective timber cutting and commercial firewood cutting. Of these activities, logging involves little biomass burning and therefore its contribution to emissions from on site forest biomass burning is negligible. Cultivation and charcoal production are the main sources of on-site biomass burning emissions. On-site burning contributed 51,843.18 Gg of CO_2, 226.23 Gg of CH_4, 0.311 Gg of N_2O, 11.24 Gg of NOx and 1,979.47 Gg of CO. On-site decay contributed 5,337.95 Gg of CO_2.

2.3.5 Waste Management

Anaerobic decomposition of organic waste disposal sites is a major source of methane. Other waste sources include treatment of sludge and residual solid by-products, industrial and domestic wastewater.

2.3.5.1 Solid Waste Disposal

Urban population statistics were used in estimating methane emissions from solid

waste disposal sites, since there is no organised waste collection or disposal countrywide. Recovered methane is taken as zero in the calculations since there is no recovery in Zambia. Methane emissions from solid waste disposal sites were 17.81 Gg accounting for 26.4 percent of total methane emissions.

2.3.5.2 Domestic/Commercial Wastewater and Sludge

Wastewater includes all liquid wastes from factories, hotels, restaurants and residential premises. In Zambia, although part of wastewater is managed with formal handling and/or treatment systems, there is no information on the provision of the wastewater handled by the various wastewater-handling systems. Only urban population was used in estimating methane emissions from wastewater since the wastewater produced in rural areas is not managed. Zambia has no information on emissions from sludge. Sludge is not included in the analysis since there is no sludge handling in Zambia. Domestic and commercial wastewater was the largest source of methane emissions of 48.62 Gg accounting for 72.1 percent of total methane emissions.

iii) Agriculture

- Enteric fermentation
- Animal wastes
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- Savannah burning
- Agriculture waste burning
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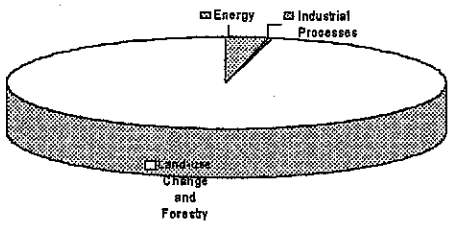

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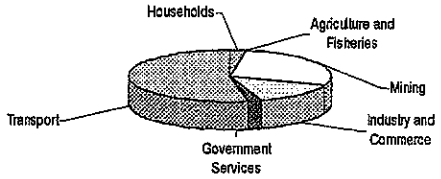

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2.3.5.3 **Industrial Wastewater and Sludge**

Industrial wastewater includes all liquid wastes from factories and industries. Methane emissions from this source were 0.96 Gg accounting for 1.4 percent of total methane emissions.

Table 2.3 Total Emissions of Greenhouse Gases (Gg) 1994

	GREENHOUSE GAS SOURCE	CO_2	CH_4	N_2O	NOx	CO	NMVOC	SO_2
	TOTAL NATIONAL EMISSIONS	72,710.05	735.98	63.14	1,197.84	10,787.82	79.03	6.42
1	Energy (Fuel Combustion & Fugitive)	2,294.885	64.315	44.40	1,052.807	993.830	77.451	6.335
	A. Fuel Combusion	2,294.885	64.315	44.40	1,052.807	993.830	77.451	6.335
	Oil Refinery	-	-	-	0.0012	0.00187	0.0124	0.0186
	Households	57.046	56.811	39.333	920.176	828.587	63.227	2.6319
	Agriculture and Fisheries	1.231	1.947	1.342	31.50	28.274	2.408	0.1035
	Mining	657.329	0.045	0.1160	1.569	4.384	0.7536	0.8726
	Industry and Commerce	319.488	5.207	3.586	85.660	78.89	6.404	2.1358
	Government Services	48.238	0.0054	0.0077	0.4747	2.130	0.031	0.1937
	Transport	1,211.553	0.1626	0.0177	13.427	51.563	10.651	0.3786
	B. Fugitive Fuel Emissions	-	0.137	-	-	-	-	-
	Coal Mining	-	0.137	-	-	-	-	-
2	Industry	300.465	-	0.084	0.0881	0.0393	1,5747	0.083149
	A. Cement Production	139.340	-	-	-	-	-	0.083
	B. Lime Production	153.661	-	-	-	0.0393	-	-
	C. Ammonia Production	7.464	-	-	-	-	0.0224	0.000149
	D. Glass Manufacture	-	-	-	-	-	0.0423	-
	E. Nitric Acid Production	-	-	0.084	0.0881	-	-	-
	F. Road Paving	-	-	-	-	-	1.51	-
3	Agriculture		378.04	18.34	133.71	7,814.48	-	-
	A. Enteric Fermentation		76.48	0	0	0		
	B. Animal Wastes		3.04	0.0003	0	0		
	C. Rice Cultivation		0.72	0	0	0		
	D. Savannah Burning		297.29	3.68	132.98	7,803.84		
	E. Agricultural Waste Burning		0.51	0.02	0.73	10.64		
	F. Agricultural Soils		0	14.62	0	0		
4	Land-Use Change & Forestry	70,114.70	226.23	0.311	11.24	1,979.47	-	-
	A. On Site Burning	51,843.18	226.23	0.311	11.24	1,979.47		
	B. Off Site Burning	12,933.57						
	C. On Site Decay	5,337.95						
5	Waste		67.39					
	A. Solid Waste Disposal		17.81					
	B. Domestic/Commercial Waste Water and Sluge		48.62					
	C. Industrial Waste Water and Sluge		0.96					

Source : **Adapted from CEEEZ (1999)**

2.4 Greenhouse Gas Sinks

The main carbon sinks in Zambia are regrowth natural forests regenerating after forest clearing and / or abandonment of managed cultivated land (fallow) and reforestation plantation. Statistics based on these showed that the national annual uptake of CO_2 in 1994 was 71,504.00 Gg. This implies that in 1994 Zambia was a net CO_2 emitter (Table 2.4).

Table 2.4 CO_2 Final Budget for 1994.

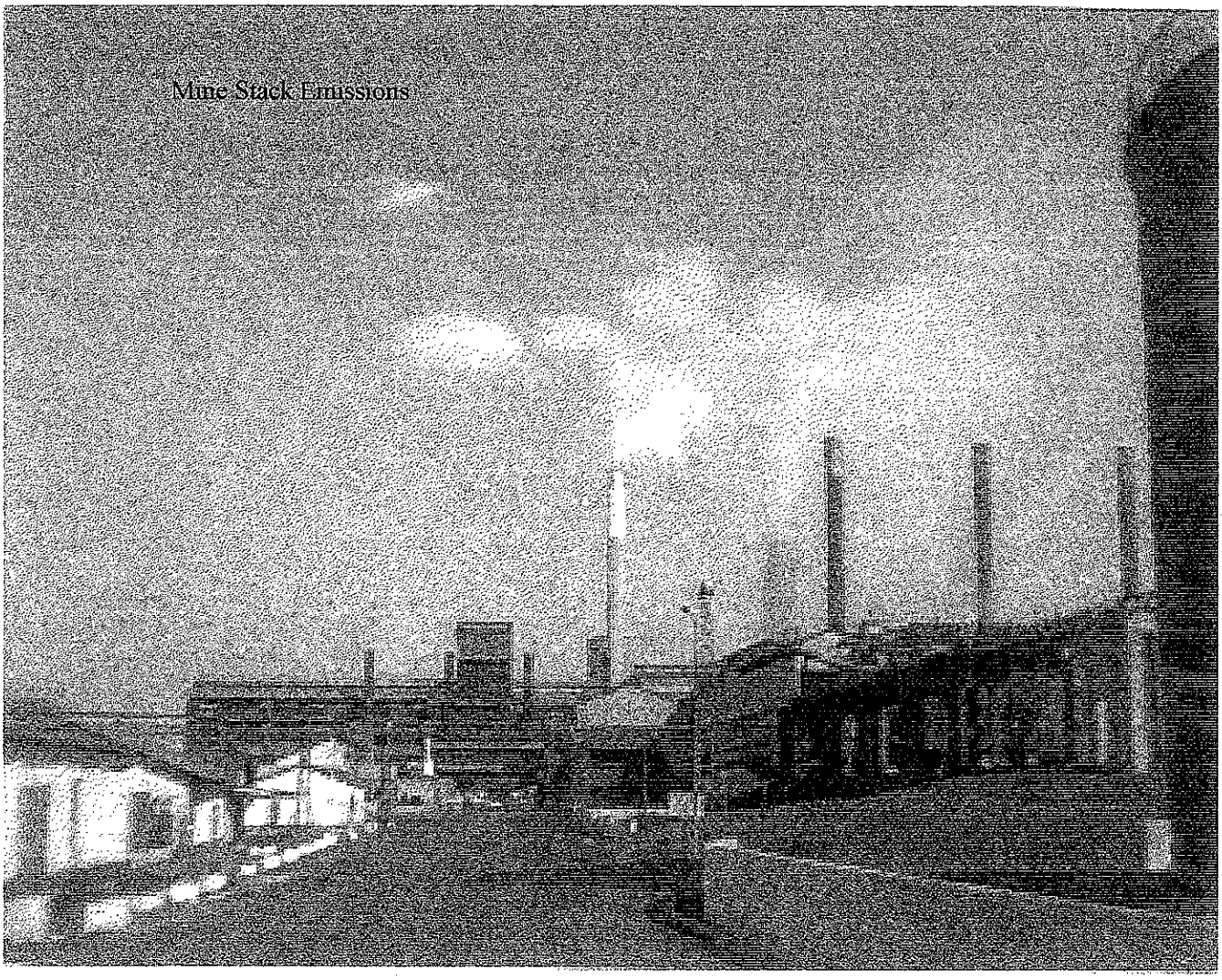
Emission Source	**Carbon dioxide (Gg)**
Energy	2,294.885
Industry	300.465
Land-use Change & Forestry	70,114.70
Sub-Total	*72,710.050*
Uptake by Regeneration and managed plantations	71,504.00*
Balance	**1,206.05**

Source: Adapted from CEEEZ Report, 1999.

CHAPTER 3

MITIGATION OPTIONS

It has been shown that Zambia's economic sectors are sensitive to impacts due to climate change. Given the fact that Zambia (1994) was a net CO_2 emitter, mitigation options are required in order to reduce CO_2 and other GHGs so as to minimise their concentration in the atmosphere.



Mine Stack Emissions

3.1 Introduction

This Chapter addresses mitigation options, policies and programmes that Government has put into place in order to reduce primarily carbon dioxide (CO_2) and methane (CH_4) gases in energy, industry, mining, agriculture and forestry sectors.

3.2 Energy

So far Zambia has conducted two studies that are directed towards reducing CO_2 emissions in the energy sector. These are the National Energy Efficiency and Conservation Programme of Zambia conducted in 1995 by the African Development Bank (ADB) and the German Technical Agency (GTZ) on behalf of the Zambian Government and the Status of Energy Conservation and Substitution in Zambia conducted in the same year by the Department of Energy (DOE). The ADB/GTZ study focused on removing barriers towards implementing energy efficiency and conservation measures in six major industries and how financial institutions like the Lusaka Stock Exchange (LuSE) and the Development Bank of Zambia (DBZ) among others could play the role of facilitator. The DOE study on the other hand was intended to improve efficiency in selected industries through energy audits. Energy substitution at Nchanga mine through the Trolley Assist Haulage mechanism is an example of increased use of electric power in place of diesel.

3.2.1 Energy Supply Mitigation Options

The traditional energy supply sub-sector comprises woodfuel that is consumed mostly by rural dwellers including people living in peri-urban areas. Mitigation measures in this sub-sector include :

- *Improving the charcoal production process.*

Policy : Forest-based Industries and Non-wood Forest Product Development.

Programmes : In 1997, the Forest department circulated a manual on improved charcoal production for use by charcoal burners. The Ministry of Environment and Natural Resources is currently evaluating the manual's impact. Other projects in biomass conservation include community based management of forest resources which is being implemented in Mpika, Mufulira, Kasempa and Mumbwa under the Environmental Support Programme. Donor agencies like USAID and FINNIDA are involved in similar projects in other parts of the country too.

As regards the commercial energy supply sub-sector, hydroelectricity, petroleum and coal predominate. Under the electricity sub-sector hydro as opposed to diesel power generation offers the best opportunity for reducing GHG emissions. The relevant mitigation option for achieving this goal is :

- *Development of mini-hydro power stations where the potential exists, particularly as a replacement for diesel generators.*

Policy : Developing the hydro potential to take advantage of the strategic location of the country in the sub-region.

Programmes : Examples of mini-hydros which are being considered include three in Northwestern province (i.e.West Lunga – 2.5 MW, Kabompo Gorge – 34 MW and Chikata Falls – 3.5 MW).

- *Commercialisation and subsquent diversting of shares by government in the procurement, transportation, refinery and distribution of oil products and feedstocks to enhance GHG abatement efficiency.*

Policy : Streamlining operations of the petroleum industry in order to increase efficiency.

Programmes : Government is implementing the Petroleum Sector Rehabilitation Project whose initial phase involved sealing leakages along the Tazama Pipeline followed by the rehabilitation of the Indeni Oil Refinery to make its operations more efficient.

- *Avoid environmental degradation, air and water pollution by setting GHG minimum standards from coal production.*

Policy : Ensuring that both coal mining and utilisation have minimal environmental impacts

Programmes : Coal mining at Maamba Collieries in Southern Province is associated with spontaneous GHG emissions due to internal combustion of coal in disused mining sites. The same can happen at coal slurry dumps except that the impact is reduced.

3.2.2 Energy Demand Mitigation Options

a) Household

In the household sector there are three mitigation options that have been recommended to reduce GHG emissions. These are :

- *Employing energy efficient cook-stoves.*

Policy : Improve the technology of charcoal production and utilisation.

Programmes : Use of high energy efficiency cook-stoves reduces GHG emissions as well as conserving fuelwood and charcoal. The improved charcoal stove project (1987 – 1990) involved training about 500 tinsmiths in Mandevu, Chawama and Kanyama compounds in Lusaka and an enterpreneur in Kabwe to produce replicas of the prototype design produced by the NISIR. The project is on going even though acceptability has been slow due to high cost of raw materials. A SADC project code named PROBEC which is aimed at conserving biomass in general has already been implemented in some member countries and Zambia hopes to benefit from it in the future.

- *Electrifying households in the low income groups.*

Policy : Improving accessibility to electricity.

Programme : Insofar as the rural electrification project is concerned the Government through ZESCO has embarked on an ambitious programme to electrify rural areas and urban townships currently not served with electricity. About 7,000 housing units were electrified in Lusaka's Matero and Chilenje compounds in 1995 ; 1,300 and 5,000 housing units in Twapia and Chifubu (Ndola) in 1996 and 1999 respectively and 2,800 housing units in Buchi and Kamitondo (Kitwe) in 1999.

- *switching to other cleaner energy fuels like solar.*

Policy : Promote the wider application of NRSE technologies

Programme : Under a four-year pilot project launched in 1998 and coordinated by ESCO and DOE, some 400 housing units in Chipata, Lundazi, Nyimba and Petauke in Eastern Province will be provided with solar energy.

b) Transport

In the transport sector Government is currently reviewing the Transport and Communication Policy for approval. Mitigation options for this sector include :

- *improving vehicle technical efficiency.*

Policy : Transport and Communication.

Programme : Collaborative effort is envisaged between the ECZ, Road Traffic and Customs to improve vehicle certification (in oder to set standards suited for the Zambian market) and enforce regulations governing vehicle emission levels.

- *Maximum utilisation of vehicle capacity as well as switching to fuels with lower emissions.*

Policy : Transport and Communication.

Programme : Pooling of transport among commuters has the effect of conserving fuel and thereby reducing GHGs. Use of fuel blended with ethanol would similarly reduce GHGs and therefore when implemented the proposed Luena Sugar Plantation project would provide the desired change. Conversion of vehicles to run on blended fuel would also save foreign exchange calculated at 15 percent of the total petroleum import bill (CEEEZ & CHI-CHI 1999).

c) **Mining**

The Zambia Consolidated Copper Mines consumed 24.29 Petajoules of energy resulting into CO_2 emissions amounting to 657.329 Gg in 1994. Mitigation options particularly with regard to the rehabilitation of the Nkana smelter are currently being addressed. Recently, the British Government through the Department for International Development released US$27 million out of the US$80 million pledged for this exercise. Some of the mitigation options included in the rehabilitation project include :

- *Replacing the reverberatory smelters with the flash smelting furnaces.*

Policy : Energy Conservation and Substitution.

Programme : Though not yet implemented, Kasali et al, 2000 have shown that the flash smelting technology has a calculated energy intensity of 4.352 GJ/tonne of copper which is lower than that for the reverberatory smelting technology quoted at 17.406 GJ/tonne of copper. The use of the flash smelting technology would thus reduce the amount of purchased fuel for the copper smelting process and hence CO_2 emissions.

- *fuel switching from diesel to electricity in load-haul-dump machinery.*

Policy : Energy Conservation and Substitution.

Programme : The substitution of diesel with electricity is more noticeable at Nchanga Open Pit Mine the largest copper producing mine in Zambia. A fleet of heavy dump trucks having electric wheel-motors powered by an inboard diesel engined power generator are adapted to take electric power from a trolly wire system for a part of their haulage route (about 2 km long), thereby saving diesel fuel. Other energy substitution measures include use of 11.5 km long conveyor belt installed at RAMCOZ Mine in Luanshya for transporting ore from Baluba Shaft to the Plant Site Concentrator as well as use of electric loaders at Mufulira Mine.

- *Use of Ceramic Concentrate filters*

Policy : Energy Conservation and Substitution.

Programme : Use of ceramic concentrate filters to dry the slurry to a more manageable moist content is as good an energy technology saver as it is a GHG reducer. The enrgy intensity of the baseline coal dryer is estimated at 1.17 GJ/tonne of copper concentrates compared to 0.86 GJ/tonne for ceramic concentrate filters (Kasali et al, 2000).

- *Use of Oxyfuel Smelters.*

Policy : Energy Conservation and Substitution.

Programme : Conversion to the so called Oxyfuel (Oxygen enrichment) smelting process from the reverberatory furnance process reduces energy input requirements. The estimated energy intensity of the Oxyfuel smelting process is 12.19 GJ/tonne of copper compared to 17.41 GJ/tonne of copper for the baseline coal smelter (Kasali et al, 2000).

- *Switching from the use of kerosene Acid Plant Heaters to electric.*

Policy : Energy Conservation and Substitution.

Programme : Replacement of kerosene with electric heaters with an estimated energy intensity of 0.789 and 0.567 GJ/tonne of copper respectively would result into fuel saving.

Table 3.1 below shows the impact of mitigation options in the CO_2 emission levels of the baseline scenarios for the stated years. It is obvious that besides the expected CO_2 reduction arising from implementation of mitigation options proposed for the mining sector, foreign exchange saving would be a major outcome too.

Table 3.1 Comparison of Baseline and Mitigation Scenario CO_2 Emission Levels (x 1000 tonnes) for the Mining Sector in 2010 and 2030

Scenario	2010	2030
Baseline	1,237.18	2,669.83
Mitigation	730.41	1,514.60
CO_2 Reduction %	40.96	43.27

Source : Kasali, 2000.

3.3 The Manufacturing Industry

The Manufacturing Industry does not have a specific climate change policy per se. However, most sectoral policies have objectives that are targeted at reducing GHGs and averting environmental degradation in general. Major industries in this category include Nitrogen Chemicals of Zambia (NCZ), Chilanga Cement plc, Zambian Breweries, City Breweries. Amanita etc. Mitigation options recommended for the manufacturing industry include :

- *Improving the efficiency of coal and diesel fired boilers.*

Policy : Energy Conservation and Substitution.

Programme :Recently the City Breweries in Lusaka increased efficiency of its boilers. A series of measures that include rubbering steel pipes and sealing of leakages in order to reduce steam losses are used to conserve fuel and ultimately lead to fewer emissions. Other companies which have employed energy conservation measures much earlier in order to improve profits include the NCZ and KTZ in Kafue. In 1998 the Indeni Oil Refinery improved the efficiency of its boilers by installing a pre-heat exchange unit which led to a 30% reduction in SO_x emissions. However, the conversion of coal fired boilers to electric as a mitigation option has yet to be implemented in Zambia.

- *Conversion of cement production from wet to a dry process.*

Policy : Energy Conservation and Substitution.

Programme : In the cement industry it has been recommended to switch to dry from the wet process. Of the two cement companies in Zambia Chilanga Cement plc in Lusaka is a sure candidate for the stated conversion. However, it must be mentioned that the conversion is costly and could be realised in medium and long-term only.

- *Replacing diesel power generators with mini hydros wherever doing so is economically feasible.*

Policy : Promoting electrification of productive areas and social institutions.

Programme : The above mitigation option is particularly suited to remote areas not connected to the national grid system but have water streams nearby that could be harnessed for power generation. The proposal for developing mini hydros in Kabompo and Mwinilunga districts in North-Western Province is a case in point. These districts are famous for pineapple growing but production expansion has been hampered by lack of sTable power supply. ZESCO is proposing to develop the West Lunga (2.5 MW), Kabompo Gorge (34 MW) and Chikata Falls (3.5 MW) minihydros as a solution. Meanwhile the Dutch government has shown interest to participate in minihydro development in Kabompo and Mwinilunga districts through the AIJ mechanism (refer to Chapter 7, section 7.2).

3.4 Agriculture

The Agriculture Sector Investment Programme (ASIP I) has been the driving policy in the agriculture sector since the early 1990s. Phase II of this policy is currently being implemented and has special features that include the empowerment of rural farmers through the Rural Investment Fund.

3.4.1 Mitigation Options for Methane Emissions from Rice Cultivation

Paddy rice was Zambia's second largest crop produced in 1999 (MOF, 1999).The mitigation option for reducing CH_4 emissions from rice cultivation is :

- *promotion of intermittent flooding and drainage of rice paddies.*

Policy : Enabling farmers in all regions to take full advantage of the potential for using irrigation to enhance farming profits, diversify and intensify crop production and reduce risks of financial loss.

Programmes :This policy has yet to be implemented.

3.4.2 Mitigation Option for CO_2

Farming in Northern and Luapula provinces is strictly chitemene cultivation which involves clearing trees and putting them into hips before burning. The CO_2 emissions can be mitigated by :

- *use of organic fertilisation without recourse to vegetation burning*

Policy : Maintain an agricultural extension and information programme to provide advisory services to farmers to improve farming

Programmes : The Intergrated Sustainable Agricultural Project in the Ministry of Agriculture, Food and Fisheries is promoting various activities to that end. Paramount among these is the use of livestock dung in place of chemical fertilisers, adoption of conservation farming practices to improve soil fertility by mulching, conservation tillage, contour farming, terracing, strip croping and promotion of agro-forestry. For instance according to the study by Kasali (2000) conservation tillage would result in potential energy savings of 0.058 and 0.577 Petajoules by the year 2010 and 2030 respectively. Organic fertilisation programmes receive support from a number of Donor Agencies while major beneficiaries so far have been farmers in Southern, Central, Eastern and Lusaka Provinces.

3.4.3 Mitigation Options for Methane and Nitrous Oxide From Livestock

Promoting effective extension services particularly to the traditional sector through improved animal nutrition,

husbandry, draught power, hygiene and disease prevention would mitigate against CH_4 and N_2O emissions in the agriculture sector. The mitigation required therefore is :

- *use of mechanical and chemical feed processes and providing strategic supplementation.*

Policy : Animal Production and Disease Prevention.

Programmes : Under the above mentioned policy the Livestock and Pest Research Centre in Chilanga has conducted studies on use of ammoniated crop residue use with poultry manure and results have shown that animals respond with better weight gains and fewer methane and nitrus oxide emissions responsible for unpleasant smell. Farmers in Southern province for instance, under the Southern Province Household Food Security Programme, are being taught how to manage their crop residues with chemicals like alkali-ammonia to make them more palaTable. Crop residues (e.g. urea mollases mineral blocks) are currently being used by smallholder farmers throughout Zambia to supplement ruminant feed during the dry season.

3.5 Waste Management

There has been no specific law dealing with waste management in the country until recently. GHG emissions from all types of waste can be mitigated by :

- *Establishing engineered land-fills where GHGs could be reduced by piping.*

Policy : The EPPCA of 1990 and the Waste Management (Licensing of Transporters of Waste and Waste Disposal Sites) Regulations of 1993

Programmes : The Environmental Council of Zambia (ECZ) is empowered under the above mentioned law to inspect, issue license and impose fines when an operator is found to infrige the law.

Nearly all big companies in the country have registered with the ECZ and are obliged to submit 6-monthly reports for review. Municipal Councils along the line of rail are in the forefront of implementing the law and Lusaka City Council has so far designated 13 areas as dump sites for solid waste.

However, these efforts have fallen short of establishing engineered land-fills where GHGs could be reduced by piping them for subsquent use in domestic and industrial applications.

3.6 Carbon dioxide Sink Measures

Depletion of vegetation through agriculture and energy consumption is a threat to overall balance of GHG emissions in the country. The chitemene cultivation is both destructive as well as being a big source of CO_2 emissions as mentioned earlier. Current efforts directed at maintaining CO_2 sinks are :

- *To ensure adequate protection of forests, by empowering local communities and promoting the development and use of forest and non-wood forest products.*

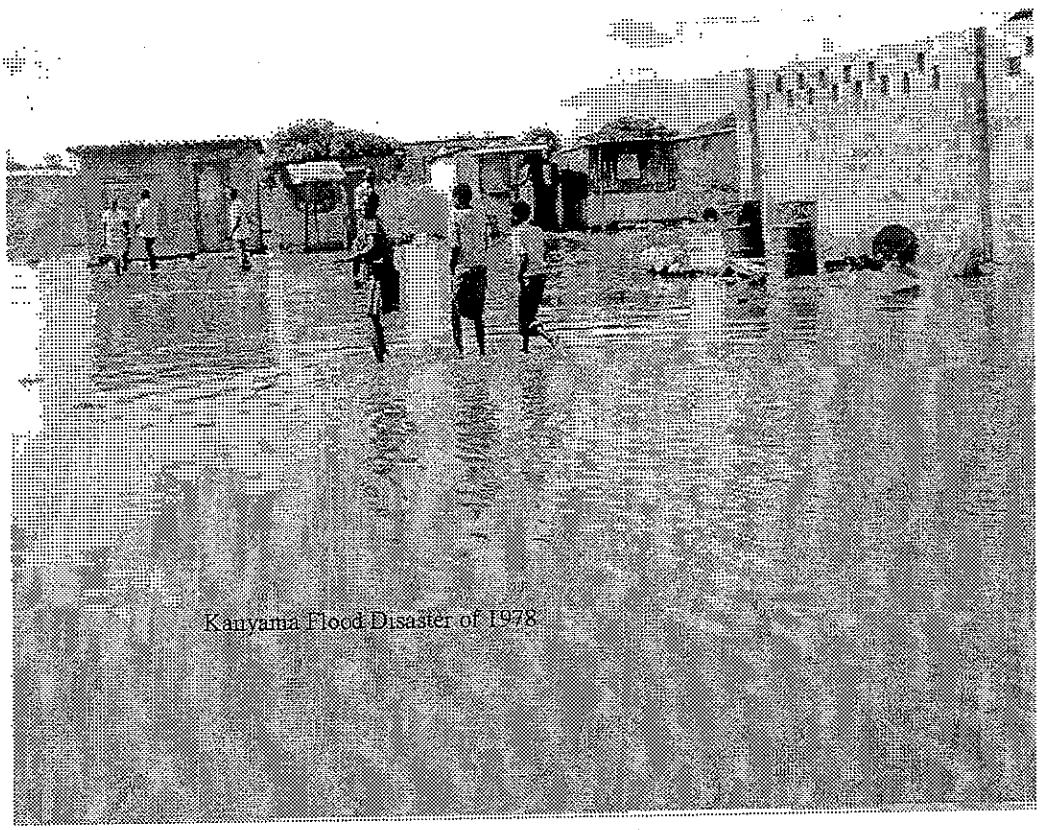
Policy : Sustainable forest resource and ecosystem management.

Programme : The Government, through the Environment Support Programme and Zambia Forestry Action Programme in particular, is implementing community based management of forest resources in a number of provinces to arrest the aforesaid destruction. Donor agencies, the private sector and NGOs are also involved in these activities. The USAID supported CLUSA-ZAMBIA project is active in Eastern province while FINNIDA and the Dutch government are involved in Southern and NortWestern provinces respectively.

CHAPTER 4

VULNERABILITY AND ADAPTATION ASSESSMENT

The Southern African region is prone to natural disasters. In 1978 and 1992 Zambia lost life and property due to floods and drought respectively. The worst affected areas were Lusaka and parts of agro-ecological Zone I in Southern Province. The vulnerability and adaptation assessment is an attempt to evaluate the sensitivities of vulnerable resources and hence recommend measures directed towards adapting the country to impacts due to climate change. Kanyama compound on the outskirts of Lusaka became an artificial lake following excessive rainfall of 1978.



Kanyama Flood Disaster of 1978

4.1 Introduction

The Vulnerability and Adaptation Study was conducted under the US Country Studies Programme to enable Zambia meet her obligation under the United Nations Framework Convention on Climate Change (UNFCCC). The overal objectives of the study were to evaluate how climate change affects anthropogenic activities and natural systems, evaluate sensitivities, thresholds and vulnerabilities of natural systems as well as identifying possible technological improvements and practical adaptation measures designed to minimise effects due to climate change.

The study was conducted in 1998 on five vulnerable economic sectors namely Agriculture, Food and Fisheries, Wildlife, Forestry, Health and Water.

National policies under which various climate change related programmes are being implemented were subjected to sensitivity analysis whose results have confirmed, albeit for financial constraints, Zambia's preparedness to adapt to impacts due to climate change (Macwani and Chipungu, 1999 and Appendix 1).

4.2 The Agriculture, Food and Fisheries Sector

This sector is important for maintainance of food security.

Scope of Assessment

The vulnerability and adaptation study on crop production focussed on sensitivities of selected crops to climate change.

The crops analysed include three maize varieties (MM 752, MM603 and MM601), one sorghum variety (SIMA) and three groundnut varieties (Natal Common, Makulu red and Chalimbana).

The study covered three regions selected on the basis of characteristic meteorological variables and ecological features that naturally divide the country into Agro-ecological zones (AEZ) I, II and III. (Appendix 2). Three towns namely Livingstone, Lusaka and Mansa represented agro-ecological zones I, II and III respectively. The growing seasons for maize varieties MM752, MM603 and MM601 correspond to AEZ III, II and I respectively. The sorghum variety (SIMA) grows favourably in AEZ II and III and good soils of AEZ I while the groundnut varieties (Natal common, Chalimbana and Makulu red) grow well in agro-ecological zones III, II and I respectively.

Methodology

Two General Circulation Models (GCM), namely CCCM and GFDL were used to create climate change scenarios (2 x CO_2) for the IBSNAT simulation technique. The DSSAT3 (Decision Support System for Agro-technology Transfer) software system together with the IBSNAT application programme was then used to simulate crop growing length and yields under rainfed and irrigated conditions. Water balance parameters, and nitrogen availability parameters for the selected crops were also simulated in order to estimate the vulnerability of agricultural production to climate change.

Results

a) Maize Production

The results of the DSSAT3 simulation model for 1977/78 season showed that MM752 and MM603 maize varieties would not mature in agro-ecological Zones I and II respectively. This would in turn lead to widespread yield reduction. The situation was different for MM601 in Zone III where no significant yield reduction was noted. Maize yields simulated over a 30-year period indicated that MM752 variety in Zone I would decrease under 2xCO_2 condition whereas MM603 in Zone II and MM601 in Zone III would show increases in

yield under similar conditions (Tables 4.1 and 4.2). Overall, higher yields were simulated when the planting date is 10th December in Zone I and II whereas for Zone III planting date did not influence yield. Water balance simulation under $2xCO_2$ indicated a decrease in precipitation for Zones I and II and an increase for Zone III (Table 4.3).

Simulation for soil nitrogen levels showed an increase in Zones I and II due to reduced nitrogen leaching and a decrease in Zone III due to excessive nitrogen leaching under $2xCO_2$ condition (Table 4.4).

b) **Sorghum Production**

DSSAT3 simulations indicate that Sorghum production would increase under the $2xCO_2$ scenario when planted on appropriate dates in all the represented agro-ecological Zones (Table 4.5). Water balance parameters did not indicate significant variations under normal climate and climate change while simulations for leached nitrogen in sorghum stalks did not show significant differences under climate change either (Tables 4.6 and 4.7).

c) **Groundnut production**

DSSAT3 simulations showed that groundnut production yields, water balance parameters and nitrogen availability parameters did not significantly vary under normal and climate change conditions (Tables 4.8 to 4.10).

Generally, the results for maize production especially in AEZ II indicated that crop production would decrease under the simulated climate change scenario.

Adaptation Measures, Policy Framework and Programmes

A number of response strategies have been cited to adapt the agriculture sector to the inevitable effects of climate change. The adaptation measures proposed are consonant with the existing agriculture policy framework. The overall objective of the agriculture policy is to ensure household and national food security, increase income and employment; ensure that the existing agricultural base is maintained and improved upon to maximise the sector's contribution to GDP through agro-industry and export earnings.

The following adaptation measures are linked to existing policy objectives and GRZ programmes that would enhance their implementation.

- *Development of drought-tolerant and early maturing crop varieties.*

Policy: Crop research to generate and adapt technologies that will increase productivity and diversify production.

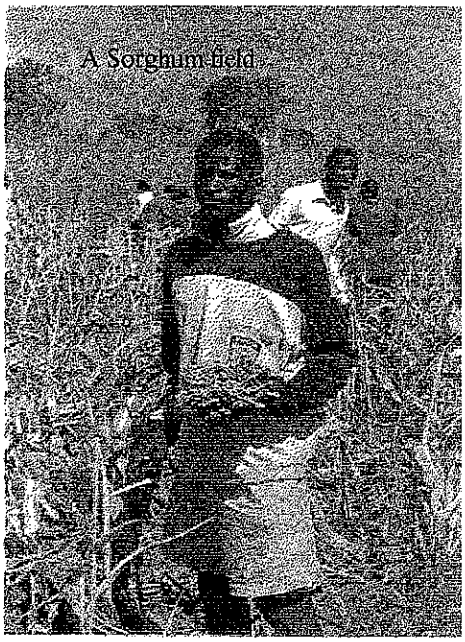
Programmes: Several institutions under the Ministry of Agriculture Food and Fisheries are involved in adaptive crop research aimed at increasing crop production in various agro-ecological zones. They include Mount Makulu Agricultural Research Station, ZAMSEED and Golden Valley Agricultural Research Trust (GART).

Research activities include developing early maturing high yielding and drought-tolerant cultivars appropriate to agronomic parameters obtaining in agro-ecological zones I and II; late maturing cultivars suitable for the high rainfall agro-ecological zone III and many other comprehensive adaptive research activities.

- *Crop diversification.*

Policy: Crop research to generate and adapt technologies that will increase productivity and diversify production.

Programmes: The Ministry of Agriculture Food and Fisheries promotes crop diversification by encouraging the cultivation of traditional food crops like sorghum, cassava and millet in order to reduce dependence on maize.



A Sorghum field

Crop diversification activities include seed multiplication for open pollinated and local crops in order to widen the menu of available seeds.

Moreover, the Programme Against Malnutrition (PAM), a non-governmental organisation (NGO) has been involved in crop diversification activities as a response strategy towards drought management.

In 1995/96, PAM initiated the Drought Rehabilitation Programme with the support of donor agencies like World Bank, FINNIDA, NORAD, FAO and SIDA under which the seed emergency distribution programme was launched. The programme promotes the distribution of drought-tolerant and early maturing crops like pearl millet, sorghum, cassava, sweet potatoes, groundnuts, cowpeas and maize varieties e.g. MM441, MM502, MM601, MM603, MM604.

The programme concentrates more in 32 districts of Southern, Lusaka, Eastern, NorthWestern and part of Central Provinces which are prone to drought (agro-ecological zones I and II). In the high rainfall northern region (agro-ecological zone III), the programme focuses on flood disaster management where seeds are distributed as mitigation against harvests destroyed by floods.

- 3. *Improvement of crop management through information dissemination to farmers and construction of supporting infrastructure like dams for water storage in drought-prone areas of the country.*

Policy1: Maintain an agricultural extension and information programme to provide advisory services to farmers to improve farming.

Programmes: The Extension Services Unit of the Ministry of Agriculture Food and Fisheries has officers stationed in all districts of the country to provide farmers with information and crop management skills to boost production. Among extension services provided are:

- Improving post-harvesting use of new and traditional crops where farmers are taught how to process and store their produce.
- Involving farmers in disease management and pest/weed control under the Integrated Pest Management Programme that promotes reduction in dependence on chemical control.
- Impart farm management skills to farmers (e.g. Farm input management which involves how to source seeds, soil characteristics and fertilizer requirements, information about distinguishing income generating crops (cash crops) and food security crops etc). Farm output management on the other hand involves advising farmers on suitable periods to harvest produce, whether to market their crops – crop marketing skills etc.

Policy 2: Enable farmers in all regions to take full advantage of the potential for

Policy 2: Enable farmers in all regions to take full advantage of the potential for using irrigation to enhance farming profits, diversify and intensify crop production, and reduce the risk of financial loss.

Programmes: Under the Agriculture Sector Investment Programme (ASIP) government has embarked on Dam rehabilitation and construction project funded by the International Fund for Agricultural Development (IFAD) and other donor agencies. The main objective of the project is to alleviate effects of drought. The priority areas for this project are the drought-prone low rainfall provinces such as Southern, Western, Central, Eastern and Lusaka. For instance in Southern province, two dams namely Siafwakwenda and Man'gwato in Choma and Kalomo districts respectively have been rehabilitated. Two more dams are earmarked for rehabilitation in Choma district while surveys are being conducted in other provinces before project implementation. The dams are multi-purpose in that the water stored is used for irrigation and drinking by humans and livestock.

The Rural Investment Fund (RIF) is another government programme funded by the World Bank that supports dam rehabilitation activities.

Policy 3: Marketing and Trade

Programmes: The Government has put in place the Market development and Infrastructural Improvement Branch under the Ministry of Agriculture Food and Fisheries. Its main responsibility is to facilitate the development of agricultural markets, provide market support such as enterpreneurship training, strengthening of agricultural credit delivery and provide appropriate legal framework for a competitive market. The Branch is also tasked with the development of rural infrastructure such as roads, storage facilities and markets. The Branch is supported by two donor agencies namely the World Bank and UNDP.

Among programmes being implemented by the Market development and Infrastructure Branch are:

- restructuring of Credit Union and Savings Association of Zambia (CUSA) and the Co-operative Bank in order to revamp the agricultural credit facility for the farming community.

- setting up of modalities for the Castor Growers Association of Zambia (CGAZ) to access funds through RIF, for purchase of inputs, processing and marketing.

- Establishment of the Agricultural Market Information Center (AMIC) to enhance market transparency and facilitate price arbitrage and increased market integration of agricultural segments; thereby contributing to reduction in transaction costs resulting in more efficient resource utilisation.

- import and export section which expedites processing of import and export permits to support private sector development.

- agricultural standards and gradings section which in conjunction with the Food Reserve Agency (FRA) and Zambia Bureau of Standards developed an effective and efficient monitoring mechanism to promote quality standards of goods and services to safeguard the interests of consumers.

- infrastructure development unit in charge of ensuring the development of agricultural market infrastructure such as roads, storage of cereals, fish, horticultural products and livestock.

- entrepreneurship development section which in collaboration with other

institutions like Small Entrepreneurship Development Board (SEDB), Future Search, Cooperative College etc trains traders and farmers in agribusiness skills as a way of promoting efficiency, effectiveness and growth of the agricultural marketing entrepreneurs.

- *Maintenance of all feeder roads to be done in a timely manner to avoid wastage of produce especially during epidemics.*

Programmes: The Ministry of Local Government and Housing has the responsibility of maintaining feeder roads in the country. The Market development and Infrastructural Improvement Branch under the department of Economics and Market Development of the Ministry of Agriculture Food and Fisheries augment its efforts.

- *Establish a permanent disaster relief fund as an eventuality against climate change.*

Policy: Working Strategies against effects of climate change.

Programmes: Zambia experienced one of the most severe droughts in 1991/92 season resulting in serious food shortages that threatened the survival of the population. This led to government undertaking several adaptive response strategies to minimise the effects. Some of these programmes are ongoing and could enhance the realisation of establishing a permanent disaster relief fund. Institutions involved in disaster management include the Disaster Management Unit under the Republican Vice President's office, NGOs like Programme Against Malnutrition (PAM), Oxfam and Care International which are involved in distribution of relief food, farming inputs such as seeds and fertilisers; the Food Reserve Agency (FRA) – a government agency that stock piles staple grain, purchases excess production from net surplus areas within the country for resale in net deficit areas in order to dampen price fluctuations.

- *To maintain local gene plasm and to encourage local seed production and supply at community level.*

Policy: Crop research to generate and adapt technologies that will increase productivity and diversify production.

Programmes: PAM in collaboration with Mount Makulu Research Station and the Seed Certification and Control Institute promotes and distributes already existing food crops like cassava, millet, sorghum and sweet potatoes to rural communities in order to restock informal seed systems and boost household food security.

Table 4.1 Simulation of Maize Growing Seasonal Yield Using DSSAT3 Simulation of Maize Production at Sites in Zambia

Livingstone

Model	Year	Maize Cultivated	Actual yield (kg/ha)	Actual growing season length (days)	Simulated yield (kg/ha)	Simulated growing season length (days)
Normal Climate, Rainfed	1977-1978	MM752	3000	80-120	3039	165
Normal Climate, Irrigation	1977-1978	MM752	4000	80-120	2789	165
CCCM Climate 2xCO2, Rainfed	1977-1978	MM752	-	-	795	126
CCCM Climate 2xCO2, Irrigated	1977-1978	MM752	-	-	893	130
GFDL Climate 2xCO2, Rainfed	1977-1978	MM752	-	-	959	130
GFDL Climate 2xCO2, Irrigated	1977-1978	MM752	-	-	2338	137

Lusaka

Model	Year	Maize Cultivated	Actual yield (kg/ha)	Actual growing season length (days)	Simulated yield (kg/ha)	Simulated growing season length (days)
Normal Climate, Rainfed	1977-1978	MM603	3500	120-160	3635	156 135
Normal Climate, Irrigation	1977-1978	MM603	4000	120-160	4075	156
CCCM Climate 2xCO2, Rainfed	1977-1978	MM603	-	-	2765	135
CCCM Climate 2xCO2, Irrigated	1977-1978	MM603	-	-	2740	134
GFDL Climate 2xCO2, Rainfed	1977-1978	MM603	-	-	2765	137
GFDL Climate 2xCO2, Irrigated	1977-1978	MM603	-	-	3095	138

Mansa

Model	Year	Maize Cultivated	Actual yield (kg/ha)	Actual growing season length (days)	Simulated yield (kg/ha)	Simulated growing season length (days)
Normal Climate, Rainfed	1977-1978	MM601	2000-3500	150-180	3124	147
Normal Climate, Irrigation	1977-1978	MM601	4000	150-180	3124	147
CCCM Climate 2xCO2, Rainfed	1977-1978	MM601	-	-	3519	136
CCCM Climate 2xCO2, Irrigated	1977-1978	MM601	-	-	3519	136
GFDL Climate 2xCO2, Rainfed	1977-1978	MM601	-	-	3079	136
GFDL Climate 2xCO2, Irrigated	1977-1978	MM601	-	-	3079	136

Source: Based on Report by B Chirwa, M Phiri and P Mulenga (1998)

Table 4.2 DSSAT3 Simulated Mean Maize Yields (kg/ha) over 30 Years at 3 Stations in Zambia

Livingstone

Climate Scenario	10 Nov	20 Nov	30 Nov	10 Dec
Normal climate rainfed	417.9	750.5	939.63	1883.70
Normal climate irrigated	362.7	641.2	876.37	1862.40
CCCM $2xCO_2$ rainfed	138.0	469.2	472.5	637.23
CCCM $2xCO_2$ irrigated	182.0	518.8	604.0	823.07
GFDL $2xCO_2$ rainfed	188.6	602.4	644.4	839.77
GFDL $2xCO_2$ irrigated	192.8	701.0	677.8	1121.67

Lusaka

Climate Scenario	10 Nov	20 Nov	30 Nov	10 Dec
Normal climate rainfed	1792.5	2110.5	2258.0	2347.7
Normal climate irrigated	1938.1	2260.9	2356.8	2351.7
CCCM $2xCO_2$ rainfed	3306.0	3172.9	3205.7	3549.9
CCCM $2xCO_2$ irrigated	3436.6	3348.8	3480.5	4088.9
GFDL $2xCO_2$ rainfed	3461.0	3327.0	3480.5	3970.6
GFDL $2xCO_2$ irrigated	3585.4	3520.0	3748.1	4434.7

Table 4.2 DSSAT3 Simulated Mean Maize Yields (kg/ha) over 30 Years at 3 Stations in Zambia Livingstone (continued)

Mansa

Climate Scenario	10 Nov	20 Nov	30 Nov	10 Dec
Normal climate rainfed	405.4	452.3	246.8	424.9
Normal climate irrigated	405.4	388.9	191.5	88.6
CCCM $2xCO_2$ rainfed	2323.9	2550.0	2397.2	2206.1
CCCM $2xCO_2$ irrigated	2323.9	2550.0	2397.2	2206.1
GFDL $2xCO_2$ rainfed	977.0	1264.0	1295.9	1271.8
GFDL $2xCO_2$ irrigated	259.0	459.0	754.5	945.2

Table 4.3 Water balance Parameters for Maize at Livingstone, Lusaka and Mansa

Livingstone

Model	Precipitation (mm)	Evapotranspiration (mm)	Runoff (mm)	Extr Water (mm)	Drainage (mm)
Normal climate rainfed	748.0	206.0	13.1	145.3	529.5
Normal climate irrigated	748.0	515.1	13.3	148.2	560.0
CCCM $2xCO_2$ rainfed	548.0	209.6	6.7	145.1	381.0
CCCM $2xCO_2$ irrigated	601.0	218.1	6.9	148.1	404.8
GFDL $2xCO_2$ rainfed	738.7	221.3	12.0	145.1	497.1
GFDL $2xCO_2$ irrigated	734.4	231.1	13.0	148.2	536.5

Lusaka

Model	Precipitation (mm)	Evapotranspiration (mm)	Runoff (mm)	Extr Water (mm)	Drainage (mm)
Normal climate rainfed	807.6	319.1	69.2	179.8	452.1
Normal climate irrigated	807.6	328.1	69.2	198.7	579.4
CCCM $2xCO_2$ rainfed	692.2	309.1	64.4	184.6	457.3
CCCM $2xCO_2$ irrigated	692.2	312.3	68.7	184.9	524.3
GFDL $2xCO_2$ rainfed	692.2	309.1	69.4	184.6	457.3
GFDL $2xCO_2$ irrigated	607.6	314.8	69.6	187.7	568.1

Mansa

Climate Scenario	Precipitation (mm)	Evapotranspiration (mm)	Runoff (mm)	Extr Water (mm)	Drainage (mm)
Normal climate rainfed	2927.4	633.5	477.0	324.9	1685.1
Normal climate irrigated	2927.4	634.2	474.0	329.9	1789.1
CCCM $2xCO_2$ rainfed	2951.6	631.9	489.6	334.1	1689.0
CCCM $2xCO_2$ irrigated	2951.6	631.9	489.6	334.1	1689.0
GFDL $2xCO_2$ rainfed	3426.7	637.5	736.4	334.7	1904.0
GFDL $2xCO_2$ irrigated	3426.7	661.2	732.5	338.8	1887.1

Table 4.4 Selected Nitrogen Availability Parameters for Maize at Livingstone, Lusaka and Mansa

Livingstone

Model	N leached (kg/ha)	Soil N (kg/ha)	Tops N (kg/ha)
Normal climate rainfed	108.2	188.0	54.6
Normal climate irrigated	109.1	191.0	49.8
CCCM $2xCO_2$ rainfed	78.2	216.1	57.8
CCCM $2xCO_2$ irrigated	86.8	210.8	60.5
GFDL $2xCO_2$ rainfed	98.9	201.7	54.6
GFDL $2xCO_2$ irrigated	106.8	188.9	59.2

Table 4.4 Selected Nitrogen Availability Parameters for Maize at Livingstone, Lusaka and Mansa (Continued)

Lusaka

Model	N leached (kg/ha)	Soil N (kg/ha)	Tops N (kg/ha)
Normal climate rainfed	108.2	188.0	54.6
Normal climate irrigated	109.1	191.0	49.8
CCCM $2xCO_2$ rainfed	78.2	216.1	57.8
CCCM $2xCO_2$ irrigated	86.8	210.8	60.5
GFDL $2xCO_2$ rainfed	98.9	201.7	54.6
GFDL $2xCO_2$ irrigated	106.8	188.9	59.2

Mansa

Model	N leached (kg/ha)	Soil N (kg/ha)	Tops N (kg/ha)
Normal climate rainfed	190.0	201.4	75.5
Normal climate irrigated	219.0	178.0	62.2
CCCM $2xCO_2$ rainfed	200.3	174.6	97.3
CCCM $2xCO_2$ irrigated	200.3	174.6	97.3
GFDL $2xCO_2$ rainfed	239.3	163.7	55.2
GFDL $2xCO_2$ irrigated	159.0	146.2	19.7

Table 4.5 DSSAT3 Simulated Mean Sorghum Yields (kg/ha) over 30 Years at 3 Stations in Zambia

Livingstone

Climate Scenario	20 Nov	25 Nov	30 Nov	10 Dec
Normal Climate rainfed	351.3	216.2	77.7	208.8
Normal Climate irrigation	432.6	77.4	49.4	208.8
CCCM 2 x CO_2 rainfed	479.5	114.4	107.1	296.0
CCCM 2 x CO_2 irrigation	432.6	77.4	49.4	296.0
GFDL 2 x CO_2 rainfed	479.5	114.4	107.1	296.0
GFDL 2 x CO_2 irrigation	432.6	77.4	49.4	296.0

Lusaka

Climate Scenario	20 Nov	25 Nov	30 Nov	10 Dec
Normal Climate rainfed	38.0	146.6	344.6	522.3
Normal Climate irrigation	174.5	5.7	194.4	456.1
CCCM 2 x CO_2 rainfed	451.6	254.4	415.3	610.8
CCCM 2 x CO_2 irrigation	400.7	22.6	290.7	535.4
GFDL 2 x CO_2 rainfed	451.6	254.4	415.3	610.8
GFDL 2 x CO_2 irrigation	226.4	22.6	290.7	535.4

Mansa

Climate Scenario	20 Nov	25 Nov	30 Nov	10 Dec
Normal Climate rainfed	913.5	545.5	336.6	63.6
Normal Climate irrigation	797.4	445.3	227.2	46.6
CCCM 2 x CO_2 rainfed	1055.4	631.5	404.6	76.3
CCCM 2 x CO_2 irrigation	924.4	552.3	378.6	126.4
GFDL 2 x CO_2 rainfed	1095.6	681.6	520.5	198.3
GFDL 2 x CO_2 irrigation	926.5	552.8	381.6	132.6

Table 4.6 Water Balance Parameters for Sorghum at Livingstone, Lusaka and Mansa

Livingstone

Model	Precipitation (mm)	Evapotranspiration (mm)	Runoff (mm)	Extr Water (mm)	Drainage (mm)
Normal climate rainfed	682	166	13	146	499
Normal climate irrigated	675	173	12	148	575
CCCM 2xCO_2 rainfed	682	166	13	146	499
CCCM 2xCO_2 irrigated	675	170	12	147	564
GFDL 2xCO_2 rainfed	682	166	13	146	499
GFDL 2xCO_2 irrigated	675	173	12	146	575

Lusaka

Model	Precipitation (mm)	Evapotranspiration (mm)	Runoff (mm)	Extr Water (mm)	Drainage (mm)
Normal climate rainfed	806.90	284.86	68.66	284.86	452.17
Normal climate irrigated	806.90	302.86	68.66	302.86	563.79
CCCM 2xCO_2 rainfed	806.90	284.41	68.69	384.41	452.38
CCCM 2xCO_2 irrigated	806.90	289.52	68.07	289.52	517.72
GFDL 2xCO_2 rainfed	806.90	284.41	68.69	284.41	452.38
GFDL 2xCO_2 irrigated	806.90	297.83	68.97	297.83	554.28

Mansa

Model	Precipitation (mm)	Evapotranspiration (mm)	Runoff (mm)	Extr Water (mm)	Drainage (mm)
Normal climate rainfed	2857.21	636.69	470.24	325.03	1624.38
Normal climate irrigated	2857.21	639.52	469.69	324.62	1682.90
CCCM 2xCO_2 rainfed	983.72	200.28	167.03	325.48	490.07
CCCM 2xCO_2 irrigated	2857.21	636.66	469.86	324.86	1675.10
GFDL 2xCO_2 rainfed	2857.21	632.55	470.72	325.55	1627.69
GFDL 2xCO_2 irrigated	2857.21	363.62	469.90	324.86	1675.10

Table 4.7 Selected Nitrogen Availability Parameters for Sorghum at Livingstone, Lusaka and Mansa

Livingstone

Model	N leached (kg/ha)	Soil N (kg/ha)	Tops N (kg/ha)
Normal climate rainfed	171	158	4
Normal climate irrigated	186	144	3
CCCM 2xCO_2 rainfed	171	158	5
CCCM 2xCO_2 irrigated	183	147	3
GFDL 2xCO_2 rainfed	171	158	5
GFDL 2xCO_2 irrigated	186	144	3

Lusaka

Model	N leached (kg/ha)	Soil N (kg/ha)	Tops N (kg/ha)
Normal climate rainfed	52.97	231.83	7.14
Normal climate irrigated	76.1	197.21	6.41
CCCM 2xCO_2 rainfed	53.0	231.00	7.72
CCCM 2xCO_2 irrigated	63.83	214.52	7.14
GFDL 2xCO_2 rainfed	53.0	231.00	7.72
GFDL 2xCO_2 irrigated	74.1	200.34	6.97

Table 4.7 Selected Nitrogen Availability Parameters for Sorghum at Livingstone, Lusaka and Mansa (Continued)

Mansa

Model	N leached (kg/ha)	Soil N (kg/ha)	Tops N (kg/ha)
Normal climate rainfed	222.24	126.31	18.17
Normal climate irrigated	227.55	121.72	15.93
CCCM $2xCO_2$ rainfed	82.59	125.79	20.48
CCCM $2xCO_2$ irrigated	176.86	190.28	19.14
GFDL $2xCO_2$ rainfed	177.72	165.10	22.59
GFDL $2xCO_2$ irrigated	183.52	261.48	19.31

Table 4.8 Simulation of Groundnut Growing Season Yields Using DSSAT3 Simulation of Sorghum Production at sites in Zambia

Livingstone

Model	Year	Groundnut Cultivar	Actual Yield (kg/ha)	Actual Growing Season (days)	Simulated Yield (kg/ha)	Simulated Growing Season length (days)
Normal climate rainfed	1977-1978	Makulu Red	140	80-120	676	181
Normal climate irrigated	1977-1978	Makulu Red	140	80-120	663	181
CCCM $2xCO_2$ rainfed	1977-1978	Makulu Red			727	181
CCCM $2xCO_2$ irrigated	1977-1978	Makulu Red			663	181
GFDL $2xCO_2$ rainfed	1977-1978	Makulu Red			676	181
GFDL $2xCO_2$ irrigated	1977-1978	Makulu Red			663	181

Lusaka

Model	Year	Groundnut Cultivar	Actual Yield (kg/ha)	Actual Growing Season (days)	Simulated Yield (kg/ha)	Simulated Growing Season length (days)
Normal climate rainfed	1977-1978	Chalimbana	1900	120-160	1040	153
Normal climate irrigated	1977-1978	Chalimbana	1900	120-160	1021	153
CCCM $2xCO_2$ rainfed	1977-1978	Chalimbana		-	1049	153
CCCM $2xCO_2$ irrigated	1977-1978	Chalimbana		-	1030	153
GFDL $2xCO_2$ rainfed	1977-1978	Chalimbana		-	1049	153
GFDL $2xCO_2$ irrigated	1977-1978	Chalimbana		-	1030	153

Mansa

Model	Year	Groundnut Cultivar	Actual Yield (kg/ha)	Actual Growing Season (days)	Simulated Yield (kg/ha)	Simulated Growing Season length (days)
Normal climate rainfed	1976-1977	Natal Common	1090	150-180	676	168
Normal climate irrigated	1976-1977	Natal Common	1090	150-180	663	168
CCCM $2xCO_2$ rainfed	1976-1977	Natal Common			727	168
CCCM $2xCO_2$ irrigated	1976-1977	Natal Common			663	168
GFDL $2xCO_2$ rainfed	1976-1977	Natal Common			676	168
GFDL $2xCO_2$ irrigated	1976-1977	Natal Common			663	168

Table 4.9 Water Balance Parameters for Groundnut at Livingstone, Lusaka and Mansa

Livingstone

Model	Precipitation (mm)	Evapotr (mm)	Runoff (mm)	Extr Water (mm)	Drainage (mm)
Normal climate rainfed	440.0	470.0	10.0	36.0	267.0
Normal climate irrigated	885.0	385.0	17.0	37.0	640.0
CCCM $2xCO_2$ rainfed	440.0	262.0	10.0	37.0	273.0
CCCM $2xCO_2$ irrigated	885.0	385.0	17.0	37.0	640.0
GFDL $2xCO_2$ rainfed	440.0	262.0	10.0	37.0	273.0
GFDL $2xCO_2$ irrigated	885.0	376.0	17.0	38.0	647.0

Lusaka

Model	Precipitation (mm)	Evapotr (mm)	Runoff (mm)	Extr Water (mm)	Drainage (mm)
Normal climate rainfed	485	287	59	93	259
Normal climate irrigated	485	289	63	93	304
CCCM $2xCO_2$ rainfed	485	280	59	94	364
CCCM $2xCO_2$ irrigated	485	282	63	95	309
GFDL $2xCO_2$ rainfed	485	280	59	94	264
GFDL $2xCO_2$ irrigated	485	282	63	95	209

Mansa

Model	Precipitation (mm)	Evapotr (mm)	Runoff (mm)	Extr Water (mm)	Drainage (mm)
Normal climate rainfed	1449.0	292.0	277.0	346.0	728.0
Normal climate irrigated	1449.0	291.0	303.0	346.0	751.0
CCCM $2xCO_2$ rainfed	1449.0	294.0	297.0	345.0	724.0
CCCM $2xCO_2$ irrigated	1449.0	291.0	303.0	346.0	751.0
GFDL $2xCO_2$ rainfed	1449.0	292.0	277.0	346.0	728.0
GFDL $2xCO_2$ irrigated	1449.0	291.0	303.0	346.0	751.0

Table 4.10 Selected Nitrogen Availability Parameters for Groundnut at Livingstone, Lusaka and Mansa

Livingstone

Model	N leached (kg/ha)	Soil N (kg/ha)	Tops N (kg/ha)
Normal climate rainfed	46.00	28.0	42.0
Normal climate irrigated	120.00	28.0	39.0
CCCM $2xCO_2$ rainfed	47.0	28.0	42.0
CCCM $2xCO_2$ irrigated	120.0	28.0	39.0
GFDL $2xCO_2$ rainfed	47.0	28.0	42.0
GFDL $2xCO_2$ irrigated	120.0	28.0	39.0

Lusaka

Model	N leached (kg/ha)	Soil N (kg/ha)	Tops N (kg/ha)
Normal climate rainfed	12	36	100
Normal climate irrigated	14	36	96
CCCM $2xCO_2$ rainfed	12	35	99
CCCM $2xCO_2$ irrigated	15	35	95
GFDL $2xCO_2$ rainfed	12	35	99
GFDL $2xCO_2$ irrigated	15	35	95

Mansa

Model	N leached (kg/ha)	Soil N (kg/ha)	Tops N (kg/ha)
Normal climate rainfed	55.0	42.0	49.0
Normal climate irrigated	56.0	42.0	47.0
CCCM $2xCO_2$ rainfed	52.0	41.0	55.0
CCCM $2xCO_2$ irrigated	56.0	42.0	47.0
GFDL $2xCO_2$ rainfed	55.0	42.0	49.0
GFDL $2xCO_2$ irrigated	56.0	42.0	47.0

Source: Based on Report by B Chirwa, M Phiri and P Mulenga (1998).

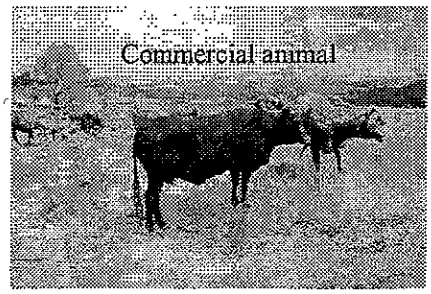
The Livestock Sub-sector

The Livestock sub-sector falls under the Ministry of Agriculture, Food and Fisheries. Major species of livestock reared in Zambia include cattle, goats, pigs, sheep and poultry.

The Vulnerability and Adaptation study addressed livestock susceptibility to meteorological variables depicting climate change within agro-ecological zone II only.

Scope of Assessment

As stated above, the study only covered agro-ecological zone II whose


Commercial animal

selection was based on it having the largest livestock population in the country.

Methodology

Effort was directed towards determining the effect of climatic indicators namely temperature, rainfall, relative humidity, solar radiation, day-length and wind speed on livestock production.

No IPCC recommended primary approach for creating climate change scenarios was employed in this study. The meteorological variables – livestock population's correlation analysis was done using empirical approaches without model-backed simulations.

Results

There was a general decline in livestock population statistics over a five-year period (1990-1995) even though no correlation between climatic indicators and livestock population was observed. The decline in population statistics may have been due to inherent factors in the sector such as poor nutrition especially in the dry season which contributes to high calf and adult mortality of between 25 – 30 percent in small-holder farming community and 2 percent in commercial farming sector; livestock diseases; poor animal husbandry practices; weak linkage between livestock extension and research and poor marketing infrastructure.

Adaptation Measures, Policy Framework and Programme

Adaptation measures have been recommended to deal with effects of drought and excessive rain conditions on livestock production in the country. The measures are in harmony with sectoral response policy strategies devised following previous experience of drought and excessive rain.

The overall government policy objective for the livestock sub-sector is to encourage its development in order to expand the supply of livestock products and improve food security, generate incomes and employment, contribute to industrial development and the country's balance of payments; and increase the use of animal draught power.

The measures, policies and programmes are presented below:-

- *Encouraging farmers to use crop residues of groundnuts, cotton, beans and urea molasses and minerals to supplement livestock nutrition during drought.*

Policy: Animal production and disease prevention.

Programmes: The Southern Province Household Food Security Programme (SPHFSP) sensitizes farmers to collect crop residues from the field and store them at homesteads. The farmers are also trained on how and when to give crop residues to

animals and also how to treat crop residues to make them more palatable.

The department of Research and Specialist Service – Animal Production and Health Sub-programme in collaboration with other institutions such as the University of Zambia and National Institute for Scientific and Industrial Research are involved in training traditional small-holder farmers in on-farm manufacture of urea-molasses multi-nutrient blocks using simple equipment.

Moreover, the Palabana Dairy Training Institute demonstrates to farmers its findings on successful responses of animals fed on treated supplements of dry season foodstuffs.

- *Sinking wells and boreholes at community level to boost water supply in vulnerable areas.*

Policy: Animal production and disease prevention.

Programmes: The projects involving sinking of wells and boreholes in vulnerable areas are funded through the Rural Investment Fund (RIF) particularly in Southern Province. Recent strategies have called for the local communities to contribute a certain percentage towards the costs of putting up or rehabilitating agricultural infrastructure.

The context under which the RIF – a World Bank Project, is implemented requires the local communities to contribute their labour and locally available raw materials. This fosters a sense of ownership and pride in the community.

- *Restocking in badly affected areas.*

Policy: Animal production and disease prevention.

Programmes: The Department of Animal Production and Health (DAPH) collaborates with other relevant institutions to train small-holder farmers especially in Eastern, Southern and Western provinces in sustainable range management techniques in order to improve their communal grazing areas. The farmers are also advised on the need for control in stocking animals on pastures to allow for required carrying capacities.

Under critical periods such as the 1991/92 drought, animals were translocated to areas with relative surplus of fodder while badly affected areas were restocked.

- *Promoting the rearing of drought-tolerant goats.*

Policy: Animal production and disease prevention.

Programmes: Since 1996, the Livestock Development Center in Batoka has been involved in goat production for milk under the UNDP funded project called the Smallholder Farmers System Diversification. The Center disseminates information to farmers on the importance of rearing goats due to their drought-tolerance and highly nutritious milk.

The Golden Valley Agricultural Research Trust (GART) also promotes goat rearing among smallholder farmers.

- *Extension services capacity to be strengthened through the provision of adequate transport and housing to livestock personnel if current policy objectives are to be realised.*

Policy: Animal production and disease prevention.

Programmes: The Department of Animal Production and Health provides literature to farmers to augment the on-farm practical skills imparted through extension services. The department also contracts private entrepreneurs to supplement government efforts in reaching out to farmers. The newly launched Private Sector Animal Development Programme would tremendously complement government

efforts in rendering extension services if appropriately supported.

- *Capacity building within the livestock sector should be accorded high priority.*

Policy: Disease and pest control.

Programmes: The Ministry of Agriculture, Food and Fisheries has programmes aimed at building technical capacity in the extension unit by training extension officers and farmers to expedite the dissemination and appreciation of on-farm technologies that will boost livestock production. In peri-urban areas, private veterinary practices supplement government capacity by providing disease and pest control services to commercial farmers.

- *For livestock sustainability to occur participatory methodologies like Participatory Rural Appraisal (PRA) and Participatory Needs Assessment (PNA) should be promoted*

Policy: Animal production and disease prevention.

Programme: In 1999, livestock production personnel in North-Western, Copperbelt, Central, Lusaka and Western provinces were trained in PRA and PNA methodologies under the Participatory Extension Approach (PEA) programme. In Luapula province, the programme was launched earlier through funding from the Finnish government. The programme will be extended to other provinces and is expected to sustain livestock extension activities by incorporating farmers input in service delivery.

The Fisheries sub-sector

The Fisheries sub-sector is administered under the Ministry of Agriculture, Food and Fisheries. It has a significant contribution to the national economy.

Effects of climate change will therefore render the fishery sub-sector vulnerable based on its socio-economic significance to the country.

Scope of Assessment

The vulnerability and adaptation study on Fisheries covered selected fishery areas representing the three agro-ecological zones of Zambia. The selected fisheries are Lake Kariba, Lake Itezhi-tezhi/Kafue river and Mweru-Luapula representing agro-ecological zones I, II and III respectively. All these fisheries are inland fresh water ecosystems as Zambia is a landlocked country.

The study focused on the effect of variations in climatic indicators on fresh water fishery and fish farming. Only fish species of commercial importance were considered in the study and they include Breams, Sardines, Catfish and Labeo whose habitat preferences and distribution are widespread throughout the three agro-ecological zones.

Fishing in Lake Mweru

Methodology

Meteorological variable and habitat parameters (e.g. temperature, rainfall, water depth and vegetation) were studied in

relation to fish production, abundance and distribution.

Two approaches were employed namely to establish effects of temperature change on fish growth and feeding on one hand and impacts of change in fish habitat conditions (e.g. flow rates and water depth) on fish migration and spawning on the other.

Results

The study observed that lower rainfall would reduce nutrient levels in rivers and lakes (major fisheries) leading to reduced fish breeding activity and hence depletion of fish species in the long-term. Commercial fish species (e.g. breams, sardines etc) in the drought-prone agro-ecological zones I and II were particularly identified as being most vulnerable to such climatic change.

Conversely, a rise in water levels in river channels would submerge the surrounding swamps and dambos thereby turning them into ideal fish breeding grounds resulting in increased population in the long-term.

Fish farming would undergo similar consequences from reduced water levels in ponds.

Adaptation measures, Policy framework and Programmes

Under the Agriculture Sector Investment Programme, the overall policy objective of the fishery sub-sector is to ensure that it makes a maximum sustainable contribution to the national economy through improved nutrition, generation of income and creation of gainful employment particularly in rural areas.

Adaptation measures can be implemented within this policy framework and programmes derived from specific sectoral objectives.

- *Strict licencing to regulate influx of fishermen to fisheries.*

Policy: Capture fisheries.

Programmes: The Fisheries department acknowledges the significance of strict licensing as it controls the number of people going to fisheries thereby limiting exploitation of the resource to optimise fishing. However, the department has limited capacity to enforce strict licensing due to inadequate manpower and financial constraints. One of the policy objectives of the fisheries sub-sector under ASIP is to involve local communities in management, planning, formulation and implementation of sound strategies. This objective is being implemented under the co-management programme. The administrative structure of co-management programme comprises village management committee, zonal fishery committee, fisheries district committee and fisheries central committee.
Kariba and Bangweulu fisheries communities have so far mobilised, formed committees and resettled fishermen. Under the programme, local communities are the managers of the resource and can regulate fish bans.

The major constraints in implementation of co-management at the moment include lack of legislation and legal framework to empower the committees. This has however, been addressed in the new draft fisheries bill before Parliament where co-management approach has been incorporated. The bill also outlines how the licensing system will be implemented in the new Fisheries Act.

- *Promotion of fish farming and encourage fish conservation.*

Policy: Capture fisheries.

Programmes: Aquaculture or fish farming has been incorporated in the new Act. The objective is to encourage aquaculture to reduce pressure on natural fisheries. It also aims at promoting farming of fast growing and acceptable fish species by households with fish ponds so as to increase production and enhance food security.

American Peace Corps and the UNDP Smallholder Project are supporting the aquacultre promotion programme.

Under the fish conservation programme, protected species include *Tilapia spp*, *Labeo spp* and *Clarias spp*.

- *To develop fish research in both the natural fisheries and aquaculture. It is therefore essential to conduct research in the physical and biological factors affecting availability and abundance of fish. Moreover, adaptive measures ought to be carried out in order to facilitate sustainable fisheries management.*

Policy: Capture fisheries and Aquaculture.

Programmes: Research in aquaculture involves generation of information useful in sound management to enhance production. Activities focus on species that are culturable, feed formulations, growth characteristics of fish and general production of hybrids.

Research in natural fisheries is demand-driven in which the discovered information is passed on to the extension department for dissemination to communities.

Biological research in natural fisheries focuses on the frequency of breeding, how to protect breeding populations, and how long it takes for commercial species e.g. sardines, to mature.

Limnological studies in natural fisheries concentrate on correlation of amount of plankton to fish abundance.

Successful adaptive research was conducted in Itezhi-tezhi dam where limnological investigations revealed that its phytoplankton and zooplankton are similar to those of Lake Kariba and Tanganyika. In 1992, sardine (kapenta) species from Lake Tanganyika were moved into Lake Itezhi-tezhi and production increased between 2 to 3000 metric tonnes per potential yield. By 1999, sardines in Itezhi-tezhi had reached exportable levels.

Under the Lake Tanganyika Research Project in limnology that has been running for 9 years with funding from FINNIDA and FAO, fish abundance studies to estimate the biomass of fish stocks using hydrocostic techniques have been conducted.

Future research will focus on gear technology, liftnet and many others.

- *Facilitating development of water harvesting techniques by construction of conservation dams so that during drought years water is available to farmers to ensure that fish farming as an economic activity is not affected at community level.*

Policy: Currently no specific policy.

Programmes: The fisheries department has no conservation dams and relies on dams already built by the Water department under Rural Investment Fund (RIF). The department has plans to identify, with donor assistance, conservation dams that will be stocked with fish to ensure availability during critical years. It is also addressing the dynamics of fish growth and fish threats in dams of Eastern and Southern provinces so as to devise programmes for sensitization of communities around those dams.

4.3 The Wildlife Sector

Wildlife plays an important role in the sustainable development of the country through provision of many ecological, nutritional, industrial raw materials, tourism and economic benefits.

Zambia has 19 National Parks covering about 6 percent of the country, and 34 GMAs covering a further 22 percent of the country. In addition, 31 game ranches stocked with 26 species of wildlife and 7 crocodile farms have been established in different parts of the country.

However, poaching, land-use pressure, bush fires and destruction of natural habitats continue threatening the wildlife and natural habitats in the country.

In order to strengthen wildlife conservation and management, Government in November 1999, transformed the National parks and Wildlife Service Department into an autonomous entity, the ZAWA (Zambia Wildlife Authority).

Scope of Assessment

The Vulnerability and Adaptation Study in Wildlife Sector focused on wildlife found in protected and ecologically sensitive areas. Thus, the vulnerability of the sector was investigated by considering the effects of climate change on two major categories of wildlife namely wetland animals (e.g. puku, lechwe, waterbuck etc.) and bush animals such as lion, elephant, buffalo etc.

Effort was made to describe possible impacts of climate change on wildlife habitats.

Methodology

An attempt was made to estimate potential adverse effects of temperature, rainfall and soil moisture content on wildlife found in protected and ecologically sensitive areas. Basically, the aim was to develop a relationship between drift in vegetation and its impact on wildlife habitat using analogue scenarios of drought and excessive rain conditions.

Results:

It was observed from available data sources that under drought conditions reduced soil moisture content would give rise to poor quality fodder, stress and uncontrollable migrations would in turn expose animals to poaching and predation. Under excessive rainfall, wetland animals (e.g. puku, lechwe, waterbuck etc) would suffer severely from abnormal inundation of their prefered habitat while bush animals like lion, elephant and buffalo would thrive from abundant food and water resources.

Adaptation Measures, Policy Framework and Programmes

The wildlife policy seeks to improve sustainable human welfare and hence conserve and use the nation's renewal resources wisely. Within this policy framework, there are several ongoing pogrammes that could enhance the implementation of some adaptation measures.

- *Sinking boreholes to provide water to game during drought conditions .*

Policy: Improve sustainable human welfare and hence conserve and use the nation's wildlife resources wisely.

Programmes: During the 1991/92 drought, many animals died due to inadequate surface water and poor quality fodder. As a result, some private safari enterprises sunk boreholes to provide water to wild animals and humans. By 1996, the following areas had boreholes where water is pumped by windmills as shown below:

Sichifulo Game Management Area (6 boreholes), Mulobezi Game Management Area (2 boreholes), Nabwalya Game Management Area (7 boreholes; 4 for animals and 3 for humans), Mwanya Game Management Area (3 boreholes) and Lupande Game Management Area (4 boreholes).

Government through the National Parks and Wildlife Services facilitated the exercise.

- *Curling of game to create conditions for wildlife sustainability.*

Policy: Improve sustainable human welfare and hence conserve and use the nation's wildlife resources wisely.

Programme: The department of National Parks and Wildlife Services (now known as Zambia Wildlife Authority (ZAWA)) curled hippos in the Luangwa valley and lechwe in the Lochnivar area of the Kafue flats in order to scale down populations to sustainable levels for the maintenance of ecological and aesthetic integrity of the habitats. The exercise is carried out whenever animal populations increase beyond the carrying capacities of their habitats.

- *Encouraging game ranching in order to protect vulnerable species as well as providing farmers with source of income.*

Policy: Improve sustainable human welfare and hence conserve and use the nation's wildlife resources wisely.

Programmes: In 1990, the Zambian Government authorized breeding of wild animals on private estates and since then, 31 Game ranches have been established in different parts of the country and are stocked with grazers and browsers for the promotion of tourism as well as providing game meat. The country also has 7 crocodile farms for tourism and other commercial benefits.

Currently, 26 species of wildlife are stocked in game ranches for both consumptive and non-consumptive uses.

- *To undertake research aimed at addressing adverse impacts of climate change on wildlife resources.*

Policy: Improve sustainable human welfare and hence conserve and use the nation's wildlife resources wisely.

Programmes: To date, no specific research has been conducted to establish
adverse impacts of climate change on wildlife. However, during the year 1999, the Wildlife Research Division of the National Parks and Wildlife services conducted large mammal counts in six National Parks and Game Management Areas (GMAs) respectively. The National Parks covered include Kafue, Luambe, Lochinvar, Blue Lagoon, North Luangwa and South Luangwa while the GMAs are Mumbwa, Lumimba, Lupande, Munyamadzi, sandwe and Kafue flats.
The newly formulated SADC Wildlife protocol has within its framework measures to minimise wildlife losses due to drought and floods.
It is envisaged that its sound management and proactive strategies will be incorporated into the new wildlife policy soon to be put into place for implementation.

- *Identifying and protecting migratory routes of wildlife.*

Policy: Improve sustainable human welfare and hence conserve and use the nation's wildlife resources wisely.

Programmes: There are many migratory routes of wildlife identified between National Parks and Game Management Areas – but no monitoring and protective measures have been put in place to manage them.

- *Undertaking protective management measures to protect displaced wildlife populations.*

Policy: Improve sustainable human welfare and hence conserve and use the nation's wildlife resources wisely.

Programme: The government promotes community participation in order to curb poaching and manage the wildlife resource on a sustainable basis. This is practiced through the Administrative Design for Game Management (ADMADE) model that incorporates benefit sharing.

4.4 The Forestry Sector

The forest resources provide a wide range of socio-economic benefits that include commercial timber (*Baikiaea plurijuga and Pterocarpus angolensis*), woodfuel, medicine, food and many others. The distribution of vegetation types is related to the amount of rainfall, moisture content and temperature existing in a given area. The main plateau soils of Zambia for instance are covered with miombo woodlands dominated by *Brachystegia*, *Julbernardia* and *Isoberlinia*. In the upper valley areas where temperatures are generally high with low rainfall the soils are covered with munga woodlands which are dominated by *Acacia* and *Combretum* species while mopane woodlands of the *Colophospernum* species dominate the lower valleys. Lastly, the alluvial floodplains are covered with tall grass and woody thickets on termite's moulds.

Scope of Assessment

Although all vegetation types in the country were considered, main focus was on miombo woodlands that are estimated to cover 60 percent of the country's total surface area and are a source of woodfuel for most Zambians followed by commercial timber of the Baikiaea species (Table 4.11).

Methodology

The SPSS/PC statistical programme was used to establish correlation between vegetation types and climatic variables. It's input climatic data for each province were averages calculated over thirty years.

Baikiaea flower

Results

The results from the SPSS/PC programme showed that the propotional distribution of miombo and chipya are positively correlated to mean seasonal raindays while the opposite was true for mopane, munga and kalahari vegetation types. The reverse is true when mean annual temperature is considered for both groups of vegetation. Projections of future vegetation distribution patterns indicated that under projected climatic variables[1], miombo woodland cover would suffer a 50 percent reduction across the country whereas mopane and munga would predominate. The kalahari and dry evergreen forest (e.g. *Cryptosepalum, Parinari and Marquesia*) would disappear. For another set of projected climatic variables[2] the country would be predominantly covered by miombo, chipya, kalahari and *Cryptosepalum* while mopane, munga and *Baikiaea* species would disappear (Tables 4.12 and 4.13.

[1] low rainfall (500 mm), high temperature (20°C) and few rain days (50 days)

Table 4.11 Distribution of Forest types by Province ('000' ha)

No.	Province	Miombo	Kalahari	Mopane	Munga	Cryptosepelum	Chipya	Baikiaea	Total
1	Central	5732	36	587	811	0	171	71	**7408**
2	C/Belt	2376	19	0	1	0	128	0	**2524**
3	Eastern	3110	0	1638	928	0	4	9	**5689**
4	Luapula	2941	0	0	1	0	524	1	**3467**
5	Lusaka	1539	0	0	468	0	0	48	**2055**
6	Northern	9528	0	1008	81	0	740	4	**11361**
7	N/West	5892	2513	17	28	952	52	50	**9504**
8	Southern	3275	828	1019	1044	0	0	222	**6388**
9	Western	440	6370	189	378	812	0	438	**8627**
Total		**34833**	**9766**	**4458**	**3740**	**1764**	**1619**	**843**	**57023**

Source : **Ndola. State of Environment Report, 1994, Based on FAO 1986 Study Report Forest Department Zambia**

Table 4.12: Provincial Vegetation Distribution Pattern by Forest Type in `000' hectares under projected climate variables[1]

No.	Province	Miombo	Kalahari	Mopane	Munga	Chipya	Baikiaea	Total
1	Central	2296	0	3111	2667	222	75	8371
2	C/Belt	782	0	0	909	76	0	.1767
3	Eastern	1764	0	2389	2048	171	57	6429
4	Luapula	1075	0	0	1248	104	35	2462
5	Lusaka	637	0	0	740	0	20	1397
6	Northern	3522	0	4772	4090	341	114	12839
7	N/West	2946	0	3992	3421	285	95	10739
8	Southern	1980	0	2683	2300	0	64	7027
9	Western	2674	0	3623	3106	0	86	9489
Total		17676	**0**	**20570**	20529	1199	546	**60520**

Source : Based on Report by Chipepo and Mwansa (1998)

Table 4.13: Provincial vegetation distribution pattern by forest type in `000' hectares under Projected climate variables [2]

No.	Province	Miombo	Kalahari	Mopane	Munga	Cryptosepelum	Chipya	Baikiaea	Total
1	Central	6297	5112	0	0	0	1333	0	12742
2	C/Belt	2145	1742	0	0	0	454	0	4341
3	Eastern	4836	0	0	0	0	1024	0	5860
4	Luapula	2947	0	0	0	0	624	0	3571
5	Lusaka	1747	0	0	0	0	0	0	1747
6	Northern	9657	0	0	0	0	370	0	10027
7	N/West	8074	6558	0	0	2471	2045	0	19148
8	Southern	5430	4408	0	0	0	0	0	9838
9	Western	7333	5953	0	0	2243	0	0	15529
Total		48466	23773	**0**	**0**	4714	5850	**0**	82803

Source : Based on Report by Chipepo and Mwansa (1998)

[2] high rainfall (2000 mm), many seosonal rain days (200 days) and low temperature (10°C)

Adaptation Measures, Policy framework and Programmes

The strategies proposed to adapt the sector to the above antincipated climatic changes include :

- *Promoting the use of alternative sources of energy (e.g. solar and biogas) in order to reduce pressure on miombo woodlands that are predominantly harvested for charcoal production especially in peri-urban areas, Northern and Luapula provinces.*

Policy 1 : Promote the wide application of NRSE technologies.

Policy 2 : Sustainable forest resources and ecosystem management.

Programmes : In Chapter 3 section 3.2.2 reference to DOE's involvement in promoting use of solar technology in order to reduce charcoal consumption was made. Insofar as the second policy is concerned, the Forest department has already presented a project proposal to the African Development Bank (ADB) that is designed to protect and conserve miombo and Baikiaea species in the country.

- *Establishing a forest resources data base.*

Policy 1 : Sustainable forest resources and ecosystem management.

Policy 2 : Forest research, extension and training

Programme : Under ESP and ZFAP, the Forest department is conducting a pilot project in Chibombo district for developing a forest data base. Training of foresters is envisaged under ZFAP all that is required are funds to implement various recommended programmes.

- *Capacity building and strengthening of instututional and legal framework for sustainable management of forest resources.*

Policy : Forest research, extension and training.

Programme: Within ZFAP, there is scope for implementing Joint Forestry Management practices. When funds are available, sub-programmes at district level would be implemented with involvement of NGOs like Women for Change for the purpose of highlighting gender issues for instance.

- *More research on data collection is needed if the sector is to benefit from use of accurate simulation models on climate change.*

Policy: Forest research, extension and training

Programme: Isolated inventories especially around the Copperbelt and Eastern provinces are being conducted under ESP in order to improve data collection and monitoring.

4.5 The Water Sector

Water is essential to life and Zambia has abundance of it. However, like other countries in the region, Zambia has experienced consistent droughts leading to water scarcity in most parts of the country. Similarly, excessive rainfall has inconvienced people living in the valley areas and towns having a high water table like Lusaka.

Scope of Assessment

The focus was on surface water potential

using data from the National Water Resources Master Plan (NWRMP) report prepared by JICA in 1995. Groundwater was not included in the projected water demand estimates shown below owing to the lack of accurate data. Nevertheless, the JICA report quotes estimates for surface and groundwater potentials calculated for an average year at 237 million m^3/day and 157 million m^3/day respectively.

Methodology

An estimation of surface water potential was conducted from the knowledge of water resources in the country. Projected water demands for the years 2005 and 2015 were then computed using baseline socio-economic scenarios namely population growth rates, agriculture expansion, industrialisation and conservative growth case (Table 4.14).

Results

The water balances between water demands and the water resources for the drought year with a ten year return period showed that Southern province is extremely vulnerable and does infact experience critical water shortages during drought conditions(Table 4.15).

Adaptation Measures, Policy Framework and Programmes

The following measures are designed to adapt the water sector to socio-economic demand scenarios described above .

They include :

- *Improvement of water resource management through development and implementation of well costed and phased integrated river basin management plans.*

Policy : Water Resources Management

Programmes: Through the SADC sponsored HYCOS Project launched in 1996/7, a telemetric sattelite based system that transmits water data of selected rivers to member states including Zambia has been installed. At country level, the National Water Policy of 1994 has since given rise to separation of water supply from water management issues thereby defining clear roles for water resources suastainable utilisation. The Ministry of Local Government and Housing co-ordinates water supply issues while water management is handled by the Ministry of Energy and Water Development.

- *Vesting ownership of groundwater in the State.*

Policy : Water Resource Management

Programe : Not fully integrated until the policy is clearly defined.

- *Strengtherning legal policy and Action Plans as well as institutional restructuring of the sector to promote private sector participation.*

Policy : Water Resource Management

Programmes : The Ministry of Energy and Water Development has formulated the Water Resources Action Plan (WRAP) in order to reinforce objectives of the National Water Policy. The main goal of the WRAP is to support the development of the nation's water resources management (WRM) capacity as well as implementing strategies for integrated and decentralised WRM and promote awareness in general. Implementation of the WRAP is being sponsored by the Norwegian Agency for Development Co-operation, the World Bank and the UNDP.

Table 4.14 **Total Projected Water Demands and Total Surface Water Resource Potential by Province. (Unit 1000 m^3 / day)**

Province	Base Scenario Agricultural Expansion			Base Scenario Industrialisation			Conservation Scenario			Water Resource Potential	
	1995	2005	2015	1995	2005	2015	1995	2005	2015	Avg.Yr.	Drgt. Yr.
Lusaka	859	1267	1501	895	1384	1718	848	1216	1402	10800	3700
C/Belt	1296	1859	2433	1331	1965	2472	1286	1811	2409	13000	6600
Central	679	1249	1285	686	1270	1328	678	806	835	33600	11000
N/West	81	491	922	84	513	723	80	279	544	38900	21500
Western	71	419	791	75	359	775	69	100	446	20300	16300
Southern	1819	2575	3178	1827	2721	3747	1815	2564	2877	5300	1200
Luapula	228	509	1570	226	513	1580	224	230	779	26300	17700
Northern	878	1092	1691	891	979	1606	883	943	1535	67500	44800
Eastern	132	487	822	158	591	993	147	357	684	21500	13400
Zambia	**6043**	**9948**	**14193**	**6173**	**10295**	**14942**	**6030**	**8306**	**11511**	**237200**	**136200**

Source :Based on Report by Mwanza and Nkolonganya 1998

Table 4.15 Water Balances for 3 Scenarios for Average Year and Drought Year (Unit 1000 m^3 / day)

			Lusaka	C/Belt	Central	N/West	Western	Southern	Luapula	Northern	Eastern	Zambia
Base Scenario Agricultural Expansion	1995	Average. Year	9941	11704	32921	38819	20229	3481	26072	66622	21368	**231157**
		Dr.ought Year	2841	5304	10321	21419	16229	**-619**	17472	43922	13268	**130157**
	2005	Average. Year	9533	11141	32351	38409	19881	2725	25791	66408	21013	**227252**
		Drought. Year	2433	4741	9751	21009	15881	**-1375**	17191	43708	12913	**126252**
	2015	Average. Year	9299	10567	32315	37978	19509	2122	24730	65809	20678	**223007**
		Drought. Year	2199	4167	9715	20578	15509	**-1978**	16130	43109	12578	**122007**
Base Scenario Industrialisation	1995	Average. Year	9905	11669	32914	38816	20225	3473	26074	66609	21342	**231027**
		Dr.ought Year	2805	5269	10314	21416	16225	**-627**	17474	43909	13242	**130027**
	2005	Average. Year	9416	11035	32330	38387	19941	2579	25787	66521	20909	**226905**
		Dr.ought Year	2316	4635	9730	20987	15941	**-1521**	17187	43821	12809	**125905**
	2015	Average. Year	9082	10528	32272	38177	19525	1553	24720	65894	20507	**222258**
		Drought. Year	1982	4128	9672	20777	15525	**-2547**	16120	43194	12407	**121258**
Conservation Scenario	1995	Average. Year	9952	11714	32922	38820	20231	3485	26076	66617	21353	**231170**
		Drought. Year	2852	5314	10322	21420	16231	**-615**	17476	43917	13253	**130170**
	2005	Average. Year	9584	11189	32794	38621	20200	2736	26070	66557	21143	**228894**
		Dr.ought Year	2484	4789	10194	21221	16200	**-1364**	17470	43857	13043	**127894**
	2015	Average. Year	9398	10591	32765	38356	18854	2423	18502	65965	20816	**217670**
		Drought. Year	2298	4191	10165	20956	15854	**-1677**	9902	43265	12716	**1117670**

Source : Based on Report by Mwanza and Nkolonganya 1998

4.6 The Health Sector

This sector addresses malaria morbidity and mortality rates as a function of impacts due to climate change. The choice of malaria as opposed to other diseases like pneumonia, diarrhoea, measles and malnutrition is meant to underscore its ranking as the top most killer disease in Zambia as well as being one that is widely researched and documented.

The endemicity of malaria depends on climate, topography conditions and socio-economic status of an area.. Generally, the hot and low lying river valleys in the country offer ideal mosquito breeding grounds throughout the year. Incidentally, these areas are highly populated and are at the same time destinations for tourist who visit the areas to view game etc. In the highland areas of the country between 1200-1400 meters above sea level malaria transmission is seasonal and may be absent during cooler months. In urban areas malaria transmission is prevalent in compounds surrounding big cities and towns.

The *Anopheles gambiae* is the vector of transmission while *Plasmodium. falciparum* is responsible for 97 percent of all recorded cases.

Scope of Assessment

Malaria vulnerability for selected towns namely Lusaka, Choma, Livingstone and Mansa representing agro-ecological Zones II, I and III respectively was considered.

Methodology

The focus in this study was centered on malaria incidence rate, distribution and transmission as functions of temperature, rainfall and relative humidity. The meteorological variables used were averages calculated over a period of ten years (1972-1982). The relationship between malaria incidence rates and temperature, rainfall and humidity was obtained by using a simple corelation co-efficient fomular as shown below :

$$r = \frac{\sum xy}{((\sum x^2)(\sum y^2))^{1/2}} \quad (N-2)$$

The significance of **r** was estimated by

$$f = \frac{r^2}{1-r^2}$$

Results

Notwithstanding data short-comings, it was shown that the months during which temperatures are low can be exploited to guide national efforts in preventing and controlling malaria disease. This takes advantage of the fact that high temperatures above the mosquitoe survival range (20°C to 25°C) would reduce the incidence rate, transmission and distribution of malaria. Similarly, excessive rainfall coupled with temperatures below 16°C would be detrimental to both mosquitoe and parasite development because heavy rainfall interferes with the mosquitoe reproductive cycle. This is due to a multiplicity of hostile vector disease pathogens that are at play. Generally, correlation was low between malaria incidence rate and humidity compared to temperature and rainfall.

Adaptation Measures, Policy Framework and Programmes

The following adaptation measures were recommended :

- *Redressing the imbalance created by the Malaria Extermination Act* (1964).

Policy : The Health Reforms (1992)

Programmes : The Health Reform Programme (1992) is currently being

implemented through the principles of equity, partnership and accountability throughout the country. It is felt that the policy framework for malaria control (1997) would assist in ensuring better control measures for malaria disease in the long-term.

- *Creation of Malaria Data Base.*

Policy: The Health Reforms (1992)

Programme: The partnership and collaboration that has evolved in recent years for the control and prevention of malaria represent unique support for building a data base of the various components of the malaria programme namely parasitological, entomological, epidemiological and sociological aspects.

When completed, this will form the basis for surveillance system whose components would include mapping, remote sensing and verification procedures.

- *Promotion of malaria awareness.*

Policy: The Health Reforms (1992)

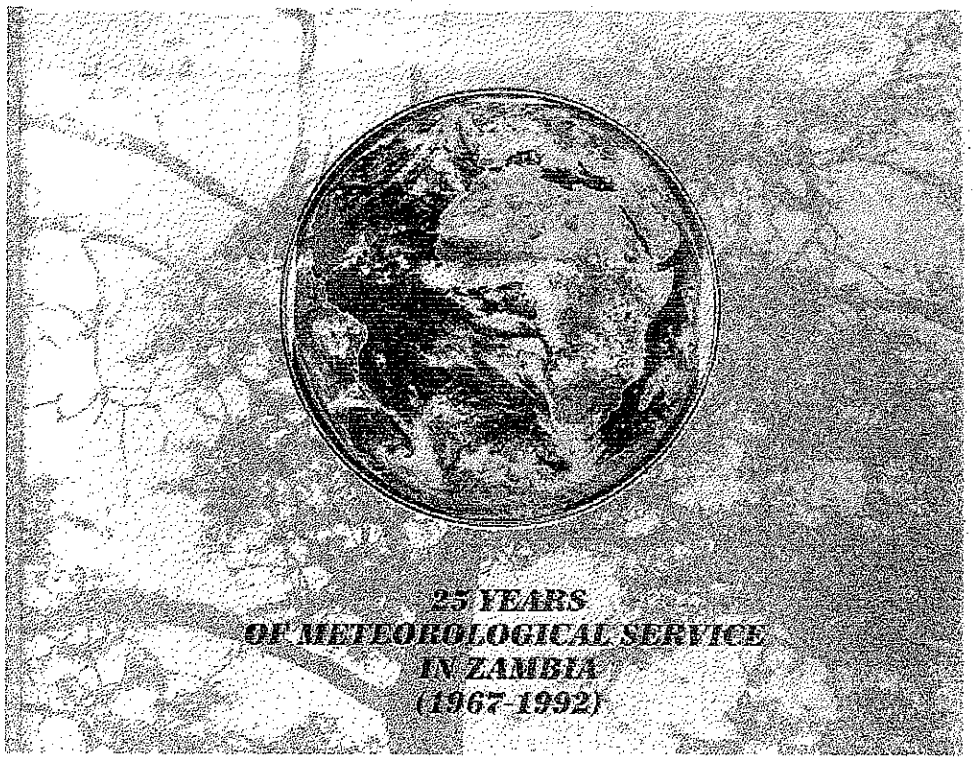
Programme: Zambia, under Roll Back Malaria programme sponsored by the WHO, is building sustainable malaria sub-programmes where local realities and situations through a series of consultative actions are entrenched.

CHAPTER 5

SYSTEMATIC OBSERVATIONS AND RESEARCH

The Meteorological Department of Zambia is the lead institution in climatic data observations and research in the country. Other institutions involved in climate related studies include the Copperbelt and Lusaka University, some NGOs and private companies.

The National Climate Change Study Committee (NCCSC) plans to undertake a review of study results obtained to date with the view to focus on study areas that deserve thorough investigation.



5.1 Introduction

This Chapter addresses climatic data observations and research both of which are part of the overall climate change study currently taking place in the country.

The Zambia Meteorological Department (ZMD) collects continuous and high quality homogenous meteorological observations. The type of data collected and observations made include rainfall, temperature, sunshine, humidity, solar radiation and cloud cover. A rain gauge is used for measuring rainfall while humidity is measured with a cyctometer or hygrograph. On the other hand a thermometer or a thermograph is used for temperature recordings while sunshine is measured with appropriate recorders. Cloud cover is physically observed every three hours daily and so far the ZMD's work has been satisfactory.

The ZMD operates over 40 observational network stations spread throughout the country for collecting climatic data as mentioned above. However, the network could be improved by reducing the distance between stations in order to conform to World Meteorological Organisation's standard of 240 km.

Zambia is fully involved in the activities of climate change with the following bodies:

- Inter-governmental Panel on Climate Change (IPCC)
- United Nations Framework Convention on Climate Change (UNFCCC)
- United Nations Environment Programme (UNEP)

The Ministry of Tourism Environment and Natural Resources (MTENR) is the focal point of climate change activities in the country. To date, Zambia has conducted a number of climate change related studies namely GHG inventories, mitigation analysis, vulnerability and adaptation and policy framework.

Among the ministries and institutions that have participated in these studies include:

- The Ministry of Environment and Natural Resources
- Ministry of Agriculture, Food and Fisheries
- Ministry of Energy and Water Development
- Ministry of Tourism
- Ministry of Health
- National Institute for Scientific and Industrial Research
- Centre for Energy, Environment and Engineering of Zambia
- Environmental Council of Zambia
- Denams Consultants
- Njuwe Consultants Limited
- The University of Zambia – Physics Department

5.2 Data Collection and Systematic Observations

Weather observations are measured at various synoptic and climatological stations spread throughout the country. This real time data is then sent to the forecast & research division for analysis. This recorded data is then processed and archived in the Climatology and Advisory Services Division.

However, the ZMD's programmes are adversely affected by:

a) Limited number of observation stations in the country which, in turn affect the reliability of climatic data collected and hence their usefulness to clients (e.g. departments of Tourism, Water Affairs and Agriculture).

b) Irregular inspection of existing observation stations due to lack of transport.

c) Deterioration in observations of upper radiosonde. This weakness compromises efficiency and safety of the aviation industry.

d) Shortage of basic equipment and skilled human resources. In most stations, basic equipment required for standard meteorological functions is absent. Moreover, skilled human resources are in short supply resulting in some stations submitting incomplete data sets on some meteorological parameters.

5.3 On-Going Research

At regional level, the Drought Monitoring Center in Zimbabwe provides monthly climatic data on seasonal variations to SADC member states. This data is useful in forecasting weather trends such that timely decisions could be made. Locally, the ZMD is involved in two research studies namely "occurrences of dry spells" and "Long-term study on trends of both rainfall and temperature variations in Zambia". Recently the latter study was updated from 1994 to date.

The World Meteorology Organisation facilitates workshops as well as providing weather global data to enable member states keep abreast with up to date information.

With the establishment of the National Climate Change Steering Committee (NCCSC), plans are underway to review all climate change studies with a view to bring out all important research issues that need to be studied in greater detail.

5.4 Future Research

Based on the analysis of previous study results, future research could include:

- Modelling of vegetation-climate interactions
- Climate change impacts on crops, fish, game and animal production together with associated economic implications
- Genetic improvement of crops with higher water use efficiencies and more tolerant to extreme weather events.
- Indirect effects of climate change on socio-economic sectors
- Effects of climate change impacts on human health
- Wider application of renewable energy resources
- Improvement on emission factors on land-use change and forestry
- Develop local specific emission factors in agriculture and waste management
- Study and determine the extent of the effect of spontaneous combustion of coal waste at Maamba Collieries on CO_2 and other GHG emissions.

5.5 Climate Data Bank and Services

Proper data management is vital to address climate change impacts. The Climate Data Bank and Services under the Zambia Meteorological Department falls short of meeting the needs of various institutions involved in climate change studies. There is need therefore to re-organise the Climate Data Bank and Services so that it would fulfil user data requirements. Close collaboration of the Climate Data Bank and Services with the Central Statistical Office should be strengthened.

CHAPTER 6

EDUCATION, TRAINING AND PUBLIC AWARENESS

Zambia has made commendable strides in promoting environmental awareness through formal, informal and non-formal systems. The Environmental Education and Public Awareness is a component of the National Environmental Action Plan (NEAP) that is being implemented through the Environmental Support Programme (ESP). Presently a number of institutions including the University of Zambia offer limited training opportunities in climate change related studies.

University of Zambia

6.1 Introduction

Studies on climate change conducted by government departments and institutions of higher learning including the holding of workshops by the National Climate Change Steering Committee (NCCSC) have created environmental awareness among the Zambian people.

6.2 Environmental Education

Informal education is one of the most effective ways of influencing public attitudes and behaviour. The electronic media (television and radio) as a tool for mass communication can make public outreach easy. Though not entirely satisfactory, dissemination of environmental news by the electronic media has of late become regular and sometimes qualitative.

Formally, environmental science is taught at primary, secondary and tertiary levels. At primary level the course content is very basic and covers interaction between man and nature and it is integrated in subjects like environmental science, social studies, home economics etc. At secondary level environmental education is only taught up to Grade 9 and it is integrated in subjects like biology, geography, general science, agriculture science and languages. The curriculum for senior classes is being revised to include environmental science beyond grade 9. At tertiary level, universities and colleges that have science schools/departments do offer study courses that are biased towards the environment (e.g. Environmental Management, Cleaner Production and Environmental Physics). The schools of Natural Sciences, agricultural sciences and engineering at University of Zambia and Copperbelt University afford a good example.

Government, NGOs and private companies have also contributed towards disseminating non-formal environmental education. The Chongololo Club of the air programme sponsored by the Bata Shoe Company and the ECZ newsletter sponsored by Barclays Bank of Zambia Limited are examples of how private companies have assisted in propagating environmental information.

6.3 Environmental Training

As part of Zambia's Enabling Activities, the Environmental Council of Zambia conducted a training workshop for print and electronic media personnel. The training workshop brought together 16 Journalists who were trained in climate change activities. The objective of the training workshop was to train journalist on climate change matters and give them necessary skills to develop cost effective public awareness programmes that will assist in disseminating climate change information to the general public and thus increase awareness.

Another training workshop involved Government Planning Officers who it is hoped would integrate the findings of the various climate change studies into the national development plans.

Similarly, there is need to enhance capacity of the National Study Teams (NST). The NST comprises various professionals with different backgrounds. Capacity building in various climate change matters is therefore necessary if existing expertise is to contribute more effectively. In this regard, training is required in the following areas:

- Climate change assessments (GHG inventories, mitigation , vulnerability and adaptation assessments)
- Linkages of vulnerability and adaptation with climate change variations
- Developing JI, AIJ and CDM projects
- Designing government programmes and preparation of national plans for

implementing mitigation options and adaptation technologies

- Activity data and emission factors (default values have been used in most sections of the studies)
- Land-use, change and forestry
- Policy assessments
- Macro-economic evaluation of mitigation options
- Sectoral composition of energy technologies and their energy intensities and cost.
- Energy efficiency, conservation and substitution
- Enhancing skills in project proposal formulation, economic, financial and environmental assessments.

6.4 Public Awareness

Discussions, dissemination and consultative workshops on climate change issues in Zambia have been organised by the Environmental Council of Zambia since 1997. Key stakeholders were invited to these workshops for consultations and dissemination of information to them. These activities have helped to encourage and stimulate interest in climate change and its environmental impacts in the various sectors of the national economy.

A Climate Change Newsletter published quarterly by the Environmental Council of Zambia presents news items and articles on various activities on climate change taking place in Zambia. The newsletter is widely circulated to key stakeholders and the international community.

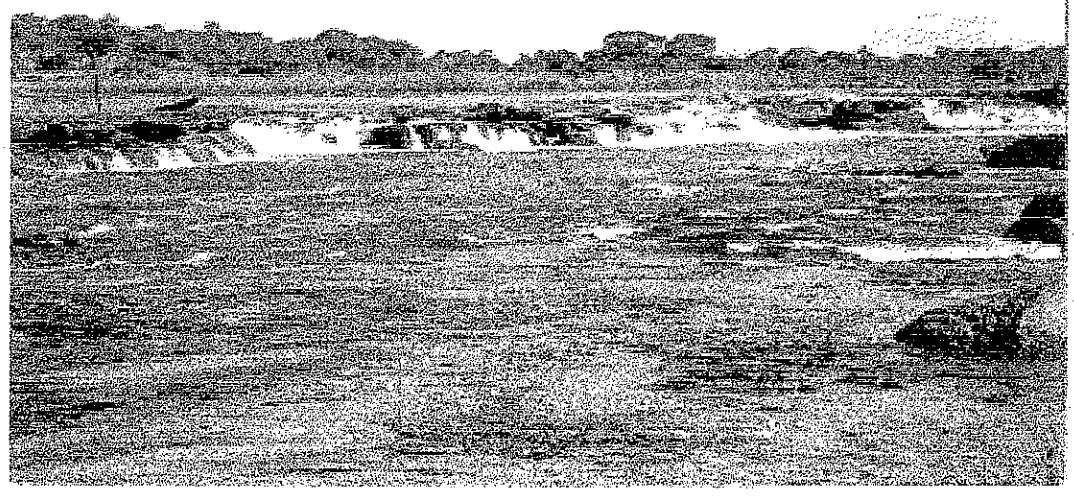
Enviro-line is another quarterly publication by the Environmental Council of Zambia. It is an environmental education and public awareness magazine. The magazine has a wider audience, which includes communities, media organisations, government departments and schools. The magazine contains wide range environmental issues on activities of the Environmental Council of Zambia, NGOs, government and communities. In addition, the ECZ Communication Unit gives lectures and talks in schools and community groups on environmental matters.

CHAPTER 7

IMPLEMENTATION MECHANISMS FOR CLIMATE CHANGE

Some districts in remote parts of Zambia depend on diesel power generators for electricity generation. Besides being costly to run these generators emit large amounts of GHGs. One way of reducing GHG emissions from diesel generators is by replacing them with mini-hydros wherever the option is economically feasible. There exist suitable sites for mini-hydro development in districts referred to above and which development could attract funding under the AIJ mechanism.

Cascade falls ideal for minihydro development



7.1 Introduction

Financing mechanisms of the Climate Change Convention could offer Zambia opportunities for development. Recently, two workshops on Clean Development Mechanism (CDM) were conducted in Lusaka and the Copperbelt for awareness purposes. As for the AIJ mechanism, Government has already received inquiries on future development of minihydros in Northwestern province of Zambia.

7.2 Financing Mechanisms

Zambia has as yet not benefited from the existing financing mechanisms under the United Nations Framework Convention on Climate Change. Opportunities exist under the Joint Implementation (JI), Activities Implemented Jointly (AIJ) and Clean Development Mechanism (CDM) for partnerships between Zambia and cooperating partners in priority areas of national development. Zambia as a country has identified the following indicators for sustainable development:

- Poverty alleviation
- Technology development and transfer
- Increased investment opportunities

Although there is no specific National Climate Change Policy in Zambia, the Government has made firm commitment to address climate change issues and fulfil its obligations to the Climate Change Convention. The results of several studies that have been conducted so far show great opportunities in various areas where reductions in greenhouse gases can be achieved. However, the investment conditions in Zambia are unfavourable towards initiating climate change investment activities. The main reason for this is high interest on investment capital.

Interesting AIJ options, taking into account criteria like cost-effectiveness, the quantity of CO_2 that may be offset and the availability of Zambian and foreign investors include the following:

- Replacement of diesel generating sets with mini hydro stations
- Coal briquetting
- Sugar cane processing; co-generation of heat and power
- Substitution of fossil fuel fed boilers with electric boilers in the industrial sector.

The Dutch Government through the Directorate General of International Cooperation (DGIS) of the Ministry of Foreign Affairs sent an Identification Mission to Zambia involving consultants of ETC Energy. The purpose of the Mission was to assess Zambia's Policy Framework and explore opportunities for AIJ in Zambia within the framework of Joint Implementation, Proef-Projecten Programma (JI-PPP). The Identification Mission was followed by a visit of consultants from Planet of Holland whose task was to prepare project proposals on the identified areas with particular attention to the following:

- Financial costs and technical data
- Specific roles and responsibilities of different project partners
- Inclusion of typical AIJ issues such as baseline, environmental impact assessment, estimation of amount of CO_2 gases to be reduced.

The consultants from Planet met high-ranking Government officials and Zambian entrepreneurs whose business activities lie in areas identified.

Another initiative in which Zambia is involved is the SADC Climate Technology Initiative (CTI) Needs Assessment.

The purpose of this initiative is to facilitate the implementation of article 4.5 of the United Nations Framework Convention on Climate Change. This article states that "The developed country parties to the Convention shall take all practical steps to promote, facilitate and finance as appropriate, the transfer of, or access to environmentally sound technologies and know-how to other parties, particularly developing countries..."

In this initiative, the Climate Technology Initiative, an organization supported by some OECD countries the majority of which are Annex 1 Parties to the Convention, is taking measures to fulfil the provisions of article 4.5 of the convention as stated above.

CTI will do this by:

- Building on the energy profiles of developing country parties or regions and identifying and evaluating short-term opportunities for accelerating diffusion of climate friendly technologies.

- Engaging relevant stakeholders to jointly determine the technology selection and implementation paths consistent with the country or region's (in the case of SADC) sustainable development goals.

In the transfer of technologies that must follow the selection of technologies and implementation paths, CTI are committed to the following principles:

- Technology transfer cooperation must be country or region driven with broad stakeholder participation.

- Cooperation shall recognize the importance of markets in technology transfer and shall be guided by market based approaches

- Focus shall be on technologies with clear development and climate gains and on removing those barriers, which inhibit transfer of such technologies.

7.3 Purpose of the Needs Assessment in SADC

The purpose of the national assessment is to:

- Establish stakeholder consensus on which technologies are of high national priority and should receive investment attention or other forms of diffusion support.

- Enlist interest and commitment from key stakeholders to support investment or barrier removal actions for purposes of enhancing the commercial or other diffusion of the high priority technologies

- Outline an implementation plan for the market based diffusion of climate technologies and related barrier removal actions

7.3.1 Conducting the Needs Assessment

The needs assessment will be conducted by the SADC ELMS Technical Committee member in each member state in close cooperation with the national climate change focal point and with assistance from any other persons or experts they may wish to involve.

7.3.2 Criteria for Technology Selection

Technology shall be selected based on the following criteria, which were agreed at a SADC Regional Workshop on Climate Technology Investment Needs Assessment held earlier in Sept. 1999 in Gaborone, Botswana:

- Development Benefits
- Market readiness
- GHG emissions reduction potential
- Regional application
- Local environmental benefits

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APPENDIX 1

Sensitivity Analysis of National Policies

The sensitivity of national policy objectives in coping with impacts due to climate change was assessed utilising an empirical approach that assigns scores to conditions as shown in Box 1 below. National Policies for economic sectors considered in the Vulnerability and Adaptation Assessment are:

Energy:

- Woodfuel
- Electricity
- Petroleum
- Coal
- New and Renewable Sources of Energy
- Energy Conservation and Substitution
- Energy Pricing

Agriculture:

- Crop Research to generate and adapt technologies which will increase productivity and diversify production
- Maintain an agricultural extension and information programme to provide advisory services to farmers to improve farming
- Enable farmers in all regions to take full advantage of the potential for using irrigation to enhance farming profits, diversify and intensify crop production and reduce the risk of financial loss
- New product development and
- marketing and trade.

Livestock:

- Animal production and disease prevention
- disease and pest control and
- research.

Fisheries:

- Capture fisheries
- Aquaculture

Wildlife:

- Improve sustainable human welfare and hence conserve and use the nation's wildlife resource wisely

Forestry:

- Sustainable forest resources and ecosystem management
- Forest based industries and non wood forest product development
- Forestry research extension and training
- Forest licences
- Export of forest products and
- Gender considerations in sustainable management of forest resources

Water:

- Water use (Quality Aspect)
- Water resource management
- Rural water supply and sanitation
- Urban water supply and Sanitation and
- Water tariffs

Health

- Health Reform

Box 1 Sensitivity Analysis of Policy Objectives

If objective is	Weight: Yes	No	Other
1) Climate change oriented	50	0	
2) Conservative and/or designed to reduce negative impact	15	0	
3) Already being translated into GRZ programme	20	0	
4) Linked to technical adaptation, current (1995) policy or realisable in future only	10	5	1
5) Inclined to address more of urban than rural issues	5	10	

For conditions 1 to 3, a weight of 50, 15 and 20 respectively is applied when an affirmative response is implied. A policy objective that is biased towards addressing impacts under climate change scenarios proposed in the vulnerablity assessment study is assigned a bigger weight compared to the rest. Moreover, a policy objective is redundant when its intended goals remain a pipe dream under antincipated climate change. Condition 4 is an indication of the level of preparedness for climate change while condition 5 underscores the importance of employing a balanced approach towards solving national issues. Based on the above conditionalities and associated weights, a policy is assumed a success if one of its objectives has a total weighted score of 50 or above.

Generally and since economic liberation in 1991/2, Zambia has strived to develop policies that are climate change friendly. However, two policies in Forestry and one in the Water sector failed the sensitivity analysis test. These are:

- Export of Forest Products
- Gender Considerations in Sustainable Management of Forest Resources
- Urban Water Supply and Sanitation

For these policies to pass the sensitivity analysis test a modification was made on the basis of costs and benefits such that they would be acceptable to policy makers in ministries concerned. The recommended alternative policies are:

Policy on Export of Forest Products should have a second objective that would ensure proper control over harvesting of teak species (e.g. *Baikiaea*).

Thus:

- To tighten controls over vulnerable teak species for the benefit of future generations

Policy on Gender Considerations in Sustainable Management of Forest Resources should be biased towards women involvement in community based forest programmes for as

house managers they are more inclined to protect trees for firewood harvesting. Thus:

- To empower women economically so as to promote their participation in managing wood lots for woodfuel harvesting

The second objective under policy on Urban Water Supply and Sanitation namely Development and Implementation of a National Water Conservation Strategy is key to sound water management practices in densely populated centres where current water demand outstrips supply. Indiscriminate drilling of boreholes should be regulated for instance lest doing so should lead to the collapse of aquifers and thus depress the water supply equation even further. In the same vein it should be Zambia's policy to construct additional pipelines for supplying densely populated cities with river water. Thus:

- To sensitise consumers on better methods of water harvesting at household level

- To encourage consumers who rely on surface water to construct community dams especially in most vulnerable areas

APPENDIX 2

A Summary of Agro-cological Zones of Zambia

Agro-ecological Zones	Geographic Coverage	Soil classification	Annual rainfall (mm)	Altitudes (m above sea level)	Growing season (days)	Area covered (10^6xHectares)	Area covered (%)
I	Valley areas of Luangwa, Lusenfwa, Gwembe, Siavonga and Sesheke	Siliceous, iso-hypethermic, Coated typic Ustipsamment	About 800	300 - 900	80 – 120	14.7	19.7
II	Central, Southern, Lusaka, Eastern and Parts of Western Province.	Clayey, Kalolinitic, Iso-hypethermic, oxic-Paleustult	800 – 1000	900 - 1300	100-140	26.97	36.1
III	Luapula, Northern, North-Western, Copper Belt and parts of Central Provinces	Fine, Kaolinitic, iso-hypethermic, oxic-Paleustult	Over 1000	1100 - 1770	160	32.95	44.2