KHOTSO PULA NALA

Lesotho's Second National Communication to the Conference of Parties (COP) of the United Nations Framework Convention on Climate (UNFCCC)

Ministry of Energy, Meteorology and Water Affairs, November 2013

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Glossary of Acronyms and Abbreviations

AAP	**African Adaptation Programme**
ABC	All Basotho Convention
AfDB	African Development Bank
AG	Attorney General
AGOA	Africa Growth and Opportunity Act
ATES	Access to Electricity Study
AMCOW	African Ministers' Council on Water
AOGCM	Atmospheric-Ocean General Circulating Model
BOS	Bureau of Statistics
CDM	Clean Development Mechanism
CO_2eq	Carbon Dioxide Equivalent
COP	Conference of the Parties
DAR	Department of Agricultural Research
DE	Department of Environment
DES	Development, Equity and Sustainable
DMA	Disaster Management Authority
DMC	Drought Monitoring Centre
DNA	Designated National Authority
DPP	Director of Public Prosecutions
DOE	Department of Energy
DMA	Department of Water Affairs
EAP	Energy Action Plan
EAPP	Electricity Access Pilot Projects
EFs	Emission Factors
EFL	Education for All
EMP	Electricity Master plan
EPF	Energy Policy Framework
ERC	Energy Research Centre
FANR	Food, Agriculture and Natural Resources
FAO	Food and Agricultural Organization
FINESSE	Financing Energy Services for Small Scale Energy Users
FPE	Free Primary Education
GCMs	General Circulation Models
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse Gas
GIS	Geographical Information System
GOL	Government of Lesotho
GTS	Global Telecommunication System
HDI	Human Development Index
IEC	Independent Electoral Commission
IEWS	Improvement of Early Warning System to Reduce Impacts of Climate Change and Capacity Building to Integrate Climate Change into Development Plans (IEWS)
IMTF	Interim Management Task Force

INC	Initial National Communication
INDF	Interim National Development Framework
IPCC	Intergovernmental Panel on Climate Change
LCD	Lesotho Congress for Democracy
LDHS	Lesotho Demographic and Health Survey
LEAP	Long-range Energy Alternatives Planning system
LEC	Lesotho Electricity Company
LEMP	Lesotho Energy Master plan
LEWA	Lesotho Electricity and Water Authority
LHDA	Lesotho Highlands Development Authority
LHWP	Lesotho Highlands Water Project
LMS	Lesotho Meteorological Services
LREBRE	Lesotho Renewable Energy-Based Rural Electrification
LUCF	Land Use Change and Forestry
LULUCF	Land Use, Land Use Change and Forestry
LVAC	Lesotho Vulnerability Assessment Committee
MAGICC	Model for Analysis of Greenhouse Induced Climate Change
MCC	Maseru City Council
MCST	Ministry of Communications, Science and Technology
MDGs	Millennium Development Goals
MHP	Muela Hydropower Plant
MEMWA	Ministry of Energy, Meteorology and Water Affairs
MMP	Mixed Member Proportion
MOAFS	Ministry of Agriculture and Food Security
NAPA	National Adaptation Programme of Action
NCCST	National Climate Change Study Team
NCJ	Network of Climate Journalists
NCMs	National Communications Models
NCSA	National Capacity Self Assessment
NEAP	National Environmental Action Plan
NEMP	National Electricity Master Plan
NES	National Environment Secretariat
NGOs	Non-Governmental Organizations
NGOs	Non Government Organizations
NREB	National Rural Electrification Board
NREF	National Rural Electrification Fund
NREP	National Rural Electrification Programme
NDSP	National Strategic Development Plan
NUL	National University of Lesotho
OECD	Organization for Economic Cooperation and Development
ORASECOM	Orange Senqu River Commission

PDNA	Post Disaster Needs Assessment
PRS	Poverty Reduction Strategy
PRSP	Poverty Reduction Strategy Paper
PS	Principal Secretary
PSC	Project Steering Committee
PSPC	Power Sector Policy Committee
PV	Photovoltaics
RBO	River Basin Organisation
RCMs	Regional Circulation Models
RET	Renewable energy technology
REU	Rural Electrification Unit
REWG	Rural Electrification Working Group
RRSU	Regional Remote Sensing Unit
RR UNDP	Country Resident Representative
RSA	Republic of South Africa
RTH	Regional Training Hub
S&T	Science and Technology
SACU	Southern African Customs Union (SACU)
SADC	Southern African Development Community
SADC-HYCOS	SADC Hydrological Cycle Observing System
SCENGEN	Scenario Generator
SNC	Second National Communication
SRES	Special Report Emission Scenario
SRV	Senqu River Valley
STI	Science, Technology and Innovation
STIP	Science, Technology and Innovation Policy
TMP	Tourism Master Plan
TNA	Technology Needs Assessment
TSP	Tourism Strategic Plan
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
USA	United States of America
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
V&A	Vulnerability and Adaptation Assessment
WASCO	Water and Sewage Company
WASA	Water and Sewage Authority
WB	World Bank
WMO	World Meteorological Organization

Foreword

Mr Bruno Tseliso Sekoli

Climate change is one of the most serious environmental and economic challenges facing the world today, and mitigating its effects must be one of the top priorities of governments, companies, NGOs and individuals. The Fourth Assessment Report of the Intergovernmental Panel on Climate change (IPCC) points to human activity as one of the major causes of global warming. Business as usual may lead to a disastrous transformation of the planet, and recent scientific findings emphasize the growing urgency of reducing greenhouse gas emissions.

Small mountainous landlocked developing countries such as Lesotho are highly vulnerable to the impacts of climate change. Lesotho will face serious challenges from extreme weather events such as intense rainfall, extensive dry periods and heavy snowfall. These coupled with the fact that about a quarter of the population live in the rural areas, which are mainly mountainous, and depend on agriculture and agriculture-related activities for their livelihood, amplify the country's vulnerability to these extreme weather events. However, though many do not understand the complexities of climate change, Basotho have already started to note, with concern, erratic rainfall, the frequency with which heavy snowfall occurs, and the intense dry periods, as well as the increasing land degradation and loss of some biodiversity

The achievement of the United Nations Millennium Development Goals (MDGs), the realization of the National Vision 2020 and the successful implementation of the National Strategic Development Plan (NSDP) are highly dependent on the sustainable management and utilization of our natural resources. The increasing intensity and frequency of floods, snow and droughts that our country has experienced in the past ten years bear testimony to our vulnerability to the adverse impacts of climate change and the vagaries of climate variability. It is, therefore, our responsibility as a nation to join hands with the rest of the world to combat global warming.

The Second National Communication (SNC) of Lesotho to the United Nation's Framework Convention on Climate Change (UNFCCC) is a clear manifestation of our unwavering commitment to contribute towards the global efforts to limit and hopefully reverse the adverse effects and impacts of climate change. As such, the implementation of the research and extension recommendations highlighted in the SNC captured from the various themes of national circumstances, mitigation of greenhouse gases, and vulnerability and adaptation assessments will not only fulfill our obligations to the UNFCCC, but also create a conducive environment for the realization of the Millennium Development Goals (MDGs) and the National Strategic Development Plan (NSDP).

It is the responsibility of my Ministry of Energy, Meteorology and Water Affairs (MEMWA), through the Department of Meteorology which is the national climate change focal point, to ensure the full implementation of the strategies and measures for curbing the adverse impacts of climate change and variability on all the sectors of economic growth, and to promote sustainable economic growth and development. . However, this requires collective efforts among all stakeholders in the public and private sector organizations, including Non-Governmental Organizations (NGOs), civil society, the donor community, and local communities. The Government will provide all the necessary support required for the successful implementation of the strategies and measures spelt out in the SNC.

This SNC is not only important as a submission to the UNFCCC, but as a capacity building and institutional strengthening process for national climate information and understanding. In this regard, I wish to commend all those involved, directly or indirectly, in the preparation of Lesotho's Second National Communication, 2013.

Thank you.

Mr. Bruno Tseliso Sekoli
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Lesotho's second National Communication Report

EXECUTIVE SUMMARY

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Introduction

Lesotho ratified the United Nations Framework Convention on Climate Change (UNFCCC) in February 1995. As a Party to the UNFCCC and in pursuant to Article 4, paragraph 1, and Article 12, paragraph 1 of the Convention, Lesotho prepared and submitted her Initial National Communication (INC) to the Conference of Parties (COP) to the UNFCCC in April 2000. Subsequent to the INC, in 2002, Technology Needs Assessment (TNA) was prepared for the Energy and Land-Use, Land-Use Change and Forestry (LULUCF) Sectors as they were found out to be the major emitting sectors in the INC. Lesotho also prepared the National Adaptation Programme of Action (NAPA) which identified urgent and immediate adaptation needs in 2007. The Second National Communication (SNC) builds on and continues the work done under the INC, TNA and NAPA in furtherance to meeting her obligation under the UNFCCC.

The main objective of the SNC is to communicate to the Conference of Parties (COP), what policies and measures the country has taken and envisaged to implement the Convention. The SNC, particularly, highlights Lesotho's efforts in areas of mitigating climate change and adaptation to the impacts thereof. The report also includes greenhouse gases (GHGs) inventories for 1995-2000 (base year 2000), and addresses pertinent issues, particularly with regard to public awareness, technology transfer and capacity building needs as well as gaps, constraints and recommendations.

National Circumstances

Geography: Lesotho is a landlocked country, completely surrounded by Republic of South Africa (RSA) with an area of 30,355 square kilometres. Lesotho is located between latitudes 28° and 31°S, and longitudes 27° and 30°E. The landscape is a rugged terrain with elevation from 1,388 m to 3,482 m. Only 10% of the country's land is arable. Lesotho is segregated into four (4) distinct agro-ecological zones/regions, namely, the Lowlands (17%), Foothills (15%), Mountains (59%) and Senqu River Valley (9%). These zones are characterized by significant climatic and ecological differences. The geo-morphological and topographic conditions have largely confined favourable socio-economic

conditions to the lowlands, the foothills and the Senqu River Valley, leaving the mostly barren and rugged mountain region mainly for grazing.

Climate and Climate Change: The climate of Lesotho is generally classified as temperate with alpine characteristics. The country experiences hot summers and relatively very cold winters. Air temperatures tend to be lower than in other countries at similar latitudes mainly due to greater elevation above mean sea level. The main characteristics of the country's climate are that it has four distinct seasons with huge fluctuations in temperature and erratic rainfall.

The mean summer temperature over Lesotho is about 25° C and the mean winter temperature about 15° C. The highest maximum temperature ever recorded is 38.5°C and the lowest minimum temperature is -21°C. The highlands experience severe winters with number of frost days of up to 180 days per year. Snowfall is common between May and September, with occasional heavy snowfalls that often cut off the rural population from access to basic services. The yearly precipitation varies between about 500 millimetres in the Senqu River Valley to about 1200 millimetres over the northern highlands and along the Drakensburg range. Rainfall season starts in October and ends in April and accounts for 85% of the annual precipitation. Both inter-seasonal and intra-seasonal rainfall is highly variable. This often leads to periodic localized floods and droughts that cause considerable economic losses and other adverse social and environmental impacts.

Studies by the Intergovernmental Panel on Climate Change (IPCC) and Lesotho Meteorological Services suggest that climate change scenarios for Lesotho include increasing temperatures, changes in rainfall patterns, decreasing summer precipitation, increasing intensity and frequency of extreme weather events. Lesotho experienced its heaviest rainfall in the last ten years between December 2010 and February 2011, resulting in major floods which inundated most of the country. The farming sector suffered heavy losses, particularly in terms of crops and seasonal employment opportunities. The damage and loss of property, assets and livelihoods due to recent Lesotho floods was estimated at M462.7 million, equivalent to 3.2% of the GDP. The financial requirements to oversee post-disaster recovery and reconstruction have been estimated at over M600 million. This reality indicates that the effects of climate change are beginning to be felt in Lesotho.

Population: At the time of the last census (2006), the resident population of Lesotho amounted to 1,876,633 with an annual growth rate of 0.08%. This implies a substantial decline from the annual growth of 1.5% during the period 1986 to 1996. Even though Lesotho is relatively a small country, two-thirds of the country is sparsely inhabited, comprising of rugged mountains and deep valleys with small, scattered villages on mountain sides. The population distribution of Lesotho in 2006 was 23.6% urban and 76.3% rural. However, it is estimated that annual increase of urban population is 3.5%. Population density is lower in the highlands than in the western lowlands. Regarding the age structure, about 33.5% of the population is less than 15 years old, 61.1 % is aged 15-64 years, while 5.4% is 65 years and older.

Economy: Lesotho's economy is based on water (exported to South Africa), light manufacturing (textile, clothing and leather), customs duties from the Southern African Customs Union (SACU), agriculture (wool, mohair and livestock), and to some extent, remittances from Basotho in South

Africa. The majority of households subsist on farming or migrant labour, and almost 50% of the population earns some income through small-scale crop cultivation or animal husbandry, although drought has decreased agricultural activity. Recently, the mining sector is also making a significant contribution to the economy. Lesotho's economy remains intricately linked to that of its regional and international partners, especially South Africa. Revenue from SACU, which forms a significant portion (over 60% in 2008-2009) of the Government's budget, has reduced by 50% in 2010-2011. The government has responded by strengthening its tax system to reduce dependency on customs duties. As demand for migrant labour by the South African market declined and unemployed migrant workers returned to Lesotho, remittances shrank from about 60% of Gross Domestic Product (GDP) in the 1980s to about 20% in 2005. This was a huge strain on the country's economy. Despite Lesotho's market-based economy being heavily tied to its neighbour South Africa, other global partners remain critical. The United States of America (USA) is an important trade partner because of the export sector's heavy dependence on apparel exports. Such exports have grown significantly because of the trade benefits contained in the Africa Growth and Opportunity Act (AGOA).

Per capita income at the nominal rate in 2009 was US$642. Economic growth declined from 4.4% in 2008 to 1.9% in 2009, due mainly to the effects of the global economic crisis as demand for the country's exports declined and SACU revenue fell precipitously when South Africa - the primary contributor to the SACU revenue pool - went into recession. However, Lesotho's GDP in 2010 grew by an estimated 5.6% as the global economy began to recover.

Economic Sectors

ENERGY: Lesotho has abundant potential energy resources in the form of renewables (mainly localised wind, hydropower and solar), but limited biomass. More than 95% of electricity consumed in the country is from hydropower. Currently, Lesotho produces about 72 MW of electricity from the Muela Hydropower station which satisfies electricity needs in summer. The Government embarked on a programme to promote the use of solar panels in rural areas so as to minimize wood consumption through the Lesotho Renewable Energy-Based Rural Electrification (LREBRE) especially for those communities far away from the national grid.

Lesotho is highly dependent on imported fossil fuels (>95%) for its energy requirements for transport and industries. Biomass forms an important energy source in the rural domestic sector, as a result, the government is promoting the use of clean technologies e.g. energy efficient cook-stoves. These technologies reduce GHG emissions and also have positive impacts on the livelihoods of Basotho.

WATER: Water is Lesotho's most valuable natural resource. Currently, the river systems have resulted in Lesotho Highlands Water Project (LHWP) which supports Lesotho's largest source of foreign income. It is a key determinant of economic growth and a resource that must be carefully managed as part of the sustainable environment program. Lesotho is an upstream riparian state with South Africa and Namibia in the Senqu/Orange river basin.

The country is well endowed with water resources, however, the amount of water available changes markedly, seasonally and annually. Lesotho's natural water resources are estimated at 5.23 km^3/yr, by far exceeding the country's requirement of 2 km^3/yr. Groundwater resources are estimated at 0.5 km^3/yr. The distribution within the country is far from uniform with the north-western lowlands and majority of the highlands better watered as compared to the southern parts of the country. There are basically three river sub-systems in Lesotho, namely, the Senqu (Orange), the Makhaleng and the Mohokare (or Caledon).

A number of initiatives have been implemented and some are planned, to promote the conservation and wise-use of the wetlands of Lesotho. Many of these initiatives are primarily linked to the management and harvesting of water resources of the country and conservation of biodiversity.

Major dams have been constructed in the framework of Phase I of LHWP, they include Katse Dam, Mohale Dam and Muela Dam. The Muela dam acts as the tail-pond of the Muela hydropower station. Phase 2 of the LHWP that includes the construction of the third dam at Polihali, Tlokoeng in the Mokhotlong District is still under negotiations.

AGRICULTURE: Although majority of the population is engaged in agriculture and informal sector activities in rural areas, this only contributes to about 10% of the GDP (down from more than 25 % in the 1980s). A large proportion of poor rural households have access to agricultural land however, many of those who own land do not have the necessary agricultural inputs. Maize remains the country's staple food.

MINING AND QUARRYING: One of the main mineral resources in Lesotho is diamonds. The contribution of the mining and quarrying sector to GDP increased from 0.2 % in 2003 to 2.3 % in 2004, the main contributor being the Letšeng Diamond Mine. There are other mines that produce and contribute significantly less compared to the Letšeng, which include among others; Kao, Liqhobong and Liphofung diamond mines. Recently, Letšeng recovered three of the world's top twenty rough diamonds including the 603 carat Lesotho promise in August 2006.

Minor deposits of coal, galena, quartz, agate and uranium have been identified, but are believed to be of little commercial value. Lesotho also possesses deposits of clay, which are being exploited for the manufacture of bricks, high-quality ceramic ware and tiles.

TOURISM: This sector has the potential to be a major driver of economic growth for Lesotho. However, not much has been invested in this sector. It is a labour-intensive industry, with a potential to generate jobs especially in the rural areas where poverty is rife. The Tourism Master Plan (TMP) for Lesotho was produced in 2006 to advance tourism in Lesotho. The three priority areas identified under the TMP (2006) for tourism development and advancements were subsequently translated into four tourism development zones in the Tourism Strategic Plan (TSP) of 2007. These are the Highlands Circuit, the Heritage Circuit, the Roof of Africa Circuit and the Maseru Business Circuit.

Political and Decision-Making Structure: Lesotho is a constitutional monarchy with a democratic parliamentary system of governance under the constitution of 1993. The King is Head

of State but has no executive or legislative powers. The government is headed by a Prime Minister, who is the leader of the majority party in the National Assembly. Lesotho follows a bicameral system of parliament consisting of two (2) chambers; the National Assembly with 120 seats (eighty (80) seats are contested under the First-Past-The-Post system while the remaining forty (40) seats are filled up by the party-list proportional representative system) and the Senate, comprising 33 members (22 principal chiefs whose membership is hereditary and 11 appointees of the King, acting on the advice of the Prime Minister). Both the National Assembly and the Senate serve a fixed term of five years. Lesotho is the first country in Africa and the eighth in the world to adopt the Mixed Member Proportional (MMP) electoral model for party representation in Parliament.

National Policies and Development Plans

Lesotho's development policies continue to strongly focus on the attainment of sustainable development. However, climate change does not explicitly feature in most development plans previously developed. **Lesotho Vision 2020** document outlines Lesotho's long-term perspectives within which national short to medium-term plans are being formulated to enable Lesotho's aspirations. The Lesotho **Poverty Reduction Strategy (PRS)** outlined national priorities and strategies to reduce poverty and promote equitable economic growth. PRS came to an end in 2008. In order to bridge the period between the end of the PRS and the start of another 5 year development plan, an **Interim National Development Framework (INDF)** was put in place in order to guide resource allocation, until the completion of the development plan.

The process of preparing the 5 year **National Strategic Development Plan (NDSP)** for the period 2012/13 – 2016/17 was launched in February 2011. The NSDP marks, as a point of departure, the need and urgency for Lesotho to radically transform its economy and driving the country on the sustainable development path. The NSDP specifically integrates climate change. Among its objectives, it also focuses on promoting the greening of the economy and improving environment and climate change governance.

There is no climate change policy in Lesotho but efforts are underway to develop climate change policy and strategy with support from development partners. In addition, there are a number of policies and measures in various sectors which are closely aligned with the objectives of the UNFCCC.

The **National Environment Act** of 2008 provides the necessary legal framework for the protection and conservation of the Environment. Through the ***National Environment Act, 2008,*** Government plans to enhance the resilience of the country to extreme weather events and other environmental disasters.

The **National Adaptation Programme of Action (NAPA)**, which was prepared in 2007, and will be implemented within the framework of the main national development programmes, in particular, the National Vision 2020, the NSDP and the Millennium Development Goals (MDGs), has been designed with a view of empowering the vulnerable communities to adapt to climate change. NAPA identified eleven priority areas. Priority 3 (Capacity Building and Policy Reform to Integrate Climate

Change in Sectoral Development Plans) and priority 4 (Improvement of an Early Warning System Against Climate Induced Disasters and Hazards) are under implementation through a project entitled "**Improvement of Early Warning System to Reduce Impacts of Climate Change and Capacity Building to Integrate Climate Change into Development Plans (IEWS)**" which started in 2011.

National Inventory of GHG Emissions

Lesotho's 2000 national inventory of greenhouse gas emissions was developed using the methodology described in the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories prepared by the Intergovernmental Panel on Climate Change (IPCC). The study investigates the contribution of Lesotho to global GHG emissions and /or removals.

The National Greenhouse Gas Inventory for Year 2000 is the second inventory to be prepared by Lesotho, following the first one for the year 1994 which was used for the INC. The results seem to reflect a clear picture of Lesotho's socio-economic circumstances: an economy dependent on natural resources, a low but growing energy sector and industrial sector that is still in its infancy. The results for carbon dioxide equivalent (CO_2eq) emissions and removals clearly indicate that the agriculture and energy sectors are most important with respect to emissions, and Land-Use Change and Forestry (LUCF) sector is most important with respect to removals.

Data availability has been a huge challenge in developing the 2000 GHG inventory with most of the data only being available at an aggregated national level, rather than at point-source level. Default Emission Factors (EFs) provided in the methodologies were used in almost all the sectors since national data is not available.

GHG emissions reported in this report are for gases (CO_2, CH_4 and N_2O) with Global Warming Potential (GWP). For other gases (CO, NO_X, NMVOC and SO_2), emissions have been calculated and presented in sectoral reports but are not included in the overall GHG emissions.

The total national GHG emissions are estimated to be 3,512.89Gg CO_2eq. However, since LUCF is a sink with estimated removals of 1,377.98Gg CO_2eq, the net national emissions is reduced to 2,134.91Gg CO_2eq. Therefore, Lesotho remains a net emitter of GHG. As compared to the 1994 emissions (4,475.87Gg CO_2eq), the 2000 net emissions have been reduced by about 52%. Most of the net reductions have occurred in the LUCF sector. Agriculture accounts for 63% of the total emissions followed by Energy with 31% and Waste with 6%. Industrial Processes contributes insignificant emissions accounting for almost zero hence not included.

Nitrous Oxide (N_2O) is the major contributor accounting for 41%, followed by methane with 36% of the total CO_2eq emissions. Carbon dioxide accounts for the least emissions with 23% of the total emissions.

Vulnerability, Adaptation and Policies

A number of sectors that were felt to be particularly relevant to Lesotho situation were assessed for vulnerability and adaptation to climate change. These sectors include; agriculture, soils and land degradation, forestry, water resources, livestock and rangelands, culture and health. Droughts, floods and snow affect most parts of Lesotho. Thus, the developed adaptation measures and strategies focus on (i) enhancing agricultural productivity, (ii) planting trees, (iii) improving nutrition, (iv) accessing reliable and user-friendly sources of energy, (v) arresting land degradation through the use of appropriate soil and water management and conservation measures, and (vi) reducing the incidences of insect pests and diseases.

The sectors of focus included: (i) Agriculture, (ii) Water Resources, (iii) Soils and Land Degradation, (iv) Forestry, v) Livestock and Rangelands, (vi) Health, (vii) Culture and Historical Heritage.

Agriculture: Both the projected increases in precipitation and temperature from September to May for the northern part of Lesotho for the period 2010 to 2040 will likely positively impact on yield of maize, sorghum and wheat. The increase in precipitation and temperature during September to May on the other hand will negatively impact growth of crops such as beans and cucurbits. The high temperature and high humidity will lead to incidences of fungal diseases and offset the high growth pattern induced by a combination of high rainfall and temperature. The projected decrease in precipitation for the country in July to August, beginning in 2010 to 2100, will lead to low soil moisture reserves and will negatively impact on the growth of winter crops especially wheat.

The projected scenarios suggest reduced precipitation for the southern parts of Lesotho and coupled with increased temperatures it should be expected that the crops that are grown currently in this region will be much more adversely affected.

Proposed adaptation measures include relay and intercropping as in the implementation of the locally developed Machobane farming system; the use of conservation farming techniques especially in vegetable production where water collection and conservation ensure moisture availability to plants; allocation of land and production of high value crops such as vegetables, mushroom production which is done on limited space and contributes to family income generation. Adoption of drought resistant crops like sorghum for the southern region of the country and development of water harvesting techniques throughout the country will lessen the impacts of climate change.

Water Resources: An increased temperature directly affects evapotranspiration. Changes in evapotranspiration impact on the water balance of runoff, soil moisture, water in reservoirs, and salinization of shallow aquifers. Changes in streamflow, dams and wetlands capacity depend on changes in volumes and timing of precipitation. It is evident that reduced precipitation in winter and summer, as projected by the scenarios will reduce streamflow, the result of which will be hydrological drought. This will directly affect water supply and sanitation.

Rehabilitation of degraded wetlands has to become a priority for Lesotho government as a form of adaptation. Clear environmentally sustainable policies that improve pastures and grazing land would protect wetlands from their persistent degradation and this would be facilitated by encouraging fodder production which would lead to stall feeding. The Local Government Act which promotes decentralization can relieve urban centres of increasing population that exerts pressure on water resources. The movement of people from urban to rural areas can be promoted if services and jobs are created in rural communities.

Forestry: The genetic variability of most tree species is probably large enough to allow them to acclimatise to average changes in temperature and precipitation. However, in the northern region, increased droughts and forest fires may be the major risk for forests as most of the plantations are concentrated in the north. The increased temperature and reduction in precipitation calls for tree provenances of more southern origin and wider spacing in plantations which may reduce the impacts of the climate change. Regular management with shorter rotations enhances the turnover of the current tree populations with a faster introduction of more resistant tree species and provenances into forests.

Insect and pest populations are expected to increase but the extent to which they may be controlled by natural enemies or if they require management control is not known.

Adaptation measures must include, for example, selection of pest resistant or drought tolerant trees species, use of stocks from a range of provenances, under-planting of genotypes of species adapted to expected new climate conditions, or assisted natural regeneration of functional species such as Pinus halepensis in the south. Currently, there are guidelines regarding choice of species according to different ecological zones especially exotic tree species e.g. Pinus halepensis in the southern districts alongside indigenous tree species and Pinus radiata in the northern districts and Eucalyptus rubida. There is need to intensify training and awareness campaigns with communities on the integrated fire management strategy.

Livestock and Rangelands: The predicted increased precipitation in autumn and winter has potential to change the severity and distribution of important livestock diseases and pests as well as to change in the productivity of rangeland and rain-fed crops and forage. Rainfall projections indicate severe impacts on water resources are likely, resulting in growing season for both natural vegetation and crops being shortened. Lower precipitation in spring and summer could result in water shortages and drought. Reduced fresh water availability, dry spells, extended drought, hailstorms, frost, strong winds, flash floods and associated land degradation could therefore, be expected.

Major effects of climate change on rangelands could be on vegetation biodiversity, land degradation, and water dynamics. Climate change and climate variability have affected, and are projected to continue to affect, individuals, populations, species and ecosystem composition and function. Climate change affects land degradation through changes in vegetation, soils, and the hydrological

cycle. As the rangelands are affected by climate change, vegetation and soil properties, and rangeland water dynamics and livestock productivity will be affected.

Anticipated climate change combined with other drivers of change is likely to intensify water scarcity for both human and livestock in Lesotho. Increasing temperatures are expected to increase evaporative demand. Rainfall change and variability is very likely to affect vegetation in Lesotho grasslands resulting in reduction in cover and forage productivity. Expected frequent warming and fire due to prolonged droughts is very likely to reduce carbon stocks. High temperatures and greater dry spell duration have potential to increase vegetation flammability resulting in extensive rangeland fires. Climate change is likely to increase opportunities for invasive species because of their adaptability to disturbances. Adaptation strategies should address the tolerance of livestock to heat, ability to survive, grow and reproduce in conditions of poor nutrition, parasite infestations and disease prevalence. This suggests that animal genetic improvement strategies in Lesotho should be centred around developing animal genetic material that are adapted to these conditions. Such strategies could be based on genetic selection and crossbreeding practices. Indigenous African (Sanga) breeds such as Nguni, Tuli and Mashona are more disease resistant and drought tolerant, furthermore, they are crucial to the effective management of the environments in which they were developed. Therefore, the possibilities of adoption of such breeds should be explored and be given a chance for animal production improvement and rangeland management. Therefore, practical adaptation measures could include identification and strengthening of local breeds that have adapted to local climatic stress and feed sources and improving local genetics through crossbreeding with heat and disease tolerant breeds. However, if climate change is faster than natural selection, the risk to survival and adaptation of the new breed is greater.

Livestock production practice adjustments such as diversification, intensification, and/ or integration of pasture management, livestock, and crop production could also serve as adaptation strategies. Maintaining a diverse herd has a number of advantages and it represents a critical adaptation measure. A diverse herd is an adaptation to a diverse ecology in which vegetation can be highly varied in both spatial and temporal scales.

Soils and land degradation: Lesotho is faced with the following potential and existing impacts of land degradation:

- The decrease of land quality, which results in the decrease in productivity which has an effect on the livelihoods of people in terms of food insecurity, poverty and migration.
- Reduction of habitat for living species, for both micro and macro flora and fauna.
- The impact of degradation on the likely increase on GHG emissions, for example the increase in carbon through the oxidizing of organic matter induced by tillage.
- The likely impact on land degradation on ecosystems functions and landscape processes such as water and nutrient cycles, which in turn affect water availability and primary productivity of ecosystems and their services to communities.

- The decline of the buffering capacity of soils, resulting in undesirable changes that may directly affect land productivity.
- The impact of degradation on the biodiversity of ecosystems at many levels, above and below the ground.

High temperatures will affect vegetation growth with the result that there will be reduction of vegetation cover. To a large extent, precipitation will be below normal suggesting insufficient soil moisture and high probability for drought. Even though there are also indications of precipitation that is above normal, it must be noted that because of the high variability and extreme events (e.g. hail and thunder storms) there is a greater likelihood that the above normal occurrences will occur over short time durations and will be infrequent. High intensity short duration storm events imply floods hence destruction of biodiversity and soil erosion.

Adaptation to potential impact of soil to erosion should include programmes that improve land cover such as afforestation and re-grassing, conservation agriculture, resting of arable land and rotation of cereal crops with fodder. There will be a need to improve breeds of livestock and introduction of breeds that are adapted to the new climatic conditions and appropriate numbers of stocking rates should be maintained.

Health: Drought diminishes dietary diversity and reduces overall food consumption, and may therefore lead to micronutrient deficiencies. Countries within the 'Meningitis Belt' in semi-arid sub-Saharan Africa experience the highest endemicity and epidemic frequency of meningococcal meningitis in Africa. The spatial distribution, intensity and seasonality of meningococcal (epidemic) meningitis appear to be strongly linked to climatic and environmental factors, particularly drought, although the causal mechanism is not clear. In 2010 meningitis was one of the top five causes of adult mortality in Lesotho.

The persisting regular droughts cause many farmers, especially subsistence farmers, to leave their fields fallow and in time rodents will likely starve and migrate to households for survival. On their trails could be their predator snakes, some of which could be poisonous. This could lead to high incidences of plague and morbidity and mortalities from snake bites, or even shock for some from sights of rodents and snakes.

In 2010, there were 1,924 suspected cases of measles and 27 deaths. It is expected that with the predicted changes in temperature, people especially the poor and rural communities, will be more vulnerable to measles because of crowding especially in confined spaces. There were 22 Hepatitis B cases in 2010. Four cases of Anthrax were reported in 2010. Extended droughts will cause increases in the incidence of this bacteria borne disease as animals groping for fodder will be liable to feed off soil infested with the anthrax bacteria. While Lesotho lies outside of the current malaria zone, it is anticipated the belt will expand deeply into southern Africa with the possibility of reaching some parts of the country.

Adaptation measures includes: development of surveillance and monitoring system, e.g. establishment of weather warning systems that focus on health-related adverse conditions; strengthen knowledge management in order to improve communication networks for information sharing; strengthen the Ministry of Health and Social Welfare (MOHSW), now formally known as Ministry of Health's education programmes and decentralization - including climate change education; ecosystem interventions - intensify afforestation and biodiversity interventions throughout the country; medical interventions - Introduce work schedules that avoid peak daytime temperatures for outdoor; infrastructure - promote roof water harvesting practices and conservation dams; fast-track solar and wind energy installations and expansion of electricity grid; institutional and policy interventions - integrate climate change in health policies and strategies.

Culture and Historical Heritage: Similar to the health sector, Culture is intrinsically linked with all the sectors under assessment. Water, soils and land, agriculture, forestry, livestock and rangelands - all have some health and cultural aspects. As a result impacts and vulnerabilities associated with these sectors will also be true for culture and health.

Likewise, effective adaptation to climate change by the rest of sectors will automatically develop resilience in health and culture. The following Agro-derived adaptation should be considered to form a base for diversified livelihoods, curb erosion, enhance food security and create employment:

- Multiple uses of conservation dams apart from use by livestock and for irrigation to include fish and duck farming.
- Changing the balance of land-use towards a more rangeland orientation to curb soil erosion and mitigate emissions.
- Intensification of orchard farming and silvicultural treatment schedules to suit climate variations.
- Adjustment of planting dates and crop variety (e.g., promotion of drought-resistant plants such as agave and aloe which are known to potentially possess health benefits). Industries that extract useful material from these plants will create employment.

Mitigation Analysis, Policies and Measures

As a Non Annex I Party, Lesotho is not obliged to implement targeted GHG mitigation options, but as a signatory to the UNFCCC, it must engage itself in voluntary actions to mitigate GHG emissions. Therefore, within the framework of the preparation of the second national communication process, Lesotho undertook mitigation analysis and assessment of options to reduce the sources of greenhouse gas or enhance their sinks.

In the energy sector, all efforts being undertaken by the Government of Lesotho to achieve greenhouse gas mitigation objectives are reflected in the energy policy document through which the Government is committed to promote the use of cleaner energy sources and technologies.

Various scenarios for mitigation of GHG emissions have been qualitatively and quantitatively assessed. It was found that the most promising mitigation options are: (i) revision of electrification targets to allow more Basotho access to clean energy for lighting, heating and cooking, (ii) dissemination of efficient stoves in households to reduce the use of firewood and vegetable waste and (iii) dissemination of solar home systems to reduce the use of paraffin for lighting.

In the non-energy sectors, reforestation of indigenous forests, afforestation of Gullies and degraded lands, rehabilitation of Wetlands, capturing methane emissions from manure and agriculture waste and increasing feed efficiency for livestock, recycling and/or composting of waste present high potential for greenhouse mitigation and sink enhancement.

The implementation of mitigation measures will require financial resources which are beyond the capacity of Lesotho. Therefore, Lesotho will develop a climate change financial resources mobilization strategy to support the implementation of climate change mitigation projects and policies. The country will also ensure wide stakeholders participation and involvement in the design and implementation of mitigation plans and make all necessary efforts to mainstream climate change issues in the national development strategies.

Other Relevant Information

Other information and activities considered relevant to the achievement of the objectives of the Convention includes (i) technology transfer, (ii) research (iii) systematic observations, (iv) information on education, training, public awareness and capacity-building and (v) efforts to promote information sharing. The role of NGOs in the implementation of adaptation and mitigation activities with local communities is quite significant.

Technology transfer: Technology is one of the critical factors necessary to enhance the adaptive capacity of a vulnerable country, sector or community. Lesotho undertook its climate change technology transfer needs assessment in 2004 to prioritise technologies that would contribute towards its adaptation and mitigation efforts. Key sectors with critical technology needs are energy, agriculture, land use and waste management.

The technology needs assessment has greatly benefited from the activities that are being undertaken in other countries in the southern Africa region with technical assistance from the Climate Technology Initiative (CTI). The appropriate technologies were identified based on the following criteria: (i) development benefits (employment creation potential, capacity building, health and quality of life improvement, human and material resource mobilization), (ii) market potential (affordability, cost, finance, investment, barriers, durability and availability), and (iii) climate change (reduction in GHG emissions, enhancement of sinks and effects on the environment).

Research and Systematic Observation: Measurements, monitoring, and research related to the climate-meteorological and hydrological parameters in the country are performed by

the Lesotho Meteorological Services (LMS). The meteorological observing system in the country consists of 91 manually manned weather stations (40 climate stations, 7 of which serve agro-meteorological purposes and 51 precipitation stations) and 3 automatic wind monitoring stations.

Education, Training and Public Awareness: At present, climate change is not fully addressed as an isolated component in Lesotho's educational system, rather it is treated as subsections in Geography and Science , with some aspects under Development Studies. Natural Sciences and Social Studies are two areas presented at Primary School education level in which issues of climate change could logically be addressed. Despite no explicit references to climate change, there are numerous openings where the subject may be taught. For instance, topics such as *Taking Care of the environment* in class 3, *Land degradation* in Class 4 and *Management of Lesotho Environment* in class 5 could accommodate issues of climate change. These topics are taught even in classes 6 and 7 using a spiral approach.

At secondary education level, environmental protection issues are included in the curricula of subjects on Geography, Development Studies, Science and Agriculture. In senior schools, climate change issues are discussed during Biology and Geography lessons. For example, In Lesotho Junior Certificate geography topics such as weather, climate, vegetation, population studies, farming systems, and sources of energy can house a lot of concepts of climate change without destroying subject boundaries. In Geography, two learning outcomes related to climate change are that by the end of the science programme learners ought to:

- *"have developed scientific skills, knowledge and attitude which enable them to care for and improve the environment"*
- *"have acquired scientific knowledge, skills and attitude that would enable them to respond appropriately to environmental changes and disasters"*

In Development Studies topics such as problems of development, industrialization and resources can carry climate change issues.

Lesotho's tertiary education institutions offer varying levels of training in climate change-related topics although there are no full-fledged formal programmes on climate change per se. The curriculum of several of the programmes includes modules that partially address climate change issues, such as ecology, Biology, Geography, Development Studies, Meteorology and climatology, Synoptic climatology and Environmental Science.

However, as is the case with the tertiary level institutions, most schools lack basic equipment and materials for effective environmental studies, including climate change. There is need to build capacity both for teachers and teacher training institutions to adequately promote environmental education, including climate change.

Information Sharing and Networking on Climate Change: Lesotho Bureau of Statistics (BOS) is mandated to collect, compile, analyze, abstract and publish major statistical information on a wide range of topics, including the environment, hence climate change. BOS

maintains a centralized data bank that is easily accessible on request. Other participants in environmental data and information collection include: (i) academic institutions, and (ii) private sector organizations, including NGOs. However, access to such data and information is generally difficult and limited because such data and information are compiled for internal use, and some cases the users do not acknowledge the original source of the data and information. Lesotho Meteorological Services is the sole custodian of the weather and climate data and information, data is regularly published in the print and electronic media. Weather forecasts and announcements are carried out several times and at regular intervals daily, through the various communication media. The Lesotho Meteorological Services website http://www.lesmet.org.ls remains the most relevant national source of information, containing, *inter alia*, all reports and data about GHG emissions, scenarios for climate change at the national level, vulnerability reports, mitigation strategy, etc. Lesotho engages in data exchange through the Global Telecommunication System (GTS) via Regional Telecommunication Hub (RTH) in Pretoria, South Africa.

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

The analysis on constraints, and gaps, and related financial, technical and capacity building needs was undertaken. Some of the overarching critical issues that need to be addressed include, amongst others, the following areas:

- Limited human resources capacity in terms of numbers and skill range and depth;
- Limited climate change systematic data observation, collection and storage;
- Lack of capacity to use and apply analytical tools and models for enhancing effective and efficient decision making;
- Unclear sectoral policies that impact or are impacted by climate change;
- Limited institutional capacity;
- Limited sustainable funding for climate change research and programmes;
- Limited coordination of climate change research and interventions.

Concluding remarks

Lesotho has in recent years seen an increase in the frequency and intensity of climate related extreme events and disasters. Therefore, Lesotho needs to make deliberate efforts to respond to the challenges imposed on its socio-economic sectors and peoples guided by an integrated climate change policy which the government has to start developing.

Lesotho is a net emitter of GHG. Efforts must be put in place to develop appropriate mitigation measures to reduce our levels of GHG emissions and enhance our sink capacity. As we develop, Lesotho should target to become a carbon neutral country. Lesotho needs to build local capacity to

apply and/or develop various analytical models and tools in order to reap maximum benefits from a wide range of climate change mitigation options. This could best be taken up by research institution and universities.

The majority of Basotho lives in the rural areas and is dependent on climate sensitive sectors as sources of their livelihood. Climate change poses an additional challenge to poor and vulnerable communities who are already exposed to other multiple challenges. Programmes should be developed to enhance resilience of its people to the negative impacts of climate change.

Lesotho Government should continue to strengthen the link with other multilateral and bilateral institutions to facilitate capacity building and technology transfer in the various areas of climate change policies, science and technologies.

1 Introduction

1 INTRODUCTION

1.1 Background

Global climate change is one of the greatest threats to the world community, leading to adverse social, economic and environmental effects. The continuing increase in atmospheric concentrations of greenhouse gases (GHGs) has had a perturbing effect on the earth's radiation balance, which has resulted in the rise of the annual mean surface temperature around the globe. In its Third and Fourth Assessment Reports (2001, 2007), the Intergovernmental Panel on Climate Change (IPCC) presented new and solid evidence that in the last 50 years global warming has, by and large, been the result of human activities - and the impact of those activities will continue to be the main cause of climate change in the centuries to come. According to all IPCC emission scenarios, projections show a rise in global surface temperatures. The expected increase in global surface temperature ranges from 1.4^{0}C to 5.8 ^{0}C in the 1990 - 2100 period. Predictions indicate that the negative effects of climate change will be felt most severely by poor and least developed countries, of which Lesotho is one. These countries have limited capacity to adapt to the impacts of the emerging climate patterns.

According to the criteria stipulated in Article 4.9 of the UNFCCC, Lesotho is categorized as one of the countries that are highly vulnerable to the impact of climate change, deserving special attention. Lesotho manifests several of the specified conditions since it is a country prone to natural disasters, liable to drought and desertification, and is mountainous, with a largely fragile ecosystem. The country experiences frequent droughts that result in poor harvests and large livestock losses to rural farmers, exacerbating poverty and suffering. Heavy snowfalls, strong winds and floods that pose devastating social impacts also affect Lesotho. These adverse climatic conditions undermine the economic development of the country and the well-being of the nation.

Lesotho's economy is heavily dependent on climate sensitive sectors. The INC highlighted that the direct effects of climate change on the various economic sectors could be felt in areas such as water, agriculture, ecosystems, biodiversity, health and energy. Majority of the population dwell in rural areas where agriculture is the main source of livelihood. The limited use of irrigation facilities and high dependence on favourable climatic conditions for the realization of good harvest tend to introduce huge instability in the standards of living of the people. Export of water to the Republic of South Africa is one of the largest sources of foreign exchange for the country.

Lesotho joined other nations in ratifying the United Nations Framework Convention on Climate Change (UNFCCC) in February 1995 as a Non-Annex I Party, thus becoming obligated to adopt and implement policies and measures designed to mitigate and adapt to the effects of climate change. In response to Article 4 (paragraph 1) and Article 12 (paragraph 1) of the Convention, Lesotho prepared, published and reported her Initial National Communication (INC) to the Conference of Parties (COP) to the UNFCCC in April 2000 for the base year 1994. Subsequent to the INC, Technology Needs Assessment (TNA) was prepared for the Energy and Land-Use, Land-Use Change and Forestry (LULUCF) Sectors. As a Least Developed Country, Lesotho developed the National

Adaptation Programme of Action (NAPA) which identified urgent and immediate adaptation needs in 2007. The Second National Communication (SNC) is in furtherance to meeting her obligation under the UNFCCC. The SNC builds on and continues the work done under the INC, TNA and NAPA. As such, it includes additional information as an update to the INC, in accordance with the sets of guidelines contained in the annex to decision 17/CP.8. The main objective of the National Communications is to present and communicate to the COP, how Lesotho is implementing the Convention. The information provided in the SNC was for the base year 2000. Further detailed updates covering more recent years will be provided in the Third National Communication (TNC), which will be launched immediately after submission of the SNC to the COP.

Prior to SNC, LMS undertook a Stocktaking Exercise to identify gaps and constraints in the INC to be addressed in the preparation of the SNC. The institutional arrangements employed under the INC were to some extent rejuvenated and blended with new set of expertise to ensure continuity and at the same time benefit from building on existing experiences.

The preparation of the SNC was very participatory, interactive and above all delivered in a systematic manner. This Communication was funded by the Global Environmental Fund (GEF), technically supported by the United Nations Environment Programme (UNEP), and implemented by the Ministry of Energy, Meteorology and Water Affairs (MEMWA) of the Government of Lesotho. The Lesotho Meteorological Services (LMS), a department under MEMWA, is responsible for the coordination of Climate Change issues in Lesotho, and thus the implementation of the SNC project.

1.2 Structure of the Second National Communication

The Second National Communication contains eight chapters constituting the major reporting elements as elaborated by Article 4 (1) and 12 (1) of the Convention and UNFCCC guidelines for national communication by non-Annex I Parties. Chapter 1 provides the rationale and summary of the processes for preparing the SNC in Lesotho. Chapter 2 briefly describes the national circumstances, with specific emphasis on the aspects of Lesotho development priorities, policies and strategies, linked directly or indirectly to the implementation of the climate change convention on a continuous basis. Consequently, Chapter 3 presents national policies and development plans. Chapter 4 is devoted to reporting the information, data and methodologies for preparation and compilation of GHG inventories in Lesotho, in accordance with the requirements for non-Annex I Parties decision as laid out in UNFCCC decision 17/CP.8. The chapter also presents results of the GHG inventory in analytical, tabular and graphical forms to aid better understanding. Chapter 5 captures information on the methodologies and analysis of the various sectoral mitigation opportunities, various measures and policies to facilitate climate change mitigation. Chapter 6 refers to impacts and vulnerability assessment of different sectors to climate change. It also deals with the measures that could be taken to facilitate adequate adaptation to the impacts of climate change in Lesotho. Chapter 7 focuses on information related to the implementation of the convention, such as technology transfer, research and systematic observation, information dissemination and networking. Finally, Chapter 8 makes a detailed assessment of constraints and gaps, and related financial, technical and capacity needs to enhance implementation of the Convention.

2 National Circumstances

2 NATIONAL CIRCUMSTANCES

2.1 Introduction

This chapter aims to reflect significant changes in Lesotho's natural and socio-economic characteristics relating to climate change since the INC. It provides details on national development priorities and objectives that serve as the basis for addressing issues relating to climate change. Information provided in this chapter is critical for understanding a country's vulnerability, its capacity and its options for adapting to the adverse effects of climate change, as well as its options for addressing its GHG emissions within the broader context of sustainable development. These national circumstances are broadly described to serve as basis for expositions and discussions elsewhere in the document.

2.2 Geographical Profile

Lesotho is a country which occupies 30,355km^2 of land that lies between 1,388 and 3,482 meters above sea level. The country is completely landlocked by the Republic of South Africa (RSA), as shown in Figure 2.1. It is divided into 4 ecological zones: the Lowlands region that occupies 17% of the land area, the Foothills, Mountains and the Senqu River Valley (SRV) cover 15%, 59% and 9% respectively. The geo-morphological and topographic conditions of the country have largely confined socio-economic conditions to the Lowlands, the Foothills and the SRV, leaving the barren and rugged Mountain region mainly for grazing.

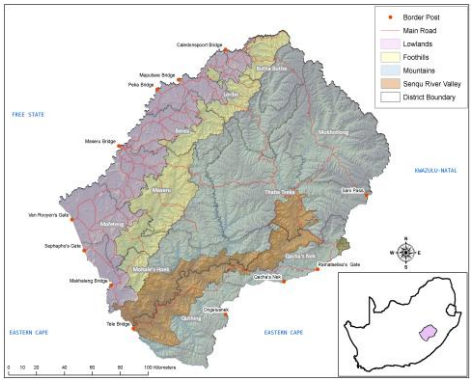

Figure 2.1 Map and Overview of Lesotho

2.3 Environmental issues

Land degradation is one of the environmental issues of major concern in Lesotho. It is mostly aggravated by cumulative effects over decades of poor land management due to soil erosion, reduction in soil quality, veld fires, deforestation and overgrazing. Topography and soil textures play an important role, but poor agricultural practices, including overstocking and overgrazing, are thought to be major contributors to the problem. Adding to these factors, strong winds and occasional high intensity rainfall, it is not surprising that the country is often considered to exhibit one of the worst cases of soil erosion in southern and central Africa. The already existing factors on environment are exacerbated by climate change.

Pollution of surface and groundwater from industrial activities, agricultural chemicals, unimproved pit-latrines, uncontrolled urban drainages and landfills is also common.

2.4 Government and Administration

2.4.1 Political setup

Since independence in 1966, Lesotho political landscape has been characterized by instability and unrest that is often associated with electoral systems and the acceptance of election results. After political riots that followed the 1998 General elections, Lesotho's political parties, with the assistance of Southern African Development Community (SADC) neighbours, began a process of dialogue that aimed at building a more stable system of parliamentary representation. These negotiations culminated in increasing the parties' representation in the parliament by adding 40 seats that are filled through a proportional representation formula to the 80 constituency-based first-past-the-post seats. The General Elections of May, 2002 were held under this mixed representation parliamentary system. Although also overwhelmingly won by the Lesotho Congress for Democracy (LCD) like the 1998 elections, proportional representation enabled 9 opposition parties to be represented in parliament, thus allowing a boarded and more inclusive participation in the legislation process.

The February 2007 General Elections, like the previous general elections, were also hotly contested, with the biggest challenge to the ruling LCD coming from the newly formed All Basotho Convention (ABC), a party whose leader had defected from the ruling party. This election was once again won by the LCD, with an overwhelming majority. There were, however, a number of contestations, including the way in which proportional representation seats were allocated by the Independent Electoral Commission (IEC). The IEC was pressurized to review the allocation, and this prompted some intervention by SADC.

There has been a big push to decentralize government functions in Lesotho in order to strengthen service delivery at the local level since the late 1990s. With the relevant legislation in place, local government elections were held on 30 April 2005. Candidates were drawn from 14 of the 16 registered political parties. However, within Maseru the capital city, candidates were drawn from 6 political parties only and the voter turnout merely ranged between 4% and 17%. These low participation rates, together with limited resources for Local Government councils, pose serious challenges for the legitimacy and acceptability of elected local representatives throughout the country.

There is a lot of concern in Lesotho about gender equity, an issue that features in a multitude of the country's policy documents. In this regard, in 2004, an amendment[1] was made to the Local Government Election Act of 1998, providing for the reservation of one third of the nominations in each local council area, for females, during the nomination process, in accordance with a target that was set out by SADC for member states. Consequently, in Local Government elections of 2005, there was a 51% increase in female nominees, compared to 20% in the General Elections of 2002.

[1] Local Government Elections (Amendment) Act 2004, Lesotho Government Gazette No. 75, Section 18 (A) (1A)

2.4.2 Administration

Lesotho is a parliamentary constitutional monarchy, with the King as the Head of State. There are three arms of government, namely, the Legislature, the Executive and the Judiciary. The first arm, namely the Legislature, has a bi-cameral parliament consisting of the Upper House or Senate, and the Lower House or the National Assembly. The Senate comprises 33 members (22 principal chiefs, who are members by heredity rights and 11 other members, nominated by the King). Its role is to examine and review draft legislation or bills which, according to the 1993 Constitution, Section 78 Article 2 [S. 78(2)], have to be initiated and passed by the National Assembly.

The National Assembly with 120 elected members has a fixed term of 5 years. The Prime Minister is a leader of the majority Party or Coalition of Parties in parliament. He heads the Executive arm of Government and Cabinet of Ministers.

The Judiciary consists of the Court of Appeal, the High Court (whose Chief Justice is appointed by the Monarch, acting on the advice of the Prime Minister), Subordinate Courts and Courts-Martial, as well as tribunals exercising a judicial function. According to the Constitution, the judiciary is independent and free from interference, subject only to the Constitution or any other law. The legal system in Lesotho is based on the English Common Law and Roman Dutch Law; judicial review of legislative acts in the High Court and the Court of Appeal, and accepts compulsory International Court of Justice (ICJ) jurisdiction with reservations.

The Attorney General (AG) is a legal advisor to the government, pursuant to Section 98 (S.98) of the Constitution. He/she is also in charge of legal matters handled by the office of the Director of Public Prosecutions (DPP), who is responsible for mainly criminal matters. The office of the DPP is a public office, pursuant to Section 99 (S.99) of the Constitution, with the power to institute criminal proceedings against any person in any court, except for a court-martial.

There is also the office of the Ombudsman, whose role is to investigate and decide on administrative matters, in any Government department, wherein a person suffered some injustice in the course of performance of official duties.

2.5 Climate and Climate Change

Lesotho's climate is continental temperate with alpine characteristics that are distinct from the rest of the Southern Africa sub-continent. The climate is thus, highly variable characterized by droughts, floods, frosts, snow, hailstorms and tornadoes. Winters are more severe in the highlands, where snowfalls often cut off the population from basic health services and other necessities of life. These climatic extremes will be exacerbated by climate change.

Recent heaviest snowfall in June 2010 in the Maluti Mountains

Climate change scenarios paint a gloomy picture. They predict warmer temperatures and change in

rainfall patterns, that is, decreasing summer precipitation and the late onset of summer rains, a gradual increase in autumn rainfall as well as wetter winters. They also show an increase in intensity and frequency of extreme weather events such as floods and droughts[2]. While drought conditions are generally a common phenomenon of the climate in Southern Africa, in Lesotho the occurrences have become more frequent in recent years, indicating that the country is already experiencing the adverse impacts of global warming.

The worst dry spells were experienced in 2002/3, when 760,000 people were affected, as well as in 2006/7 when rainfall levels for the critical months of January to March were 45% of the expected precipitation[3]. For the months of December 2010 and January 2011, Lesotho saw unprecedented rains, floods and rock slides that destroyed crops, livestock and property. This was a setback on economic progress and it aggravated the dire economic conditions in the country. These heavy rains were the worst since 1933. They exerted a significant impact upon key sectors including agriculture, transport, health and education, with total losses and damages estimated at M462.7 million which was 3.2% of the GDP. Heaviest damages were sustained by the roads sector (M80.3 million), livestock (M29.8 million), education (M28.3 million), and housing (M22.4 million). Heaviest losses in production were sustained by crops (M103.6 million), road transport (M57.4 million), and commerce (M20.5 million) the post-disaster recovery and reconstruction costs have been estimated at M666,739 million.[4]

Collapsed infrastructure as a result of torrential rainfall in 2011

While adverse impacts of climate change are felt globally, developing countries, such as Lesotho, landlocked with vulnerable mountainous eco-systems, are the most vulnerable due to limited financial, technological and human resources to address the negative impacts of climate change. Moreover, as one of the least developed countries, Lesotho lacks the capacity to take necessary adaptive measures. Without adaptation measures, Lesotho will be vulnerable to increased losses and damages from severe weather, making achievements of growth targets increasingly difficult.

Lesotho's emission of GHGs is insignificant in global terms; the country remains highly vulnerable to the effects of climate change caused by global emissions. The country is currently embarking on implementing mitigation initiatives in pursuit of attaining a low carbon development pathway. However, there are challenges attributed to financial and technical constraints.

2.6 Population and Human Development Indicators

As indicated in the INC of 2000, the 1996 population census had estimated the population of Lesotho at 1.96 million, suggesting that the intercensal annual growth rate had gone down from

[2] MNR 2000, Lesotho's First National Communication under the UNFCCC. LMS, Lesotho
[3] Consolidated Appeals Process (July 2007), Lesotho Drought 2007: Flash Appeal, United Nations, p3
[4] Source; Disaster Management Authority 2011, and Lesotho Post Disaster Needs Assessment, GOL

2.8% in the 1976-86 period to 2.0% in the 1986-96 intercensal period. The 2006 national census gave a de jure population of 1.88 million, with an annual growth rate of 0.08%, implying a substantial decline from the annual growth rate of 1.5% during the period 1986 to 1996. In 2009 the total population was estimated at 2.07 million, with the rural population estimated as 73.8% of the total population, as against 77.2% in 2006.[5]

Lesotho's Human Development Index (HDI), like that of its sister countries within the Southern African Development Community (SADC), had increased gradually between 1975 and 1990. Since the 1990s there was a general loss in gains in human development in the sub-region, the main causes being drought conditions and other climate related shocks, including associated increases in oil and food prices[6]. In Lesotho, this had an impact on poverty, which was aggravated by the high prevalence of HIV and AIDS. The country's social indicators worsened rapidly over the last decade due to increased mortality and reduced incomes associated with HIV and AIDS related deaths since the 1990s. In 2000, Lesotho's HDI value was 0.535, resulting in a ranking of 132 out of 173 countries.[7] However, the 5 years ending 2005 saw some changes, with HDI values of 0.493 and 0.494 in 2002 and 2003 respectively and the resulting rankings of 145 out of 175 countries and 137 out of 174 countries respectively. In 2005 some slight improvement was recorded, with the HDI value of 0.549, ranking the country at 138 out of 177 countries. This placed Lesotho in a third position in the SADC region after South Africa and Botswana. This modest improvement shifted the country upwards from the Low Human Development category of countries to the Medium Human Development group.

The value of Lesotho's HDI for 2010 was low, once more, placing the country at 0.427, in the low human development category, positioning the country at 141 out of 169 countries. The estimates take into account the effects of excess mortality due to HIV/AIDS, which also results in lower life expectancy, higher infant mortality and death rates. When this HDI value of 0.427 is discounted for inequality, it falls to 0.282, a loss of 34%. This is due to inequality in the distribution of the new dimension indices, introduced by UNDP in 2010, namely Gender Inequality Index (GII) and Multidimensional Poverty Index (MPI).[8]

Life expectancy stood at 35.2 in 2004 [UNDP HDR 2006], a drop from 56 years in 1997 [UNDP HDR 1999]. According to 2010 estimates, it now stands at 50.67 years. Infant mortality increased from 74 children per 1,000 live births in 2000 to 91 and 94 children per 1,000 live births in 2004 and 2006 respectively. Maternal mortality is also high, with the risk estimated at 1:32, meaning that 1 out of every 32 women faces the risk of death.

[5] Lesotho Statistics
[6] UNDP (2007) Human Development Report 2007-2008-Fighting Climate Change: Solidarity in a Divided World, Table 2
[7] UNDP HDR Report for 2004
[8] GII reflects women's disadvantages in 3 dimensions (reproductive health, empowerment and economic activity). Empowerment is measured by the share of parliamentary seats held by gender, and attainment of secondary and higher education by each gender; while reproductive health is measured by maternal mortality and adolescent fertility rates. MPI, on the other hand, identifies multiple deprivations in the same households in education, health and standard of living.

2.7 Economic Outlook and Development

As one of the least developed countries, and with a highly open market-based economy with imports amounting to about 90% of the Gross Domestic Product (GDP); and being inextricably linked to a more economically advanced South Africa, Lesotho is heavily dependent on remittances from migrant labourers employed in the South African mines and other industries. The country also depends on diamond mining, external assistance, customs duties from the Southern African Customs Union (SACU),[9] the sale of water to South Africa, and the textile sector, which is the largest source of employment in the manufacturing sector. The contribution of agriculture to GDP has been declining with time.

Lesotho's economic growth, leading up to the recent global recession, averaged 3.4% a year from 2004 to 2008.[10] The real GDP at market prices grew steadily in recent years from M3.9 billion in 2000 to M4.8 billion in 2006[11]. The main performers were mining and quarrying, manufacturing, building and construction and the tertiary sector, particularly transport and communications. In 2006, the tertiary sector contributed 44% to the GDP at factor cost while the secondary and primary sectors, respectively, contributed 35% and 21%. In the 5 years ending 2006, real GDP grew at an average 3.8% per annum. While real Gross National Income (GNI) grew at an average 5.1% per annum. However, during this period GDP per capita only grew at an average 1.8% and GNI per capita at an average of 3.2%.

Economic performance deteriorated in 2009, in the wake of the global crisis which had a negative impact on food and energy prices. The global crisis resulted in a significant decline in revenues from the Southern African Customs Union (SACU), which had hitherto accounted for around 60% of the country's total revenue. The fall in SACU revenue to 30% in 2010/11[12], leading to a significant reduction in total Government revenue, was mainly due to a recession that hit South Africa, which is a primary contributor to the revenue pool. Unemployment, resulting from loss of jobs as a result of retrenchments from the South African mines left the impoverished rural population with reduced access to its traditional coping strategy of migrant labour. With estimates indicating that each migrant labourer supports himself and at least five dependents[13], the impact of unemployment on household incomes among the rural populations is self-evident. Loss of jobs for women who were employed in the Lesotho garment manufacturing firms which closed or reduced operations at the expiry of the Multi Fibre Agreement in 2004, and the uncertainty regarding extension of Africa Growth and Opportunity Act (AGOA), aggravated the situation. Unemployment in Lesotho shot up from a high 23% in 2008 to 29.4% in 2009. This lowered household incomes, resulting in the aggravation of poverty.

Subsistence agriculture and income earnings from migrant labour in the South African mines have been the traditional providers of household livelihoods in Lesotho since the late 19th century. However, in recent years, there has been a shift in the structure of the economy that has made

[9] Lesotho is a member of SACU, together with Botswana, Namibia, South Africa and Swaziland
[10] The World Bank: Lesotho Country Brief
[11] Central Bank of Lesotho (2007) Annual Report 2006, Table 1A
[12] IMF Press Release No 10/224, 2 June 2010
[13] Setsabi, A.M. Lesaona, M.A. and Molefi, J.J. (1992). A study of the Socio-Economic Situation of the Basotho Miners, National University of Lesotho) pp 2 – 17.

these traditional sources of livelihoods marginal. The relative contribution of agriculture to the GDP has been gradually declining from 20% in 2000 to 13% in 2006. Similarly, the average number of Basotho employed at the South African mines has dropped gradually from 95,913 in 1997 to 51,595 in 2006. Wages and salaries, and informal sector incomes, as well as remittances from relatives working in urban areas, have become important sources of livelihood in Lesotho.

Despite the 2008/09 global economic and financial crisis, the economy has shown signs of recovery since 2010/11. The recent improved performance of the Lesotho economy resulted mainly from the robust performance of the mining of diamonds and quarrying sector, particularly the improved output at the Letseng Diamond Mine, as well as from the recovery of the textile and clothing sub-sectors that was boosted by measures recently introduced by Government to improve the business climate. However, this performance had a marginal impact on the rural sector where the majority of the population continued to depend on low productivity agriculture and remains vulnerable.

In pursuing the single-digit inflation target that was set under the SADC macro-economic convergence targets, Lesotho reduced the inflation rate from 11.01% in 2002 to 3.46% in 2005. However, in 2006, the inflation rate increased to 6.05%. For 6 years ending 2006, the inflation rate averaged 6.6%, implying that Lesotho had stayed within the SADC target of a single digit. However, trends in Consumer Price Indices (CPIs) show that it will be difficult for this country to remain within this target. Adverse weather has caused decreased cereal production throughout Southern Africa, including the Republic of South Africa (RSA), which supplies close to 70% of Lesotho's food requirements. The rapid increase in the prices of oil and cereals on the RSA market have a direct impact on these commodities imported into Lesotho where food constitutes the largest weight, 39.8% in the CPI basket. As a result, poor households that depend on food purchases and donations to meet their food requirements face a multitude of challenges.

2.8 Economic Sectors

2.8.1 Energy Sector

There are no indigenous sources of oil, coal, or natural gas in Lesotho. About 2,000 barrels of oil are imported per day. There is also no oil refinery and as a result, all petroleum products, including kerosene, jet fuel, and gasoline are imported.

Katse Dam, Source for Muela Hydropower generation

The Lesotho Highlands Water Project (LHWP), which was commissioned in 1986 and designed to capture, store and transfer water to South Africa, has rendered Lesotho almost self-sufficient in the production of electricity from the 'Muela Hydropower station which became operational in 1998. The station was designed to produce 72MW hour at full capacity. This satisfies electricity needs of the country in the summer season. However, in winter, which is the peak period for electricity demand, electricity is imported from South Africa to meet consumption which reaches 130MW. Electricity, however, only accounts for 3% of the energy that is consumed in Lesotho. It is estimated that 60% of households in the country use biomass for heating and cooking, and that 95% use paraffin or candles for lighting (Ministry of

Natural Resources, 2000). While biomass accounts for 72% of the national energy balance, about three quarters of the total energy demand is met by biomass in the form of wood, shrubs, animal dung and agricultural residues. The only other fuels consumed in significant quantities are coal and paraffin.

Despite massive electricity infrastructure development in the county over the last years, electricity access remains at 28% of households in Lesotho, with most of these being located in urban areas. It is estimated that only 4% of rural households have access to reliable electricity. The Government of Lesotho objective is to increase the electrification targets from this current 28% to at least 35% by 2015, countrywide.

Distribution of electricity is under the auspices of the Lesotho Electricity Company (LEC), a parastatal entity. Planning and infrastructure development is the responsibility of the Government. Since its establishment in 2002, this Company has embarked on the rural electrification project designed to avail electricity to those rural communities closer to the national grid. The electrification rate is 16%, with 44% in urban areas, and 6.0% in rural areas. The Government has set a target of lifting the electrification rate to 25% by 2015. Plans are underway to increase the capacity of the 'Muela hydropower facility from the current maximum nominal generating capacity of 72 MW to 1000 MW (via pumped-storage), through construction of the Polihali Dam which is still under negotiations.

Four mini (micro) hydro plants were operationalized in the 1980s. Mini hydropower units in Lesotho consist of systems with capacity of up to 2MW. There are three isolated mini-hydro power plants, and a further one which is grid connected. The total installed capacity of these units is about 3.25 MW, only two of these are currently operational. Twenty-two further sites have been identified for the purposes of harnessing hydropower potential.

Extension of the national grid into remote mountainous areas poses a difficult challenge to rural electrification. Government has therefore created the Rural Electrification Unit with a mandate to develop and utilize renewable energies for these communities. A number of pilot schemes to introduce wind and solar based energies are under development. A wind farm is in the process of being established at Letseng-la-Terae, in the mountainous District of Mokhotlong. Government has also declared the intention to adopt wind energy as the major source of energy for the future with the estimates of up to 6,000 MW to be produced by 2020.

In an effort to alleviate the heavy use of biomass, especially for cooking, Lesotho is promoting the use of improved cooking stoves. Research has demonstrated that these portable stoves each with a nominal effective thermal power of 1.5 kW, need only 250 g of small brittle sticks/twigs of wood to bring 6 litres of water to boil, 80% less than traditional open fires. This is an appropriate technology, which reduces GHG emissions and also has a positive impact on health as it reduces indoor air pollution.

2.8.2 Water Sector

The Global Circulation Model (GCM) simulations results of future scenarios of climate change of the INC up to year 2062 show that there would be lower surface flow that would lead to dry springs and

wells, as well as lower water tables which would result in an ecological disaster. The lower run-off could affect the 30-year multi-billion water project, the Lesotho Highlands Water Project (LHWP), which was initiated in 1986 with the construction of two giant dams at Katse and Mohale, and an elaborate water transfer system to South Africa. Since Lesotho is, first and foremost, obliged to provide for her domestic water needs, she will need to address the eventuality of having to honour the terms of the Water Treaty, while at the same time providing for the needs of her population.

Phase 2 of the LHWP that includes the construction of the third dam at Polihali, Tlokoeng, in the Mokhotlong District, was scheduled to commence in 2012. This phase of the project involves the construction of a 165 meter high dam wall and a 2.2 billion cubic meter reservoir.

Other initiatives, such as the Lowlands Water Supply Project and the Six Towns Water Supply Project, have been undertaken to provide bulk water for domestic, commercial and industrial use. In June 2009, a US$ 423 million contract was signed for the design and supervision of the construction of the Metolong Dam. This project will supply water for domestic and industrial uses in Maseru and surrounding areas which experience periodic water shortages. It is scheduled to be completed in 2013.

In terms of the regulatory environment, a Water and Sanitation Policy was developed in 2007, while the Water Act was enacted in 2008. The former Water and Sewerage Authority (WASA) has been transformed into a water utility company, WASCO. A multi-sector regulator, the Lesotho Electricity and Water Authority (LEWA), which will regulate tariffs of both the electricity and water sectors has also been established.

Issues relating to water often have regional dimensions. Accordingly, Lesotho is a member of the SADC Protocol of Shared Water Systems. Under the auspices of this Protocol, the Orange Senqu Commission (ORASECOM) was established as a River Basin Organisation (RBO). The Phase 1 Basin Master Plan was completed in 2007. Lesotho is also a member of a Hydrological Cycle Observing System set up by SADC (SADC HYCOS) to share information on river flows; and of the African Ministers' Council on Water (AMCOW) whose mandate is to improve access to water and sanitation.

2.8.3 Agricultural Sector

About half of the population earn some income through farming (livestock and crop production). Agricultural production in Lesotho is dominated by farmers owning less than 1 hectare of land. Agriculture productivity is low mainly due to shortage of arable land, poor soil conditions, poor farming practices (including lack of mechanization), lack of farm inputs such as fertilizers and lack of access to credit opportunities. Notably, soil erosion and urban encroachment have brought down the quality and quantity of land available for growing food at an alarming rate. Ministry of Agriculture survey conducted in 1988 estimated the loss of soil to erosion at 40 million tons annually, which is equivalent to more than 2% of country's top soil. The rising demand for biomass fuels, particularly crop residue, has also had a destructive impact on the agricultural sector. It has been blamed for reduced soil fertility, soil erosion, land degradation, and dwindling biodiversity.

On average, maize accounts for 60% of the total crop land; sorghum between 10% and 20%; wheat has a 10% share; and beans are responsible for 6%. Lesotho imports food to meet its consumption demand (around 65% and 80% of its maize and wheat requirements respectively)[14]. Recurring droughts restrain food production. Increasingly erratic weather patterns, and the impact of HIV/AIDS on farming families, have also crippled the country's agricultural production capacity. Very little farmland is irrigated in the country.

[14] Financial Standards Foundation: (Country Brief, Lesotho, July 26, 2010)

2.8.4 Tourism Sector

Mahlasela Afriski Resort

Tourism has the potential to be a major driver of economic growth for Lesotho. The spectacular mountain scenery and wide range of eco-adventure, and cultural-tourism offerings make Lesotho a compelling product. It is a labour-intensive industry, with a potential to generate jobs especially in the rural areas where poverty is rife. However, not much has been invested in this sector.

Lesotho's strategic direction for tourism is set by the Ministry of Tourism, Environment and Culture (MTEC). The Lesotho Tourism Development Corporation (LTDC), established in 2004, is its implementation arm. In 2006, MTEC, together with the United Nations World Tourism Organisation (UNWTO), produced the Tourism Master Plan (TMP) for Lesotho, which was followed by the Tourism Strategic Plan of MTEC in 2007 which states the priorities and action plan for implementation of the TMP.

The strategy led to a number of accommodation facilities being built at major tourism destinations. In order to preserve culture, coupled with tourism development, Government built a Cultural Village, at the foot of the Thaba-Bosiu Mountain, the fort and the burial site for Moshoeshoe I, the founder of the Basotho Nation. Liphofung Heritage Centre has been built and Rural Homesteads established. To improve the standard of accommodation facilities, a Grading and Classification system has been introduced.

Lesotho continues to cooperate with other regional members for tourism promotion and marketing, especially through the Maloti Drakensberg Tourism Route joint bilateral marketing initiative with South Africa. Furthermore, a Transfrontier Park has been established to help spread the benefits from tourism in South Africa into Lesotho. Lesotho attracts South African nationals as tourists, many of whom come to take advantage of Lesotho's adventure activities like high altitude motor biking and quad biking. The "Lesotho Haeso" (Lesotho, my place of origin) campaign has also been introduced to promote domestic tourism, by targeting tourism frontliners. The Sehlaba-Thebe National Park has been declared a World Heritage Site.

The TMP (2006) has identified three priority areas for tourism development and advancements. These priorities have subsequently been translated into four tourism development zones in the Tourism Strategic plan of 2007. These are:

- The Highlands Circuit, covering the northern and north-western part of Lesotho, the national parks and the Katse and Mohale Dams.

- The Heritage Circuit, which is the area covering southern Lesotho through Quthing to Qacha's Nek, with entry points at Ongeluksnek, Qacha's Nek and Ramats'eliso's Gate.

- The Roof of Africa Circuit, which is the area covering the central part of Lesotho, linking through Semonkong, onto Mokhotlong, Sehlabathebe and the eastern mountains of Lesotho and the Kwazulu Natal in South Africa

- The Maseru Business Circuit, which is the area covering Maseru and its surroundings, and includes Thaba Bosiu and Roma.

Data on tourism is sketchy and only suggestive at best[15]. Statistics available on foreign visitors are dominated by data collected at Lesotho's borders and supplemented by few other surveys. Taking October 2005 as an example, these statistics show that out of the total of 28,467 "foreign arrivals" in Lesotho, only 2,034 (or 7.2%) were non-South Africans. The data also suggests the number of tourism-related visitors from Europe (mainly the Netherlands, Germany and the United Kingdom) to be 1,065. Moreover, about 10,000 (or 38%) South African visitors fall under the category of "visiting friends and relatives" (this should ideally not be part of the real tourist head count!).

2.8.5 Mining and Quarrying

Historically, mining has not been a significant contributor to the economy. However, in recent years this sector has shown a significant increase. The contribution of the mining and quarrying sector to GDP increased from 0.2 % in 2003 to 2.3 % in 2004. The main mineral resource is diamonds from the Letšeng Diamond Mine (aka "*Lets'eng-la-Terae*" or "swamp in the corner"). The mine is noted for its high percentage of large diamonds in the 10+ carat range, although the mine is expensive to operate with a low yield of around 2 carats per hundred tons[16]. With its large amount of sizable roughs, the Letšeng mine has the highest dollar-per-carat ratio of any diamond mine in the world. Letšeng Diamonds has recovered three of the world's top twenty rough diamonds. These include the 603 carat Lesotho Promise in August 2006, the 493 carat Letšeng Legacy in September 2007 and the 478 carat Leseli-la-Letšeng in September 2008. The 601 carat Lesotho Brown found in 1967 came from the Letšeng Mine. Minor deposits of coal, galena, quartz, agate and uranium have been identified, but are believed to be of little commercial value. Lesotho does, however, possess deposits of clay, which are being exploited for the manufacture of bricks, high-quality ceramic ware and tiles[17]. Detailed information on the mining sector, its contribution to employment creation and contribution to the GDP will be discussed in the Third National Communication (TNC).

2.9 Health and Social Conditions

Since the dawn of independence in 1966, there has been a realization that poor coverage with social services is largely responsible for the perpetuation of poverty in the country. It has therefore been a

[15] Growth Strategy Paper, Ministry of Finance and Development Planning 2008/2009
[16] "South African Diamond Mines". *khulsey.com*. Retrieved 01-06-2012
[17] The Economist Intelligence Unit (2004-02-20). *Lesotho: Mining*.

priority of all the governments to upgrade access infrastructure in order to improve social conditions in rural areas. However, despite heavy investment in this sub-sector that spans close to three decades, and a modest economic performance, social conditions have deteriorated, particularly in the rural areas, the main challenges being worsening poverty and the scourge of HIV/AIDS. These are the main social issues of major concern to policy-makers, development partners and civil society institutions in recent years.

Despite the fact that the first case of HIV/AIDS in Lesotho was reported in 1986, the country is today regarded as having one of the highest infection rates in the world.[18] Results of a demographic and health survey that was conducted by the BOS in 2004[19] revealed that the infection rate stood at 24% amongst the 15-49 year age group although in urban areas it went up to 29%. The HIV/AIDS pandemic has been associated with deepening poverty in rural Lesotho. It constitutes an alarming threat to Lesotho and its people, since it is an impediment to the country's economic development and also hampers responses to humanitarian and development needs. The loss of bread winners has resulted in large dependency ratios.[20]

Recently, the country has faced food deficits for several consecutive years, including those years when there was normal rainfall. There is a growing food deficit as both agricultural production and productivity are not only undermined by adverse climatic conditions but by animal and human pressure, poor land management practices, and a fragile land base. The growing vulnerability and deepening food insecurity is generally associated with widespread livelihood failure for many rural households today, leading to premature urbanization. Hence, both health and social conditions are being compromised.

In recent years, Lesotho has observed an upsurge in the number of orphans as a result of HIV/ AIDS related deaths. The 2004 Lesotho Demographic and Health Survey (LDHS) found that only 47% of the children under the age of 18 lived with both of their biological parents, while 24% lived with their mothers, 4% with their fathers, and 26% with neither of their biological parents.[21] Orphanhood has worsened what is already regarded as declining livelihoods in rural Lesotho. Increased household sizes, heavier burdens on households that are headed by the aged and by females, and the loss of breadwinners have combined to put pressure on already depressed rural livelihoods.

Since the early 2000s, there has been an upsurge of opportunistic diseases that are associated with HIV/ AIDS and changes in life style throughout Lesotho. According to the Bureau of Statistics[22], in 2000, 6% of the households in Lesotho had one or more chronically ill persons who were aged 15-49. The percentage was higher amongst rural households, at 7%. As a result of these HIV/ AIDS chronic illnesses, there has been a heavy demand on health services throughout the country, leading to the

[18] Ngulube-Msikita, Rachel (March 2006): **Impacts of HIV/AIDS on Rural Livelihoods in Lesotho,** FAO, p.1
[19] Ministry of Health and Social Welfare, Bureau of Statistics, and ORC Macro (Nov. 2005) **Lesotho: Demographic and Health Survey 2004,** table 11.24
[20] The dependence ratio is defined as the sum of the population aged below 15 years and that aged above 64 years divided by the population aged 15 to 64 years.
[21] **Demographic and Health Survey 2004:** table 11.24
[22] **CWIQ Survey 2002:** table 11.1

overstretching of health care services and low staff morale.[23] With the upsurge in HIV/ AIDS related chronic illnesses, family members have assumed greater roles in care giving, a practice that represents a drain in household resources, depresses productive capacities, and further threatens food security and livelihoods.

In November 2004, Lesotho introduced a non-contributory pension. Everyone over the age of 70, except those people already receiving a government pension, receives M350 (US$45) each month. Its announced objective was to reduce the poverty of the elderly. In 2006, around 3.6% (72,000 eligible people) were receiving pension and more than half of these were women. The scheme is financed out of the state budget, amounting to 2.4% of the national budget, or 1.43% of GDP.

2.10 Progress on Millennium Development Goals (MDGS)

Among others, climate change is a critical developmental issue on poverty, food security, economy, environment, health, human rights, governance and equality. It is, therefore, an MDG issue. Fighting poverty and climate change must go hand in hand.

So far, progress on the achievement of MDGs by Lesotho is mixed. Good progress has been made towards the achievement of MDG Education Targets in recent years. In 2000 Government embarked on a programme of Free Primary Education (FPE), as a major strategy towards achieving universal primary education and the Education for All (EFL) goals. FPE was intended to be introduced gradually, over a seven year period. As a consequence of this programme, whereby Government provides for school fees and text books while parents pay for uniforms and other school materials, the net enrolment for primary education increased from 60.0% in 1999 to 82.0% in 2000, and further to 83.1 % in 2006. The FPE Policy ensures equal access to primary education for boys and girls; and, among other objectives, also aims to reduce gender disparities in primary education.

Lesotho is lagging behind in the achievement of several goals that include eradication of poverty and hunger, and addressing child and maternal mortality.[24] Information on the progress of the MDGs indicates that the eradication of extreme poverty is very slow. Lesotho is rural in character and an estimated 73.8% of its population lives in rural areas[25]. Extreme and chronic poverty is concentrated in the rural areas, particularly the mountain areas, where an estimated 71% of the population live below the international poverty line of US$1 per day. Poverty indicators show that the estimated number of rural poor in 2009 was 923,108 or 61%, out of the rural population of 1.52 million. Poverty headcount ratio at rural poverty line, as a percentage of rural population in 2003 was 60.5, while poverty headcount ratio at national poverty line, as a percentage of the population was estimated at 56.3. An income share held by the lowest 20% of the population in 2003 was estimated at 3.0%.[26] In 1999/2000, out of an estimated 437,776 households nationwide, 326,180 or 75% were classified as rural, and of the latter, 89% were classified as farming households. This explains why

[23] Khalema, K. and Letsie, M. (January 2005) **National Health Care Waste Management Plan,** Kingdom of Lesotho, p.14
[24] Budget Speech 2011/2012
[25] Bureau of Statistics, August 2010
[26] Lesotho Statistics

agriculture is regarded as one of the critical vehicles through which the Government can effectively address issues of poverty and unemployment in the country.

Progress is slow in the achievement of MDG 7, namely ensuring environmental sustainability. Official documents reveal that Lesotho is a resource-poor country where an estimated 76% of the population is directly dependent on subsistence dry land agriculture and informal trade for all or part of its livelihood. As was emphasized in the country's INC to the COP, agro-ecological conditions in this country paint a gloomy picture, where arable land not only constitutes a mere 9% of the total land area, but is known to be gradually shrinking due to severe soil erosion and extreme forms of land degradation.

While both targets 7.A, that is, integrating the principles of sustainable development into country policies and programs, and reversing the loss of environmental resources; and 7.B, that is, reducing rate of loss of biodiversity by 2010, have not been achieved, there is some progress in Target 7.C that is, halving, by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation. As of the second quarter of 2010, 56.8% of urban residents and 3.8% of rural residents had piped water, while 6.1% of the urban population and 23.9% of the rural population relied on public wells. 29.4% of the population had access to a pit latrine, while 38.1% of the population had no access to sanitation facilities. In 2007, only 40.8% of households, nationally, had access to septic tanks or a sewer network while about 63% of households had access to some form of solid residual collection[27].

During the period covered by the INC, the proportion of people without access to potable water was 36%, but by 2008 (within the period under review), the proportion had fallen to 14.5%, well ahead of the MDG target of 19%,[28] whereas 47.3% of the population did not have access to basic sanitation, and this was still far from the MDG target of 33%.

2.11 Institutional Framework on Climate Change

The institutionalization of climate change issues and processes is mandated to the Lesotho Meteorological Services under the Ministry of Energy, Meteorology and Water Affairs through the climate change unit established within the LMS. The unit carries out climatic monitoring, research and assessment. It is supported by an Ad hoc inter-disciplinary and inter-sectoral National Climate Change Committee (NCCC) comprising of relevant Government Agencies, Academia, the Private sector and Non-Governmental Organizations (NGOs).

In accordance with its responsibilities, the LMS carries out regular collection, processing, formatting, and proper keeping of the data relating to weather, climate and climate change for the Government. It has been designated as the National Focal Point to the UNFCCC and as the Designated National Authority (DNA) for reporting on climate change to the UNFCCC and for managing applications for carbon trading through the Clean Development Mechanism (CDM) respectively. It is a key government institution responsible for overseeing the coordination of climate change issues in

[27] Financial Standards Foundation: (Country Brief, Lesotho, July 26, 2010)
[28] Lesotho Millennium Development Goals Status Report 2008 and Statistical Updates

Lesotho, and thus the implementation of the SNC project. The structure of the implementation framework of the SNC is illustrated in figure 2.2 below.

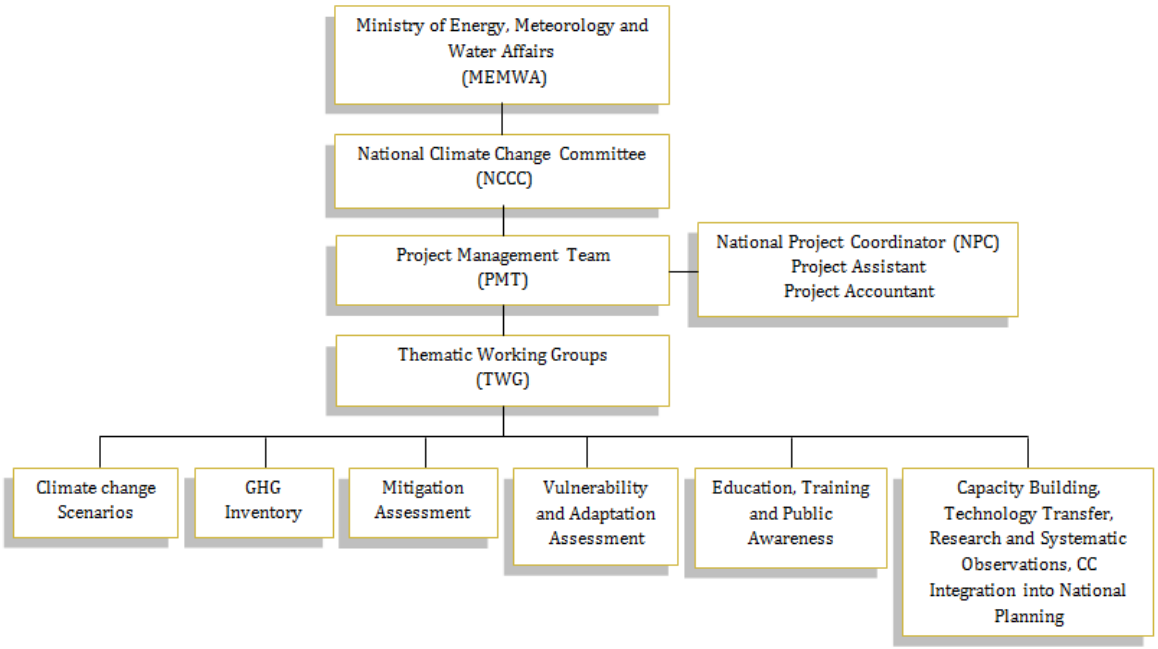

Figure 2.2 Flow-chart of the implementation framework of the SNC

3 National Policies And Development Plan

3 NATIONAL POLICIES AND DEVELOPMENT PLANS

3.1 Introduction

Lesotho's development policies continue to strongly focus on the attainment of sustainable human development, a goal which broadly encompasses poverty reduction, employment creation, and provision of social services. While maintaining this focus, developments have taken place by way of formulating national and sectoral policies that attempt to respond more accurately to the present national priorities, economic environment as well as unfolding scenarios.

Lesotho is among the countries which, during the last decade, embarked on formulating national visions that represent their long-term goals towards both sustainable economic growth and development.

3.2 Lesotho National Vision 2020

In the year 2000, a long term National Vision (Vision 2020), that would guide development efforts in Lesotho was developed to provide a long-term perspective within which short to medium term plans could be made. The views, beliefs, priorities and aspirations of the nation are embodied in the vision statement:

"By the year 2020, Lesotho shall be a stable democracy, a united and prosperous nation at peace with itself and its neighbours. It shall have a healthy and well developed human resource base, its economy shall be strong, its environment well managed and its technology well established ".

The National Vision has six pillars, namely:-

i) A stable Democracy; ii) a Nation at Peace with itself and its Neighbours; iii) A Healthy and Well Developed Human Resource Base; iv) A Strong Economy and Prosperous Nation; v) A Well Managed Environment; vi) A Well Advanced Technology

With regard to "A Well Managed Environment" pillar which is closely related to climate change, the Vision states that "By the year 2020, Lesotho shall be renowned for its environmental management. The country's diversity of life systems will be supported and protected by a nation which is environmentally conscious and whose people are in balanced existence with the natural environment. Basotho will be empowered in designing and managing biodiversity conservation projects relevant to their own communities. Environmental education will be integrated at all levels of learning. There will be institutional and legal frameworks to promote and protect a healthy and sustainable environment. Every development in the country will be subjected to an intensive environmental impact assessment to gauge its environmental friendliness".

A comprehensive country review was conducted as part of the African Peer Review Mechanism and concluded that Lesotho has made considerable progress in many areas, including governance, peace and political stability, gender equality, dealing with social vulnerability, expansion of new sectors such as manufacturing and mining and significant increase in trade/exports, development of

infrastructure, dispensation of justice through alternative dispute resolution mechanisms, high literacy rates and human resource development and increasing coverage of health services[29].

The review noted challenges to address to be in the areas of public sector reform, environment, HIV and AIDS, technological progress and achieving high, sustained and shared economic growth that results in poverty reduction.

3.3 Poverty Reduction Strategy Paper (PRSP)

In order to facilitate the implementation of the National Vision 2020, in 2004 the Government prepared a three year (2004/05 – 2006/07) Poverty Reduction Strategy; Paper, outlining strategies and programmes, that were needed to put Lesotho on a sustainable path towards poverty eradication and also achieving the vision priorities. The programmes that were targeted at achieving MDGs were also integrated in the Poverty Reduction Strategy (PRS). The key priorities of Lesotho's PRS were as follows:

i) employment creation and income generation
ii) increase agriculture and food security
iii) developing infrastructure
iv) deepening democracy, governance, safety and security
v) improving quality and access to essential health care and social welfare
vi) improving quality and access to education
vii) managing and conserving the environment
viii) improving public service delivery
ix) mainstreaming HIV/AIDS and gender, youth and children into sectoral plans

It is therefore clear that successful implementation of the PRS will bring Lesotho towards realization of Vision 2020 as well as part of the MDGs.

At the expiry of the PRSP implementation period in 2008, a thorough review of the process was carried out. The review found that many of the policies and programmes included in the PRSP were implemented, but weak institutional capacity and lack of a well defined and focused growth and job creation strategy prevented Lesotho from performing better than she did. One of the successes of the PRS period was the establishment of the Local Government structures in 2005. The structures would be taken into account as a basis for planning and poverty reduction at the local level during the medium term operational plan.

3.4 Interim National Development Framework (INDF)

Although the priorities and goals contained within the PRS remained valid, as a credible expression of the aspirations of the Basotho nation, the review found that there were still some lessons to be learned. An updated and comprehensive National Development Strategy was required to respond to the changing development climate, since the PRS was developed, and to employ more effective strategies, in order to exploit opportunities and address challenges facing Lesotho. Based on the

[29] Draft National Strategic Development Plan, Part I: Growth and Development Strategic Framework, November 2011

lessons learned from the PRS experience, therefore, the Government decided to replace the PRSP with a 5 year national development plan.

In order to bridge the period between the end of the PRSP and the start of the 5 year development plan, an Interim National Development Framework (INDF) was put in place, in order to guide resource allocation, until the completion of the development plan.

How the government could achieve the above was explored in more detail in the Draft Growth Strategy, prepared by the Government of Lesotho in 2008. The draft Growth Strategy examined potential drivers of growth in Lesotho, as well as the key binding constraints holding back each sector. Appropriate interventions were then identified.

The Growth Strategy, *inter alia,* focuses on agricultural development, reflecting its importance for an ever increasing number of livelihoods, at a time when production is low and unpredictable. Initiatives should focus on supporting food insecure households in intensifying and diversifying their agricultural production.

3.5 National Strategic Development Plan (NSDP)

In February, 2011 the process of preparing the 5 year National Strategic Development Plan (NDSP) 2012/13 – 2016/17 was launched.

The NSDP marks, as a point of departure, the need and urgency for Lesotho to radically transform its economy, intellectual and skills profiles by taking advantage of its location and defining a future that is characterized by the capacity to produce goods and services for the large Southern African (SACU and SADC) markets as well as the African continent and the global markets. This requires political and social stability as well as world class technical skills and institutions that are capable of technical innovation and meeting the challenges of global competitiveness, as they pursue overall economic and social goals of high broad-based and sustainable economic growth and employment generation that will lead to poverty reduction.[30]

The overarching objectives elaborated in the NSDP include the following:

- Protection of the environment and promotion of climate friendly technologies and practices;
- Promoting HIV/AIDS prevention, care and treatment; and
- Radically transforming technical, vocational and higher education to produce world class skills, and expanding access to technology, applications, innovations and networks.

The chapter on environment and climate change under the NSDP strives to achieve the following objectives:

- Facilitate the reversal of land degradation and protect water sources through integrated land and water resource management

[30] Concept Note on the National Strategic Development Plan: Towards an Accelerated and Sustainable Economic and Social Transformation, 2012/13-2016/17

- Increase biodiversity conservation, protection of cultural heritage and promote sustainable use Strengthen range management institutions and range carrying capacity
- Promote and increase the greening of the economy
- Improve land use and physical planning
- Improve the delivery of environmental services, including Environmental Impact Assessments, waste and sanitation and environmental health
- Improve environment and climate change governance

3.6 National Adaptation Programme of Action (NAPA)

In terms of Article 4.9 of the UNFCCC, Lesotho meets the criteria for countries that are particularly predisposed to adverse effects of climate change and have low adaptive capacity, thus deserving special attention. Accordingly, Lesotho prepared a National Adaptation Programme of Action (NAPA) through the Least Developed Countries Fund (LDCF) and completed it in 2007.

The sectors that were assessed during the NAPA process included the following: water, rangelands, forestry, agriculture, soils, health and energy. However, only a limited selection of priority adaptation options was possible, based on recommendations resulting from communities' consultations. The health and energy sectors are not specifically addressed, on account of financial constraints; yet these sectors of the economy in Lesotho are threatened by climate change risks to such a degree that, if not addressed, they are likely to nullify any efforts for adaptation in the prioritized sectors. A proposal, focusing on developing the necessary information base for climate change adaptation in energy and health sectors has, therefore, been prepared under the Africa Adaptation Programme.

Eleven adaptation activities were identified and prioritized for implementation in the various vulnerability zones. This prioritization was based on six criteria: impact on vulnerable groups and resources, impact on the economic growth rate of the vulnerable communities, impact on poverty reduction, synergies or alignment with multilateral environment agreements, employment creation and prospects for sustainability. Selection was made in the context of the major developmental challenges facing the country: environment degradation, unemployment, poverty, gender equity and HIV and AIDS as well as the policies and programmes put in place to combat the challenges.

The NAPA is designed, and will be implemented within the framework of the main national development programmes, in particular, the National Vision 2020, the National Strategic Development Plan and the Millennium Development Goals. Its implementation strategy has been designed with a view of empowering the vulnerable communities to adopt adaptation capacities.

Progress to date is the implementation of Priority 3 (Capacity Building and Policy Reform to Integrate Climate Change in Sectoral Development Plans) and priority 4 (Improvement of an Early Warning System Against Climate Induced Disasters and Hazards) through a project entitled "**Improvement of Early Warning System to Reduce Impacts of Climate Change and Capacity Building to Integrate Climate Change into Development Plans (IEWS)**" which started in 2011. Furthermore, preparations are underway to implement priority 1 (Improve Resilience of Livestock Production Systems under

Extreme Climatic Conditions in Various Livelihood Zones in Lesotho) and priority 2 (Promoting Sustainable Crop Based Livelihood Systems in Foothills, Lowlands and Senqu River Valley.

4 National Greenhouse Gas Inventory

4 NATIONAL GREENHOUSE GAS INVENTORY

4.1 Introduction

The Intergovernmental Panel on Climate Change (IPCC) has, since its creation in 1988, provided conclusive evidence that greenhouse gas (GHG) concentrations in the atmosphere are increasing beyond tolerable levels, and thus causing global climate change; and that the climate change will impact negatively on many countries. Lesotho, having appended her signature and ratified the United Nations Framework Convention on Climate Change (UNFCCC), is duty-bound to fulfil the obligations of the same. To that end, the first national GHG inventory study was undertaken in 1996 and reported GHG emissions for base year 1994. Moreover, the second national GHG inventory study has been undertaken for the base year 2000. The study assesses the country's contribution to global GHG emissions and/or removals and includes all the GHGs dealt with in the first inventory, namely; Carbon Dioxide (CO_2), Methane (CH_4), and Nitrous Oxide (N_2O) as well as GHG precursors Carbon Monoxide (CO), oxides of Nitrogen (NO_x) and Non-Methane Volatile Organic Compounds (NMVOCs). In addition, Sulphur Oxides (SO_x), which were not assessed in the first inventory, have been included.

The recommended **2006 IPCC Guidelines for National Greenhouse Gas Inventories** could not be used because of the absence of data at the level required. The study therefore continued to employ the **Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories**. The GHG emissions were assessed in five sectors: (1) Energy, (2) Industrial Processes, (3) Agriculture, (4) Land Use Change and Forestry, and (5) Waste. The GHG analysis for the second inventory was done for years 1995 to 2000, although the report only presents results for base year 2000.

Data availability has been a huge challenge in developing the 2000 GHG inventory with most of the data only being available at an aggregated national level, rather than at point-source level. This has made it difficult to undertake a detailed and informative review of data sources as it was often not possible to disaggregate data (particularly in the energy sector). Lower tier (tier 1) calculation method was therefore used. In a number of cases no information was available, which led to the omission of some sources in the waste and industrial sectors. Default Emission Factors (EFs) provided in the Revised 1996 IPCC Guidelines were used in almost all the sectors since national data is not available.

4.2 Total Emissions

A summary of the national greenhouse gases inventory results for 2000 is presented in Table 4.1. Lesotho emitted a total of 3,512.89 Gg of CO_2 equivalent (CO_2eq) emissions in 2000 without Land Use Change and Forestry (LUCF). The LUCF sector provides a net sink of 1,377.98 Gg of the CO_2eq emissions which makes the total net emissions to be 2,134.91 Gg of CO_2eq. This shows that Lesotho remains a net emitter of GHGs. Highest emissions without LUCF are from the agriculture sector (figure 4.1). GHG emissions from industrial processes are too small to be to be reported here. It was difficult to obtain relevant data in this sector.

Table 4.1 Summary of GHG Emissions Inventory for All Sub-Sectors in 2000 (Gg)

Sources	CO_2	CH_4	N_2O	Total Sinks/ removals
Energy	805.03	11.00	0.14	
Industrial Processes	0.00	0.00	0.00	
Agriculture		40.83	4.44	
Land-use Change and Forestry (LUCF)*	200.58	0.00	0.00	-1,578.56
Waste		8.03	0.10	
Total GHG Emissions by Gases	805.03	59.86	4.68	
GWP**	1.00	21.00	310.00	
Total CO_2 Equivalent	805.03	1,257.06	1,450.80	

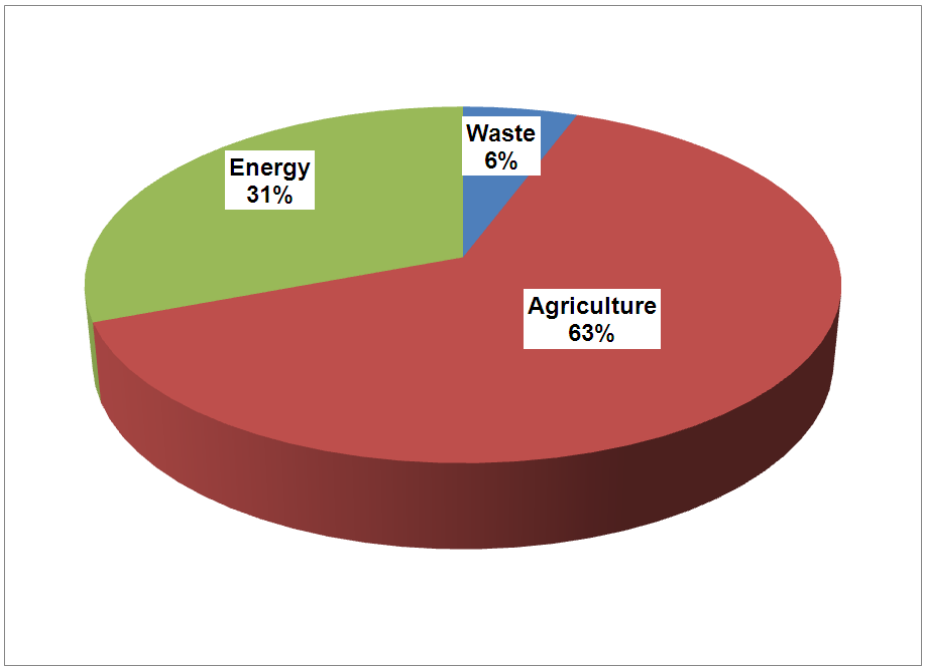

Figure 4.1 Lesotho's Sectoral Contribution to 2000 CO_2eq Emissions without LUCF

The 1994 net emissions were recalculated to be 4,475.87 CO_2eq using the updated data and also correcting some technical errors in the then report. Details of the recalculations are provided at the sectoral reports below. Comparing the 2000 and the recalculated 1994 values, the total equivalent emissions in 2000 were about a half of their counterparts in 1994.

4.3 Emissions by Sector

4.3.1 Energy Sector

Emissions from Energy sector make a total of 1,079.43 Gg CO_2eq. Most of the emissions come from residential fuel combustion followed by the similar use of petrol and diesel by road transportation (figure 4.2). Residential emissions emanate from the use of coal, Liquid Petroleum Gas (LPG) and paraffin. The highest sources were other kerosene and coal. CO_2 is the major contributor, making about 75% of total sectoral emissions. Compared to 1994, the emissions have increased by about 30%.

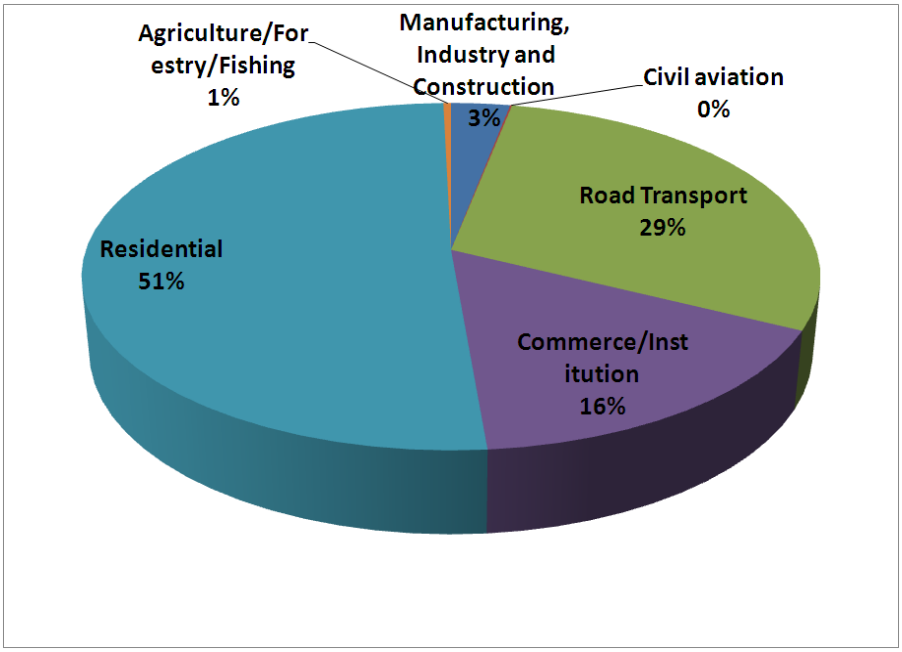

Figure 4.2 Breakdown of Lesotho's Energy Sector CO_2eq Emissions in 2000

Even though biomass fuels form an important component of energy mix in Lesotho, their related emissions are reported for information only and are not included in the national totals because biomass consumption is assumed to equal its regrowth (IPCC, 1996). Lesotho being a landlocked country, the only potential source of international bunkers would be international aviation. However, since aircrafts that fly to and from Lesotho are refuelled only at OR Tambo International Airport in Johannesburg, South Africa, there are no net emissions for this category.

4.3.2 Agriculture Sector

Emissions from this sector are from crops, livestock and agricultural soils. Emissions from this sector make a total of 2,233.83Gg of CO_2eq. Agricultural soils are the main sources of emissions in this sector (figure 4.3). N_2O emissions from agricultural soils make highest equivalent emissions and they are followed by CH_4 emissions from livestock. Nearly all the CH_4 emissions are from domestic livestock enteric fermentation and manure management, and N_2O emissions from animal waste management.

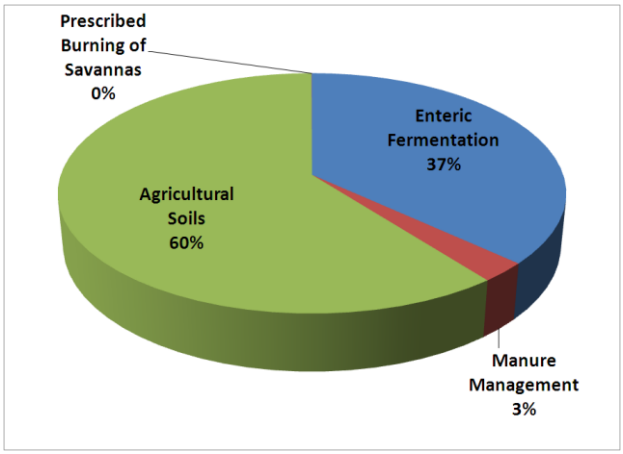

Figure 4.3 Lesotho's CO_2eq Emissions from Agricultural Sector in 2000

Recalculation of the 1994 emissions and comparison with 2000

The initial 1994 N_2O emissions were underestimated by a factor of ten. The miscalculations were identified in Worksheet 4-1 (Supplemental) Pasture Range and Paddock, and solid storage and drylot. Using the recalculated values, the 2000 CO_2eq emissions are 4.27% lower than their 1994 counterparts. The change is due to the decrease of N_2O emissions from agricultural soils mainly as a result of reduced fertilizer applications to soils.

4.3.3 Land Use Change and Forestry

Land Use Change and Forestry sector has a gross CO_2eq emissions of 200.58 Gg and sinks of 1578.56 Gg making a net sink of 1,377.98 CO_2eq. This is significantly different from the 1994 results in which there were net CO_2eq emissions. The difference is largely a result of the following activities whose assumptions were reconsidered in this study:

- In the 1994 inventory, it was assumed that there had been 14% increase of total land surface area in arable land in the past 10 years according to IUCN[31] (1993). The arable land increase amounted to 424 970 ha. The 2000 inventory study is suggesting that, contrary to the impression that arable land more than doubled in the past 10 years, it has reduced due to settlement encroachment. This means that annual change in carbon stock in living biomass and mineral soils reported based on this assumption is erroneous.
- The 1994 inventory further assumed that 48 kha of abandoned managed land were re-growing. The description of abandoned managed land is land that was formerly cropland and rangeland that had degraded to gullies and rocklands. The figure was based on the assumption that all of the gullies become rehabilitated. It must be noted that even currently, quantitative information on rehabilitated gullies is not available, but because of sparse vegetation due to continued overgrazing, though not quantified, it is known that gullies continue to expand and millions of tons of soil lost annually. For this reason, a situation of non-growth describes Lesotho's situation better.
- For 2000 inventory, there was no information found on commercial wood harvests and apparently no liming was used during the period. This situation differs from that of the 1994 inventory.

[31] IUCN – International Union for Nature Conservation

4.3.4 Waste Management Sector

The waste sector in Lesotho is divided into two distinct sectors; the solid waste management and wastewater collection and treatment. The sector was assessed for emissions from domestic, commercial and industrial waste. The total emissions from this sector are 199.63 Gg CO_2eq. CH_4 makes more than 80% of the CO_2eq emissions. Bulk of these emissions is from industrial wastewater. GHG emissions in this sector have doubled since 1994. It is noted that there are no records for degradable sludge in this sector and there is need to establish whether the industry maintains such records and if not should be encouraged to do so.

4.4 Gaps and Recommendations

There are a number of challenges related to this study which include:

- Sectoral data unavailability. The data unavailability problem was particularly more prominent in LUCF;
- Appropriate national emission factors are not available such that default IPCC factors which do not necessarily reflect national conditions have been extensively used;
- Expert judgment estimations had to be made in many instances hence this introduced high levels of uncertainty in the results;
- Summary tables have high significant figures. This results in low sectoral emissions not being properly reflected;
- High staff and expertise turnover affected continuity and consistency in the study approach.

The following recommendations could improve the study in future:

- Intensification of coordination across Ministries, Departments and Sectors on collection and exchange of specific data among stakeholders;
- A geo-information based approach in storage and management of data is advocated for data accessibility and manipulation within the context of a National Spatial Data Infrastructure (NSDI);
- It is imperative that another land resource inventory be undertaken to build upon the information established in 1988;
- National Research institutions like the National University of Lesotho and the Lesotho Agricultural Research Department should incorporate some aspects of the GHG inventory into their research agendas;
- Research be undertaken to establish national specific emission factors so that results reflect more closely what actually takes place in the country;
- Since the final result of emissions is reported in Gg CO_2eq, inclusion of GWP formula in worksheets will result in more effective approach and better presentation;
- Establishment of a Unit within the Bureau of Statistics that will facilitate data collection and archiving for environmental and climate change studies.

5

Mitigation Analysis, Policies and Measures

5 MITIGATION ANALYSIS, POLICIES AND MEASURES

5.1 Introduction

Within the framework of the preparation of the second national communication, Lesotho has undertaken the mitigation analysis and assessment of options to reduce the sources of greenhouse gas or enhance their sinks. Like other Parties to the Convention Lesotho is expected to:

- Take precautionary measures to anticipate, prevent or minimize the causes of climate change and mitigate its adverse effects" (Article 3);
- Have "common but differentiated responsibilities" based on the national circumstances;
- Gather and share information on GHG emissions, national policies and best practices;
- Launch national strategies for addressing greenhouse gas emissions and adapting to expected impacts.

Even though Lesotho as a Non Annex I Party, is not obliged to implement targeted GHG mitigation options, as a signatory to the UNFCCC, it must engage itself in voluntary actions to mitigate GHG emissions. Therefore this Chapter covers identification, description and analysis of all measures and activities that can be implemented to reduce the GHG emissions from energy and non-energy sectors.

5.2 Energy Sector

The majority (approx. 77%) of the country's population largely depends on biomass resources for cooking and heating. Until as recently as 1998, there was total dependence on imports for commercial energy, and to-date energy remains a delicate and high priority issue in the country. The main thrust of energy policies is conservation, involving more efficient energy use, and import substitution, particularly involving the promotion of renewable sources of energy (hydro-power, solar, wind sources). The country has a comparative advantage in the generation of hydro-electricity due to altitude and the abundance of water resources. Obviously, substitution of fossil fuels with green power in the home, industrial and commercial sectors will have a reductive effect on the amount of GHG emissions. On the other hand, there are good prospects for increased harnessing of solar energy, wind and production of biogas, particularly for remotely placed mountain communities where electricity and road infrastructure coverage is either low or non-existent.

5.2.1 GHG trends from the energy sector

The GHG emissions trends for the period 1994-2000 are indicated below in Table 5.1. It appears from the table that GHG emissions experience an increase although not very significant. This increase can be attributed to many factors such as the population growth and increased activity levels and energy consumption particularly in transport sector with the importation of vehicles.

Table 5.1 GHG Emissions trend in Gg

National greenhouse gas inventory of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol and greenhouse gas precursors for energy sector								
GHG / Inventory year	CO_2 emissions	CO_2 removals	CH_4	N_2O	NO_x	CO	NMVOCs	SO_x
1994	635.99	-	7.63	0.10	4.92	137.08	17.57	-
1995	649.76	0.00	7.68	0.10	5.81	143.13	18.50	3,095.21
1996	681.24	0.00	7.83	0.11	6.03	147.10	19.08	3,194.67
1997	700.40	0.00	7.99	0.11	6.10	149.52	19.37	3,429.40
1998	750.05	0.00	8.16	0.11	6.49	157.46	20.69	3,381.21
1999	772.23	0.00	8.17	0.11	6.40	156.53	20.50	3,455.10
2000	805	0.00	11	0	7	202	26	3,578

Source: National greenhouse gas inventory for 1994 - 2000

5.2.2 Evaluation of the implementation of mitigation measures contained in the INC

In the Initial national communication, a number of measures to mitigate GHG emissions were identified as reflected in Table 5.2.

All the efforts being undertaken by the Government of Lesotho to achieve greenhouse gas mitigation objectives are reflected in the Energy Policy Framework for the Kingdom of Lesotho (Draft), through which the Government is committed to promote the use of cleaner energy sources and technologies by:

- Participating in and contributing to the international dialogue and negotiations on limiting climate change through United Nations Framework Convention on Climate Change and its protocols;

- Carrying out information dissemination campaigns aimed at reducing emissions from fuel consumption;
- Developing information and education materials on energy efficiency in the transport sector;
- Drawing a plan aimed at phasing out the use of leaded petrol in the medium-to-long term.

For the implementation of mitigation measures contained in the INC for the energy sector, the Government of Lesotho developed and implemented with the technical and financial support of GEF the Renewable Energy-Based Rural Electrification (LREBRE) Project in Lesotho. LREBRE aims at reducing Lesotho's energy related CO_2 emissions by promoting renewable and low GHG emission technologies as a substitute for fossil fuels utilized in rural areas of the country.

Since the start of the project, a total of 1537 Solar Home Systems (SHS) with a capacity of 65 W each have been installed, and an estimated 500 SHS have also been independently installed as a result of the project's influence.

In addition to the above mentioned project, the Government of Lesotho is implementing another Rural Electrification Project with the objective of supporting investment in the electricity supply to enhance electricity access rate and to ensure improved efficiency and therefore assist the country reduce poverty and achieve the Millennium Development Goals.

Table 5.2 Mitigation Measures contained in the Initial Communication

Sector	End Use	Mitigation Strategy
Residential/commercial	Cooking	- Introduction of biodigesters, solar heaters, electric stoves - Introduction of energy efficient coal and wood stoves - Energy switch to sources with lower GHG emission factors, eg LPG, electricity.
	Heating	- Introduction of biodigesters, solar heaters, electric stoves - Increase in solar gains from house orientation - Introduction of energy efficient heaters - Introduction of heaters that use energy sources with lower GHG emission factors
	Lighting	- Energy switch to sources with lower GHG emission factors, eg electricity, solar panels
Transport	Private Vehicle Transport	- Reduction of fuel demand through taxes - Institutionalising of improved vehicle import regulations - Employ measures to ensure better engine maintenance - Transport switch to modes with lower GHG emissions,
	Public Transport	- Improved route planning - Encouragement of higher capacity transport - Improve government trip planning and control
Industrial	Processing	- Reduce electricity tariffs - Improve boiler efficiency.

Source: Initial National Communication of the Kingdom of Lesotho

It is worth mentioning the efforts made by Lesotho Electricity Company (LEC) in conducting actions to address demand side management challenges in the country. LEC undertook direct marketing by going house-to-house and public gatherings in villages. A number of 18,286 homes and 27 villages were visited and electricity consumers were made aware of the electricity safe and efficient uses and benefits.

5.2.3 Mitigation options assessment and analysis

According to Energy Policy Framework for the Kingdom of Lesotho (Draft):

- About 56% of households in Lesotho use firewood for cooking, 39% use Gas/paraffin, 1.6% use electricity and 3.5% of households use other sources of energy;
- About 56% of households use Gas/oil for lighting, while about 38% use candles, about 10 % use electricity and less than 1% use other forms of energy;
- About 90% of households do not have access to grid electricity, the majority (more than 70%) of the Basotho, particularly those who live in rural areas, rely heavily on biomass fuels for major domestic energy end-uses;
- About 67% of all households in Lesotho use biomass fuels as main sources of energy for space heating while approximately 27% use paraffin, 4% use coal and LPG and electricity constituted about 3%.

The above information together with the set of all collected data and GHG inventory reports was used to define the baseline and construct a reference scenario from which forecasts and Mitigation scenarios were developed. Based on the available activity data, it was possible to use the software Long-range Energy Alternatives Planning System (LEAP) to construct scenarios and assess the impact of selected mitigation options on the Greenhouse gas emissions trend.

Reference scenario

The reference scenario or business as usual illustrated in Table 5.3 below gives projection of energy demand and subsequent GHG emissions for households and transport sector which are the main consumer of energy and main emitters of GHG emissions in the energy sector. As indicated in the figure, the demand in energy will reach 294 900 TJ which is almost 10 times compared to the base year 2000 energy figures. The main parameters behind this increase are the population growth, the electrification targets set in the national electrification master plan and the development targets set in the **Lesotho Vision 2020.**

Table 5.3 Projected Energy Demand and GHG Emissions for the reference scenario

Year	2015	2017	2019	2021	2023	2025	2026	2028	2030
Energy demand projection(1000Tj)	72.2	84.8	100.5	120.3	145.3	176.6	195.1	239.3	294.9
GHG emissions trend(Gg)	2162	2381.8	2638.4	2942.7	3304.9	3734.1	3978.4	4537.8	5209.6

Source: Data extracted from LEAP

Mitigation scenarios

Various scenarios for mitigation of GHG emissions have been assessed. From the quantitative assessment using LEAP software and qualitative assessment using the screening matrix comprising; potential for large impact on greenhouse gases (GHGs), consistency with national development and environmental goals, sustainability data availability criteria, it was found that the most promising mitigation options are:

- Revision of electrification targets(2015:40%, 2020:50%, 2030:60%) to allow more Basotho access to clean energy for lighting, heating and cooking;
- Reduction in the use of Kerosene for heating to reach 10 % in 2020 and 5% in 2030;
- To disseminate efficient charcoal stoves to reach a penetration rate of 30% in 2030;
- To reduce progressively the use of wood for heating in order to reach 10% by 2030;
- To disseminate SHS to reach 15% of the non-electrified population by 2030 and subsequently reduce the use of paraffin for lighting.

The dissemination of improved efficient wood stoves alone could reduce the Emissions by 14% by 2030 compared to the reference scenario as indicated in the figure 5.1

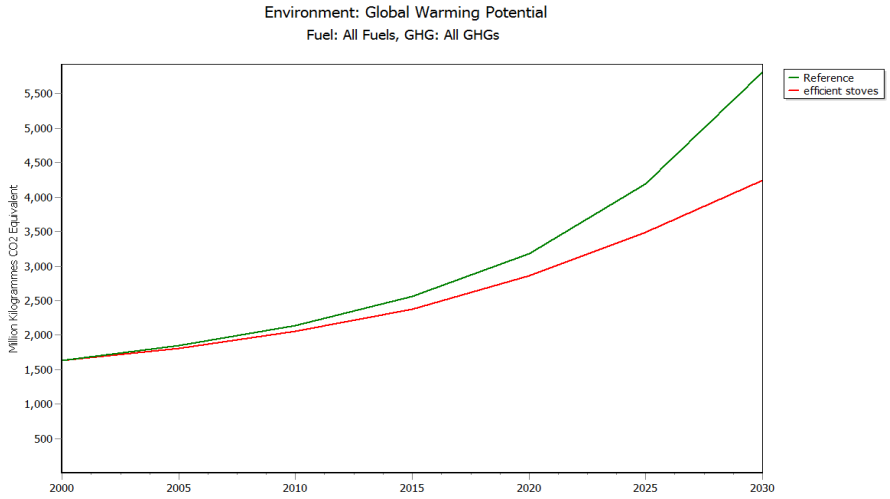

Figure 5.1 Projected GHG Emissions and efficient stoves scenarios

The impacts of quantitatively assessed options on energy demand and GHG emissions are illustrated in Tables 5.4 and 5.5 for selected years.

Table 5.4 Energy Demand (Million Gigajoules) projection for mitigation options and reference scenarios

Scenario \ Year	2015	2017	2019	2021	2023	2025	2026	2028	2030
Reference	72.2	84.8	100.5	120.3	145.3	176.6	195.1	239.3	294.9
Substitution of paraffin by LPG	49.9	56.3	64	70.8	75.1	77.9	78.5	77.1	70.7
efficient stoves	50.3	56.7	64.4	71.3	75.6	78.5	79.1	77.7	71.3
review of electrification targets	50.1	56.5	64.1	70.9	75.1	77.9	78.5	77	70.6

Table 5.5 GHG Emissions (Thousand Tonnes CO_2 Equivalent) for mitigation options and reference scenario

Scenario / Year	2015	2017	2019	2021	2023	2025	2026	2028	2030
Reference	2162	2381.8	2638.4	2942.7	3304.9	3734.1	3978.4	4537.8	5209.6
Substitution of paraffin by LPG	1980.1	2139.5	2320.7	2516	2712.9	2913.4	3013.1	3205.5	3377.7
efficient stoves	1992.4	2153.1	2335.4	2532.1	2730.4	2932.6	3033.1	3227	3400.8
review of electrification targets	2023.4	2177.6	2353	2542.7	2734.9	2930.8	3028.1	3215.8	3383.2

From the above tables, it appears that the substitution of paraffin by LPG for cooking and the review of electrification targets will have a better impact on the GHG emissions.

Table 5.6 Summary table of proposed mitigation options with targets by sector

Sector	Mitigation options	Targets
Electricity	• Continue developing Hydroelectricity to meet the electrification targets; • Promote the use of renewable energy technologies and energy efficient appliances in the energy end-use sector;	• Reducing greenhouse gas emissions by 10% by 2015; • Improving energy efficiency by 20% by 2015; • Increasing access to clean energy by 40% in 2015, 50% in 2020 and 60% by 2030.
Residential, Commercial and Institutional	• Dissemination of efficient stoves in households; • Use of LPG for domestic cooking; • Setting up of an energy efficient use and conservation extension service;	• To disseminate Efficient charcoal stoves to reach a penetration rate of 30% in 2030; • To reduce progressively the use of wood for heating in order to reach 10% by 2030;
Industrial	• Use of renewable energy technologies in hotels and guest houses; • Use of low carbon fuel for industrial boilers; • Use of more energy efficient and clean technology; • Conduct regular energy audits and implementation of energy management plan; • Declare emission standards; • Initiate energy education and extension services.	• To disseminate SHS to reach 15% of the non-electrified population by 2030 and subsequently reduce the use of paraffin for lighting.

Development of Renewable Energy in Lesotho

Hydro

Research has positively indicated potential of three renewable energy forms in the country. Hydropower is the natural starting point to develop renewable energy and the associated technologies as has indeed been the case with the development of 'Muela Hydropower Project (Part of LHDA), and other mini-hydropower schemes at Tlokoeng, Mants'onyane, Semonkong and Tsoelike.

Solar

Due to the country's altitudinal position and climate, solar-power also demonstrates viable commercial utility. In response to the available knowledge, Lesotho has in the recent years concentrated its local popularization programmes on solar energy. This has seen the development and dissemination of fruit dryers and solar cookers, and the dissemination of photovoltaic systems. Complementing the government efforts are private companies specializing on disseminating solar cookers, solar water heaters, solar dryers, and photovoltaic systems.

Wind

Studies indicate that Lesotho has considerable wind power potential and would become a net exporter of wind based power. Possibilities for wind power generation at three selected sites: Lets'eng-la-Terai, Sani-Top and Quthing have been investigated since 2000, where measuring masts and instruments were first installed. Lets'eng-la-Terai at an altitude of 3,100m above sea level demonstrates the highest potential, with well-defined flow pattern, and speeds satisfying viability requirements. These studies have influenced a renewed interest in wind energy potential in the country. Planned and on-going activities will be dealt with in more detail in the Third National Communication.

5.2.4 Policies and Strategies

Since 75% of energy demand in Lesotho, representing mainly the cooking and heating needs of rural people, is satisfied from non-commercial indigenous sources (shrubs, crop residues, and dung) whose harvest has been closely associated with environmental degradation and poor soil fertility, policies in the energy sector have put a lot of emphasis on expanding renewable energy sources and implementing biomass development programmes. The main objective of sectoral policies is to provide energy to all sectors and regions of the country with minimum social, economic, and environmental cost. In this respect, the following policy strategies have been advocated:

- Development of indigenous energy sources;
- Substitution of imported commercial energy sources with alternative indigenous sources;
- Expansion of indigenous hydro-power generation and electricity distribution infrastructure; and
- Promotion of energy conservation in various sectors of the economy.

5.2.5 Challenging Issues

A summary of Energy sector challenges is presented on Table 5.7 below. The biggest challenge is to develop technologies that will encourage the utilization of sources of energy that are not only sustainable but environmentally friendly.

Table 5.7 Summary of challenges facing the energy sector

Sector	Nature of challenges
Household sector	- to improve the choice of affordable energy options; - to reduce indoor pollution resulting from the burning of biomass; - to provide information on alternative energy sources; and - to promote thermally-efficient dwellings.
Transport	- to reduce pollution from vehicle exhausts; and - to establish a reliable fuel supply.
Industry/Commerce/ Government	- to ensure competitive energy pricing; and -to promote the efficient use of available energy
Biomass energy	- to improve availability of biomass resources; - to promote sustainable use of biomass resources; - to protect and improve management of indigenous trees and shrubs; and - to compile and update a data bank on availability and utilization of biomass resources.
Fossil fuels	- to regulate coal imports; - to promote awareness of alternative sources of energy; - to reduce pollution resulting from coal combustion; - to ensure availability and fair pricing of petroleum products; - to ensure awareness of LP gas and paraffin; and - to ensure participation by locals in the petroleum sector.
Electricity	- to increase the level of electrification; - to increase community involvement in the power sector; -to promote energy efficiency and safe use of electricity; and - to harvest benefits of regional cooperation.
Other renewable energies	- to make renewable technologies more affordable and accessible; - to improve information dissemination and public awareness; - to reduce theft and vandalism of PV panels; and - to develop and enforce standards of renewable energy systems.

Source: DoE (Feb.2002), Energy Policy Framework for the Kingdom of Lesotho: Energy Policy Summary

5.3 Non-Energy Sectors

5.3.1 GHG emission trends in the non energy sectors

The GHG emissions for the period 1995-1999 are indicated in table 5.9. GHG emission changes in the sector are observed and the significant one is the drop in CO_2 removal for the year 1997 in land –use change and forestry.

Table 5.8 GHG Emissions from 1995 to 1999

National greenhouse gas inventory of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol and greenhouse gas precursors									
Base year	Greenhouse gas source and sink categories	CO_2 emissions (Gg)	CO_2 removals (Gg)	CH_4 (Gg)	N_2O (Gg)	NO_x (Gg)	CO (Gg)	NMVOCs (Gg)	SO_x (Gg)
1995	Agriculture			33.00	3.89	0.00	0.00	0.00	0.00
	Land-use change and forestry	0.00	-1,385.16	0.00	0.00	0.00	0.00	0.00	0.00
	Waste			8.08	0.09	0.00	0.00	0.00	0.00
1996	Agriculture			0.00	3.97	0.00	0.00	0.00	0.00
	5. Land-use change and forestry	0.00	-1,392.20	0.00	0.00	0.00	0.00	0.00	0.00
	Waste			7.83	0.09	0.00	0.00	0.00	0.00
1997	Agriculture			33.66	3.86	0.00	0.00	0.00	0.00
	Land-use change and forestry	0.00	-762.02	0.00	0.00	0.00	0.00	0.00	0.00
	Waste			10.02	0.09	0.00	0.00	0.00	0.00
1998	Agriculture			28.22	3.35	0.00	0.00	0.00	0.00
	Land-use change and forestry	0.00	-1,385.15	0.00	0.00	0.00	0.00	0.00	0.00
	Waste			4.27	0.10	0.00	0.00	0.00	0.00
1999	Agriculture			31.66	3.66	0.00	0.00	0.00	0.00
	Land-use change and forestry	0.00	-1,381.58	0.00	0.00	0.00	0.00	0.00	0.00
	Waste			7.91	0.10	0.00	0.00	0.00	0.00

5.3.2 Evaluation of the implementation of mitigation measures contained in the INC

In the INC, the only non-energy sector was Forestry. The following strategies were proposed as a way to mitigate greenhouse gas emissions and enhance sinks:

- **Reforestation of Indigenous Forests**

The aim of reforestation was to reverse the trend of indigenous tree cutting by increasing the forest up to 286,600 hectares by 2030.

- **Afforestation of Gullies and Degraded Lands**

Afforestation of Gullies was targeting the planting of acacia, willow and popular species on 451,313 hectares of degraded land with the objective of providing fuel wood to rural communities, to generate sources of income for the same through the sale of trees, to stabilize the soil, and to improve the biodiversity.

- **Rehabilitation of Wetlands**

Rehabilitation of degraded wetland consisted of planting species on 20,000 hectares of degraded wetland in order to preserve the ecosystem and the surrounding habitat and improve the biodiversity.

A brief assessment of the implementation of the proposed mitigation options revealed the following:

Between 1990 and 2005, Lesotho's forests increased by 300 ha. It is estimated that 3 million tree seedlings are planted annually with a moderate survival rate of 60%. However, during the same 15-year interval, the total rate of habitat conservation (defined as change in forest area plus change in woodland area minus net plantation expansion) decreased by 69.2%.

5.3.3 Mitigation assessment and analysis for non energy sectors

5.3.3.1 FORESTRY

Lesotho's forest resources are extremely limited, with a total of 20 000 ha in forest plantations. In addition, Lesotho has very small, isolated patches of indigenous forest, mostly in remote areas. Due to the lack of available firewood and building materials, the government has encouraged plantations of exotic species like pine and eucalyptus and developed a forestry policy and forest service.

Status and condition of forest and land is largely determined by the existence of the government policies in the forest sector and also in other sectors.

The enactment of the Forestry Act 1998 together with the new Forest Policy 2008, the Environment Act 2001 and their subsequent legislations under the respective ministries provide the legal

framework to the appropriate institutions for supporting sustainable forest management in the country. Although this legal framework exists, there is need to identify and describe policies for forest protection and conservation policies, wood extraction and harvesting policies, tax rebates for efficient charcoal kilns and wood stoves.

Data representing wood production and trade is limited. Wood that is felled and sold by the government is not well documented. Moreover, wood harvested and sold by individuals or communities is also not documented. These circumstances make it impossible to fully understand how much is being removed from forests. All sawn timber that is used locally is imported from South Africa. Several major threats to forest resources are occurring in Lesotho, most notably:

- Land cleared for settlements
- Grazing in newly forested areas
- Grazing in protected areas
- Wild fires
- Drought
- Domestic, commercial, and industrial exploitation

The lack of sufficient and adequate activity data in the sector could not permit a quantitative assessment of mitigation options but a qualitative assessment was made taking into consideration other technologies in application in other developing countries.

Table 5.10, below, summarizes some of the potential mitigation measures that may be taken by GoL in partnership with all other stakeholders – NGOs and local communities, to ensure that the well-intended policies achieve the desired results.

Table 5.9 Possible mitigation options in the Forestry sector

Category/Types of Technologies	Description
1. **Forest Protection and Management**	
Protecting Forest	This option should be examined in the context of Lesotho's rural development goals and policies. Measures which increase the opportunities for harvesting and marketing of non-timber forest products such as nuts, honey and fiber are good candidates. Also, introducing small-scale rural industries such as carpentry, brick making, weaving, etc may stem the rate of deforestation associated with subsistence farming.
Improvement of harvesting techniques (silviculture), e.g. Reduce Impact Logging	The Selection System aims to keep all-aged stands through timber cuttings at shorter intervals. Many light cuttings are made. Seedlings will become established in small gaps. Under this system, two or more intensive harvests are possible during one rotation. The selective felling of exploitable trees is done over an area at periodic intervals.
2. Sink Enhancement	
Improvements in the product conversion and utilization	Analog forests attempt to reverse the loss of forest cover by planting trees and lesser plants on deforested lands, regenerating the structure and functions of original forests. This is also commonly called enhanced regeneration or enrichment planting.

efficiency	
Reforestation	Planting trees on degraded land in forest area.
Afforestation	Conversion of non-forest area into forest area by planting trees
Timber Plantation	Large-scale plantings in degraded land using short-rotation species, or long rotation species or exotic species with intensive management for wood production
Agro forestry (Social forestry)	Improving carbon sequestration and storage in both soil and biomass through planting trees intercropped with annual crops for the purpose of producing both agriculture and forest products or planting trees following contour for wind and soil protection, as well as for providing agriculture and wood products. Long rotation systems that use trees for windbreaks, border planting and over-storey shade can sequester carbon for many decades
Urban forest	Tree planting activities include parks and gardens, green belts, residential shade trees, and road side and demarcation trees in the rural areas. Urban tree planting offers advantages of reducing greenhouse gas by sequestering carbon, and reducing energy consumption for air conditioning.
	3. C-Substitution
Stoves for cooking	Replacing stoves for cooking with lower thermal efficiency (5-10%) with the higher one (40%).

5.3.3.2 AGRICULTURE

Agricultural production is a substantial contributor to national income. Much of Lesotho's terrain is suited to animal production, although the sector has suffered from drought in recent years. Emissions from this sector make a total of 2,230.43Gg CO_2e and the main GHG is Nitrous Oxide (N_2O) with 61.6% of the total emissions. The sources of N_2O are from agricultural soils which include use of synthetic fertilizer, nitrogen from animal wastes, nitrogen from increased biological N-fixation and crop residues. Other emissions are Methane (CH_4) caused by enteric fermentation from animal manure and manure management. Anaerobic decomposition of manure also produces some CH_4. These conditions often occur when a large number of animals are managed in a confined area (e.g. dairy farms, beef feedlots, and swine and poultry farms).

Most cultivated soils in Lesotho are considered to have low contamination of chemicals because of minimal use of synthetic fertilizers. Mitigation options in this sector may include promotion of sustainable farming and land management practices, use of organic fertilizers and clear policy frameworks.

A number of mitigation options are available for reduction of CH_4 in this sector. These include carbon sequestration by soils, capturing methane emission from manure and agricultural waste and increasing feed efficiency for livestock. Each of these mitigation options, however, requires farmers to change their existing practices, and need for technology transfer (IPCC, 2000). Adoption and implementation of mitigation options in agriculture sector not only provides benefits for the environment but also increases farmers' income through increased milk and meat production.

However, level of adoption of the mitigation technologies is very limited due to a number of barriers. There are four barriers that may hinder the adoption and the implementation of the

options. Such barriers are related to farm-level adoption of new methods and practices, lack of government subsidies, inadequate information and lack of capacity and skills among farmers.

5.3.3.3 WASTE

According to IPCC guidelines of 1996, the GHGs emissions from waste are mainly from the three following sources, with the last being the smallest source: (1) Solid waste disposal on land; (2) Wastewater handling (industrial and domestic wastewater); and (3) Waste incineration of fossil based products such as plastics. The main GHG emitted from these wastes is CH_4 while N_2O is only emitted in small amounts from human sewage and waste incineration.

Municipal solid waste production in Lesotho was estimated to 52 100 metric tons in 2000. According to the study *"An Integrated Solid Waste Management Plan (ISWMP) for Maseru City"*, by A-Prof.Harro von Blottnitz, March 2009, the projected waste potential in 2020 is estimated at 205 000 t/a of which 40,000 t/a can be reduced, 45000t/a re-used, 55000t/a recycled and 65000t/a disposed.

Mitigation options comprise the following:

- Recycling of waste;
- Composting of waste;
- Incineration;
- Methane Recovery.

The implementation of the mitigation options in Lesotho will not only give environmental benefits but also economic benefits. IPCC (1996) stated that recycling and composting could reduce methane emissions up to 70% depending on technical options and scale. Producing energy from waste either from incineration or landfill gas (methane recovery) will reduce CO_2 emission through fossil fuel use displacement.

Since the waste-generation rate is correlated to population growth, among other factors such as life-styles, it is anticipated that waste generation will continue to increase with population growth and the change in life style changes. As such, without sustainable waste management systems, the rate of emission of GHGs and other waste-related hazardous substances will also continue to increase. Therefore, waste management needs to be improved not only for the purpose of combating global warming but also for other factors such as improved air quality and human health. This directly points to the need to improve waste management technologies and practices.

There are many barriers in the implementation of the waste management in Lesotho. These include:

Policy and Regulatory Barriers: In general, waste management has a very low priority in many African countries including Lesotho. The Government allocates very little funds for waste management. Policies with regards to services for protection of public health and the environment are also ranked lowly, therefore, no incentive system is provided for such services. Law enforcement is generally lacking resulting in most sectors neglecting to treat their wastes properly.

Institutional Barriers: There are several agencies at the national level involved or at least partially in waste management. These include Ministry of Public Works, the Maseru City Council, the

Department of Environment and Non-governmental organizations. However, there are no clear roles or functions of these various agencies in waste management. Lack of coordination among the agencies results in overlapping or duplication of programs. The capacity of the government agencies involved in waste management is visibly weak, especially in the cities and towns.

Technological Barriers: In Lesotho, technical expertise necessary for solid waste management planning and operation is still lacking. Research and development activities in solid waste management are often a low priority in the country. This leads to the inappropriate selection of technology and finally wasting the resources spent and making the project unsustainable. Waste recycling activities are affected by lack of availability of facilities to recycle waste material.

Socio-economical Barriers: As a developing country, Lesotho has a weak economic base. Funds allocated to development of sustainable waste management systems are hardly sufficient or non-existent. Socially, people have a negative perception towards waste handling and therefore undermine the work.

5.4 National GHG Mitigation strategy and action plan

The following actions are recommended in the first five years (2013-2018):

- Strengthen the role of Lesotho Meteorological Services to conduct and coordinate related studies and set up policies for climate change mitigation at country level;
- Set up and implement an archiving system for GHG inventory for all sectors;
- Continue to focus on better understanding of energy sources and uses to get good energy balances adequate for sectoral planning and GHG inventory using existing planning tools such as LEAP;
- Strengthen coordination and sharing of climate change related data nationally;
- Create procedures for activity data collection in sustainable manner;
- Accelerate the implementation of the National Electrification Master Plan;
- Develop renewable energy policy and strategy;
- Promote the use of energy efficient technologies (e.g. efficient cook stoves, energy-saving light bulbs).

Several specific projects can be completed over the next five years:

- Develop a number of demonstration projects that will serve as both educational and practical experiments for learning about various technologies as they are developed;
- Develop Nationally Appropriate Mitigation Actions and integrate it into national development plans;

5.5 Conclusion and Recommendations

The main obstacle to GHG emissions mitigation in Lesotho is the lack of reliable activity data for all sectors. There is therefore need to enhance systemic, institutional and human capacity to enable Lesotho fulfill its obligations under the UNFCCC.

The implementation of mitigation measures will require financial resources which are beyond the capacity of Lesotho like any other developing country. It is therefore urgent for Lesotho to elaborate climate change financial resources mobilization strategy to support the implementation of climate change mitigation projects and policies.

Adoption of the mitigation options does not only provide benefit to the environment but it may also create incremental benefit to people and consequently for the country.

One of the key factors that ensure the successful adoption and implementation of the mitigation technologies is the political will. Incorporation of this aspect into the national plans is essential. Another key factor is the level of involvement of key stakeholders in the process of developing the national plan or mitigation programs.

Participatory approach in developing the plans and programs should be encouraged. It is therefore strongly recommended that sectoral teams be established to assist the Government of Lesotho in gathering activity data, conducting sectoral studies, plans and strategies for the implementation of relevant clauses of the Convention.

Progress on the climate change issues/agenda should be followed and well disseminated to the community through programmatic actions.

6 Vulnerability, Adoption And Policies

6 VULNERABILITY, ADAPTATION AND POLICIES

6.1 Introduction

The Initial National Communication identifies three sets of factors that characterise Lesotho's extreme vulnerability to climate change. The first set of factors relates to natural conditions such as; highly variable rainfall in all timescales, the extremely fragile ecosystem and resultant high level of land degradation coupled with increasing population pressure on the land. These factors put Lesotho firmly in the category of countries that are most vulnerable to climate change and requiring special attention in particular to address the low capacity to adapt to the changing climate. According to Article 4.8 of the UNFCCC, in implementation of the commitments under the UNFCCC, *"Parties shall give full consideration to what actions are necessary under the Convention, including actions related to funding, insurance and technology transfer, to meet the specific needs and concerns of developing country Parties arising from the adverse effects of climate change...,especially countries with arid and semi-arid areas;...countries with areas prone to natural disasters; countries with areas liable to drought and desertification*; *countries with areas with fragile ecosystems including mountain ecosystems; and landlocked and transit countries."*

Further Article 4.9 states that *"Parties shall take full account of specific needs and special situations of the Least Developed Countries in their actions with regard to funding and transfer of technology."* Lesotho fits the categories of countries identified under both Article 4.8 and 4.9 of the Convention.

The second and third sets of factors are peculiar to Lesotho, and relate to the system of land tenure and customary practices, which undermine individual incentives to maintain and improve the natural resource base and to invest in land improvements and productivity-enhancing technologies. In most cases, there is poor land management and unsustainable use of land-based resources.

These three sets of factors are considered to be still valid and guide the analysis of vulnerability to quantify the impacts of climate change undertaken in this chapter. Sectors assessed are agriculture, water resources, soil and land degradation, forestry, livestock and rangelands, health as well as culture and historical heritage. Adaptation measures address as well the issues arising from second and third sets of factors including institutional and policy frameworks. The chapter also details projected future climate change scenarios up to 2100 and their impacts on the sectors.

6.2 Climate Baseline

6.2.1 Selection of stations for the baseline

Lesotho is demarcated into four distinct livelihood zones, namely the Lowlands, the Foothills, the Senqu River Valley and the Highlands. The Lowlands have been further divided into the Northern and Southern Lowlands. Meteorological data in these zones was evaluated in terms of quality and

length of the datasets, and also considering whether the datasets covered the WMO climatological base period (1961 – 1990). Stations selected for analysis of climate of Lesotho are shown in Figure 6.1.

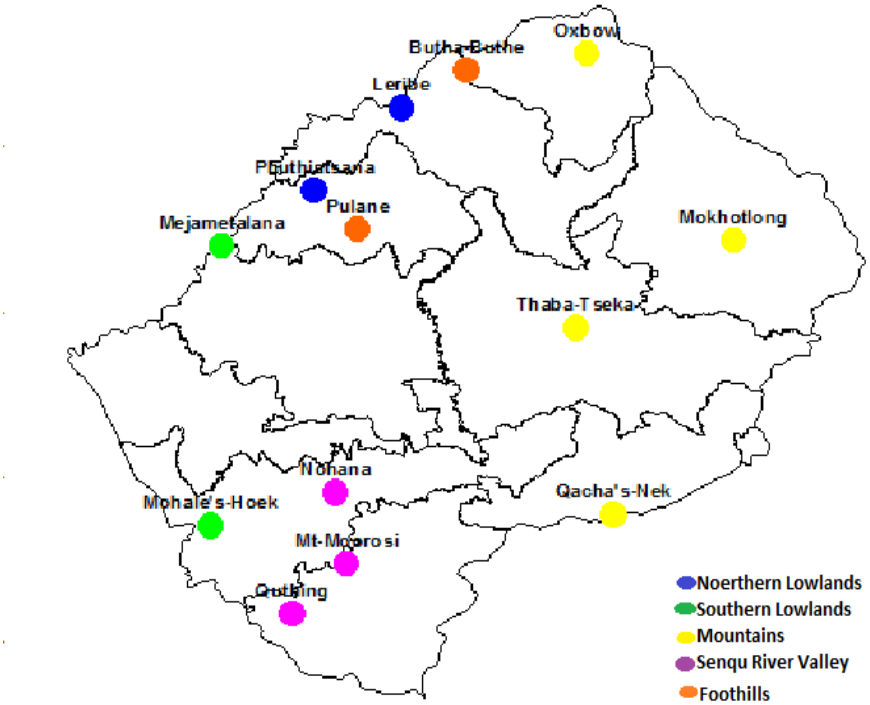

Figure 6.1 Locations of Stations

6.2.2 Historical Temperature and Rainfall Patterns

6.2.2.1 Temperature Trends

Upon observation that most of the country's meteorological stations began recording temperatures from around 1967, the base period 1971 –2000 was adopted as per the Guidelines of the Development of Regional Climate Scenarios for vulnerability and adaptation.

Lesotho has continental temperate climate with well-marked seasons of spring, summer, autumn and winter. Maximum and minimum temperatures recorded at various locations show wide variations seasonally. Mean temperatures vary from 10.9^{0}C to 27.6^{0}C during the summer (DJF) season with January being the hottest month. In winter (JJA), mean minimum temperatures vary between 0.1^{0}C to 17.3^{0}C with July being the coldest month. Table 6.1 presents the seasonal mean temperatures for five livelihood zones while figure 6.2 shows the annual mean temperature for Lesotho from 1971 to 2000. Annual Mean temperatures are highly variable from year to year with an increasing trend.

Table 6.1 Seasonal Mean Temperatures for five Livelihood Zones

REGION	TEMPERATURE (1971-2000)							
	JJA		SON		DJF		MAM	
	Max	Min	Max	Min	Max	Min	Max	Min
Southern Lowlands	17.0	1.1	24.1	9.1	27.6	13.8	22.0	8.1
Northern Lowlands	16.6	1.7	23.7	9.6	26.8	13.5	21.6	8.3
Senqu River Valley	16.1	2.3	23.2	9.6	26.8	13.9	21.2	8.3
Foothills	17.3	0.2	23.5	8.6	26.1	13.0	21.9	6.9
Highlands	15.1	0.1	21.0	7.0	23.9	10.9	19.4	6.1

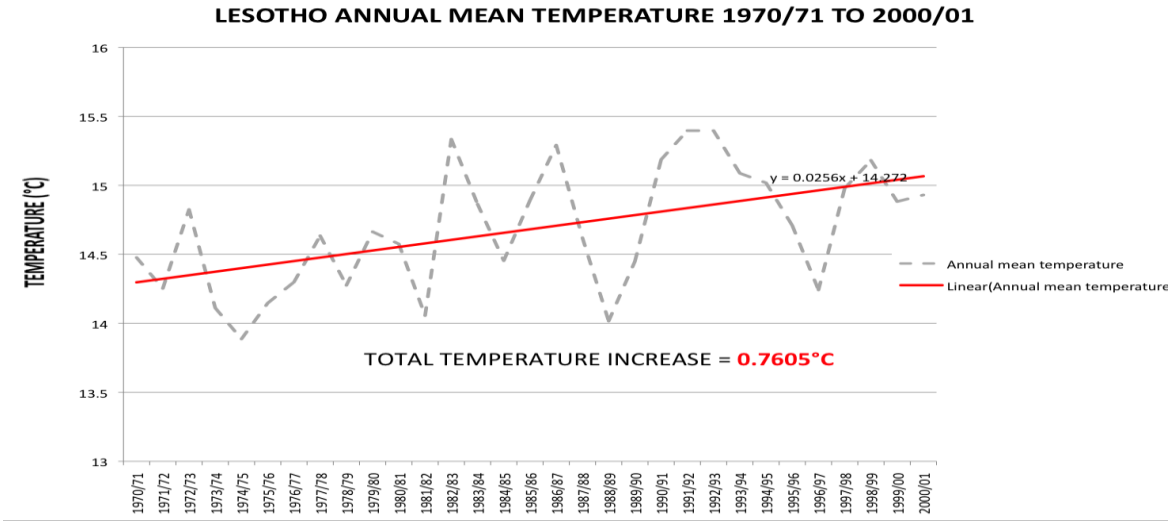

Figure 6.2 Overall Annual Mean Temperature for Lesotho

6.2.2.2 Rainfall Trends

Lesotho rainfall measurements date as far back as 1890 but in this report rainfall data used were retrieved from stations with reliable observations covering the period 1961 to 1990. Figure 6.3 overleaf depicts seasonal rainfall departure from normal within the various livelihood zones. Largely,

on the basis of rainfall and temperature variability, Lesotho's annual weather cycle for this particular analysis are divided into four distinct climatic seasons[32] – Summer (December, January and February), Autumn (March, April and May), Winter (June, July and August) and Spring (September, October and November).

The winter months are characterized by occurrence of significant amounts of snowfall on annual basis in the high-lying areas and occasionally in the low lying areas once every 3 years (NAPA, 2007). Most of the rainfall, about 85%, occurs in the summer months. On average the country receives rainfall in the range of 400 to 1200mm per year. The highest rainfall (800 – 1200mm) occurs in the northern parts of the country, while the least rainfall (400 – 600mm) occurs in the Senqu river valley.

[32] December, January, February (DJF); March, April, May (MAM); June, July, August (JJA); September, October, November (SON)

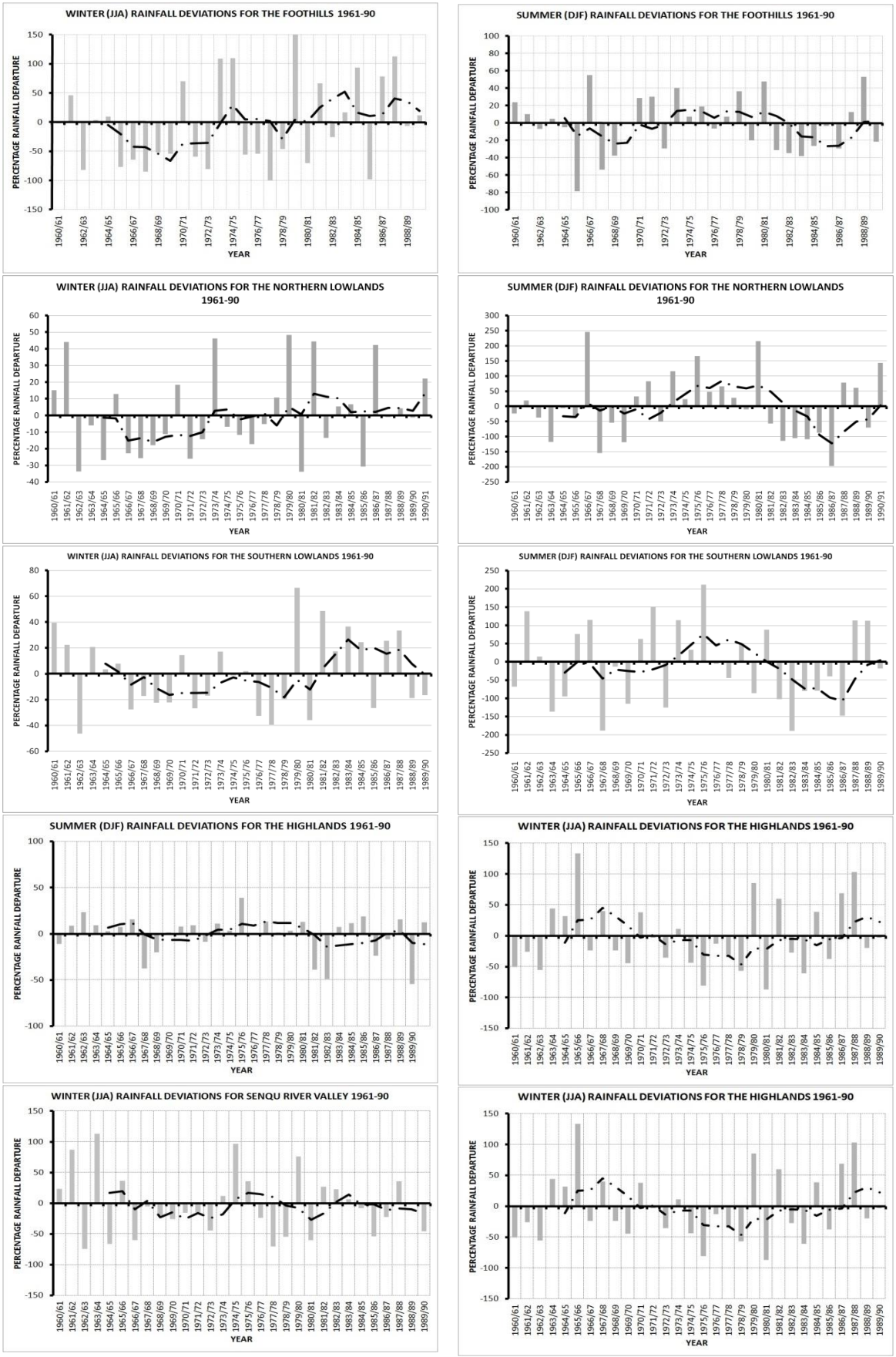

Figure 6.3 Seasonal rainfall deviations

6.3 Climate Change Scenarios

While scenarios are neither predictions nor forecasts of future conditions, they help us project and anticipate different plausible futures that conform to sets of circumstances or constraints within which they may occur. The IPCC (2000) defines scenarios as '*…the many and different possible ways for representing how the future will look like'*. They are an appropriate tool for analyzing how the driving forces may influence future emission outcomes and to assess the associated uncertainties. They are valuable in climate change analysis, including climate change modelling and the assessment of impacts, mitigation and adaptation.

6.3.1 Model Selection

Climate change scenarios were created using a coupled gas cycle/climate model MAGICC/SCENGEN (the Model for Analysis of Greenhouse Induced Climate Change and a Regional Climate SCENario GENarator). The climate model in MAGICC is an upwelling-diffusion, energy-balance model that produces global and hemispheric mean temperature output together with results for oceanic thermal expansion. The MAGICC climate model is coupled interactively with a range of gas-cycle models that give projections for the concentrations of the key greenhouse gases. Climate feedbacks on the carbon cycle are therefore accounted for. The global-mean temperatures that are generated in MAGICC are used to drive SCENGEN. SCENGEN produces spatial patterns of change from a data base of atmosphere/ocean GCM (AOGCM) data from the CMIP3/AR4 archive. The pattern scaling method used by SCENGEN is based on the separation of the global-mean and spatial-pattern components of future climate change, and the further separation of the latter into greenhouse-gas and aerosol components. Spatial patterns in the data base are normalized and expressed as changes per $1^{o}C$ change in global-mean temperature. These normalized greenhouse-gas and aerosol components are appropriately weighted, added, and scaled up to the global-mean temperature defined by MAGICC for a given year, emissions scenario and set of climate model parameters. For the SCENGEN scaling component, the user can select from a number of different AOGCMs for the patterns of greenhouse-gas-induced climate (Wigley, 2008).

MAGICC consist of eight GHG emissions models while SCENGEN has seventeen ensemble GCMs. Out of the eight GHG models that are found in MAGICC, the Hadley Centre Coupled Model version 2 (HadCM2) was selected as the model to be used for analysis in MAGICC. This was due to the fact that this model was found to provide results which are very close to the results that were generated by the average of all models and it was therefore taken to be a representative of all the eight models.

For climate scenarios, models were selected, out of the seventeen GCMs in SCENGEN, based on their individual and collective performance in reproducing the observed baseline. The performance was

mainly determined by the ability of the model or set of models to pick temperature and rainfall seasonality. The result of five ensemble GCMs was found to better resemble current precipitation patterns of Lesotho, as illustrated on Figure 6.4, while six ensemble GCMs output resembled temperature patterns as presented on Figure 6.5. GCMs used for projecting precipitation are CSM98, HAD295, IAP, HAD300 and ECH498 while those used for temperatures are IAP97, LMD98, GFDL90, ECH498, HAD295 and CSI296.

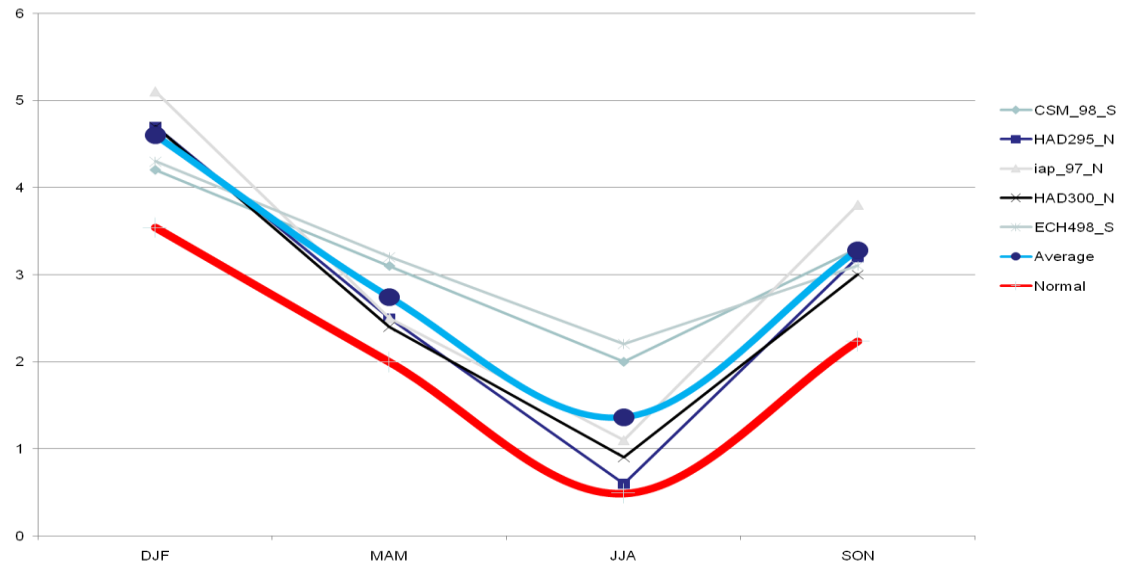

Figure 6.4: Precipitation model selection

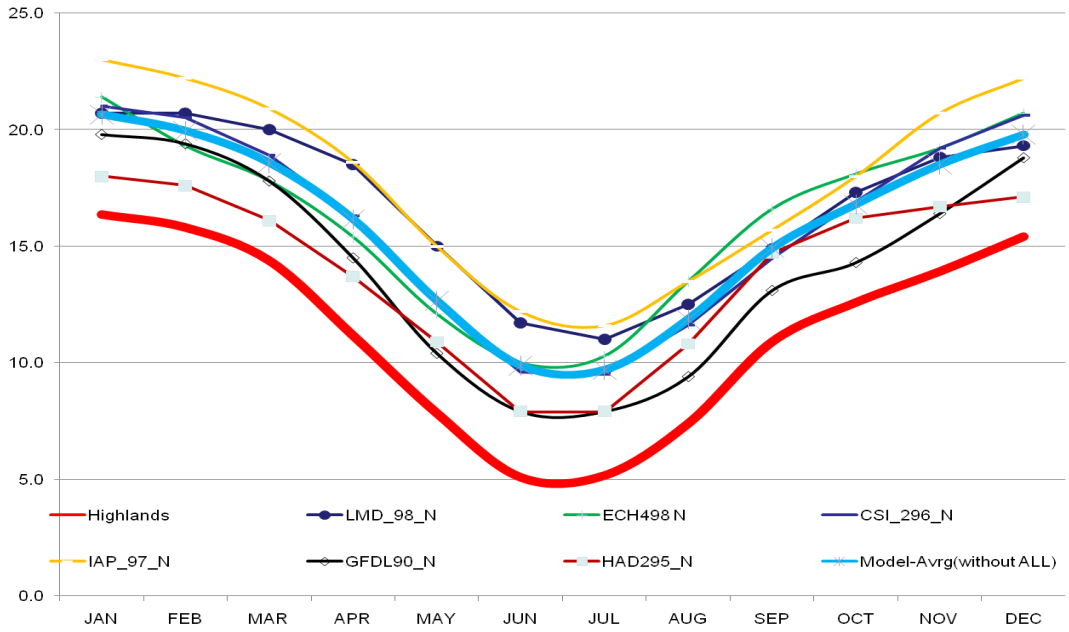

Figure 6.5 Temperature model selection

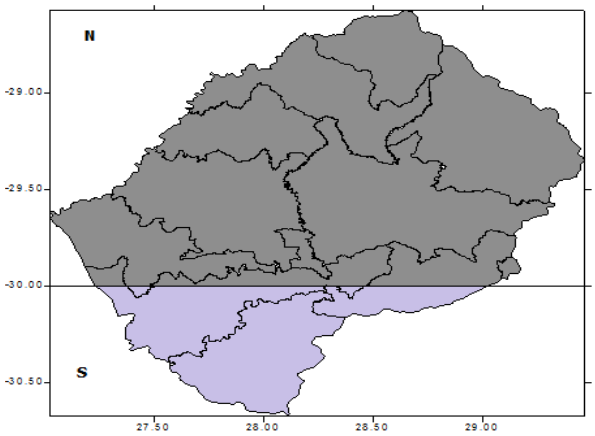

Figure 6.6 The northern and southern region assessed by MAGGIC SCENGEN

The MAGICC/SCENGEN modelling process generated two sets of values for Lesotho, one for the northern parts and another for the southern parts of the country as illustrated in figure 6.4. The scenarios developed focused on temperature and precipitation. The annual temperatures for 90 years from the year 2010 through to 2100 as well as seasonal rainfall for the same period were modelled. The projections were made based on four possible storylines[33]/ Policy[34] scenarios, namely: A2-ASF, A1B-AIM, B2-MESSAGE and B1-IMAGE. A2-ASF was used as a Reference[35] Scenario.

6.3.2 Temperature Scenarios

Figures 6.7 and 6.8 indicate temperature projections for four different policy scenarios from 2010 to 2100, for the northern and southern parts of the country respectively. Generally, all four policy scenarios show warming in Lesotho (south and northern parts) for all the years up to 2100. There is an average increase in temperatures of about 0.45° C in 2010 and 4.5° C by 2100 for the reference scenario (A2-ASF). A1B-AIM shows temperature increase of 0.35° C in 2010 to 3.6° C in 2100, B2-MESSAGE depicts increase of 0.48° C in 2010 and 3.2° C in 2100 and B1-IMAGE shows increases of 0.45° C in 2010 and 2.5° C in 2100, as depicted in Table 6.2 and Figure 6.9. It is anticipated that there will be a gradual increase in mean annual temperature change ranging from 0.4 to 4.7°C in the northern parts of the country whereas in the southern they will range from 0.2 to 3.8°C by 2100, depending on different policy scenarios.

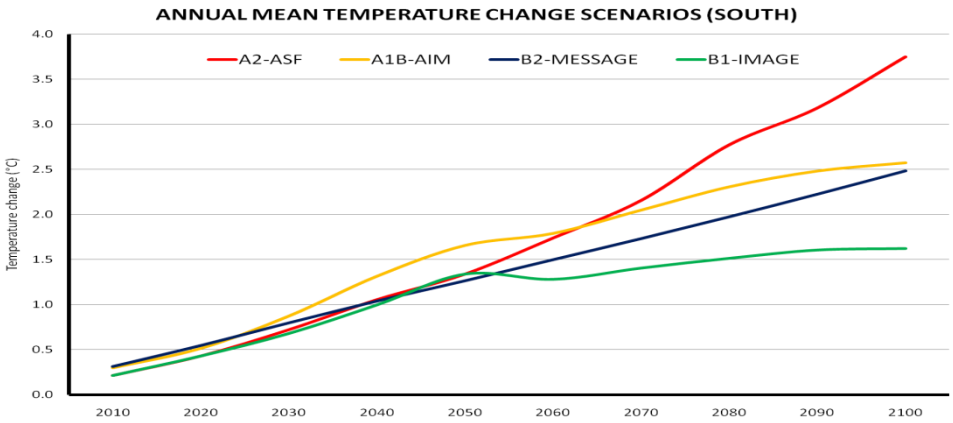

Figure 6.7 Annual Mean Temperature Change Scenarios (North)

[33] Storylines assume a distinctly different direction for future developments, such that the four storylines differ in increasingly irreversible ways. Together they describe divergent futures that encompass a significant portion of the underlying uncertainties in the main driving forces (IPCC Special Report Emissions Scenarios, 2000).

[34] The policy scenarios assume coordinated global action to reduce greenhouse gas emissions to a level that allows stabilisation of atmospheric concentrations.

[35] The reference scenario projects how Lesotho and the world could evolve if no new climate change mitigation policies are introduced.

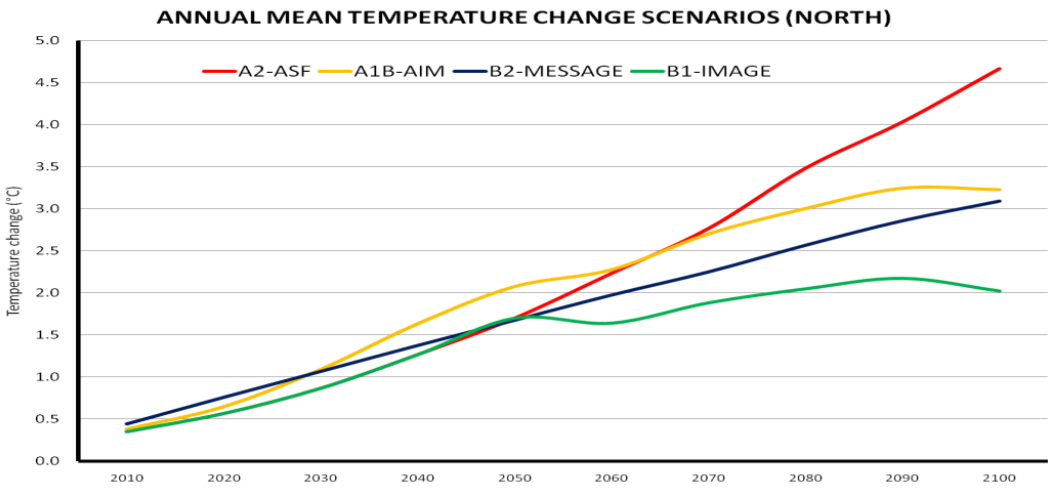

Figure 6.8 Annual Mean Temperature Change Scenarios (South)

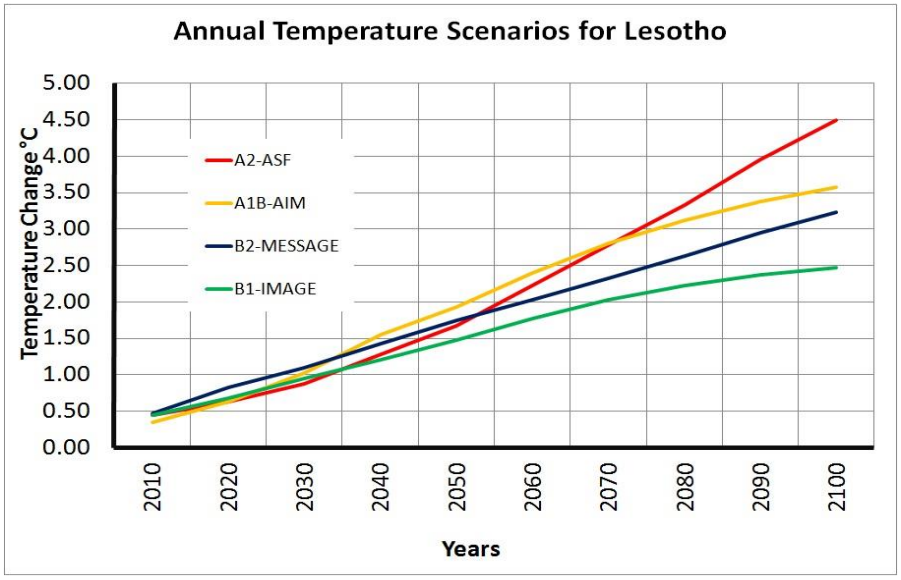

Figure 6.9 Annual Temperature Scenarios for Lesotho

Table 6.2 Annual temperature change from 2010 to 2100

Scenario	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**	**2080**	**2090**	**2100**
A2-ASF	0.45	0.63	0.88	1.28	1.68	2.23	2.78	3.33	3.95	4.50
A1B-AIM	0.35	0.63	1.03	1.55	1.93	2.40	2.80	3.13	3.38	3.58
B2-MESSAGE	0.48	0.83	1.10	1.43	1.75	2.03	2.33	2.63	2.95	3.23
B1-IMAGE	0.45	0.68	0.95	1.20	1.48	1.78	2.03	2.23	2.38	2.48

6.3.3 Precipitation Scenarios

In the northern parts of the country, precipitation is anticipated to remain at 0.7% below normal from 2010 to 2040, then increase to slightly above normal from 2050, reaching the highest increase of 5.3% in 2100. In the southern parts of the country, precipitation will be slightly below normal from 2010 to 2040 and thereafter increases to normal for the rest of the period as illustrated on figure 6.11. Figures 6.10 and 6.10 present precipitation scenarios for the northern and southern regions for December, January and February (DJF)

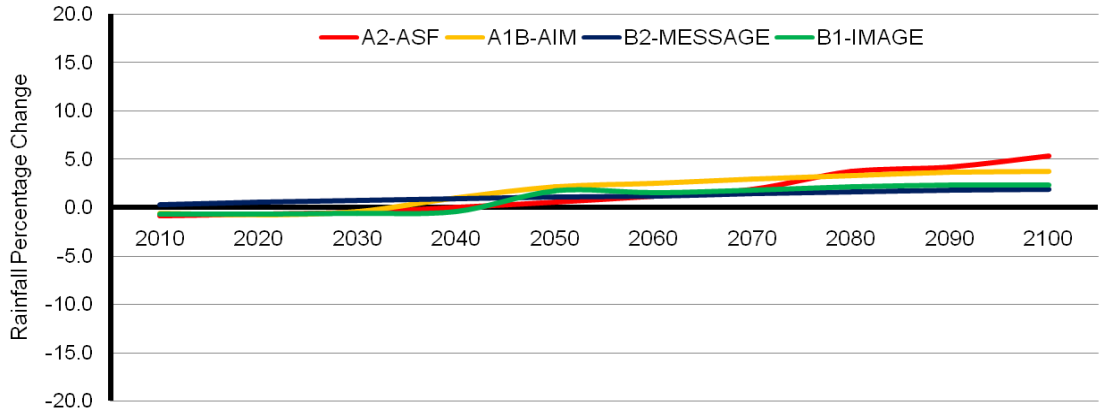

Figure 6.10 Lesotho Precipitation Scenarios for the Northern Region (December-February)

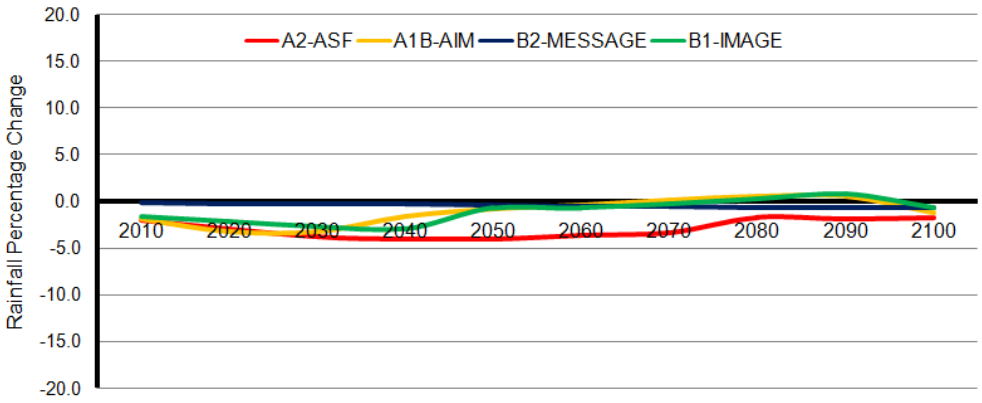

Figure 6.11 Precipitation Scenarios for the Southern Region (December-February)

Figures 6.12 and 6.13 present precipitation scenarios for the northern and southern regions for March, April and May (MAM). The northern parts will see increase in precipitation from 1.2% above normal in 2010 to the highest of 17.4% in 2100. In the southern parts of the country, the values will fluctuate about normal, reaching the highest increase of 6.8% in 2100.

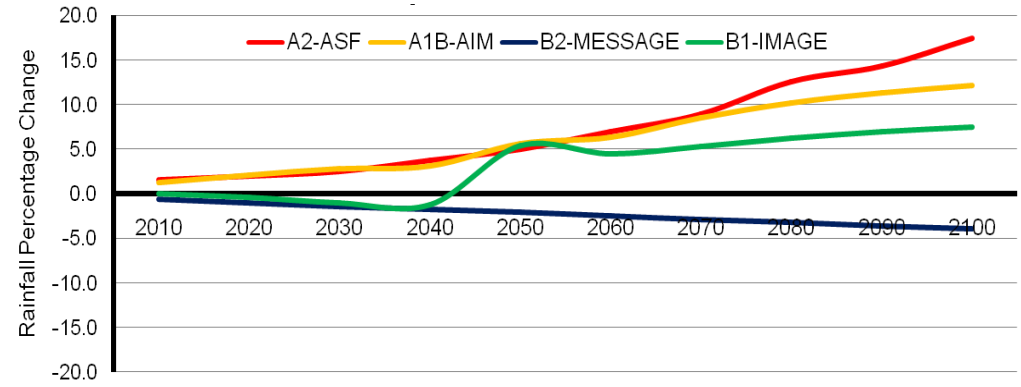

Figure 6.12 Precipitation Scenarios for the Northern Region (Mar-May)

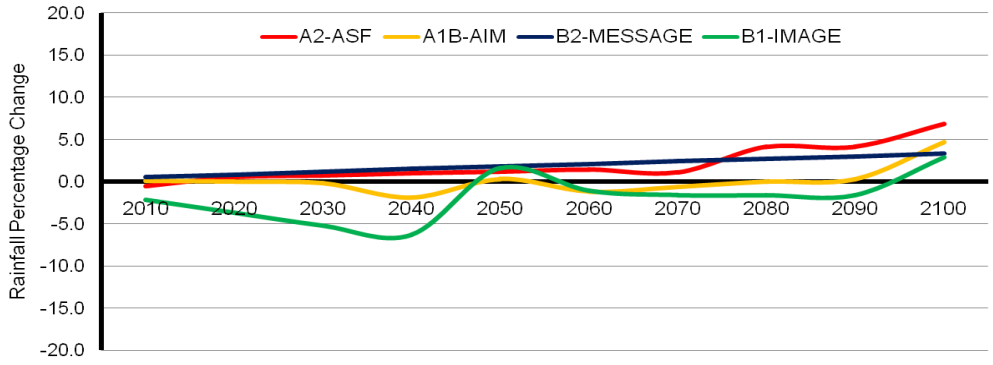

Figure 6.13 Precipitation Scenarios for the Southern Region (Mar-May)

Figures 6.14 and 6.15 present precipitation scenarios for the northern and southern regions for June, July and August (JJA). Below normal rainfall is anticipated in the northern parts of the country with a significant decrease of 0.8% in 2010 to 20.5% in 2100. Similarly, the southern parts will also receive below normal rainfall of 1.1% in 2010 to 9.3% in 2100.

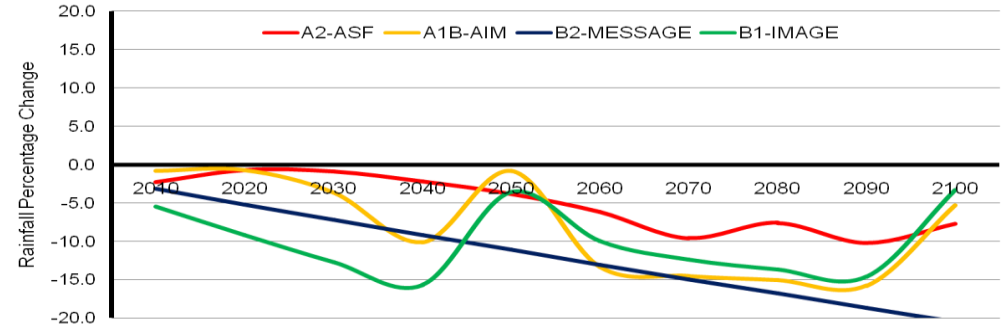

Figure 6.14 Precipitation Scenarios for the Northern Region (June-August)

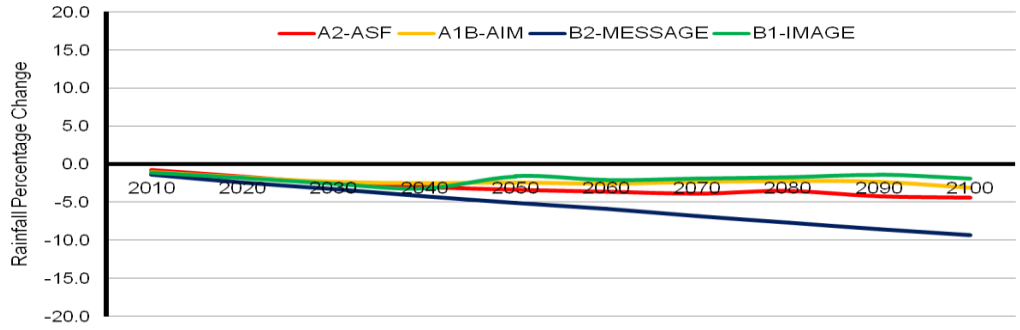

Figure 6.15 Precipitation Scenarios for the Southern Region (June-August)

Figures 6.16 and 6.17 present precipitation scenarios for the northern and southern regions for September, October and November (SON). Precipitation in the northern regions is projected to be increasing from 1.0% above normal in 2010 to 6.9% in 2100 while it will be slightly above normal from 2010 to 2050, decreasing to normal for the rest of the period in the southern regions.

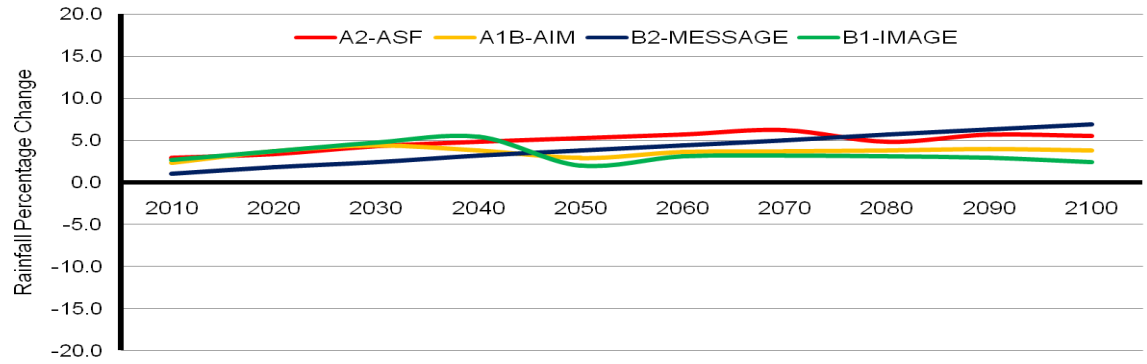

Figure 6.16 Precipitation Scenarios for the Northern Region (September – November)

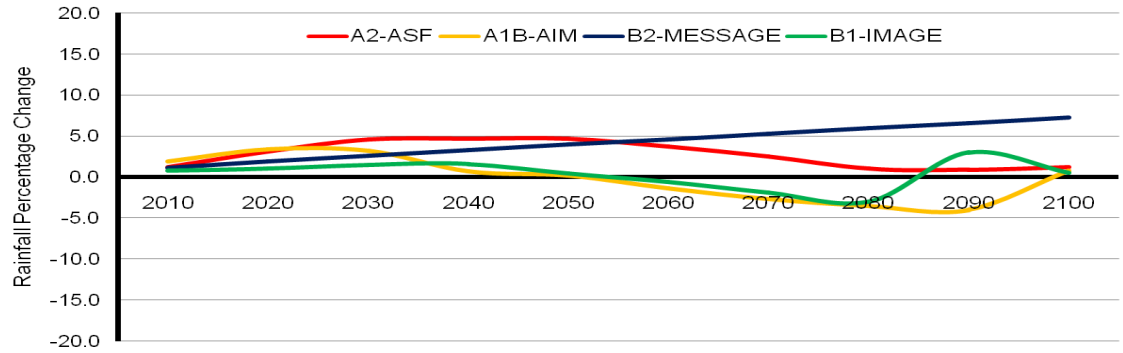

Figure 6.17 Precipitation Scenarios for the Southern Region (September-November)

6.3.4 Summary of precipitation scenarios

In general, the results indicate that the summer months in the northern parts of the country will have normal to slightly above normal precipitation for all the scenarios; while for the southern region precipitation will be below normal to normal. Autumn will experience above normal precipitation in the north with the exception of B2-MESSAGE scenario which shows decrease in

precipitation throughout the period 2010 to 2100. In the southern region, precipitation will be normal to above normal except for B1-IMAGE scenario which projects below normal precipitation. Winter will experience below normal precipitation for both the north and the southern region with the northern region showing a significant decrease. The spring shows above normal precipitation for both regions except for the A1B-AIM scenario which shows a precipitation that is slightly below normal from 2060 in the southern region. Although seasonal rainfall projections indicate decrease of rainfall in some seasons and increase in others, these changes are within 5% of normal rainfall. However, projections in the northern region show up to 15% increase for autumn and up to 15% decrease in winter.

6.4 Sector Vulnerability and Adaptation

6.4.1 Agriculture and Food Security

6.4.1.1 Introduction

The World Food Summit of 1996 defined food security as existing "when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life". Food security is built on three pillars: Food availability, access and use. In Lesotho, food security is a perennial problem as the country has not been able to meet the domestic food demand, particularly cereals, since 1960s. Marketing and distribution is hardly efficient. There is a need as well to enhance food storage techniques to reduce post-harvest losses and improve in the use of available food.

The 2006 population census estimated that 77% of Lesotho's population resided in rural areas and of the rural population 80% depended on agricultural activities for their livelihoods (Lesotho Population Census, 2006). Agriculture is mainly subsistence in nature (90%) with commercial farming at only 10%. Agricultural production has been declining in recent years and the contribution of agriculture to the GDP has remained at 10% to 20% for the period 1995 to 2000. The production and the resultant contribution of the sector to the GDP are directly influenced by climatic variability from year to year since it is rain-fed. Its contribution to the GDP notably increased in 1996, due to a good rainy season experienced in 1995 whereas in the cropping years 1997, 1998, 1999 and 2000, it was lower than normal due to poor climatic conditions.

Drought is the most prominent cause of crop failure in Lesotho. It is however a feature of Lesotho's climate, and renders agricultural production highly vulnerable. Meteorological drought occurs in three out of every ten years. Even in those years in which total annual rainfall is normal, i.e. at least 500 mm (for the driest regions) and 900 mm (for the wetter northern regions), erratic rainfall patterns, with huge spatial and seasonal variations, often adversely impact on this critical sector. Seasonal variations in rainfall are characterised by droughts and flooding, excessive heating and cooling occurring within a short time.

The climate of Lesotho is suitable for cereal cultivation, vegetable and temperate fruit crop production. Maize and sorghum are summer crops that are well adapted to warm, temperate climate experienced in the lowlands and foothills of Lesotho (AIS, 1990). Production of both crops is much lower in the highlands. Wheat is also adapted to growth throughout the country and can be grown as a winter crop in the lowlands and foothills and a spring/summer crop in the highlands.

Climate vulnerability and extreme climate events have in the past affected farmers in the southern African region including Lesotho. However, the ability of farmers to adapt to the changing climate develops over a period of time; yet the current increasing frequency, magnitude and duration of extreme climate events do not allow sufficient time for recovery from the last event. The other compounding factors include soil erosion, competition between crops and livestock for land, loss of arable land to human habitation due to increased migration to lowlands and high poverty levels. Inability to cope with climate variability is reflected in the national crop production and yield data.

6.4.1.2 Climate Change Impacts and Vulnerability on Agriculture

Based on the projected future climate scenarios, expert judgement was used to identify potential impacts on the sector.

The projected increase in precipitation from September to November for the northern parts of Lesotho for the period 2010 to 2040 will positively impact on yield of maize, sorghum and wheat. The increase in precipitation is expected to increase leaf area which in turn will result in increased dry matter production and yield. The projected slight increase in temperature in combination with increased precipitation will lead to increased growth rate, higher leaf area with the resultant increase in dry matter accumulation and higher yield of grain crops. The increase in precipitation and temperature during September to May on the other hand will negatively impact the growth of crops such as beans and cucurbits (pumpkin family). The high temperature and high humidity will lead to incidences of fungal diseases and offset the high growth pattern induced by a combination of high rainfall and temperature. On the other hand, the projected decrease in precipitation for the country in June to August, beginning in 2010 to 2100, will lead to low soil moisture reserves and will negatively impact on the growth of winter crops especially wheat. Farm operations in preparation of the subsequent summer agricultural season in August / September will be adversely affected by low soil moisture. The projected decline in rainfall in the season June to August, serves to further highlight the importance of water conservation and harvesting to ensure crop survival beyond this period of water shortage.

The persistence of the projected low rainfall in the southern parts of Lesotho coupled with the slight increase in temperature indicates the continuation of drought conditions for the southern parts of Lesotho. Hence, it should be expected that the types of crops that are currently grown in this region will be much more adversely affected. Grain crops such as maize, wheat, vegetables and fruits will continue to have low and decreasing yield unless water harvesting, and introduction and adoption of drought tolerant crops are embraced. The projected low precipitation, around the current levels, and the slight increase in temperature will have minimal effect on the production of sorghum whose most favourable temperature for growth is approximately 27^0C. In addition the root structure and morphology of sorghum enable it to tolerate drought and heat better than both maize and wheat. Spring is expected to receive above normal rainfall therefore contributing positively to agricultural growing season.

Under the current projected increase in temperature most crops will not have optimal growth and as a result will have reduced yield to varying degrees. When dry conditions coincide with high temperatures, reduction in growth and yield is exacerbated as crops are very sensitive to drought

and heat during reproductive period (flowering to grain filling). In Lesotho this growth period often coincides with the December to February wet and hot weather. The high rainfall accompanied by high temperatures will favour profuse growth of crops but at the same time increase plant lodging (plants bending over due to excessive moisture in soil). Negative aspects of high rainfall and high temperatures will be increased incidences of diseases and pests. Yield in low lying areas, which are prone to flooding and water-logging, will be drastically reduced. In these areas production of beans in particular, might lead to large or total crop failure due to their high sensitivity to water-logging and disease incidence.

6.4.1.3 Adaptation Options and Strategies

Adaptation to climate change encompasses all adjustments made to human, ecological and physical systems as a perceived vulnerability. Adaptation can be at an individual level (autonomous adaptation) where actions are taken as a reaction to climate event subsequent to the initial impact. Autonomous adaptation includes all initiatives triggered by market and welfare changes and undertaken by private sector due to climate change. Deliberate policy decisions by government based on awareness of climate change constitutes policy-driven or planned adaptation. Response to climate change by resource poor farmers is often low due to limited or lack of understanding of climate and land tenure insecurity thus leading to reduced capacity by farmers to manage risk effectively. Short term adjustments to climate change can include changes in tillage practices. Longer term measures include adjustment of livestock breeds; improve water management and building irrigation systems; creating supporting policies that promote adaptation measures towards more effective implementation (e.g. policies supporting growth and diversification, strengthening institutions, protecting natural resources, investing in research and development, improving disaster management and weather insurance).

Adaptation measures driven by farmers' initiative as well as government advice have occurred to a limited extent in Lesotho. Adaptation has been done on an individual basis as well as organized groups. The adaptation measures include use of short season and drought resistant crop seed types as well as the indigenous maize varieties. Measures to reduce yield variability or total crop failure are currently being addressed by some farmers through relay and intercropping as in the implementation of the locally developed Machobane farming system; the use of conservation farming techniques especially in vegetable production where water collection and conservation ensure moisture availability to plants; allocation of land and production of high value crops such as vegetables in particular mushroom which is done on limited space and contributes to family income generation. There is need to reduce weeds in crop fields in order to minimize or remove competition for nutrients and moisture between crops and weeds; alter time of sowing to align with precipitation pattern and introduce organic matter in soil and reduce its loss in order to retain soil water. More detailed methods to adapt to changing climate based on available resources and technological aptitude of farmers are given in Appendix 1.

High value crops were introduced to Lesotho but production was low and is currently non-existent for most of those crops. Currently, 75 tonnes of seed potato are produced and production needs to be increased to commercial levels. Lesotho has an advantage in seed potato production as the cool climate ensures low disease infestation. Asparagus was successfully produced within 25 kilometre

radius of the Basotho Canners in Mazenod, Maseru. Production of white asparagus was curtailed by increasing costs of production including fertilization and transportation. Another crop of note was sunflower whose production led to value addition in the oil that was expressed from sunflower seed. Other crops that adapted well to Lesotho climatic conditions were groundnuts, paprika, and garlic. Mushroom production is the latest innovation though currently its production is low. Another crop that is abundant in Lesotho but has not been recognized as a cash crop is prickly pear. Its advantages are that the fruit can be exported and the succulent leaves can be processed into animal feed. In order to encourage higher production of current crops and any new crops, there has to be higher investment to ensure higher production and better profits, quality controls have to be in place to adhere to international standards. Farmers have to be encouraged to set up businesses for value adding of agricultural produce e.g. local canneries (for excess vegetable and fruit) and drying of fruit.

6.4.2 Water Resources

6.4.2.1 Introduction

It has been observed that changes in precipitation patterns, due to global warming are projected to increase the risk of flooding and drought in many areas of the world (IPCC, 2008). These events will lead to changes in water quantity and quality. In turn, that will affect food availability, economy, water accessibility and energy infrastructural development such as hydropower. The link between water resources management and many other sectors such as energy, food security, sanitation, health and hygiene and nature conservation cannot be overemphasized. Decreased land precipitation and increased temperature lead to reduced soil moisture, which result in agricultural drought, meteorological drought and hydrological drought. The different forms of drought adversely affect agricultural production as well as for domestic and industrial water supplies.

Lesotho is an upstream riparian state with South Africa and Namibia in the Senqu/Orange river basin. The country is drained by three major river systems - the Senqu (Orange) and Mohokare (Caledon) originating from the Mount Aux Sources in the Northeast along the Drakensberg and Makhaleng originating from the central Maloti and flowing in a south westerly direction into the Republic of South Africa (RSA). 59% of the Orange River basin lies in South Africa, with the remainder occupying Lesotho, Namibia and Botswana. However, 46% percent of mean annual runoff is generated from Lesotho (upstream) of the basin from just 3% of the land area. South Africa contributes 50% of mean annual runoff, Namibia 4% from 27% of the land area. Although Botswana contributes 11% of the land area, its contribution in the mean annual flow has not been realized (Table 6.3).

Table 6.3 Contribution by Water Resources States to Orange/Senqu River Basin

	Botswana	Lesotho	Namibia	South Africa
Area (%)	11	3	27	59
Flow (%)	0	46	4	50

It is eminent that most of the Orange River Basin runoff of 11,500 million m^3 /yr (364.7 m^3/s) comes from the upper Vaal tributary in RSA and from Lesotho in the upper part of the basin known as Senqu. This makes Lesotho a relatively water abundant country in the middle of a water stressed area of Southern Africa. However, seasonal distribution and proximity to the consumer affect this relative abundance of water resources in Lesotho. Tremendous shortages are realized in rural areas where more than 75% of the population lives. Increasing population continue to inflict stress on water resources particularly in the rural villages where majority of Basotho lives. Problems of climate change may further exacerbate the water shortages in all sectors dependent of water resources availability.

Lesotho is well endowed with a variety of wetlands. Lesotho contains some of the unique wetland ecosystems in the Southern African region, the majority of which are associated with drainage systems. Almost all the wetlands in Lesotho are in the high precipitation areas of the mountain region, and are found in the headwaters of catchments and are origins of the major river systems. In terms of types, the wetlands of Lesotho can be classified into five main types, i.e. mires, marshes, artificial impoundments, natural lakes and rivers. Wetlands are associated with soil stabilization, sediment and toxin retention, nutrient removal and transformation and organic matter production and export. Notwithstanding the importance of wetlands to the people and the economy, the systems continue to be degraded (Figure 6.18), mainly because of uncontrolled livestock grazing and trampling, siltation and erosion, encroachment by cultivation, overexploitation of resources and climate change which impacts on precipitation and temperature.

Figure 6.18 Khubelu wetlands showing signs of gully erosion and sheet erosion

6.4.2.2 Climate Change Impacts and Vulnerability on Water Resources

The major effects of climate change on Lesotho water systems will be through changes in the hydrological cycle, the balance of temperature, and rainfall. Climate change scenarios developed for

the second national communication show an increase in temperature and decrease in winter rainfall in the north.

The increased temperature scenarios will directly affect evapotranspiration, which in turn will impact on the water balance of runoff, soil moisture, water in reservoirs, salinization of shallow aquifers, changes in stream flow, dams and wetlands capacity. The predicted reduced precipitation in winter and summer will reduce stream flow resulting in hydrological drought. This will directly affect water supply and sanitation. Thus, under the reduced stream flow, water supply may not keep pace with demand. A Water Evaluation and Planning system (WEAP) model was used to predict water demand for Maseru city under prevailing urban population growth of 3.9% by 2020, Figure 6.19. Water demand shows a steady increase from 119238 m^3 in 2000 to 153819 m^3 in the year 2020.

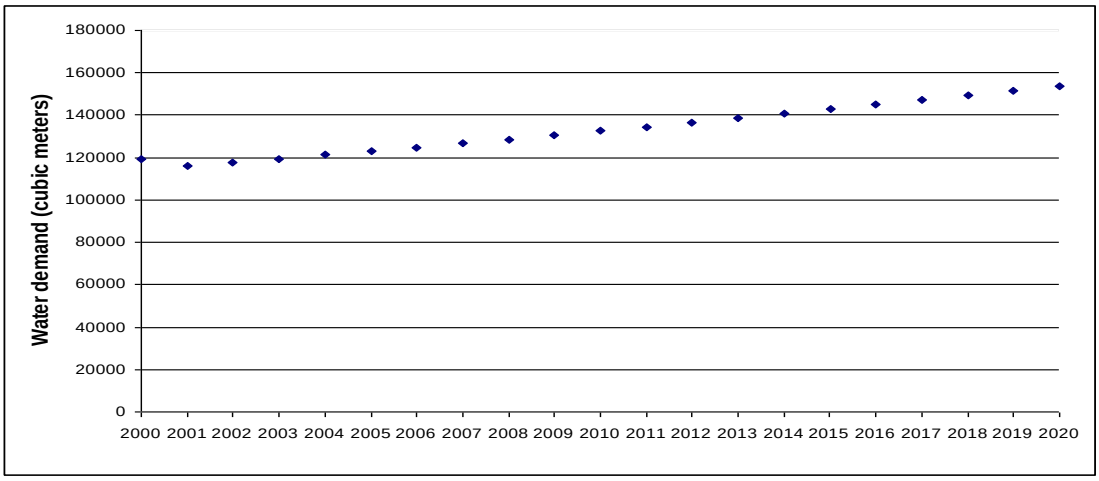

Figure 6.19 Scenarios for prediction of water demand in Maseru by 2020

The INC reported the results of the "Calibrated and Verified Water Balance Model (CLIRUN)" projecting future yields of water over Lesotho based on the projected climate change scenarios. In summary the results derived thereof indicate that the country will enter a water stress period of less than 1700m^3 per capita per year by the year 2019, implying suffering for both livestock and households. The INC further concludes that unless sufficient surface storage and reticulation infrastructure are developed, the projected lower runoff could influence future re-negotiations and reviews of the Lesotho Highlands Water Project (LHWP). Climate scenarios presented in section 6.3 reaffirms this condition. Advanced high resolution water models will be used in the Third National Communication for detailed water projections.

6.4.2.3 Adaptation Options and Strategies

In assessing climate change impacts, it is imperative to take adaptation into account. Without assessment of such impacts, the researchers could well overstate the potential effects of climate change. A reason for identifying adaptation is to inform policy makers about what they can do to reduce the risks of climate change.

It may be necessary to regularly update national and regional programmes containing measures to mitigate climate change and measures to facilitate adequate adaptation to climate change through:

- Research
- Awareness campaigns
- Legal and policy formulation
- Early warning systems

In Lesotho, mobilization of national efforts towards water resource conservation has to be enhanced through promoting change in attitudes at all levels through intensive public awareness campaigns to enforce water resources conservation, establishment and empowerment of community based water associations within the context of Local Government Act. Implementing an integrated strategy for managing water as a common resource for competing users will happen when resources are correctly valued**,** commensurate with their contribution to productivity, and the incentive exists. This can be achieved through the forces of supply and demand, and introduction of technological change.

6.4.2.4 Conclusions and Recommendations

Since water sustains life, the management of water resources demands a holistic approach, linking social and economic development with the protection of natural ecosystems. Integrated water resources management becomes the pillar of effective management. Managing water as an economic good is an important way of balancing its competing uses and achieving its equitable, efficient and sustainable utilization while encouraging its conservation and protection.

It is widely recognized and accepted that Lesotho has relatively abundant water resources but owing toits inaccessibility; climate change will create water scarcity. In order to allocate these resources to users effectively and equitably, there needs to be a strong legal basis governing water use and management. Abstraction permits, compulsory licensing and water-use authorizations are methods to determine and monitor water use and allocation. A typical licensing system requires a custodian of water resources who determines the allocation of these resources. The Department of Water Affairs within MEMWA has been given this mandate. Lesotho as an upstream riparian state within the Orange Senqu river basin has an obligation to maintain in stream flow requirements.

The prevailing state of climate pattern will force Lesotho to increase water allocation towards agriculture in future. This will require an intensive water harvesting program that stores water harvested for future use in all spheres of economic activities.

6.4.3 Forestry

6.4.3.1 Introduction

Forest ecosystems are important components of the global carbon cycle in at least two ways. First, terrestrial ecosystems remove nearly 3 billion tons of atmospheric carbon every year (3Pg C/ year) through net growth, absorbing about 30% of all carbon dioxide emissions from fossil fuel burning and net deforestation(Canadell et al., 2007). Forests are major contributors to this terrestrial carbon sink and its associated economic benefits. Second, 4 billion hectares of forest ecosystems (4 x 10^3 Mha; about 30% of the global land area) store large reservoirs of carbon, together holding more than double the amount of carbon in the atmosphere(FAO, 2006; Sabine et al., 2004). Although the climate protection role of forests is in no doubt, it is complex to determine how much of the forest

carbon sink and reservoir can be managed to mitigate atmospheric carbon dioxide build-up, and in what way. Effective implementation of good management practices ensures the multiple functions of forests and can increase forest carbon stocks. Lesotho is sparsely and one of the least forested in the region. In Lesotho, forests are generally poorly managed due to lack of adequate human and financial resources to implement good management practices such as silvicultural treatments, species selection, and designing rotation cycles that enhance forest carbon stocks.

Table 6.4 below is the forest inventory carried out in 1995 by Social Forestry Project financed by German government.

Table 6.4 Distribution of woodlot according to districts in Lesotho

DISTRICT	Plantable Area (Hectares)	Planted Areas up to 1993/94	Survived or Actual Stocked Area	Area Stocked with Eucs	Area Stocked with Pine	Area Stocked with Other	Number of woodlot -10 - 20	Number of woodlot 21 - 50	Number of woodlot >50	Total Number of woodlot
MASERU	3,953.2	2,478.4	1,590.7	534.2	927.2	129.3	68 89	22.0	3.0	114.0
BEREA	1,188.3	1,111.7	807.8	508.8	288.7	10.3	50 63	3.0	2.0	68.0
LERIBE	3,186.3	3,064.8	1,798.8	1,241.1	495.2	65.5	38 56	14.0	7.0	77.0
BUTHA BUTHE	1,087.1	946.2	507.2	351.3	128.0	27.9	28 15	4.0	1.0	20.0
MOKHOTLONG	143.0	44.0	20.5	0.0	4.5	16.0	13 13	0.0	0.0	13.0
THABA TSEKA	254.0	176.0	49.5	7.3	9.0	33.3	14 15	0.0	0.0	15.0
QACHA'S NEK	461.4	211.0	34.3	1.5	29.1	3.7	23 23	0.0	0.0	23.0
QUTHING	955.7	925.4	426.6	48.1	350.3	28.2	57 66	1.0	0.0	67.0
MOHALE'S HOEK	688.8	484.1	441.3	160.4	263.1	17.8	24 40	10.0	1.0	51.0
MAFETENG	1,078.0	921.0	454.5	126.7	288.9	39.0	18 31	6.0	0.0	37.0
TOTAL	12,995.7	10,362.6	6,130.9	2,979.2	2,783.9	370.9	333 411	60.0	14.0	485.0

Source: Forestry Division Woodlot Inventory 95/96

Since the establishment of the new Ministry of Forestry and Land Reclamation, it is estimated that 3 million tree seedlings are planted annually with a moderate survival rate of 60%. This figure has been achieved in some cases due to an intensive countrywide watershed management programme being implemented using a cash incentive to pay labour.

Forest management practices that increase carbon sequestration in Lesotho include:

- afforestation, reforestation and forest restoration
- Increase of tree cover through agroforestry, urban forestry and tree planting in rural landscapes.

Planted forests today cover around 20,000ha but due to vandalism and damage by animals these plantations are not fully stocked. Again, the rates of carbon sequestration on forest land depend on the management practices adopted, the tree species involved and geographic area covered. Figure 6.20 shows afforestation efforts at the background of indigenous shrubs.

Figure 6.20 An example of a Forested Area through Afforestation

Trees outside forests is a common phenomenon in Lesotho as it includes trees in the rural landscape and along roads, rivers and human settlements and trees in and around towns and cities. In fact, most towns and church establishments are heavily forested. While contributing to environmental sustainability, they also provide income and a range of goods and ecosystem services for rural households, thus contributing to food security and poverty eradication. Trees outside forests can also have an important role in climate change adaptation, through diversified land-use practices, livelihoods and sources of income, and through enhancement of agricultural productivity and buffering against weather-related production losses, enhancing resilience against climate impacts on farming systems.

Wildfires are a significant source of greenhouse gas emission and their incidence is likely to increase because of climate change. The ministry has adopted an integrated fire management strategy. An intensified training and awareness campaign has been mounted with the involvement of local communities. Figure 6.21 shows damage inflicted by fires in one of the forested areas in Botha Bothe.

Figure 6.21 Forest Fires – Mafika Lisiu Forest Reserve, Botha Bothe District

6.4.3.2 Climate Change Impacts and Vulnerability on Forestry

Increased temperatures and levels of atmospheric carbon dioxide as well as changes in precipitation, and frequency and severity of extreme weather events are already having notable impacts on the condition of forests (Maile, 1990). Climate change, particularly severe weather events, affects forest pests and their ecological activities by directly impacting their development, survival, reproduction

and spread. Pests can also be impacted upon by the altering of host defences and susceptibility, and altering ecological balances such as changing relative abundance of competitors, parasites and predators. The genetic variability of most tree species is probably large enough to allow them to acclimatize to average changes in temperature and precipitation. According to Jandl (2012) there are two opposing views: the optimistic view postulates that, in a warmer world scenario, trees will grow faster, enjoy a longer growing season, flourish in areas where they had never grown before, take in more carbon and increase the carbon sink. On the contrary, the pessimistic view envisages that, warmer temperatures will mean more forest fires, more insect depredation, increase in dead and dying trees, more peatland decomposition, thawing permafrost and the transformation of terrestrial ecosystems into carbon sources. It remains true that one cannot say with certainty which path the forests will follow.

In the northern region of Lesotho, projected decrease in precipitation during the winter season and concomitant forest fires will present a major risk for forests as most of Lesotho's plantations are concentrated in that region. In the south, predicted increases in precipitation during the seasons of spring and autumn may be sufficient to compensate for increased evapo-transpiration, and there may be no major threat to the existence of forests. Insect and pest populations are expected to increase but the extent to which they may be controlled naturally is not known.

6.4.3.3 Adaptation Options and Strategies for Forestry Sector

Many adaptation options are available including:

- Investing in implementation of good forest management plans;
- Adaptive forest management that addresses arising challenges and reduce vulnerability;
- Adaptation measures which include:
  - selection of pest resistant or drought tolerant tree species;
  - use of stocks from a range of provenances;
  - assisted natural regeneration of functional species such as Pinus halepensis in the south.

Four major strategies available for mitigation of carbon emissions by forestry activities are:

- Increasing forested land area through afforestation and reforestation;
- Increasing the carbon density of existing forests at both stand and landscape scales;
- Expanding use of forest products to sustainably replace fossil fuel CO_2 emissions; and
- Reducing emissions from deforestation and degradation.

6.4.4 Livestock and Rangelands

6.4.4.1 Introduction

Rangelands are described as areas of land, which due to physical limitations, low and erratic precipitation, difficult topography, poor drainage and extreme temperatures, are unsuitable for cultivation. These areas are major sources of forage for free ranging wild and domestic animals, however, they are also a source of other ecosystems services (Stoddart *et al.* 1975), these could

include water, medicinal plants and nutrient cycling. In the Lesotho context, rangelands are considered as land on which natural vegetation is predominantly grass, grass-like plants, forbs, and shrubs suited for grazing or browsing. These include land vegetated artificially to provide a forage cover that is managed like native vegetation (Range Management and Grazing Control -Amendments - Regulations 1986).

Lesotho is endowed with its unique rangelands, wetlands, biodiversity, heritage sites, and wilderness. Lesotho's mountains rangelands are the birthplace of the most important rivers in Southern Africa. These mountain areas are important summer grazing areas by cattle, horses, sheep, and goats, they are further, an important tourist resource base. Myriad and synergic factors have been blamed for woeful degradation of Lesotho's rangeland resources in different documents (Staples and Hudson 1938; Conservation Division 1979; Phororo 1979, Motsamai 1991; Hughes *et al*. 1992; Maclaurin 1992; Phororo and Sibolla 1999; Nüsser 2001,). The major threats to rangeland resources include (1) overstocking, excessive grazing and soil erosion; (2) invasive alien species; (3) increased conversion of grasslands into areas for arable agriculture; (4) hydroelectric development; and (5) global warming (Hilary and Birks 2002).

Ecosystem services obtained from rangelands with emphasis on Lesotho include the following: (1) Productivity of livestock for most rural communities depends on the quantity and quality of forage available for grazing; (2) The high yield of rangelands provides the living and income opportunities from utilisation and sale of livestock to honour social, cultural, and economic demands; (3) Rangelands are an important source of water, thus, they purify and filter water for sustenance of life. The roles of rangelands in water management are fundamental in Lesotho. Thus, the high quality and abundant water is affectionately termed the 'white gold' as it generates royalty income through the Lesotho Highlands Water Project (LHWP) treaty and export arrangements with South Africa. Since life on earth depends on water, sound rangeland management is essential to increase the productivity of water in general and maintain an ecological balance (Lesoli, 2011). Rangelands in good condition provide the aesthetic beauty and recreational opportunities that are conducive to ecotourism development. Communities are expected to sustainably meet their essential needs while conserving their environment and generating income from eco-tourism activities. Medicinal plants form part of the rangeland resources. The plants are harvested for medicinal purposes by individuals and traditional healers as well as for sale.

Climate change has a huge impact on rangeland resources and associated ecosystem services such as forage production. This in turn leads to poor livestock production. Land degradation due to factors including injurious management of rangelands reduces livestock productivity and results in food insecurity in developing countries (Lesoli, 2011). Features of degradation in grazing lands include loss of desirable perennials, soil erosion, decline in soil carbon and poor water infiltration rates (World Meteorological Organization, 2005, Lesoli, 2011). Climate change has the potential to cause inordinate impact on rangelands because the productivity of grass and shrub dominated ecosystems is closely linked to the short-term expression of climate.

Livestock is a key asset for rural people in Lesotho, fulfilling multiple economic, social and risk management functions. The impact of climate change is expected to heighten the vulnerability of livestock systems. This impact could further reinforce existing factors that are affecting livestock

production systems, such as rapid population and economic growth, rising demand for food and products. Climate change will have far-reaching consequences on livestock production, thus, it will affect among other livestock production practices, dairy, beef and wool production. Livestock productivity and well-being in natural conditions depend on their ability to cope with environmental challenges such as nutritional and thermal environments and exposure to diseases and parasites. These challenges will mainly arise from climate change impact on rangelands productivity. Thus, indirectly, changes in feed resources are linked to the carrying capacity of rangelands, the buffering abilities of ecosystems, intensified desertification processes, increased scarcity of water resources, and decreased grain production.

The direct effects from heat and water stress on grazing or browsing livestock are most likely to be manifested as decreases in feed intake, milk production, and reproduction rates (Rowlinson 2008). These effects include higher temperatures and changing rainfall patterns, which could translate into the increased spread of existing vector-borne diseases and micro parasites, accompanied by the emergence and circulation of new diseases. The impact of climate change on pastures and rangelands may include deterioration of pasture quality (Thornley and Cannell, 1996) towards poorer quality subtropical C_4 grasses because of warmer temperatures and less frost. Consequently, these changes in forage may alter the productivity of grazing livestock (Topp and Doyle, 1996). However, there could also be potential increases in yield if climate changes were favourable because of increase in CO_2.

6.4.4.2 Climate change impacts and vulnerability on Livestock and Rangelands

The understanding of challenges that range and livestock sectors face in adapting to a changing climate, should be underlined by identification and prior understanding of some of the impacts that climate change pose on these sectors. An increase in annual mean temperature change from 2010 to 2100 has been predicted to be in the region of 1-2^{o}C by 2050 and 2.5 – 3.5^{o}C by 2080. The temperature increase will more likely impact negatively on grass layer cover on rangeland and crop residues, which are important sources of feed in the country.

The predicted increased precipitation in autumn and winter has the potential to change severity and distribution of important livestock diseases and pests as well as changes in the productivity of rangeland and rain-fed crops and forage. Rainfall projections are likely to have severe impacts on water resources resulting in growing season for both natural vegetation and crops being shortened. Lower precipitation in spring and summer could result in water shortages and drought. Reduced fresh water availability, dry spells, extended drought, hailstorms, frost, strong winds, flash floods and could therefore, be expected.

Anticipated climate change combined with other drivers of change is likely to intensify water scarcity for both human and livestock in Lesotho. Increasing temperatures are expected to increase evaporative demand. Rainfall change and variability is very likely to affect vegetation in Lesotho grasslands resulting in reduction in cover and forage productivity. Expected frequent warming and fire due to prolonged droughts is very likely to reduce carbon stocks. High temperatures and greater

dry spell duration have potential to increase vegetation flammability resulting in extensive rangeland fires. Climate change is likely to increase opportunities for invasive species because of their adaptability to disturbances.

In Lesotho, where the major land use practice on rangelands is grazing, loss of vegetation will result in poor animal production and aggravated land degradation. Thus, land use and land cover change is an important factor in determining the vulnerability of ecosystems and landscapes to degradation and environmental change. Furthermore, land use and land cover changes influence carbon fluxes and greenhouse gas (GHG) emissions which directly alter atmospheric composition and radiative forcing properties; they also change land-surface characteristics and, indirectly, climatic processes.

Perennial fires in rangelands and their resultant changes in distribution of species whereby more fire loving or tolerant species such as Themida triandra and resprouting karroo bushes increase in abundance could be blamed partially on climate variability; however T. triandra dominance is believed to be curtailed by injudicious grazing by livestock. Frequent and intense burning resulting from climate variability alters biodiversity by its effects on soil organic matter and soil fertility in grasslands (Rice et al., 1998). More extreme increases in mean temperature and rainfall variability can affect vegetation growth and yields. Livestock are generally expected to be adversely affected by increased temperature, disease, and weather extremes. Changes in the distribution of diseases and disease vectors are problematic because they involve a disassociation between the pathogen and its natural controllers. The disruption of the community of organisms that keeps a pathogen in check allows it to spread rapidly. Climate change could increase the frequency with which species across a wide range of taxa are able to spread outside their home range (Karl et al., 2009).

6.4.4.2.1 Adaptation Options on Livestock and Rangelands

The actions that decrease vulnerability and increase resilience, in response to a range of immediate needs, risks, and aspirations could be viewed as the characteristics of successful adaptations. Proper management of **rangelands** can aid in the mitigation of rising atmospheric carbon dioxide concentrations via carbon storage in biomass and soil organic matter, a process termed as carbon sequestration. Rangelands have a large potential to sequester carbon.

Since the major land area (60%) of Lesotho is rangelands, establishment of a healthy grass sward on rangelands and land of limited agricultural value will generally serve as a good adaptation option of maximising soil carbon sequestration. Certain rangeland management practices such as controlled rangeland burning, although proved useful, management tools should be applied with special consideration. Controlling rangeland fires helps to maintain organic matter in the soil and further help to sustain non-fire loving plants on a site. Long-term resting of rangeland that lead to addition of organic material to the soil is an excellent means of improving soil physical, chemical, and biological characteristics and enhances recycling of nutrients. However, care must be taken because excessive morbidity due to prolonged rangeland rest could smother and kill regrowing grass tillers.

Livestock farmers throughout the country have developed their own ways of adapting to the highly variable geophysical, climatic, and biotic conditions of rangeland areas over decades. Transhumance,

for example, is a traditional mechanism developed by herders to cope with changes in the availability of water and grass at different places and times induced by climate variability.

Adaptation strategies should address the tolerance of livestock to heat, ability to survive, grow and reproduce in conditions of poor nutrition, parasites infestations and diseases prevalence. This suggests that animal genetic improvement strategies in Lesotho should be centred on developing animal genetic materials that are adapted to these conditions. Such strategies could be based on genetic selection and crossbreeding practices. Indigenous African (Sanga) breeds such as Nguni, Tuli and Mashona are more disease resistant and drought tolerant, furthermore, they are crucial to the effective management of the environments in which they were developed. Therefore, the possibilities of adoption of such breeds should be explored and be given a chance for animal production improvement and rangeland management. Therefore, practical adaptation measures could include identification and strengthening of local breeds that have adapted to local climatic stress and feed sources and improving local genetics through crossbreeding with heat and disease tolerant breeds. However, if climate change is faster than natural selection, the risk to survival and adaptation of the new breed is greater.

Livestock production practice adjustments such as diversification, intensification, and/ or integration of pasture management, livestock, and crop production could also serve as adaptation strategies. Maintaining a diverse herd has a number of advantages and it represents a critical adaptation measure. A diverse herd is an adaptation to a diverse ecology in which vegetation can be highly varied in both spatial and temporal scales. Changes of livestock composition/herd composition could serve as an adaptation strategy. Efficient and affordable adaptation practices need to be developed for the rural poor who are unable to afford expensive adaptation technologies. These could include provision of shade and water to reduce heat stress from increased temperature that could have negative impact on livestock production due to reduced feed intake resulting from heat stress. An improved management of water resources through the introduction of simple techniques for localized irrigation (e.g. drip and sprinkler irrigation), accompanied by infrastructure to harvest and store rainwater, such as tanks connected to the roofs of houses and small surface dams could also help as an adaptation measure. Furthermore, production efficiency should be maximized such that a lower number of more productive efficient animals could be an option and could lower greenhouse gas (GHG) emissions from livestock production.

Removing or introducing subsidies, insurance systems, income diversification practices, and establishing livestock early warning systems and other forecasting and crisis-preparedness systems could benefit adaptation efforts. Working towards a better understanding of the impacts of climate change on livestock, developing new breeds and genetic types, improving animal health and enhancing water and soil management would support adaptation measures in the long term. There is a need to improve the capacity of livestock producers and herders to understand and deal with climate change by increasing their awareness of global changes. In addition, training in agro-ecological technologies and practices for the production and conservation of fodder improves the supply of animal feed and reduces malnutrition and mortality in herds.

6.4.4.2.2 Other Climate Change Coping Strategies

In practice, a number of options are available by which farming communities cope with harsh climate change impacts, however data might not be available for all these strategies. Those coping strategies include continuous grazing of summer grazing areas and wetlands, illegal grazing of rested or deferred grazing areas, rented grazing in South Africa on nearby boundaries, fodder (hay) importation from South Africa, livestock loaning, small scale fodder production and harvesting of crop residues as animal feed.

To improve management and utilization of rangeland resources, the Department of Range Resources Management is finalizing the National Range Resources Policy whose key policy areas include sustainable management of rangeland resources, conservation of biodiversity and maintenance of ecosystems, rangeland monitoring and research, maintenance and protection of wetland areas and socio-economic dimensions of land users.

To enhance community participation in the management of rangeland resources, the Department of Range Resources Management promotes development and establishment of grazing associations (Group grazing arrangement where villages are allocated grazing areas, which they utilize and assume their management responsibilities). To improve livestock productivity, small stock farmers through the Department of Livestock Services of the Ministry of Agriculture and Food Security have Wool and Mohair Growers Associations whose main target is to improve both quality and quantity of wool and mohair through genetic improvement wool sheep. The production of wool and mohair is mainly for exports, while a minor part is used locally for tapestries and knitwear. As a result of this genetic upgrading, the quantities of wool and mohair increased substantially between 1999 and 2008 by 6.3 and 7.2% per year for mohair and wool respectively (Lesotho Bureau of Statistics Year Book, 2010).

The Ministry of Forestry and Land Reclamation through the Department of Soil and Water Conservation is promoting reseeding of marginal field crops with fodder species such as *Eragrostis Curvula*. Since 2007, over four hundred and fifty hectares (>450ha) of *E. Curvula* have been planted.

6.4.5 Soils and Land Degradation

6.4.5.1 Introduction

Land refers to all the elements of the physical environment that influence potential for land use. In addition to soil, land includes relevant features of geology, landforms, climate, hydrology, fauna and flora. The amount of land available is important for allocation for various purposes or land uses; for example, cropland, forestry, rangeland, settlement, industry, recreation, etc. Land is a fundamental resource for economic production and various land uses are normally determined to a large extent by related physical characteristics and economic factors (Dent and Young, 1981). Sectors of production, whether be they agriculture, mining, industry etc., are normally established on land. Development of these sectors has to maintain an acceptable quality of the land, and should not contribute towards its degradation. It is important to note as indicated in the Initial National Communication that land and other natural resources are priorities for development in Lesotho and

assessment of their vulnerability to climate change is essential in order to determine appropriate responses.

About two thirds of the country is mountainous, with steep slopes that are covered with very shallow soils. Population increase over the years has resulted in an increased pressure on the land to the extent that steep mountain slopes that should not be cultivated are being used for crop production. On average, land allocations per household had declined to less than 1.4 ha while people without land in the rural areas had risen to about 25% in 1986 (Moeti, 1996). The situation of landlessness remains a problem despite recent reported decline in population due to HIV/AIDS. Arable land is estimated to be around 9 per cent. With about 60 per cent of the country's population residing in the Lowlands which cover 17 per cent of the land, a lot of pressure is being exerted on arable land. Between 1986 and 1996, average population density on arable land increased by 5 per cent (Government of Lesotho, 2000).

Table 6.5 shows land cover change over the country as determined in 1988. Although it is outdated, this is the best information available to date.

Table 6.5 Land Cover Change in 1988

Land Use	Area in Hectares from 3 035 500 ha	% land cover
Rangelands	1 981 896	65
Forestry	12 137	0.4
Croplands	728 520	24
Cultivated Lands	301 369	
Fallow*	87 500	
Wetlands/Boglands	2 224	0.07
Others	209 362	7
Settlements	97 096	3.2

Source: Ministry of Natural Resources (Undated)

*Fallow in 1989 was estimated to be 25% of the total arable land area

Soil as a land component is directly affected by land degradation. The soil material that covers the entire country is subjected to various forms of degradation. However because of the differences found in different soils, the effect is not the same. The Soil Taxonomy of United States Department of Agriculture (USDA) has been adopted as the soil classification system for Lesotho. The system comprises six categories with the soil order being the highest and soil series the lowest. There are five major soil orders covering the important soil series of Lesotho. Table 6.6 presents the soil orders and their areal coverage.

Table 6.6 Soil orders and their land cover

SOIL ORDER	APPOXIMATE AREA (HA)	PER CENT OF TOTAL AREA[36]
Mollisols	1 700 000	56.0
Alfisols	300 000	9.9
Entisols	128 000	4.2
Inceptisols	125 000	4.1
Vertisols	70 000	2.3

Adapted from Rooyani and Badamchian (1986) and Office of Soil Survey (1979)

Reviews of the efforts of government to control soil erosion since the period Lesotho was under the British Protectorate indicate no significant improvement (Ministry of Natural resources, 1999). The spatial extent of land degradation through soil erosion has not been mapped. However, sediment yield as an indicator has been used to monitor soil loss within catchments. Table 6.7 indicates sediment yield for three stations located in three sub-catchments; CG22[37] (Mohokare), CG24 (South Phuthiatsana and CG25 (Hlotse). These are gauging stations managed and operated by the Department of Water Affairs as part of monitoring surface water over the country. As observed by Gregory and Walling (1973) drainage basin or catchment characteristics in relation to topography, rock and sediment, and vegetation are significant in understanding its behaviour. It is the interaction of these features with precipitation that determines amount of sediment generated in a catchment. Soil erosion is the main process by which soil is lost within catchments.

Factors that are responsible for soil erosion include the erosivity (energy) of the eroding agent, erodibility (susceptibility) of soil or geological material, slope and vegetation cover. The general nature of the storm events, the steep terrain, the weak soil structure and the barrenness of the land surface makes an ideal environment for erosion. Erodibility, which is determined as K-values, indicates that the lowland soils have higher values than the highland soils. As a result, despite steep slopes in the mountain areas, sediment yields have been noted to be lower than those of lowland catchments (Ministry of Natural Resources, 1999).

[36] About 25 per cent of land is classified as rock land, gully land and colluvial land

[37] "C" in the CG implies the "Caledon" river catchment while the "G" stands for "Gauging". For example the Senqu river catchment gauging station would be denoted by "SG" where the "S" represents Senqu.

Table 6.7 depicts total sediment generated by each sub-catchment between 1995 and 2000.

Table 6.7 Sediment Yield Derived from Daily Measures (1995-2000)

RIVER	STATION	SEDIMENT (TONS/KM^2)
Mohokare	CG22	38923
South Phuthiatsana	CG24	9392
Hlotse	CG25	23887

6.4.5.2 Climate change impacts and vulnerability

Lesotho like other Least Developed Countries is faced with the following potential and existing impacts of land degradation:

- The decrease of land quality, which results in the decrease in productivity which has an effect on the livelihoods of people in terms of food insecurity, poverty and migration;
- Reduction of habitat for living species, for both micro and macro flora and fauna;
- The impact of degradation on the likely increase on GHG emissions, for example the increase in carbon through the oxidizing of organic matter induced by tillage;
- The likely impact on land degradation on ecosystems functions and landscape processes such as water and nutrient cycles, which in turn affect water availability and primary productivity of ecosystems and their services to communities;
- The decline of the buffering capacity of soils, resulting in undesirable changes that may directly affect land productivity;
- The impact of degradation on the biodiversity of ecosystems at many levels, above and below the ground.

The above are linked with the different types of land degradation such as sheet erosion, mass movement, wind erosion, loss of nutrients, salinization and acidification. These are associated with increase and decrease of precipitation and increased temperatures projected by the climate scenarios.

It is recognised that climate change with edaphic and cultural issues results in the massive land degradation that dominates the ecosystem of Lesotho. The Driving forces Pressure State Impact Response model shows that pressures on the environment such as population increase have a tremendous impact on natural resources. Since natural resources are intricately linked, an impact on one results in a chain reaction of impacts. In Lesotho, natural vegetation has been overexploited. There are very few indigenous tree species that still exist. Trees and shrubs have been extensively used in the rural areas for fuel wood and as fencing and building materials consequently many species have become extinct. Generally shrub vegetation is very sparse and so is grassland due to overgrazing. Given the topography of Lesotho which is characterised by steep slopes, and the semi-arid climate, water and wind erosion play a significant role in land degradation. Overuse of arable

land and limited vegetation cover has resulted in loss of nutrients and most of the lowland soils are acidic and generally infertile.

Bare land is more reflective and heats the air above it and potentially contributes to global warming such that the result of climate change facilitates further change. Furthermore because of loss of fertility and hence the capacity to support vegetation and crops has implications on food security. Loss of vegetation plays a role in climate change. Vegetation cover, soil stability, type and duration of rainfall are among important factors responsible for soil erosion - the most significant form of land degradation in Lesotho.

Changes in the land use such as deforestation are believed to have contributed significantly to the high carbon concentration in the atmosphere. By covering the land with vegetation, climate change can be mitigated at the same time land degradation through erosion and nutrient depletion reduced. Any activity that reduces soil cover enhances its vulnerability to degradation.

In Lesotho *Driving Forces* such as population increase, urbanisation and transport produce *Pressures* on the environment, such as overgrazing, over-cultivation, over-harvesting of fuel-wood resources and vegetation clearance which degrade the *State* of the environment, which then result in *Impacts* on human health and the health of ecosystems. *Responses* are the direct and indirect actions taken by the land users and managers to the impacts on their livelihoods caused by the state of land degradation, the pressures on land causing such state, and the driving forces causing such pressures. If the responses are effective they form adaptive mechanism for the system.

The results of the GCM indicate that for both the northern and southern parts of Lesotho over the next 90 years, there will be on average about 0.4 – 4.7^{o}C increase in temperature. Extreme temperature and precipitation changes have implications on vegetation growth hence soil cover. Dry episodes will result in a reduction of soil cover, thus exposing the soil to wind and rainfall erosion.

High temperatures will affect vegetation growth which will result in the reduction of vegetation cover. High temperatures result in loss of soil moisture through evapo-transpiration. Some plant species will die due to insufficient water and land degradation will be aggravated. To a large extent, precipitation will be below normal suggesting insufficient soil moisture and high probability for drought. Even though there are also indications of precipitation that is above normal, it must be noted that because of the high variability and extreme events (e.g. hail and thunder storms) there is a greater likelihood that the above normal occurrences will occur over short time durations and will be infrequent. The implications of high intensity short duration storm events are:

- Floods;
- Destruction of biodiversity;
- Soil erosion – land degradation.

Given that the country is characterized by high intensity and short duration storms, the soil will be vulnerable to erosion even at below normal precipitation, but will be more vulnerable when precipitation is above normal.

As a result of these potential impacts ecosystem services will be adversely affected and thus communities will be rendered vulnerable.

The next communication will deal more detail about soil formation and regional aspects of land degradation and silt transportation.

6.4.5.3 Adaptation options and strategies

It has already been pointed out that land and soil policies in Lesotho began in the 1930s. This was described in Imperial Gullies: Soil Erosion and conservation in Lesotho by Kate Barger Showers, 2005 which states “A major concern of the Basotho was to keep anti-erosion costs to minimum. This resulted in initial decisions to construct the contour banks with the smallest possible specifications. Two types of terraces were used; uninterrupted and interrupted contour banks”. Despite these efforts and the incorporation of new knowledge over the past years to improve the policies the current state of land degradation suggests that they have not been effective. The fundamental problem seems to be the lack of knowledge about both, the social and physical aspects that underpin land degradation in Lesotho. In other words, policies have not been informed by comprehensive understanding based on research in this area.

This study was limited to expert judgement, with availability of resources, research based evidence is needed to overcome mistakes committed in the past and has confined itself to two key degradational problems – soil erosion and nutrient depletion. Reduction of vegetation cover increases the vulnerability of soil to erosion and can be mitigated by programmes that improve land cover. Sections of this report on forestry and rangelands indicate that afforestation and re-grassing have been and continue to be aspects of soil conservation. It has also been shown that soil conservation and land reclamation programmes have not been particularly successful. There is a need for empirical studies that for instance seek to compare different conservation approaches within watersheds. There is need for documentation of performance of different grass and tree species both exotic and indigenous with respect to land rehabilitation. Quantitative evaluation of currently employed conservation measures, whether biological or mechanical is important in assessing best options for arresting soil erosion.

Arable lands are major contributors of soil erosion through sheet erosion. During this process not only is soil lost but so are the nutrients. Supplementation of soil nutrients by subsistence farmers through chemical fertilizers has over the years become a serious economic challenge. The costs of agricultural inputs are simply beyond ordinary farmers. Secondly over the past years the continued use of chemical fertilizers without liming has contributed to unprecedented levels of soil acidity. Higa (Undated) indicates that the conventional agriculture is a system which is characterized by approaches or symptomatic therapy and therefore requires chemical fertilizers and agricultural chemicals. Soil management based on this type of practice transforms soil into a disease inducing or putrescent environment. The system has failed to recognize the organic chemistry and the biological phenomena of the soil.

Work that Prof. Teruo Higa and his co-workers have done spanning a period of over 50 years, indicate that characteristics of the soil depend to a large extent on micro-organisms that are found in it. Based on this understanding the Effective Micro-organisms (EM) technology has evolved. This technology makes use of micro-organisms to transform soil properties and to facilitate nutrient availability to plants. The technology is cheap and large amounts of EM can be produced and applied to soils and crops. It is recommended that natural farming through extensive use of EM be adopted as one of the adaptation measures. The approach ensures not only the conservation of the soil, but also improves the quality of production by eliminating harmful chemicals introduced by application of chemical fertilizers and other agro-chemicals.

There should be an investment in water harvesting through systematic earth dams constructed by communities in gullies and dongas around arable lands. Dams should be designed and constructed in accordance with engineering specification under the guidance and supervision of appropriate expertise from the Ministry of Forestry and Land Reclamation. These dams or reservoirs will serve multiple purposes such as for irrigation, drinking water for livestock and sediment control.

Conservation efforts will have to be strengthened. Conservation farming methods such as minimum tillage / pit farming should be encouraged.

It will be necessary to introduce an incentive for livestock improvement. Only improved breeds of livestock that are adapted to the climatic conditions and are economically viable should be maintained. Appropriate numbers of stocking rates should be maintained.

Increases in temperature will have adverse impact on vegetation. Because Lesotho is a natural grassland savanna, afforestation with exotic trees should not be promoted. To maintain appropriate land cover, it will be necessary through research, to establish both grasses and trees/shrubs vegetation from the indigenous species that will be tolerant to the prevailing temperatures.

6.4.6 Health

6.4.6.1 Introduction

Lesotho's climate is considered very pleasant; and does not impose restrictions to recreation and general functioning of the body system. The country lies well outside the tropics (Lesotho Meteorological Services, Undated) and as such there are very few recorded occurrences of tropical vector borne diseases such as malaria. However, according to A.Githeko et. al. (2007) there is a strong likelihood of expansion of the malaria transmission zone into South Africa and most probably into Lesotho in the future. This report addresses the vulnerability of the Health Sector by examining its effects on disease patterns.

Disease Profile: According to health statistics, there were 1,265,481 contact visits to health facilities in 2008 in Lesotho. This translated to an estimated 0.7 contacts per capita, an increase of 0.2% on the figure for the previous year. This increase was probably a result of the removal of health user fees at health centres that enabled poor people to access health care without the payments obstacles. Infectious diseases remained the major cause of recorded morbidity, with upper respiratory tract infections accounting for 24% of outpatient cases. Skin and subcutaneous infections

were responsible for 8% of the cases while diarrhoea/gastroenteritis and hypertension were responsible for 6% each and musculoskeletal ailments 5%.

Fatalities occur as a result of extreme temperatures. The fatalities are notably higher during the winter period and much lower during the warm summers. This is largely due to heavy snowfall during the winter period coupled with lack of appropriate clothing and accommodation due to poverty. The complex relationship between water quality and availability and sanitation and hygiene on the one hand, and disease prevalence on the other, as indicated in the INC, is quite apparent in Lesotho where respiratory tract infections, gastro-intestinal, genitourinary, and skin diseases continue to rise.

The prevalence of malnutrition is a function of the socio-economic and ecological factors in the country. Prospects for future improvements in nutrition are not very good as food production continues to decline, and unemployment increasing at the same time. Effective control of diseases such as diarrhoea, acute respiratory diseases and other childhood diseases is likely to remain a problem as long as nutritional status of under-fives is not improved.

Safe Drinking Water and Sanitation: It is common knowledge that there is a strong relationship between water and sanitation on the one hand, and exposure to and prevalence of disease on the other. The availability and accessibility of potable water may minimise the prevalence of potentially fatal diarrhoeal diseases such as typhoid, cholera, and dysentery. In 2004, 95% of the urban population was found to have access to safe drinking water; while only 69% of the rural population had asses to safe drinking water. Similarly, 93% of the urban population was found to be having approved means of human waste disposal as compared to a mere 46% of the rural population. Given that 75% of the country's population is in the rural areas it is clear that huge portion of the national population rely on unsafe water and poor sanitary means.

6.4.6.2 Climate change Impacts and Vulnerability

The dynamics of disease patterns especially those influenced by climate are very complex. For instance, the effects of climate change on health depend on what happens in other sectors of the economy like agriculture. However there are complications that are a direct result of physiological reasons. Acclimatization and development of immunity are some of the phenomena that make predicting climate change impacts on disease difficult. The linkages between human health and the climate have so far not been developed in Lesotho, therefore a rational approach to human health impacts assessment for climate change should emphasize continuing study and monitoring of human disease in relation to climate and environmental factors, and should acknowledge a range of possible outcomes (Ministry of Natural Resources, 2000).

Drought diminishes dietary diversity and reduces overall food consumption, and may therefore lead to micronutrient deficiencies. Countries within the 'Meningitis Belt' in semi-arid sub-Saharan Africa experience the highest endemicity and epidemic frequency of meningococcal meningitis in Africa. The spatial distribution, intensity and seasonality of meningococcal (epidemic) meningitis appear to be strongly linked to climatic and environmental factors, particularly drought, although the causal

mechanism is not clear (Confalonieri, U. et al., 2007). In 2010 meningitis was one of the top five causes of adult mortality (Health Statistics, 2010/11).

The persistent regular droughts cause many farmers, especially subsistence farmers, to leave their fields fallow and in time rodents will likely starve and migrate to households for survival. On their trails could be their predator snakes, some of which could be poisonous. This could lead to high incidences of plague and morbidity and mortalities from snake bites, or even shock for some from sights of rodents and snakes.

Four cases of Anthrax were reported in 2010. (Health Statistics, 2010/11) Extended droughts will cause increases in the incidence of this bacteria borne disease as animals groping for fodder will be liable to feed off soil infested with the anthrax bacteria. While Lesotho lies outside of the current malaria zone the Fourth Assessment Report of the IPCC anticipates expansion of the zone deep into southern Africa. Climate variability may also interact with other background stresses and additional vulnerabilities such as immuno-compromised populations (e.g. with HIV/AIDS) and conflict and war in the future, resulting in increased susceptibility and risk of other infectious diseases (e.g., cholera) and malnutrition (Boko, M. et al., 2007).

Global climate change would affect human health through varying pathways that are demonstrated in figure 6.22. These impacts include those that are directly linked to increases in extreme weather events such as heat waves, floods, cyclones, storm surges and droughts and that are indirectly linked such as an increase and shift in the distribution of vector-borne, water-borne diseases and food-borne infections. More indirect effects will come from decreased food production and associated malnutrition.

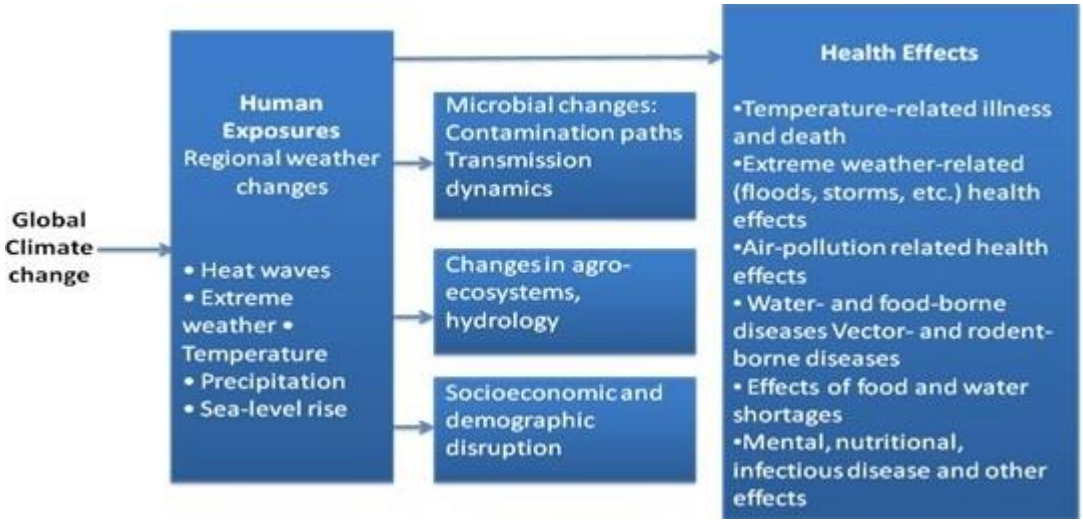

Figure 6.22 Pathways by which Climate Change Affects Human Health (WHO, 2003)

6.4.6.3 Adaptation Options and Strategies

The dynamics of disease patterns especially those influenced by climate are very complex; largely due to the fact that, the effects of climate change on health depend on what happens in other

sectors of the economy such as agriculture. Acclimatization and physiological adaptation further complicates the prediction climate change impacts on disease. Suffice to note, the linkages between human health and the climate have so far not been developed in Lesotho. Therefore a rational approach to human health impacts assessment for climate change should emphasize continuing study and monitoring of human disease in relation to climate and environmental factors, and should acknowledge a range of possible outcomes (Ministry of Natural Resources, 2000).

Public awareness, effective use of local resources, appropriate governance arrangements and community participation are necessary to mobilise and prepare for climate change. These present particular challenges in low-income countries. Furthermore, the status of and trends in other sectors affect public health, particularly water quantity, quality and sanitation, food quality and quantity, the urban environment and ecosystems. These sectors will also be affected by climate change, creating feedback loops that can increase or decrease population vulnerability, particularly in low-income countries (Confalonieri, U. et al., 2007).

Table 6.8 lists some key adaptation strategies identified for the health sector. They reflect the necessary integrated approach suggested in the Fourth Assessment Report of the IPCC. As with everything else, constraints to adaptation arise when one or more of the prerequisites for public-health prevention have not been met: an awareness that a problem exists; a sense that the problem matters; an understanding of what causes the problem; the capability to influence; and the political will to influence the problem (Confalonieri, U. et al., 2007). Owing to the variability of climate changes, over time, seasonal and regional, as in the Special Report Emission Scenarios (SRES) a lot of flexibility will likely be needed in making decisions about adaptation. Already the Fourth Assessment Report of the IPCC notes: A two-tiered approach may be needed, with modifications to incorporate current climate change concerns into ongoing programmes and measures, along with regular evaluations to determine a programme's likely effectiveness to cope with projected climate risks.

To overcome the above constraints to adaptation, more than just being aware of the existence of a problem, we must recognize the problem.

Table 6.8 Matrix for Adaptation for Identified Impacts in the Health Sector

Adaptation Measures	Heat Related Mortality/ Morbidity	Extreme Weather Conditions	Water Borne Diseases	Vector Borne Diseases
Surveillance and Monitoring	Establish new weather warning systems that focus on health-related adverse conditions;	- Strong empirical data to relate projected changes in climate variables to greater environmental hazards/exposures - Maintain disaster preparedness programmes	-Improve the capacity of epidemiological surveillance within the Ministry of Health - Establish a monitoring system that will verify the link between these diseases and climate change.	-Introduce monitoring and recording systems for recording.
Knowledge Management	Improve communication networks for information	Exchange information on extreme weather with	-Introduce health alert networks	Disseminate benefits and hygiene standards for food

Adaptation Measures	Heat Related Mortality/ Morbidity	Extreme Weather Conditions	Water Borne Diseases	Vector Borne Diseases
	sharing	relevant institutions		safety
Popular Participation	Mainstream Rural Participatory Appraisal.	-Ensure that weather outlooks reach people at grassroots levels; -Empower communities on climate and climate change issues; - Foster community resilience to climate change impacts.	Sharing of information and research with community members.	Support and strengthen Environmental Health.
Education	Strengthen MOHSW Ed. Programmes and decentralization; -Include climate change education in the curriculum.	Inclusion of climate change in health education and awareness campaigns.	Further studies must be conducted in large scales.	Increase health education and health promotion.
Ecosystem Interventions	Intensify afforestation and biodiversity interventions throughout the country.	Implement appropriate measures across all sectors.	Rehabilitate rangelands including wetlands and degraded arable lands.	-Clear vegetation that acts as habitats for disease carriers; -Preventive disease spraying.
Medical Interventions	- evaluate and analyse mortality risk heat advisory thresholds.	More research needed on the Impacts of climate change and health.	-Introduce cost effective water purification systems; -prescribe good water drinking standards;	Effective dissemination of medication.
Infrastructure and equipment Interventions	Develop hotspots map for disease outbreaks.	-State-of-the- art equipment for monitoring and analyzing of weather patterns; -Develop weather safety measures e.g. protection against lightning and safety measures against storms.	Construct water treatment facilities where necessary, improve rural sanitation and water supply; -Promote roof water harvesting practices and conservation dams.	Establish an environmental health analysis laboratory.
Institutional and Policy Interventions	Develop a public health action plan to prepare for and respond to the health impacts of climate change.	Develop climate change policy and strategy.	Evidence-based decision making should be encourages, especially among policy members.	-Public Health Regulations and Policies should be enforced; -Integrate climate change in health policies and strategies.

6.4.7 Culture and Historical Heritage

6.4.7.1 Introduction

Culture is a by-product of influences on human experiences from interactions of the multiple other sectors. Although Lesotho is one of the few countries in Southern Africa that are known to be having a very resilient culture, the country has experienced a severe weakening of both culture and historical heritage over time due to a number of factors that include, environmental degradation, population pressure, urban growth and changing land use patterns, and competition from foreign cultures and practices in the global village. A number of climate change related factors have also exerting adverse pressures on both culture and historical heritage. Amongst these are recurrent droughts and associated water scarcity, severe reductions in biodiversity, environmental degradation, and desertification; loss of agricultural productivity and associated widespread poverty and livelihoods failure and the migration of large rural populations to mainly informal settlements around urban areas; and the general loss of the social fabric that has resulted from the emergence of non-agricultural sources of livelihoods. In general, the resultant weakening of culture and historical heritage in the face of weak preservation institutions and systems has left Basotho highly vulnerable to adverse impacts of climate change.

As an agricultural grouping, Basotho have a long history of interaction with their environment from which they derive most of their livelihoods. Through indigenous knowledge systems that accumulated over close to two centuries, they developed sustainable environmental management practices that guaranteed them shelter, nutritious and healthy foods, medicinal herbs, an abundance of unpolluted water, good aesthetics and clean air. Traditional knowledge systems are also an embodiment of the country's intangible heritage in the form of, amongst others, indigenous languages, oral traditions, and religious beliefs and customs. Unfortunately, there was over 100 years of colonial plunder, during which Lesotho lost substantial parts of its indigenous knowledge systems, leading to citizens to endure high levels of cultural inferiority.

Recent years have seen renewed efforts at cultural restoration and at the preservation of the remaining cultural heritage. A lot of impetus has been drawn from international conventions and other protocols to which Lesotho is a signatory. The country has also passed a number of environmental and other laws that strongly support the preservation of the historical heritage, particularly in the form of rock paintings and other historical sites and monuments, including historical buildings. Efforts are also underway to support and develop museums/archives and national parks, and to restore indigenous knowledge systems, cultural practices and national arts. This is not only to enhance the country's ability to adapt to adverse impacts of climate change but to promote the economic and commercial aspects of culture and historical heritage as a strategy in poverty alleviation.

Environmental activism of the 1970's and 1980's led to a widespread recognition amongst government officials that Lesotho's cultural and historical heritage was a national economic asset that was under siege from a myriad of pressures, and needed preservation actions that could be understood, supported and enforced by local communities. On the other hand, there were a number of international conventions, treaties and protocols that compelled Lesotho to adopt measures to protect its cultural and historical heritage.

In 1993, concern about culture and historical heritage was raised a step further in Lesotho when the country drafted its current Constitution. A clause[38] that assured citizens of individual freedoms of participation in cultural activities in their communities and deriving benefits from scientific breakthroughs and their applications was added. The same clause pledged the adoption of policies that were designed to protect scientific, literary and artistic production by citizens. This clause was reinforced by another clause that pledges the adoption of policies that are designed to protect and advance the natural and cultural environment for the benefit of both present and future generations[39]. Similarly, the Environment Act, No. 103 of 2001 includes provisions for the protection of Lesotho's hilly and mountainous areas, forests, biological diversity and resources, and natural heritage sites[40].

Despite increasing concern about the preservation of culture and historical heritage, Lesotho's laws governing these resources continue to be scattered in various statutory instruments. In general, they provide for the documentation of threatened heritage artefacts (flora and fauna, historical buildings, monuments, relics, etc.) and prescription of measures for the protection and management of these. For many of these laws, there have been no regulations that were developed to guide implementation; hence enforcement has generally been difficult or non-existent. In the absence of reviews, most of this important legislation has become somewhat obsolete, with frequent overlaps/duplication, redundancies and conflicts, and, sometimes, incongruous provisions with international conventions to which Lesotho is a signatory[41].

6.4.7.2 Climate change impacts and vulnerability

Rural communities in Lesotho have survived and developed over centuries by mastering the ability to adapt to their natural environment and especially to varying weather and climatic conditions. Population growth and climate change are currently starting to impose significant pressure on the resources they rely on. With over 60% of Lesotho's rural population engaged in rain fed agriculture, prospective changes in the climate should be considered as very important and treated as the real threat to thousands of rural livelihoods. The existing pressures from future climate change necessitate the development and implementation of appropriate policies, methods and tools to address issues of vulnerability to weather and climate. But it is also known that it might not be easy

[38] ***The Constitution of Lesotho***, Clause 35
[39] Op cit, Clause 36
[40] ***The Environmental Act***, No 15 2001, Part VIII
[41] Lekhesa, K. (2000) ***National Cultural Policy Framework***, Department of Culture, p14

to convince the society that climate change is taking place and such change will require adaptation, simply because of local perception and beliefs. Therefore information needs to be provided to help communities to further develop their adaptive capacity with improved planning and better management decisions.

The Lesotho V & A Report (2000) observes that largely because of cultural practices Lesotho is entangled in a serious environmental crisis. Many cultural practices adversely interact with the environment, chief among them is the traditional land tenure system which does not encourage people to permanently improve the land they occupy or farm. In some cases individuals allocate themselves dongas and rehabilitate them for various uses. Negative impacts of climate change could create a new set of refugees, who may migrate into new settlements, seek new livelihoods and thus impacting cultural issues.

6.4.7.3 Adaptation Options and Strategies

Lesotho's communities heavily rely on natural resources. Their ability to adapt to the future risk of highly variable climate is therefore one of the greatest challenges especially to food security. Extreme weather events and drought could spell havoc to the poor and the vulnerable since their coping strategies are limited by the lack of knowledge and resources. The V & A Report (2000) noted that, since cultural practices cannot be easily discarded without sustainable substitutes, any adaptation strategies pertinent to culture in Lesotho have to focus on education and popular participation on the widest scale. There is a need for a pervasive manifest commitment to popular participation towards an integrated approach to socio-economic development that incorporates indigenous knowledge in the necessary evolution of culture. This includes effort towards reviewing of education curricula at all levels, to streamline it with the exigencies of climate change.

Several institutions are involved in the preservation and protection of Lesotho's culture and historical heritage. Despite the fact that their efforts are generally not well-coordinated, there is now a consensus among them to bring together formal sector institutions, communities and the private sector to a common endeavour to secure, document and develop/promote the country's cultural and historical heritage.

7 Other Information Relevant to the Convention

7 OTHER INFORMATION RELEVANT TO THE CONVENTION

7.1 Introduction

Since the preparation of the INC in 2000, a lot of work has been conducted in response to changing socio-economic circumstances, including government policies, strategies and programmes, and the increasing frequency of floods and droughts. Specifically, this chapter presents information on:

- Integration of climate change into national development plans;
- Transfer of technologies;
- Climate change research and systematic observations;
- Education, training and public awareness on climate change;
- Capacity building; and
- Information sharing and networking.

7.2 Integration of Climate Change into national development plans

As mentioned in the National Circumstances, there is currently no specific climate change policy for Lesotho. However, MEMWA is currently implementing projects that are aimed at integrating adaptation within the national sectoral plans and has embarked on efforts that will assist in the development of a comprehensive climate change policy and also formulate the strategic framework for climate change governance. In addition, as steps towards achieving the captioned subject, Lesotho has:

- Introduced climate change into education curricula in primary, secondary and tertiary schools;
- Identified various technologies that can assist the country to adapt to the adverse effects of climate change through the Technology Needs Assessment report (2002);
- Developed NAPA document outlining different adaptation options/measures in 2007;
- Promoted application of meteorological data for planning purposes especially in the vital economic areas such as agriculture and water. Also, wind and solar data is increasingly in use for development of renewable energies;
- Improved early warning networks for reduction of natural disasters in particular;
- Continually assessed the greenhouse gas emissions, vulnerability of key sectors to climate change, mitigation options and adaptation measures;
- Embarked on climate change awareness campaigns.

The *National Strategic Development Plan (NSDP)* is the key planning document for 2012/13 – 2016/17. The objective of the NSDP is 'to build a sustainable future that meets our economic management, environment integrity, social stability, and Lesotho's culture, and the needs of our future generations.' All sectors and government agencies must align plans to the NSDP as these are

the nation's priorities. Climate change was integrated into NSDP through a chapter "***Environment and Climate Change***". The elements of the climate change chapter will be treated in the Third National Communication.

7.3 Transfer of Technologies

7.3.1 Technology Development and Transfer

The need for environmentally sound technologies and technology transfer has been recognized as critical in averting the threat of climate change throughout the UNFCCC processes.

Promotion of technological development commenced as soon as Lesotho attained her independence in 1966. However, a more systematic approach to technological development started at around the year 2000 through various initiatives such as drafting of the Energy Policy and Science and Technology Policy. The National Policy on Science and Technology of Lesotho (i.e. S&T Policy, 2006–2011) calls on the Basotho to harness science, technology and innovation (STI) as tools to reduce poverty, create jobs and transform the country into a dynamic economy and an informed society. However, the policy does not directly address the issues of climate change. Lesotho has a number of comparative advantages that could be leveraged towards the achievement of its development goals and beyond, most of which are directly related to STI. The adoption of the S&T Policy is a step towards a greater role of STI in the country's development strategy. The challenge is how to convert it into a series of implementable initiatives. Actions have already been taken on some of these, such as setting the legal framework for the Inter-Ministerial Committee on Science and Technology, the Lesotho Advisory Commission for Science and Technology and the Lesotho Innovation Trust Fund.

In order to chart the implementation of the S&T Policy, the Government of Lesotho, through the Ministry of Communications, Science and Technology (MCST) requested United Nations Conference on Trade and Development (UNCTAD) to undertake a Science, Technology and Innovation Policy (STIP) Review.

The policy implementation strategy proposed in the STIP Review is based on an analytical framework that encompasses technology, human capital, institutions, networking, collaboration and communication and the knowledge base as key attributes of a knowledgeable society.

In conformance with Article 4 (paragraph 5) of the Convention and Decision 4/CP7, Lesotho conducted her Technology Needs Assessment (TNA) in 2002 through a consultative process involving all stakeholders - government, industry, civil society, and local community representatives. Using agreed national criteria, the stakeholders identified and prioritized technologies; thus the process generated a prioritized list of technologies. Among the key recommendations and outcomes of the consultative process were that adaptation issues are inherently cross-sectoral and are often interrelated with mitigation options. Hence the TNA process and activities should not be conducted in a vacuum, but ensure links with national development priorities and needs. LUCF sectors were singled out as having a high potential and an equally great need for technology transfer due to the

high levels of GHG emissions, therefore various technologies in those sectors were identified. The TNA report also identified the barriers to technology transfer in those different sectors.

7.3.2 Energy Sector

Technology transfer initiatives in the energy sector have largely been confined to the expansion of renewable energy and energy conservation. In the development of renewable technologies, emphasis is placed on the development of affordable devices that are not only locally serviceable, but are of quality standards. The following have been identified as technology needs in the Energy Sector.

- *Application of renewable energy technologies:* hydropower development; solar photovoltaic technologies; solar thermal technologies *(*solar water heaters, solar cookers, solar dryers); wind energy; and biogas technology.

- *Energy conservation technologies and practices*: Activities in energy conservation have mainly focused on the improvement of building designs and the development of heat conserving and energy-efficient technologies: residential sector *(*energy efficient cooking devices/stoves); commerce and industry, transport sector and government buildings (passive solar, design in buildings, energy auditing).

7.3.3 Land-Use and Forestry sector

Technology development and transfer in the LUCF sector has mainly centred on reforestation and agricultural development. In the area of reforestation, the aim has been to advance conservation objectives and to provide energy supplies and construction materials in the face of increasing scarcity of forest resources. More emphasis was placed on reforestation as a climate change adaptation strategy. On the other hand, efforts in agriculture have mainly centred on the promotion of production and productivity enhancing technologies. Actions have included attempts to match cultivars with agro-ecological conditions, the promotion of production and productivity enhancing technologies, promoting the use of animal manure, soil liming, crop densification, multiple cropping, irrigation, culling and breed improvement, grazing control, etc.

7.3.4 Cross-cutting barriers under technology transfer

Although many technologies have been identified and introduced in Lesotho, the rate of adoption of these technologies is slow and very low indeed. The stakeholders identified the following as barriers common to all technology initiatives in Lesotho:

- High initial cost associated with the technologies;
- Inadequate human and institutional capacities;
- Access to technology information (e.g. cost, performance, vendors, etc.);
- Lack of comprehensive technology transfer policy.

7.4 Research and Systematic Observation

Accurate, timely and widely shared information is vital for understanding climate systems, which concomitantly also allows informed formulation of climate impact mitigation and adaptation strategies by any country. Lesotho by virtue of its socio-economic and geo-topographical nature is highly vulnerable to climate change and climate variability impacts. Cognizant of the vulnerable position, Lesotho has for a long time been and continues to be dedicated to climate research and systematic observation. Local scientists and institutions continue to actively participate in various climate-related activities at national and international levels. In trying to fulfil its obligations to international treaties and national developmental goals, the country collaborates with various international organizations.

Various forms of technical and financial support from these organizations have allowed Lesotho to make significant advances in climate research and systematic observation. The Government of Lesotho also continues to play a pivotal role, particularly in the formulation of environment and climate targeted policies as well as championing the establishment of more coordinated institutional structures within the country. The Government and its local and international partners continue to strive to ensure more coordinated and efficient deployment of resources and improved flow of information amongst all stakeholders (researchers, professionals, policy-makers and the public).

7.4.1 Research

7.4.1.1 Research Institutions in Lesotho

Currently, Lesotho has limited number of institutions that carry out climate change research. However, a number of these institutions carry out research on the interface between climate change and the respective economic sectors, including education, agriculture, water resources, energy and forestry sectors. The Ministry of Energy, Meteorology and Water Affairs is responsible for coordinating all activities that are pertinent to climate change in Lesotho. Figure 7.1 below shows the major government ministries and institutions engaging in climate-related research and systematic observations.

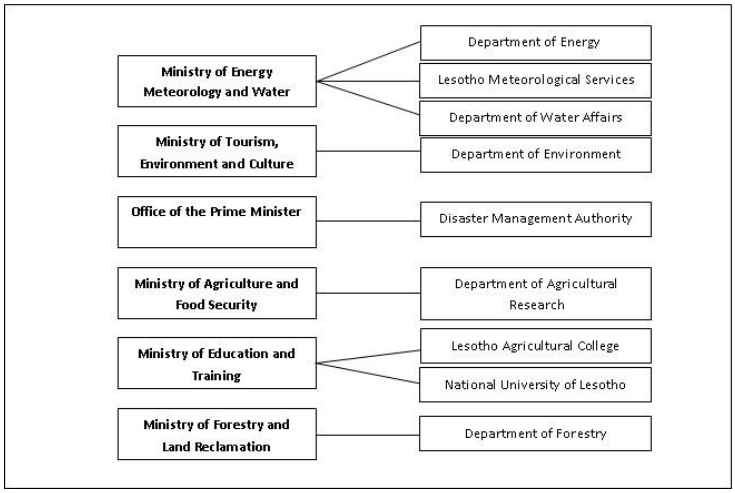

Figure 7.1 Climate Change Research Institutions in Lesotho

I. Lesotho Meteorological Services (LMS)

The primary responsibilities of the LMS include carrying out meteorological and hydrological observations, short term weather forecasting and maintaining the data records.

The department conducts research through the National Climate Change Study Team (NCCST), which was established within the department to assist in carrying out GHG inventories and climate change scenarios. The department also, in collaboration with other institutions carries out vulnerability assessments and identifies both adaptation measures and mitigation options.

II. Department of Energy (DOE)

Energy consumption patterns and choice of energy sources and technologies have a huge bearing on the impact on climate or climate-related aspects such as GHG emission levels and environment degradation. The Department is responsible for all national activities pertaining to energy, energy resources and energy-use. Most activities by the department are geared towards improved energy use, renewable energy alternatives, such as hydro-, wind and solar power, and reduction of biomass-based energy use, hence reduction in GHG emissions and deforestation. The Department works with and coordinates any other entities engaged in energy-related activities, such as the Energy Research Centre (ERC) and the LREBRE programme, both focusing on sustainable energy development.

III. Department of Environment (DE)

The department was established in 1994, then known as the National Environment Secretariat (NES). Its responsibilities include coordination of all environment-related activities across line ministries. The department is responsible for the State of Environment reporting in Lesotho. The Environment Act (2008) makes it mandatory for each line ministry to have an Environment Unit within its structures. The Units, through their respective line ministries, have to submit detailed reports of the activities to the DE at specified intervals. Its coordination role extends to cover non-governmental bodies operating in the country.

IV. Disaster Management Authority (DMA)

Lesotho is very vulnerable to impact of climate change, climate variability and other natural phenomena, such as floods, heavy snowfall and droughts. The incidences of such climate related disasters are notably on the increase. Disaster management is now among the priority areas set by the Government. The DMA coordinates all national disaster management efforts and collaborates with other regional and international institutions, such as the SADC Early Warning initiative and the SADC climate monitoring initiatives spear-headed by the SADC Services Centre formerly known as Drought Monitoring Centre (DMC) and the Regional Remote Sensing Unit (RRSU) both situated in Harare, Zimbabwe. The DMA coordinates Lesotho Vulnerability Assessment Committee (LVAC) activities and is also responsible for producing Post Disaster Needs Assessment (PDNA).

V. Department of Agricultural Research (DAR)

The DAR was established in 1952, formerly known as the Agricultural Research Institute. It remains the most active Government entity in agricultural research. It is also responsible for coordinating all agricultural research activities in the country. In Lesotho, agriculture is intricately related to climate

– making climate research and agriculture research rather synonymous. In fact, most of climate change research (impact assessments, adaptation and mitigation options) in Lesotho continues to be conducted under agricultural research projects or programmes. The DAR conducts various agriculture-related climate research activities mainly at its Maseru facilities and at a number of its smaller facilities sparsely distributed across the country. Other major institutions contributing to climate research under the auspices of Agricultural Research are the Faculty of Agriculture of National University of Lesotho, and Lesotho College of Agriculture.

While the Department is doing a commendable work together with all other related local organizations, the observations by SADC - Food, Agriculture and Natural Resources (FANR) Directorate (July 2008) with regard to agricultural research systems in Lesotho remain true; these include:

- poor research coordination fraught with capacity problems - lack of relevant coordination structures;
- poor research and implementation records;
- weak and non-existent multi-institutional collaboration research;
- poor systems and non-existent platforms for engaging in serious academic discourse; and
- lack of professional or non-professional climate bodies that can engage civil society in critical issues relating to climate, climate variability and change, adaption and mitigation remains an important area for improvement.

VI. National University of Lesotho (NUL)

NUL is the leading research institution in the country in all spheres, by virtue of it being the most endowed institution in the country in terms of human resources. A number of entities (Faculties and Departments) within the University are involved in climate-related research; notably:

- Faculty of Agriculture
  - Animal Science Department
  - Crop Science Department
  - Soil Science and Conservation Department
- Faculty of Science & Technology
  - Department of Geography
  - Physics & Electronics Department
  - Chemistry & Chemical Technology Department
- Faculty of Health & Environmental Science
  - Environmental Science Department

VII. Department of Forestry

This is the Government arm responsible for combating environmental degradation through vegetation conservation and propagation. Since vegetation is a function of climate, most researches by the department aim to establish and predict links between climate change and response of vegetation species. Thus, the department is a significant contributor to climate change research in the country.

7.4.1.2 Challenges for Climate Change Research

- Research by various institutions and individuals remain largely fragmented;
- Government and private sector funding towards research is negligible;
- Funding is largely inadequate and most of it is spent on administrative and awareness activities; and only a small portion goes into the actual research activities;
- Most institutions lack capacity to conduct comprehensive research due to various constraints, such as lack of infrastructure and skills;
- Poor exchange of information of mutual interest – leading to duplication of efforts;
- Poor research and implementation records;
- Poor data;
- Poor systems and non-existent platforms for engaging in serious academic discourse; and
- Poor research coordination fraught with capacity problems - lack of relevant coordination structures.

7.4.1.3 Recommendations

- Improved coordination and less competition among institutions/individuals – this would at least minimize unnecessary duplication and ensure more efficient deployment of resources;
- Increased funding from both local and international partners coupled with prudent financial management;
- Capacity building within institutions – including human resources, appropriate technologies and other material resources.

7.4.2 Systematic Observations

Systematic observations of climatic (meteorological observations) parameters are largely a preserve of the Lesotho Meteorological Services (LMS) while the hydrological parameters are the responsibility of the Department of Water Affairs (DWA). Very few other entities, such as the Lesotho Highlands Water Project (LHWP) and the Geography Department of NUL, undertake observations of a very limited number of parameters. The LMS coordinates all such observations and applies the World Meteorological Organization Reporting Guidelines on Global Observing Systems. Suffice to note that, systematic observations in time and space are very limited in scope in the country. The main constraints are financial, capacity and capability of the local institutions, particularly the LMS and DWA, to undertake and maintain the observations according to international procedures and standards.

Lesotho Meteorological Services (LMS): Apart from research, other primary responsibilities of LMS are monitoring, forecasting and reporting on weather and climate and maintaining up to date records of the same. The LMS keeps a computerized data bank for all basic surface meteorological parameters such as rainfall, temperature, wind, atmospheric pressure, relative humidity, sunshine hours, and cloud cover. The quality of the data is controlled according to the World Meteorological Organization (WMO) standards and procedures. The LMS has its own archive holding original hard copies of all data including some microfiche.

LMS currently runs a network of over 90 meteorological stations distributed throughout the country – comprising of 3 synoptic stations, 37 climate stations, 51 rainfall stations and 3 automatic wind stations. There are plans to improve the station network by converting some rainfall stations into climate stations as well as installing new automatic weather stations (AWS).

7.4.2.1 Challenges in Systematic Observation

The observation network faces a number problems, inter-alia:

- Observation stations are unevenly distributed across the country;
- Upper air observations are not recorded in Lesotho;
- insufficient equipment;
- Vandalism;
- Limited capacity to maintain the stations;

7.4.2.2 Recommendations

Lesotho needs strengthening of its observation and monitoring capacity on climate system in order to meet its climate-related development agenda and its international climate change and variability obligations. In line with the recognized challenges, the following are some of the main aspects requiring immediate and urgent consideration:

- Thorough review of current data and information on climate system observation by relevant bodies, and development and/or addition of new climatic parameters and information needed for research on climate and environmental changes;
- Enhancement of Lesotho's ability in acquisition and management of data and information related to climate system observation;
- Establishment of sufficient and efficient climate observation system, including assessment and feedback mechanisms;
- Enhanced financial and technical resources - including prudent financial management, capacity building, and improvement and retention of critical skills.

7.5 Education, Training and Public Awareness

Despite the fact that global climate change represents one of the most serious environmental issues today, the public is not fully aware of the consequences of climate change. The important task of all relevant institutions is to improve general public awareness and to support education, concerning these issues. Lesotho's education and training system is at four levels: (i) primary education; (ii) secondary education; (iii) higher education; and (iv) vocational education and training. The basic education (primary to secondary) lasts for 12 years and is divided into three levels of: (i) primary -7 years, (ii) lower secondary- 3 years, and (iii) upper-secondary -2 years.

The literacy rate in Lesotho is high by regional standards, having been estimated at 87 % in 2006. There are indications that since then the figure has progressively increased and current figure could

be somewhere upward of 90%. Among other factors, the increase in literacy is attributable to free primary education policy implemented by the Government in 2000; and the Education Act 2010, which actually makes primary education compulsory. Secondary education is also free for the disadvantaged communities. Government scholarships and grants are also provided for higher education and vocational training programmes.

Notwithstanding the positive improvements in the overall education system of the country, environmental and climate change issues, are not sufficiently presented in the educational curricula of Lesotho. Suffice to say, the government, the institutions of learning and training, and the whole nation are aware of the need to increase the coverage of these issues at all educational levels.

7.5.1 Education & Training

The current primary and secondary school curriculum does not explicitly cater for education on climate change. However, the curriculum is structured in such a way that opportunities exist in several subjects for the inclusion of climate change issues at all levels. Topics on environmental protection and climate change are mainly integrated within science and social science subjects, such as, biology, chemistry, geography, agriculture and development studies. Pupils are also introduced to environmental and climate change issues through extra-curriculum and optional activities, such as quizzes, debates, clubs and essay contests. It is envisaged that closer cooperation between the Ministry of Education & Training, responsible for school curriculum development and implementation, and those ministries responsible for championing environmental and climate change issues, namely Ministry of Energy, Meteorology and Water Affairs and Ministry of Tourism, Environment and Culture, would yield much desired synergies. It is positively noted, that a draft *Curriculum Framework for Secondary Education* proposed to start in 2013 envisages the teaching of climate systems and climate change in much greater depth at secondary level. However, many challenges still accompany such a positive proposal, chiefly the availability of capacity or expertise at the critical levels, especially the classroom level to deliver on the specified expectations.

Efforts to educate students at tertiary levels on the issues of environment and sustainable living in general and climate change in particular have been ongoing. These range from greater content relating to these subjects in various disciplines in higher education institutes, and equally importantly, through seminars, conferences and competitions. Lesotho's tertiary institutions offer varying levels of training in climate change-related topics and environment although there are no fully-fledged formal programmes on climate change per se. Various tertiary level education programmes include some modules (or courses) that are fully or partially dedicated to climate change issues. Such areas of study include Ecology, Biology, Geography, Development Studies, Meteorology, Environmental Science, Sociology of Environment, etc.

Currently, there is no tertiary institution offering specialized studies on climate and climate change and other critical areas such as Meteorology. In its efforts to enhance capacity in the critical area of climate change, the government continues to provide some funding towards staff development efforts. This has enabled a number of individuals from the LMS and other departments to undertake

various climate-related training programmes with renowned institutions regionally and globally. However, the availability of adequate skilled manpower remains a challenge in the country. As expected, after acquiring special skills the individuals become more marketable regionally and internationally. Thus, retaining skilled staff is a challenging issue, especially as Lesotho is enclosed in a huge and vibrant economy of the Republic of South Africa. In fact, so far the country lacks capacity to retain specialized and experienced staff in all sectors of the economy.

7.5.2 Public Awareness

There have been several efforts undertaken on many fronts to increase awareness and understanding of climate change amongst the wider public, as well as amongst specific target audiences. To date, despite the existence of financial, human and other constraints, progress has clearly been made in enhancing awareness of climate change issues. The activities in public awareness have been implemented by various groups through different means of information sharing. These include the Government through its relevant ministries (especially Ministry of Energy, Meteorology and Water Affairs, Ministry of Tourism, Environment and Culture, Ministry of Education & Training and the Ministry of Communications, Science and Technology), NGOs, intergovernmental organizations (such as UNDP), as well as the private sector.

Specifically, LMS as the custodians of climate change has engaged in public awareness campaigns for different groups which include:

- Private sector – workshops on Clean Development Mechanism (CDM) issues;
- Parliamentarians – presentations for various Clusters ;
- Students – taking opportunity on events such as “Science Fair” to make presentations as well as competitions on climate change ;
- NGOs – holding training of trainers for NGOs as well as organising climate change community gatherings (*lipitso)* together;
- Media – holding training workshops for media organisations at national and regional level.

The publication by LMS, “*Climate Change in Lesotho: A Handbook for Practitioners”(2001)* devoted to specialists, lecturers and decision-makers has also contributed greatly towards public awareness building. Various materials (brochures, banners, press releases, etc.) on climate change have been continuously been developed from time to time. Nevertheless, ongoing efforts in all spheres require further strengthening.

The preparation of the INC on climate change has positively contributed to raising awareness among all relevant stakeholders, contributing to information exchange, cooperation and building national capacities. Since submission of the INC (April 2000), there has been an observable increase in the number of activities focusing on educating and/or informing the public on myriad of issues concerning climate change. At the same time, considerable awareness has been generated through the process of the SNC executed and implemented by the LMS, which followed a broad-based participatory approach, involving research teams drawn from academia, government ministries and departments, and NGOs. The activities included a preparation of the GHG inventory, assessment of

vulnerability to climate change and development of adaptation responses, assimilation of information relating to national circumstances, research and systematic observation, education, training and public awareness.

Media Engagement - The current level of media reporting on climate change in Lesotho is much more enhanced, both in scope and frequency, than it was prior to the INC. The positive trend is partly attributable to increased climate change forums targeting media practitioners, including local and regional climate change journalism training workshops, allowing Government and other agencies to communicate more effectively about climate-change issues through the media. The SADC Network of Climate Journalists (SADC-NCJ) which focuses on translating seasonal climate forecasts for media dissemination as part of a dialogue with meteorologists and climate professionals is playing a vital role, although its effectiveness is seriously impeded by a lack of funds.

Workshops organized by various organizations ranging from government ministries and agencies to NGOs and the private sector have disseminated information on issues such as climate change and extreme weather. There are other positive indications of improved awareness which include:

- Increased participation in climate change debates by the general public;
- Voluntary adoption and implementation of sustainable practices by companies;
- Increased media (newspaper and radios) coverage of climate change issues;
- Increased use of climate friendly technologies and techniques (renewable energy, conservation agriculture etc.).

Lesotho's participation at the Conference of the Parties to the UNFCCC has created an opportunity to enhance the capacity of individual delegates, team performance, and leadership development; contributing, ultimately, to building and enriching the country's capacity as a whole.

7.6 Capacity Building

The *National Capacity Self-Assessment* (NCSA, 2005), acknowledged that the key national institutions dealing with climate change are facing severe shortage of trained staff. This stems from the fact that climate change was still a new emerging issue of great concern. Like most of other government institutions, climate change unit is also facing high staff turnover.

However, commendable but isolated efforts have been made to build capacity in different sectors with support from bi-lateral and multi-lateral institutions. One key avenue through which capacity has been built in Lesotho is through implementation of climate change programmes and projects including the preparations of the National Communications. These activities have, apart from building the capacity of local experts on issues relating to climate change, generated information and appreciation of the multi-sectoral nature of climate change. During the preparation of the SNC, many working groups and individual experts from various sectors, including government institutions,

academic sector, private sector and NGOs were involved**.** This has fostered greater understanding and cooperation amongst the stakeholders with regard to addressing climate change.

The LMS, as the National Climate Change Focal Point has been engaged in capacity building exercises with the support from UNFCCC, World Meteorological Organization (WMO) and other international organisations including multilateral and development partners. These capacity building exercises involve the training of individuals on the key aspects to address national challenges associated with weather, climate and climate change.

Various workshops were held at international, regional and national levels to capacitate national experts on climate and sectoral modelling. Experts were capacitated to use various models such as MAGGIC SCENgen, Revised IPCC Guidelines for National GHG Inventories, LEAP and WEAP during the preparation of the National Communication. However, more capacity needs to be built to make use of other sectoral climate related models.

Capacity building should be an ongoing programme in order to catch up with new tools and should be encouraged as a way of information sharing. More focus should be put on capacitating teachers, especially primary and high school teachers as they play an important role in nurturing environmental education at a tender age.

7.7 Information Sharing and Networking on Climate Change

Information sharing and dissemination within government institutions, private sector, civil society and the public is generally through workshops, meetings/conferences and circulars. A number of platforms and networks are available and some of them are already being used to facilitate awareness on issues of climate change.

Lesotho Meteorological Services is the sole custodian of the weather, climate and climate change data and information. LMS regularly publishes this information on print and electronic media. The Lesotho Meteorological Services website http://www.lesmet.org.ls remains the most relevant national source of information on climate change, containing, *inter alia*, all reports and data about GHG emissions, scenarios for climate change at the national level, vulnerability assessment reports, mitigation reports, etc.

This information is usually shared with main stakeholders including the Lesotho Bureau of Statistics (BOS). BOS also collects, compiles, analyses, manages and publishes major statistical information on a wide range of topics, including the environment. BOS maintains a centralized data bank that is easily accessible on request. Most national statistical information can be accessed on their website, www.bos.gov.ls

The most commonly used means of information sharing and dissemination on climate change by the government to reach communities is through the use of Local Government Structures such as chiefs, District and Community Councils. Moreover, structures established by the Disaster Management Authority (DMA) such as District and Village Disaster Management teams are also used. DMA

regularly put together platforms for stakeholders that are not only from the government but also include civil society organizations and the private sector. Climate change is often discussed in these platforms among other topics.

Ministry of Agriculture and Food Security also has an established and vast network of extension services in the country. This decentralized network is usually used to channel weather, climate and climate change information from LMS to the farmers although this arrangement needs to be further strengthened regarding the climate change issues.

Other stakeholders in environmental data and information collection include academic institutions, and private sector organizations, including NGOs. However, access to such data and information is generally difficult and limited because such data and information are compiled for internal use.

Other modes of sharing climate change information are through radio and television programmes. Additionally, the print media, consisting of newspapers, brochures, newsletters, magazines and scientific publications also serve to avail information to the different groups of stakeholders.

However, language used to present climate change information is too technical to be understood by most stakeholders in particular, the public and other government institutions. It is therefore imperative to develop appropriate tools to bridge the language barrier as well as identifying proper communication channels.

7.8 Conclusion

There are critical information gaps and uncertainties which must be addressed in order to improve the current understanding of both local and regional climate systems - which in turn will allow more appropriate application of climate data for sustainable development of the country. More extensive and coordinated research remains crucial. The networks of climate change observation systems scattered across the country are insufficient and generally aged; thus lack capacity to fully inform the nation on climate trends and possible long-term scenarios. More active participation by the Government, particularly with regards to policy development and strategic planning remains crucial. International community support in terms of all the relevant forms of resources and capacity building strategies also remains critical for Lesotho to fully contribute to, and benefit from, climate research and systematic observation endeavours.

List of References

Anomanyo, E.O., 2004: Integration of Municipal Solid Waste Management in Accra (Ghana): Bioreactor Treatment Technology as an Integral Part of the Management Process. MSc. Thesis, Internet.

Assessment of Energy for Rural Development in Lesotho (2011), Department of Energy

Baker B and Argentina E F V 1998. Rangeland and Livestock. In: Feenstra J F, Burton I, 22. Smith J B and Tol R S J (eds) – Handbook on Methods for Climate change impact Assessment and Adaptation Strategies, Version 2.0. UNEP.

Batjes, N. (2009). IPCC Default Soil Classes Derived from the Harmonized Soil Data Base v1.1. http://www.isric.nl/ISRIC/webdocs/docs/isric_report_2009_02.pdf

Bureau of statistics 2000. Lesotho Agricultural Census 1999/2000: Rural households and crops statistics, Vol. I.

Bureau of statistics 2000. Lesotho Agricultural Census 1999/2000: Urban crops and livestock statistics, Vol. III.

Bureau of statistics 2006. Lesotho Census of Population and Housing; preliminary report.

Bureau of statistics 2007. Lesotho Situation Report, 1981/82 – 2004/05. Ministry of Agriculture and Food Security, Department of Planning and Policy Analysis and Ministry of Finance and Development Planning, Bureau of statistics, Lesotho

Bureau of Statistics, (a) 2001: Households Population 1996: Volume iiiD (a), Maseru, Lesotho.

Bureau of Statistics, (b) 2001: Lesotho Demographic Survey 2001 Vol.1, Maseru, Lesotho.

Bureau of Statistics, 2002. Lesotho Agricultural Census 2000/01 – 2001/02

Carl Bro International, 1999: Draft Project Document - Solid Waste Management in Lesotho, Maseru, Lesotho.

Carroll, P.H. E.C. Nelson, S.E. Snyder, R.F. Howard, W.D. Bishop, J.M. Lepele, D.M.T. Nkalai, R. Davis, and R. Pitorak, 1979. *Soils of Lesotho: A System of Soil Classification for Interpreting Soil Surveys in Lesotho*.

Chapeyama Oliver; USAID 2004: "Rangeland Management in Lesotho". Report on Assessment of Needs to Reintroduction of Grazing Fees.

DANCED, 2000: Proceeding on Workshop for Decision and Policy Makers Regarding Solid Waste Management in Lesotho, Maseru, Lesotho.

Department of Energy. Draft energy policy framework for Lesotho, November 2000

DWA (2005). Lesotho National Wetlands Management Programme, GOL

FANR Directorate: SADC Secretariat, 2008. Situation analysis of agricultural research and training in the SADC region.

FAO, 2010. Global Forest Resources Assessment 2010, Country Report – Lesotho. Forestry Department, Rome.

FAO, Global forest resources assessment 2010, Country report

Government of Lesotho (2000). Gazette Extraordinary; Water Act 2008. Vol. LIII, No. 88

Government of Lesotho. Lesotho Vision 2020; 2005.

Government of Lesotho. National Strategic Development Plan (NSDP, 2012/13- 2016/17); 2013

Growth Strategy Paper, Ministry of Finance and Development Planning 2008/2009

Guillarmod A. M., 1971. *Flora of Lesotho*. Lehre Verlag von J. Cramer. Germany.

Hartley, 2001. *Synthesis Report on Preparing Integrated Natural Resource Management.* Drakensberg/Maloti Mountains Conservation Programme. Maseru, Lesotho.

Hudson D.A and Jones R. G. (2002) Simulations of present day and future climate over Southern Africa using HadAM3H Hadley Centre technical note 38 UK Me Office

International Renewable Energy Agency (IRENA), 2012, Renewable Energy Country Profile: Lesotho

IPCC (2007) Fourth Assessment Report

IPCC 2007. Climate change: Impacts, adaptation and vulnerability. Contribution of WGII to IPCC Fourth Assessment Report. Parry *et al*. (eds). Cambridge University Press.

IPCC, (2001),. Climate change 2001: Impacts, Adaptation and Vulnerability, Cambridge University Press, UK

IPCC, (2008). Climate Change and Water: IPCC Technical Report paper VI

IPCC, 2000. Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories. Intergovernmental Panel on Climate Change, Geneva, Switzerland. http://www.ipcc-nggip.iges.or.jp/public/gp/english/

Khalema, K. and Letsie, M. (January 2005) National Health Care Waste Management Plan, Kingdom of Lesotho, p.14

Land Conservation and Range Development Project Staff: 1988. *National Conservation Plan for Lesotho*. Conservation Division. Ministry of Agriculture.

Lesotho Meteorological Services (2000). Vulnerability Assessment Report. Ministry of Natural Resources.

Lesotho Review: 2011 Edition – An overview of the Kingdom of Lesotho's economy (2011), Wade Publications;

LNDC, 2005: The Feasibility Study on Waste Management in Lesotho with Respect to the Textile Industries in the Thetsane Industrial Estate. LNDC. Maseru, Lesotho.

Local Government Elections (Amendment) Act 2004, Lesotho Government Gazette No. 75, Section 18 (A) (1A)

Marneweck and Grundling (1999). Wetlands of Upper Catchment Areas of Bokong, Malibamatso and Matsoku Rivers in Leribe, Bokhotlong and Botha Bothe Districts of Lesotho. Afridev Consultants and LHDA, Report No. 26/99.

MCC, 2005: Feasibility Study for Tšoeneng Sanitary Landfill and Maseru City Solid Waste Management. Maseru, Lesotho.

Ministry of Agriculture and Food Security, 2003(a). Agricultural Sector Strategy: statement of policy and strategy in the agricultural sector.

Ministry of Agriculture and Food Security, 2003(b). Subsidies in the agricultural sector: policy statement and implementation framework.

Ministry of Education and Training, Lesotho 2005. *Education Sector Strategic Plan 2005-2015*. Maseru: Bee Gee Printers.

Ministry of Natural Resources (April 2000) Lesotho: National Report on Climate Change, First National Communication to the Conference of the Parties to the United Nations Framework Convention on Climate Change, Maseru.

Ministry of Natural Resources (Undated) Greenhouse Gas Emissions Inventory Report for the Base Year 1994, UNEP/GEF Climate Change Study in Lesotho, Project No. GF/ 2200-96-16

Ministry of Natural Resources, (2007). Lesotho Water and Sanitation Policy. Maseru, Lesotho

Ministry of Natural Resources, Lesotho Meteorological Services, 2004, Adaptation to Climate Change Technology Needs in Lesotho: Energy and Land Use Change and Forestry.

Ministry of Tourism, Environment and Culture (2007) National Capacity Self Assessment (NCSA) Project

National Electrification Master Plan for Lesotho (2007) - Electrification Master Plan Report

National Environment Secretariat (2000): *Biodiversity in Lesotho, a country study*. Morija Printing Works. Maseru, Lesotho.

Planning and Policy Analysis Department and Bureau of Statistics staff: 2005ed. *Lesotho Agricultural Situation Report 2001/01 – 2003/04*. Ministry of Agriculture and Food Security and Ministry of Planning. GOL

Pooley (2003): Mountain Flowers of the Natal Drakensberg and Lesotho. The Flora Publication Trust. South Africa.

Reason C.J.C., Jagadheesha D. (2005) A model investigation of recent ENSO impacts over Southern Africa. *Meteorology and Atmospheric Physics* 89: 181-205.

Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories Volume 3 (Reference Manual)

Science, Technology and Innovation Policy Review Lesotho. United Nations publication. UNCTAD/DTL/STICT/2009/7. New York and Geneva.

Setsabi, A.M. Lesaona, M.A. and Molefi, J.J. (1992). A study of the Socio-Economic Situation of the Basotho Miners, National University of Lesotho) pp 2 – 17.

Situational Analysis of the inputs Market. 2000. Distribution and Marketing of Agricultural Inputs. Department of Marketing. Ministry of Industry, Trade and Marketing. GOL

Stringer L C, Dyer J C, Reed M S, Dougill A J, Twyman C and Mkwambisi D 2009. Adaptation to climate change, drought and desertification: Local insights to enhance policy in Southern Africa. Environmental Science and Policy 12: (7) 748 – 765.

Sustainable Energy for All (2012): Rapid Assessment and gap analysis for Lesotho.

UNDP, Renewable Energy-Based Rural Electrification in Lesotho project, 2006

United Nations Development Programme (2012), Draft Country Programme Document for Lesotho

United Nations Development Programme (UNDP), International Human Development Indicators: Lesotho, hdr.undp.org, accessed October 2012.

Appendices

Appendix 1: On-farm adaptation choices

Type of adaptation	Action	Impact avoidance
1. Adaptation by crop choice		
Seasonal crops	♦ Plant quick or slower maturing varieties ♦ plant drought or heat tolerant crops	♦ensure maturation in growing season shortened by decreased moisture and thermal resources or maximize yields under longer growing seasons
All crops	♦ plant drought or heat tolerant crops	♦ reduce crop loss or yield reductions under reduced moisture conditions or reduce irrigation requirement
All crops	♦ plant pest resistant crops	♦ reduce yield reduction where altered climate conditions favour increase in weeds or insect pests
Seasonal crops	♦ use altered mix of crops	♦reduce overall yield variability due to climate change
2. Adaptation by altered tillage and husbandry		
Altered tillage	♦ use minimum or reduced tillage	♦ reduce loss of organic matter, reduce soil erosion, reduce nutrient loss
	♦ use terracing, ridging, level land	♦increase moisture availability to plants
		♦ spread water and increase infiltration
	♦ change fallow and mulching practices	♦ retain moisture and organic matter
	♦ alter cultivations	♦ reduce weed infestation
Altered timing of operations	♦ switch seasons for cropping	♦ change from spring to winter crops to avoid increased summer drought
	♦ alter times of sowing	♦ match altered precipitation pattern
Altered crop husbandry	♦ alter row and plant spacing	♦ increase root extension to water
		♦decrease yield variability, maximize use of n\moisture
3. Adaptation by alteration of inputs		

Type of adaptation	Action	Impact avoidance
Altered irrigation	♦ introduce new schemes to dryland areas	♦ avoid losses due to drought
	♦Increase irrigation efficiency e.g. drip irrigation	♦ avoid moisture stress
	♦ use water harvesting	♦Increase moisture availability
Altered use of fertilizers	♦ vary amounts of application	♦ increase nitrogen to take advantage of CO_2 effects or decrease to minimize input costs
	♦ alter timing of application	♦ match application to altered pattern of precipitation
Altered use of chemical control	♦ vary timing and amounts of application	♦ avoid pest, weed % disease damage

Appendix 2

Units of Measurements	
^0C	degree Celsius
CO_2eq	Carbon Dioxide Equivalent
Gg	gigagram (10^9 g)
GWH	gigawatt hour (10^6 kWh)
Kha	Kilo hectare
Km	Kilometer
km^2	square kilometre
km^3	cubic kilometre
Kw	kilo Watt
kWh	kilo Watt hour
M	Meter
m/s	meters per second
m^3	cubic meter
Mm	Millimeter
MW	Megawatt
PJ	petajoule (10^{15} J)
T	metric tonne (1000 kilograms)
t/a	ton/acre
Toe	tonne oil equivalent

Chemical Symbols	
CH_4	Methane
CO	Carbon monoxide
CO_2	Carbon dioxide
HFCs	Hydrofluorocarbons
N_2O	Nitrous oxide
NO_x	Nitrogen oxides
NMVOCs	Non methane volatile organic compounds
SO_X	Sulphur Oxides

Energy Conversion	Units
1 toe	41.85 GJ
1 PJ	277.8 GW h=23.88 * 103 toe

Global Warming Potential (GWP) of Gases for a 100 years' time horizon (IPCC, 1996)

Gas	CO_2	CH_4	N_20
GWP	1	21	310

Appendix 3: Potential Projects for Mitigation

Below is a description of projects that can be implemented. It is important that the climate change unit conduct an annual review of the mitigation potential for the proposed options and identify the most promising ones in terms of GHG abatement. Over the next five years, there is need to work through these and either eliminate them as not being feasible or affordable, or refine them into real projects and, if funding is available, move ahead with the project.

I. Capacity building on Energy and Climate Change

It is necessary to introduce courses at the University of Lesotho on Energy and GHG Inventory assessments, and to assist the science students conduct essential research projects on GHG and energy technologies especially renewable energy technologies.

II. Improving the efficiency of transport system in Lesotho.

The project aims at improving the quality of the environment through the reduction of exhaust emissions by reducing the number of road transport vehicles in particular corridors and decongesting city centers of commercial activities.

Travelling patterns in Lesotho are skewed towards road transport. This road transport system in Lesotho is very inefficient with the bulk of transport consisting of small vehicles and private cars.

Project Description: The project will consist of surveys to determine the classification, purpose of journeys and number of vehicles within various transport corridors.

A component of the project will involve review of studies and projects related to the use of other modes of transport such as rail. It will also review policies dealing with appropriate and efficient public transport system. It will also consider the decongestion of city centers of commercial activities and re-zoning area vehicle stations for other places. A costing of various modes of transport system will also be done.

III. Solar energy projects for communities

The project will involve building SHS and a solar battery charging center. The centre will have two charging stations to service batteries, a common room with demonstration system consisting of one 100pW solar panel, controls, battery, lights, a television, a radio cassette recorder and an office/storage room.

There are several villages and small cities which are far from the district capitals where the National electricity grid cannot be reached. Such areas are without electricity. The essence of this proposal is to pick a number of households for project implementation. In the initial stages, the project will consist of a solar home systems and battery charging center.

The objective is to have a village owned and controlled center that will address an identified need, build unity and improve the health, social and educational conditions of the people.

IV. Improving livelihoods of smallholder farmers

The objective of this project is to improve livelihoods through sustainable agriculture and general rural development. The project also is intended as a way of mitigating climate change by:

a. replacing chemical fertilizers with organic matter;
b. Developing methods for monitoring and reporting climate change mitigation and adaptation with the participation of smallholder farmers.

V. Smallholder agriculture carbon finance project

Objectives

Promote and implement a package of sustainable agricultural land management (SALM) practices among smallholder farmer groups.

Create reductions of emissions of GHGs through carbon sequestration by trees and soil.

Introduce sustainable agricultural practices such as manure management and use of cover crops, returning composted crop residuals to the field, and introducing trees into the landscape as methods for increasing the carbon stocks on the land.

VI. Afforestation

Objectives

Reclaim abandoned lands with afforestation for sustainable production of food for local and export markets.

Provide employment opportunities and technology transfer to local communities.

Use carbon finance to increase economic returns and reduce risk.

Appendix 4: Climate Change Working Groups; Institutions and Individuals Involved

National Greenhouse Gas Inventory Working Group

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